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BIOLOGICAL SOCIETY OF WASHINGTON
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1056th Meeting—20 March 1978

NINETY-NINTH ANNUAL MEETING

With twenty-one members present, the meeting was called to order by the President, Clyde F. E. Roper. At his request the meeting began with the reading, by the Secretary, W. Duane Hope, of the minutes of the previous annual meeting. The topics included in the report of the Secretary were the election of C. W. Hart, Jr., as Editor to succeed Austin B. Williams, the reestablishment of the Society's affiliation with the Washington Academy of Sciences, the announcement of a contest to produce an official logo for the Society, and the securing of a C-3 classification (non-profit, scientific, educational organization) from the Internal Revenue Service as a prerequisite to being issued a second-class postal classification by the United States Postal Service.

Reports by the Treasurer (Oliver S. Flint) and the Editor (Austin B. Williams) were read and accepted. The Treasurer's report indicated that during 1977 there had been expenditures of $32,248.01 against an income of $24,984.08. The reason for the excess of expenditures over receipts was explained by the fact that Allen Press was paid for *Proceedings* issues published before the end of the year, but that it had been impossible to bill for page charges and reprint costs for those issues in the same time period.

Under new business, concern was expressed about the sparce distribution of the *Proceedings* in foreign countries. The membership and the council were asked to seek an increase in awareness and distribution of the *Proceedings*.

The resignation of John Miles as Custodian of the *Proceedings* was accepted with an expression of the Society's gratitude to him for the many years of dedicated work.

The newly elected officers and councilors were announced as follows:

President: Clyde F. E. Roper

Vice President: Oliver S. Flint

Secretary: Michael Bogan

Treasurer: David L. Pawson

Councilors:

- Richard Banks
- Arthur H. Clarke
- Robert H. Gibbs
- W. Duane Hope

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WASHINGTON

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THE BIOLOGICAL SOCIETY OF WASHINGTON

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91(1), 1978, pp. 1–4

A NEW GENUS OF STOMATOPOD CRUSTACEAN FROM THE INDO-WEST PACIFIC REGION

Raymond B. Manning

Abstract.—Mesacturoides, new genus, is recognized for *Gonodactylus crinitus* Manning, 1962, and three related species. The type-species, *M. crinitus*, previously known only from the Seychelles Islands, is common in shallow water habitats at Tulear, Madagascar, as well as at Mauritius and Reunion Islands in the western Indian Ocean.

Gondactylus crinitus Manning, 1962 was based on four females of a small stomatopod collected in the Seychelles Islands. The species apparently has not been reported since its original description. In 1969 I transferred *G. crinitus* to the genus *Mesacturus* Miers, 1880, along with five other Indo-West Pacific species then assigned to *Gonodactylus*.

Recently, samples of stomatopods collected during field studies in Madagascar, Mauritius, and Reunion Island in the western Indian Ocean by Mireille Peyrot-Clausade, Station Marine d'Endoume, Marseille, France, were forwarded to me for identification. Her collections included 40 samples of *Mesacturus crinitus* from reef habitats in all three localities, indicating that the species was relatively abundant there.

This rich material prompted a reevaluation of the status of the species assigned to *Mesacturus*, which, as I noted (1969:151) includes two groups of species with very different telson types. One group, including the type-species, *Gonodactylus furcicaudatus* Miers, 1880, and *G. kempi* Odhner, 1923, is characterized by having a bizarre telson with a narrow basal part and a slender, bifurcate median projection extending posteriorly (Manning, 1969: Fig. 2). The second group of species, characterized by having a *Gonodactylus*-like telson with longitudinal bosses dorsally and distinct submedian and intermediate marginal teeth, includes *G. brevisquamatus* Paulson, 1875 (Red Sea), *G. fimbriatus* Lenz, 1905 (Zanzibar, Seychelles Islands), *G. spinosocarinatus* Fukuda, 1910 (Pacific Ocean, from Japan to Indonesia), and *G. crinitus* (western Indian Ocean). These latter four species are assigned to a new genus, characterized below.

Mesacturoides, new genus

Definition.—Rostral plate (Fig. 1*a*) sharply trispinous. Cornea (Fig. 1*a*) subglobular. Anterior margins of lateral plates of carapace convex, extending anteriorly beyond base of rostral plate (Fig. 1*a*). Propodus of claw lacking proximal movable spine (Fig. 1*d*). Mandibular palp present, 3-

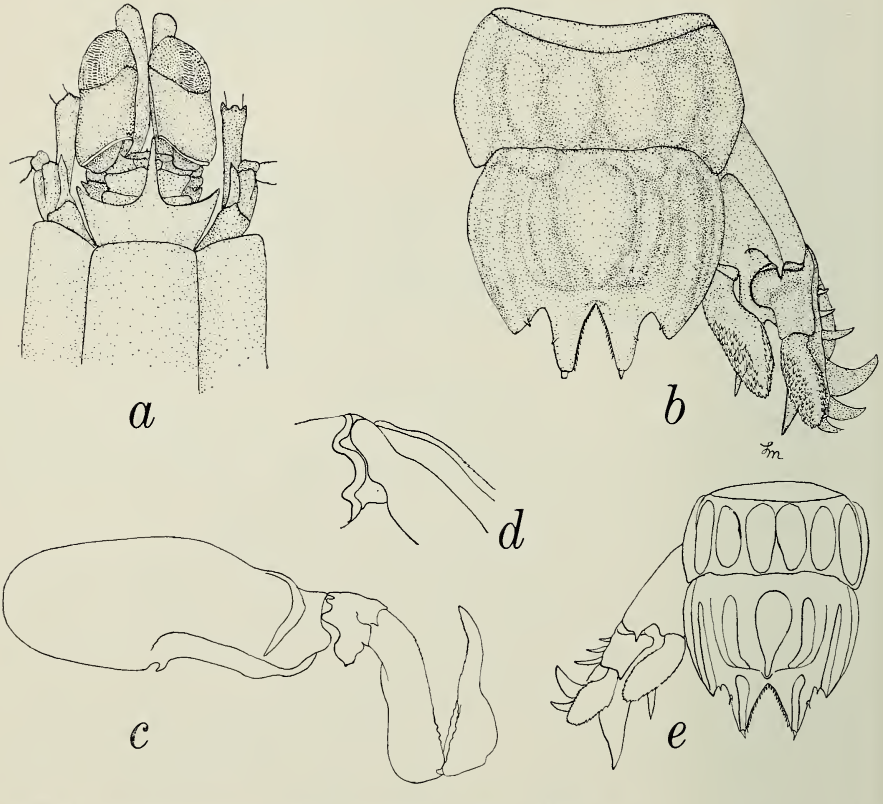


Fig. 1. *Mesacturoides crinitus* (Manning, 1962). Male, TL 27 mm, Tulear: *a*, Anterior part of body; *b*, Sixth abdominal somite, telson, and uropod; *c*, Raptorial claw; *d*, Proximal part of propodus of claw, inner face. Juvenile, TL 8 mm, Tulear: *e*, Sixth abdominal somite, telson, and uropod [Setae omitted in all figures].

segmented. Articulated anterolateral plates of abdomen present. Posterior margin of sixth abdominal somite almost straight (Figs. 1*b*, *e*). Telson a flattened plate, with median and other longitudinal prominences; posterior margin produced into 2 pairs of teeth, submedians with movable apices. Distalmost spines on outer margin of proximal segment of uropodal exopod enlarged, strongly recurved (Figs. 1*b*, *e*). Uropodal endopod abnormal in shape and setation, curved laterally, lacking dorsal spines (Figs. 1*b*, *e*). Uropodal exopod and endopod lacking fixed spines on inner margin (Figs. 1*b*, *e*).

Type-species.—*Gonodactylus crinitus* Manning, 1962.

Etymology.—The generic name is derived from the Greek, *-oides*, like, and the generic name *Mesacturus*. The gender is masculine.

Remarks.—*Mesacturoides*, as the name implies, shows clear affinities with

Mesacturus, the only other genus in the family in which the spines of the uropodal exopod are greatly enlarged and recurved. It differs from *Mesacturus* in basic telson ornamentation, having a typical *Gonodactylus*-like telson rather than the unusual telson with a long, median posterior projection found in both species of *Mesacturus*. The four species of *Mesacturoides*, *M. brevisquamatus*, *M. crinitus*, *M. fimbriatus*, and *M. spinosocarinatus*, can be distinguished by using the key to *Mesacturus* given by me in 1969 (p. 151); the first couplet in that key also can be used to separate *Mesacturus* and *Mesacturoides*.

Mesacturus and *Mesacturoides* occupy an isolated position in the family Gonodactylidae. The highly modified uropods probably are a specialization for living in burrows on reefs, but neither their function nor the behavior of these animals has been studied.

In order to facilitate recognition of members of *Mesacturoides*, additional illustrations of *M. crinitus* are presented here (Fig. 1). The telson and uropods of one of the smallest juveniles examined, a postlarva, TL 8 mm, also are illustrated here; the main generic characters, including the enlarged and recurved spines on the uropodal exopod, already are developed at this size.

At Tulear, Madagascar, *M. crinitus* was collected at 14 stations on the outer reef flat; 44 specimens, total lengths 8–30 mm, were taken there. The species also was represented at nine stations in the boulder tract, where 24 specimens, 8–25 mm long, were collected. The species may be rarer at Mauritius, where a single female, 19 mm long, was taken on the reef flat, Trou au Biches. On Reunion Island, the species occurred in seven samples (18 specimens, 9–23 mm long) on the reef flat at St. Pierre; five samples (12 specimens, 11–19 mm long) on the reef flat at St. Gilles; and in four samples (11 specimens, 10–16 mm long) at a depth of 4 m on the outer reef slope at St. Gilles. In all, 110 specimens of a species thought to be rare were collected during these surveys at 40 different stations. It seems obvious that careful sampling of microhabitats at selected localities across the Indo-West Pacific region will be required before we can begin to get a clear picture of distribution patterns of the shallow water stomatopods of that region.

Acknowledgments

I thank Mireille Peyrot-Clausade for making available the material on which this note is based. The collection has been divided among the Station Marine d'Endoume, Marseille; the Mauritius Institute, Port Louis, Mauritius; the Museum National d'Histoire Naturelle, Paris; and the National Museum of National History, Smithsonian Institution, Washington. I thank Austin B. Williams for commenting on the manuscript. The figure was prepared by my wife Lilly.

Literature Cited

Manning, Raymond B. 1962. Stomatopod Crustacea collected by the Yale Seychelles Expedition, 1957–1958. Postilla 68:1–15, figs. 1–2.

———. 1969. Notes on the *Gonodactylus* section of the family Gonodactylidae (Crustacea, Stomatopoda), with descriptions of four new genera and a new species. Proc. Biol. Soc. Washington 82:143–166, figs. 1–8.

Smithsonian Institution, Washington, D.C. 20560.

PROC. BIOL. SOC. WASH.
91(1), 1978, pp. 5–26

BREDIN-ARCHBOLD-SMITHSONIAN SURVEY OF DOMINICA: PHYCITINAE (LEPIDOPTERA: PYRALIDAE)

Jay C. Shaffer

Abstract.—This paper covers twenty-six species in twenty-three genera. Twenty-four of the species are new records for Dominica. One genus and three species are described as new. Hostplant and distributional data are provided, as are photographs of wings, head profiles, and genitalia (except those illustrated by Heinrich, 1956).

This paper covers and is largely limited to material collected during the Bredin-Archbold-Smithsonian Biological Survey of Dominica, West Indies in 1964–65.

Included are 25 species in 23 genera, plus one species recorded from Dominica, but which I have been unable to verify. One genus, *Fissicera*, and three species, *Acrobasis caribbeana*, *Piesmopoda dominica*, and *Fissicera spicata* are described as new. Three of the included species are identified to genus only (*Drescoma*, *Mescinia*, and *Moodnopsis*), and one species ([*Myelois*] *famula*) should be assigned to another genus when males become available for study.

Heinrich (1956) lists but two species from Dominica, *Sarasota furculella* and *Piesmopoda apocerastes*, only the former of which is represented in the survey collection. Certain common West Indian phycitines, notably *Ufa rubedinella* and *Elasmopalpus lignosellus*, have not yet been found on Dominica, but may well occur there.

I owe a great debt to Heinrich's monumental revision of the Neotropical Phycitinae (1956), for without that great synthesis the present paper could not have been attempted. Hostplant and distributional data (except for Dominica) cited herein are from Heinrich (1956). Dominica material is listed by locality, date (month and year only), number of each sex, and collector, the latter given by initials as follows:

JC—J. F. Gates Clarke
TC—Thelma M. Clarke
DD—Donald R. Davis
OF—Oliver S. Flint, Jr.
PS—Paul Spangler
ET—E. L. Todd

Table 1. Distribution of species.[1]

Species	United States	Mexico	Central America	Bahama Islands	Cuba	Hispaniola	Jamaica	Puerto Rico	Virgin Islands	St. Kitts	Montserrat	Dominica	Barbados	Grenada	Trinidad & Tobago	Venezuela	Guyana	Fr. Guiana	Colombia	Ecuador	Peru	Brazil	Bolivia	Paraguay	Argentina
Hypsipyla grandella	x	x	x			x	x	x				x			x	x	x			x	x	x		x	x
Hypargyria definitella								x	x			x							x			x			
Ectomyelois muriscis			x			x		x				x		x	x		x	x	x			x	x		
Fundella pellucens	x				x	x		x	x		x	x	x									x	x		
Fundella argentina	x	x			x	x	x	x	x			x				x						x			x
Coptarthria dasypyga			x									x							x						
Davara caricae	x		x		x	x		x				x			x					x					
Sarasota furculella					x			x	x			x													
Ancylostomia stercorea	x	x	x	x	x	x	x	x	x	x		x		x	x			x	x			x			
Oryctometopia fossulatella	x	x	x					x	x			x				x						x			
Bema neuricella			x	x	x			x	x			x			x			x							
Rotuda mucidella	x		x		x				x			x										x		x	
Unadilla erronella			x	x				x	x			x							x						
Unadilla maturella			x		x							x							x						
Ephestiodes stictella				x			x	x	x			x													
Varneria dubia								x				x													
Erelieva quantulella	x				x	x		x	x			x													
[*Myelois*] *famula*												x							x						

---

[1] Data extracted from Heinrich, 1956 (except for Dominica records). Dominica endemics and *Ephestia cautella*, a cosmopolitan pest, omitted.

I should like to thank Douglas Ferguson for giving of his time in discussing a number of problems associated with this study, and also Jack Scott for preparing the photographs used in Figs. 1a and 2.

Genitalia figured in Heinrich (1956) are not illustrated herein.

Acrobasis caribbeana, new species
Figs. 3a; 5b; 7a, b, c; 8a

Acrobasis caribbeana, new species.

This species differs from all other known members of *Acrobasis*, except *minimella* Ragonot, in having the combination of scale tufts on the forewings and the apical process of the gnathos developed as a simple hook (rather than trifurcate). The forewings are more narrow than those of *minimella* and have a very different coloration. In particular, the ground of *caribbeana* is a nearly uniform brown, devoid of conspicuous markings save those in the region of the raised scale tufts. Most notably, *minimella* specimens have a prominent blackish triangular patch distal to the antemedial line, this patch being absent in *caribbeana*. The genitalia do not provide diagnostic species characters.

Description.—Forewing narrow; radius 5–6 mm; ground variable, basically light chocolate brown sewn with scattered white scales, in some specimens heavily marked with dark wine-red scales; antemedial line raised in both sexes, prominent, white sewn with light reddish-brown scales, bordered distally by broad band of brown scales; subterminal line poorly developed in some specimens, absent in others. Hindwing with M_{2+3} stalked for nearly half their length. Male genitalia with apex of gnathos a simple hook.

Holotype.—♂, No. USNM 75712, labeled: "Dominica, Clarke Hall, XI-19-25-64, P. J. Spangler; Bredin-Archbold-Smithsonian Bio. Surv. Dominica; ♂ genitalia on slide 1086 J. C. Shaffer."

Paratypes.—1♂, 1♀, same data as holotype; Clarke Hall, X-12-18-64, 1♀; X-19-22-64, 1♀; XI-12-17-64, 2♀; XII-11-16-64, 1♀, all P. J. Spangler; 4-X-66, 1♀; 10-X-66, 1♀, both E. L. Todd; 1♀, 0.4 mi E of Pont Casse, VI-23-1964, O. S. Flint, Jr.; 1♀, 3 mi E Pont Casse, 30-X-1966, E. L. Todd; 1♀, 3 mi E Pont Casse, XII-1-1964, Paul J. Spangler.

Heinrich covers 39 New World species, all North American. This is the first species to be described from the Neotropics.

Hypsipyla grandella (Zeller)
Figs. 3b, 5a

Hypsipyla grandella (Zeller). Heinrich, 1956:28–29.

This widely distributed species ranges from southern Florida southward

Fig. 1. *Fissicera spicata*, new species. a, female paratype; b, holotype male.

through Central America and the West Indies to Argentina. The larva is reported to be a borer in fruits and branches of *Cedrela* and *Swietenia* (Meliaceae).

Material.—Grande Savane, Oct. 1966. 3♀, ET; S. Chiltern, Dec. 1964, 1♂, 3♀, PS.

Hypargyria definitella (Zeller)

Figs. 2a, 5c

Hypargyria definitella (Zeller). Heinrich, 1956:37–38.

Males of this species can be readily recognized by the shiny silver patches on the undersides of both fore and hind wings. The Dominica series, unfortunately, consists of but two female specimens.

Material.—One mi N of Mahau, June 1964, 1♀, OF; Grande Savane, April 1965, 1♀, DD.

Ectomyelois muriscis (Dyar)

Figs. 3c, 5d

Ectomyelois muriscis (Dyar). Heinrich, 1956:45.

Larvae feed in the fruits of *Mammea americana* (mamey, Guttiferae) and *Theobroma cacao* (cacao, Sterculiaceae). This species ranges from the West Indies and Central America south through Brazil, and is well represented among the Dominica material.

Material.—Antrim 1,000′, Mar. 1956, 1♂, JC; Anse Bouleau, Oct. 1964, 1♀, PS; Clarke Hall, Mar. 1965, 1♀; Jan. 1965, 1♀, JC, TC; Feb. 1965, 1♀, JC, TC; Mar. 1965, 1♀, JC, TC; Apr. 1965, 9♀, DD; May 1965, 1♀, DD;

Oct. 1966, 3♂, 4♀, ET; Nov. 1966, 1♀, ET; Oct. 1964, 1♂, 1♀, PS; Nov. 1964, 1♂, 2♀, PS; Dec. 1964, 1♂, PS; Macoucheri, Feb. 1965, 1♀, JC, TC; 2 mi NW Pont Casse, May 1965, 1♀, DD; South Chiltern, May 1965, 1♀, DD; Springfield, June 1965, 2♀, DD.

Fundella pellucens Zeller
Figs. 2b, 5e

Fundella pellucens Zeller. Heinrich, 1956:60.

The larvae feed on a variety of legumes. Heinrich reports: *Vigna unguiculata, Canavalia ensifermis, Canavalia maritima, Cajan cajan,* and species of *Phaseolus.*

Heinrich records specimens from Florida, the West Indies, Brazil, and Bolivia. I've seen only one specimen from Dominica, taken at Cabrit Swamp, 10–13 May 1956, by D. R. Davis.

Fundella argentina Dyar
Figs. 3d, 5f

Fundella argentina Dyar. Heinrich, 1956:61.

Heinrich reports the larvae feeding on *Poinciana gilliesi* and species of *Cassia.*

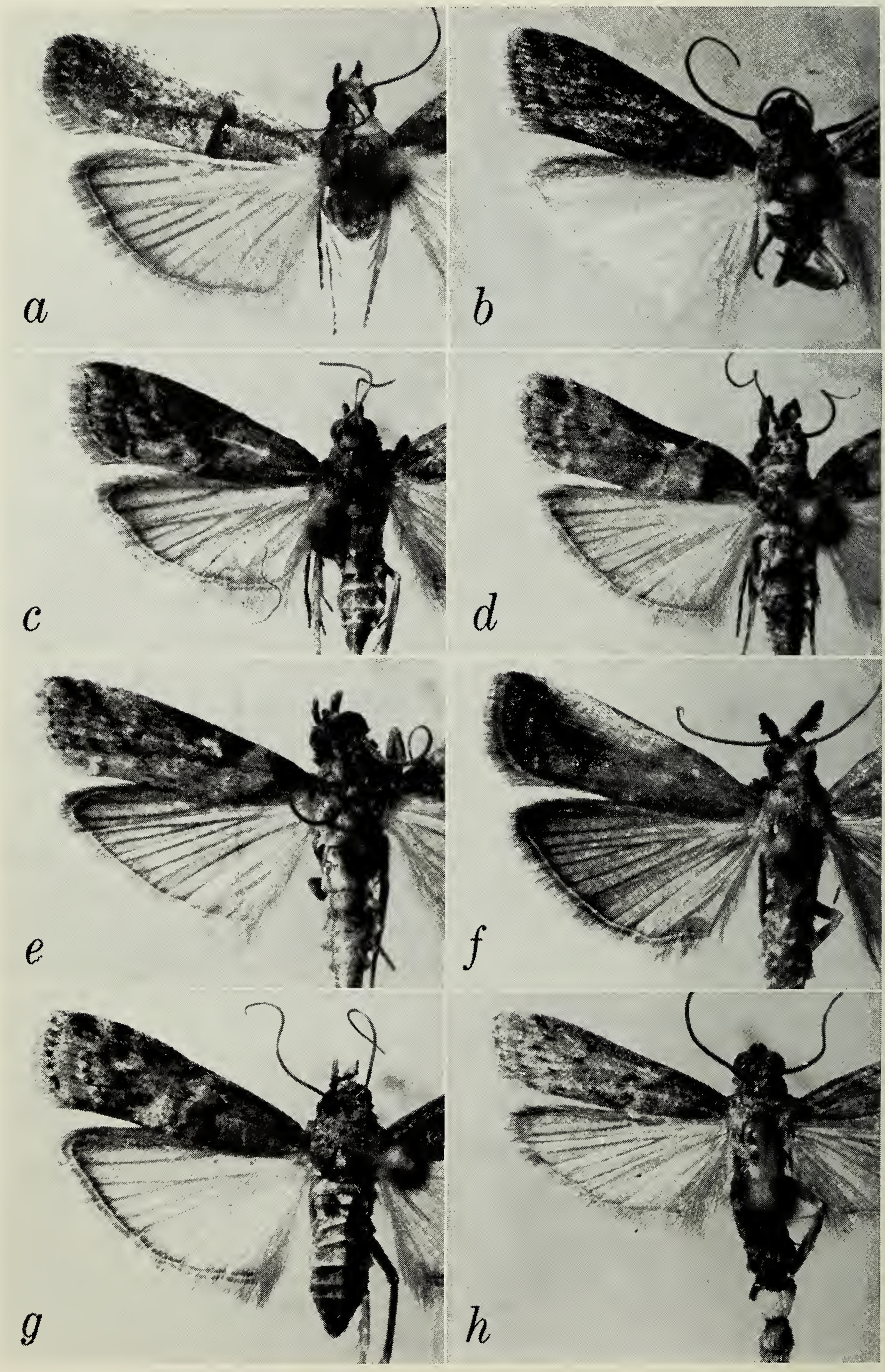
Distributed from Florida, Texas, and the West Indies south to Argentina. In the Dominica collection this species is represented by a single male, taken at Grande Savane, 11 Oct. 1966, by E. L. Todd.

Coptarthria dasypyga (Zeller)
Figs. 2c, 5g, 8b

Coptarthria dasypyga (Zeller). Heinrich, 1956:65.

This species has previously been known only from the type locality in Colombia and from Guatemala. Heinrich was uncertain as to which females should properly be associated with the type, and his figure of the female genitalia is listed questionably as belonging to *dasypyga.* The Dominica series consists of three females and a considerably paler male specimen. The difference in color between the two sexes is largely due to the differing intensity of the reddish scales, these being prominent in the females but hardly more than barely perceptible in the male. Having only one male it is impossible to say whether the variation is sexual or individual, but I believe them to be conspecific.

The genitalia of the Dominica females match the figure (718) of those of the specimen tentatively assigned to *dasypyga* by Heinrich, except that the former lack a signum and have a somewhat cordate shield near the


a
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h

ostium. In view of these differences I doubt that the Dominica females are conspecific with the one figured by Heinrich. The same character differences apply when the Dominica females are compared with the Cayuga, Guatemala females mentioned by Heinrich; and in addition the Dominica females lack the long ductus bursae of the latter specimens.

Material.—0.5 mi S Pont Casse, Apr. 1965, 1♂, DD; 2 mi NW Pont Casse, Apr. 1965, 1♀, DD; June 1965, 2♀, DD.

Davara caricae (Dyar)
Figs. 2d, 5h

Davara caricae (Dyar). Heinrich, 1956:74.

This species is common in the West Indies and ranges from southern Florida through Central America to Ecuador. It is one of the most abundant phycitines on Dominica. The larvae are reported to feed in the fruit of papaya (*Carica papayae*, Caricaceae).

Dominica females lack the ventrolateral ridges of the eighth segment collar mentioned in Heinrich's description of *caricae*. (These are omitted from Heinrich's drawing, figure 735, of the genitalia, though present in slides of *caricae* that I have examined in the National Museum collection.) While this is a clear-cut difference, I am reluctant to assign the Dominica population separate specific status, particularly since one would expect to find the common papaya-feeding *caricae* on Dominica. Considering the feeding habits of the larvae it may well have been introduced there.

Material.—Antrim, 1,000′, March 1956, 1♂, 1♀, JC; Bagatelle, March 1965, 1♀, JC, TC; Cabrit Swamp, May 1965, 1♀, DD; Cent. For. Res., May 1965, 1♂, 2♀, DD; Clarke Hall, Apr. 1965, 1♂, DD; Freshwater Lake, Nov. 1966, 1♂, 1♀, ET; Grande Savane, June 1965, 1♀, DD; Pont Casse, Apr. 1965, 1♀, DD; May 1965, 1♂, DD; June 1965, 1♂, DD; 0.5 mi S Pont Casse, Apr. 1965, 1♀, DD; 1 mi N Pont Casse, Apr. 1965, 1♀, DD; 2 mi NW Pont Casse, Apr. 1965, 10♂, 7♀, DD; May 1965, 4♂, 4♀, DD; June 1965, 5♂, 3♀, DD; 2.2 mi E Pont Casse, Apr. 1964, 1♀, OF; May 1964, 1♂, OF; 0.5 mi W Pt. Lolo, 1,600′, Feb. 1965, 1♂, 1♀, JC, TC; S. Chiltern, Dec. 1964, 5♀, PS.

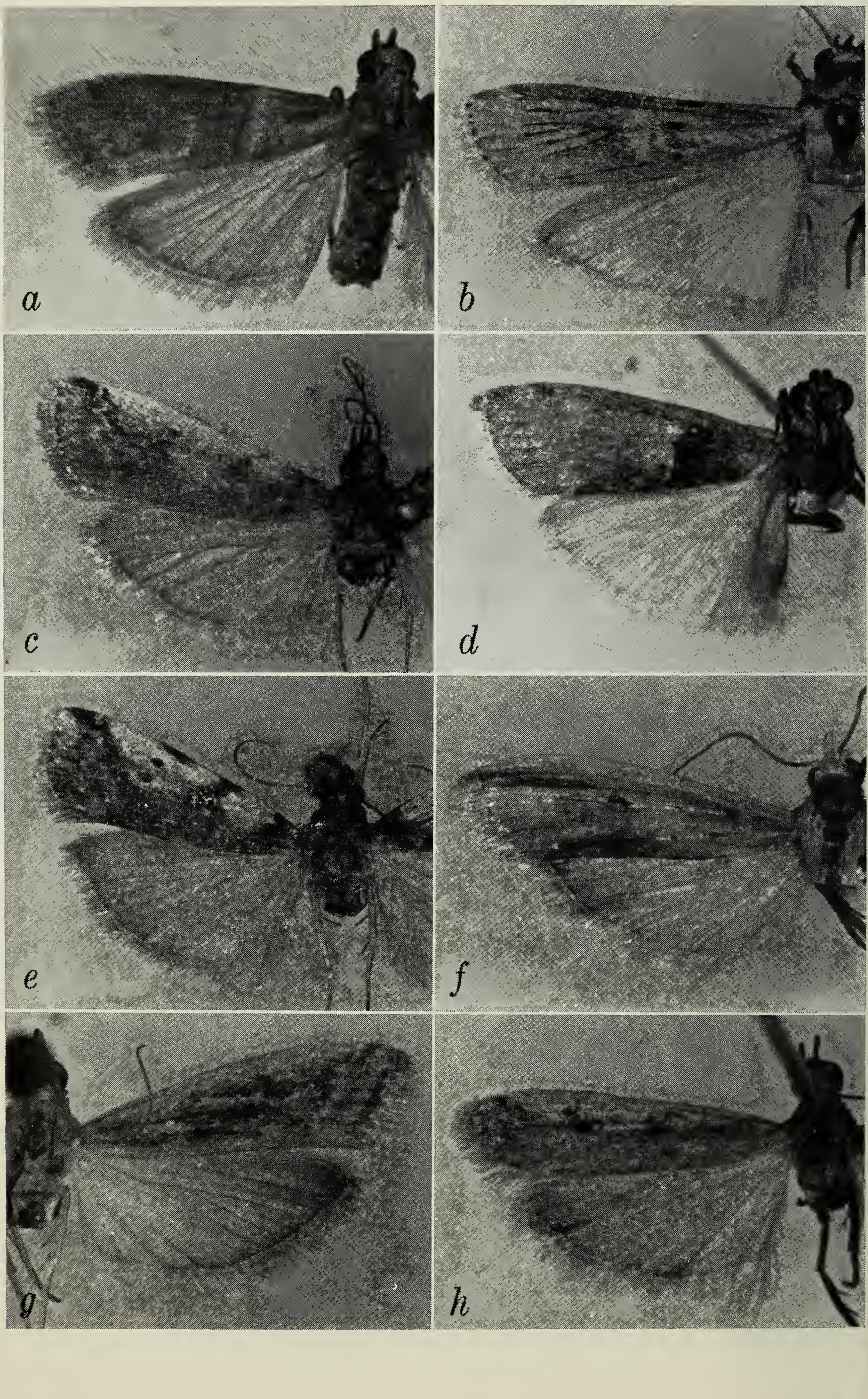
Sarasota furculella (Dyar)
Figs. 2e, 5i

Sarasota furculella (Dyar). Heinrich, 1956:77.

Heinrich records the species from Cuba (TL: Santiago), Puerto Rico, Dominica, and St. Croix.

←

Fig. 2. a, *Hypargyria definitella*; b, *Fundella pellucens*; c, *Coptarthria dasypyga*; d, *Davara caricae*; e, *Sarasota furculella*; f, *Piesmopoda dominica*, new species, male paratype; g, *Oryctometopia fossulatella*; h, *Bema neuricella*.


a
b
c
d
e
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h

Material.—Cabrit Swamp, May 1965, 1♀, DD; Oct. 1966, 3♂, 1♀, ET; Clarke Hall, April 1964, 2♂, 2♀, OF; Nov. 1964, 1♂, 2♀, PS; Dec. 1964, 1♀, PS; Grande Savane, April 1965, 1♂, DD; July 1964, 1♂, OF; Oct. 1966, 1♂, ET; 0.5 mi W Pt. Lolo, 1,600′, Feb. 1965, 1♂, JC, TC; 2 mi NW Pont Casse, May 1965, 1♂, DD; South Chiltern, Dec. 1964, 3♂, 11♀, PS. Trafalgar, May 1965, 1♀, DD. In the USNM collection are also 3 females taken on Dominica Dec. 1909 by W. D. Kearfott.

Piesmopoda dominica, new species

Figs. 2f; 5j; 7d, e, f; 8c

No one feature distinguishes this species from its relatives. Males are similar to *ragonoti* in having the labial palpi long, with the third segment fan shaped, and reaching beyond the vertex. The second segment, however, does not reach beyond the vertex as in *ragonoti*, and the basal half of the forewing is olive green rather than the bright yellow of *ragonoti*. Of the three species known only from females, *dominica* differs from *trichomata* in the shape of the eighth segment collar and in possession of longitudinal ridges on the ductus bursae, from *semirufella* in lacking a discal spot on the forewing and sclerotized plate at the ostium, and from *montella* in that the latter lacks a signum and has a very broad ductus bursae.

Description.—Frons reddish brown. Labial palpi of male ascending well beyond vertex, flattened and fan like distally with rounded apex; basal segments white; second olive brown on outer sides; outer sides of third olive brown anteriorly, terra cotta posteriorly, with line of black (broadened at apex) in between; inner sides of third segments mostly black, margins as on adjacent outer sides. Labial palpi of female less strongly ascending (at about 45°) than in male; maculation similar. Maxillary palpi short, attaining middle of frons, flat, somewhat broadened, appressed to frons; white. Tongue well developed. Base of male antenna reddish brown and black on anterior of inner sides, white on posterior of outer sides; shaft sublaminate, lacking sinus, filiform in female. Ocelli well developed, black. Vertex anterior to antennae bases black in male, light brown (often with reddish brown) in female; light brown posterior to antennae bases in both sexes. Occiput white dorsally, reddish brown (mixed with white) laterally. Patagia and tegulae olive brown.

Forewing radius 9–10 mm in most specimens (7 mm in smallest specimen examined); ground uniform olive green on basal half of forewing, ex-

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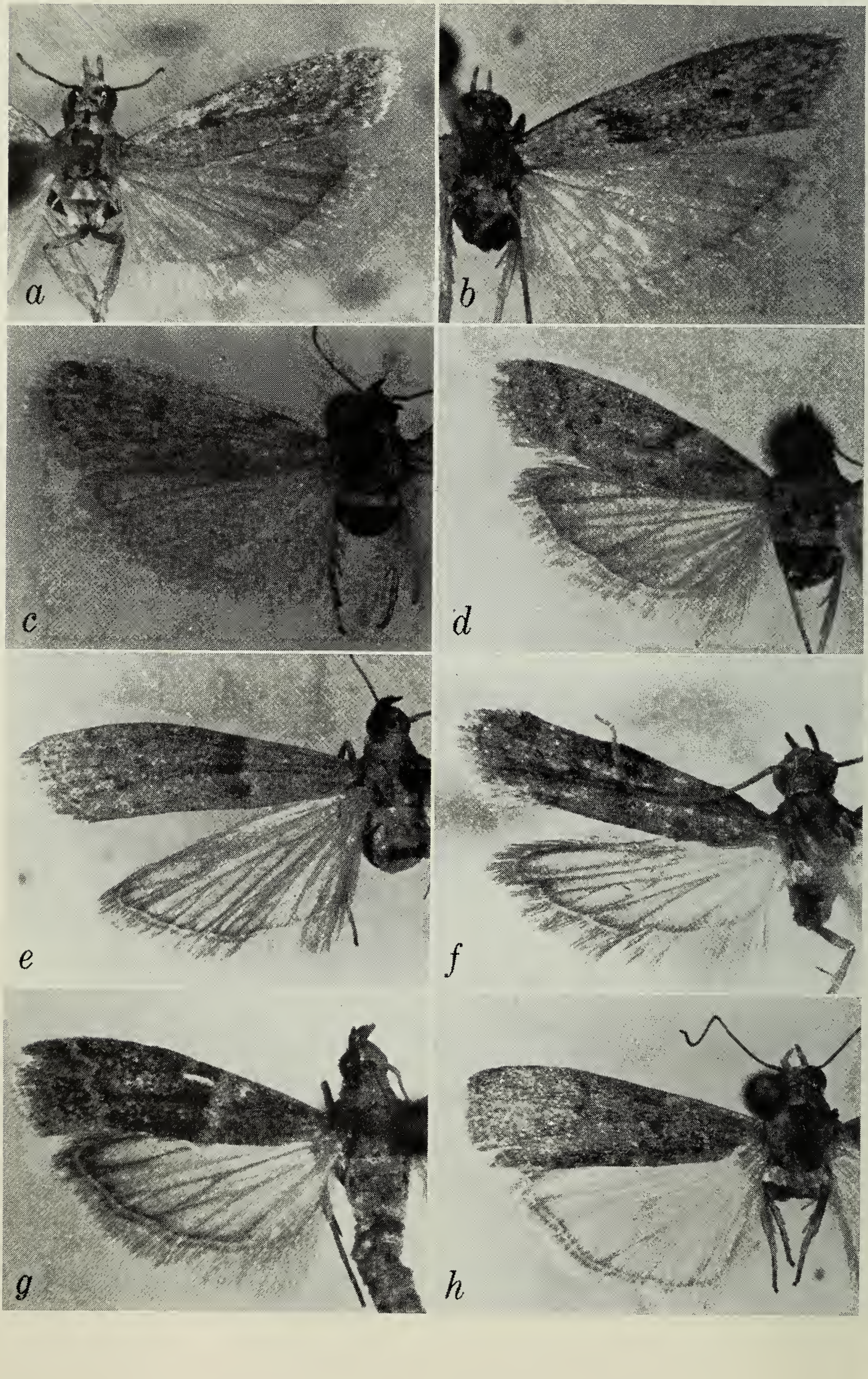
Fig. 3. a, *Acrobasis caribbeana*, new species, female paratype; b, *Hypsipyla grandella*; c, *Ectomyelois muriscis*; d, *Fundella argentina*; e, *Drescoma* sp.; f, *Ancylostomia stercorea*; g, *Mescinia* sp.; h, *Rotruda mucidella*.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tending farther apically along white costal band; distal two-thirds of costal margin white, sewn with reddish-brown scales, especially basally on extreme margin; costa reddish brown along entire margin except near apex; distal two-fifths of forewing reddish brown, with pair of poorly developed, somewhat darker subterminal lines; discal spots lacking; antemedial line lacking.

Male genitalia with each arm of bifid uncus slender, finely ciliate on dorsal surface of slender portion, and along outer margin toward broadened base. Spine of anellus sharp-pointed, basally broadened. Vinculum subtruncate. Two large masses of semi-deciduous hair-like scales originate from pair of short bars near valve bases; lesser masses of hairs present along ventral margin of sacculus.

Female genitalia with ductus bursae slender, very lightly ridged longitudinally near ostium, but lacking sclerotized region near ostium. Collar of eighth abdominal segment deeply and narrowly notched ventrally, notch opening posteriorly; collar rather strongly longitudinally ridged laterally on invaginated section. Bursa well developed, granular in appearance; ductus seminalis broadly joined to bursa near its posterior end; flared and twisted about ductus bursae where joining bursa; signum present.

Holotype.—♂, No. USNM 75713, labeled: "Dominica, Pont Casse, 2 mi. NW, v. 15. 1965, D. R. Davis; ♂ genitalia on slide 990, J. C. Shaffer."

Paratypes.—Dominica, 2 mi NW Pont Casse, 13 Apr. 1965, 1♀, 18 Apr., 3♂, 21 Apr., 1♀, 24 Apr., 1♀, 25 Apr., 1♀, 27 Apr., 2♀, 30 Apr., 3♀, 4 May, 2♀, 5 May, 1♂, 16 May, 2♂, 2♀, 17 May, 2♂, 6♀, 18 May, 2♂, 2♀, 24 May, 1♂, 1♀, 25 May, 1♀, 14 June, 1♂, all by D. R. Davis.

Other material examined.—1.3 mi E of Pont Casse, May 1964, 1♀, OF; Cent. For. Res., Apr. 1965, 2♀, DD; May 1965, 1♂, 2♀, DD.

Piesmopoda apocerastes Dyar

Piesmopoda apocerastes Dyar. Heinrich, 1956:81.

This is one of two species recorded by Heinrich from Dominica. I have not been able to find the specimen(s) on which this record is based, nor has the Dominica survey produced any material of this species.

Drescoma sp.

Figs. 3e, 5k, 8d

Drescoma Dyar. Heinrich, 1956:88–89.

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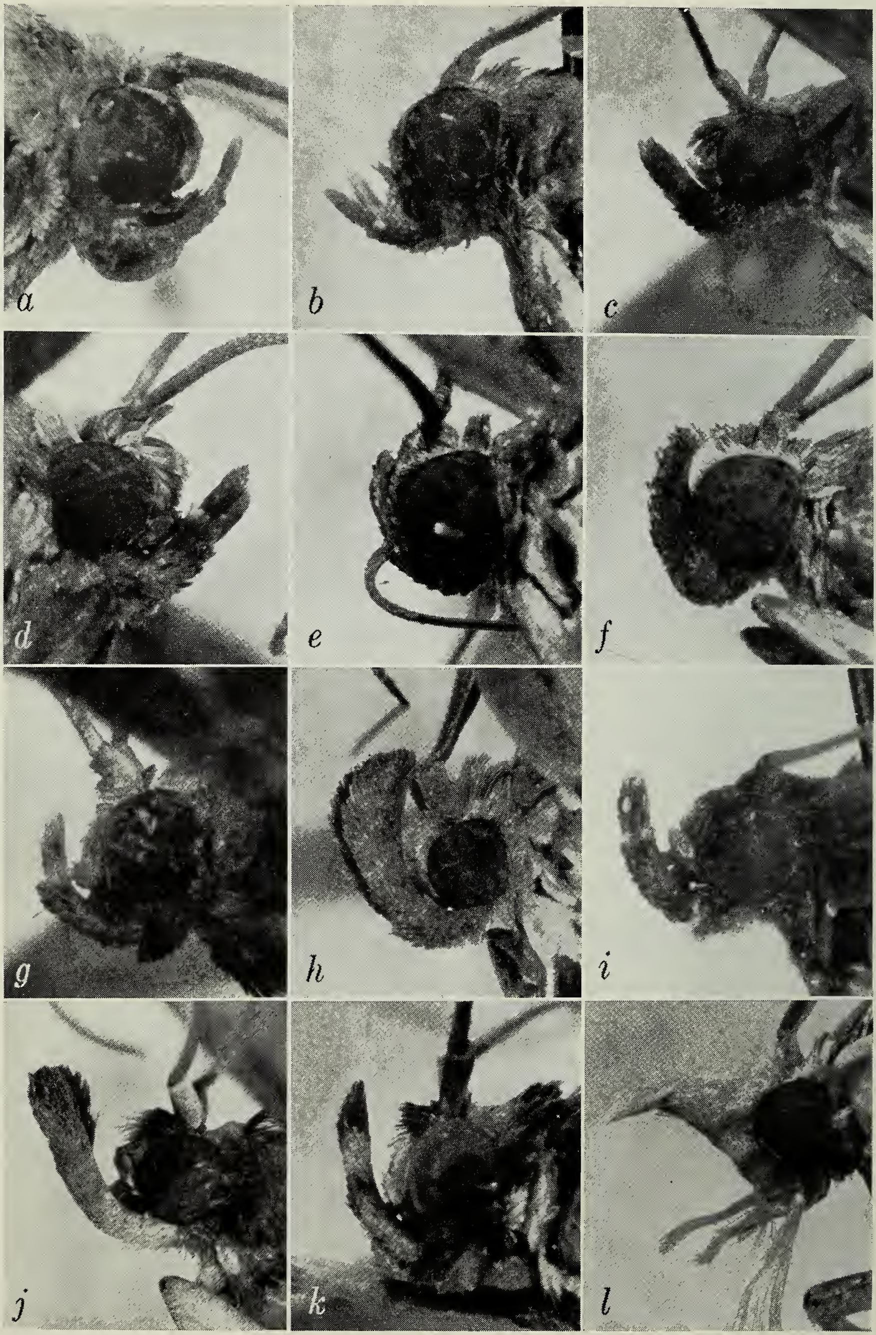
Fig. 4. a, *Unadilla erronella*; b, *Unadilla maturella*; c, *Moodnopsis* sp.; d, *Ephestiodes stictella*; e, *Ephestia cautella*; f, *Varneria dubia*; g, *Erelieva quantulella*; h, [*Myelois*] *famula*.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Heinrich covers two species of *Drescoma*, *cyrdipsa* Dyar and *cinilixa* Dyar. The Dominica series consists of but five females. These are clearly not conspecific with *cyrdipsa* as the female genitalia differ in a number of important aspects. *D. cinilixa* is known only from male specimens from Panama (type locality) and Guatemala. These specimens are considerably paler (possibly due entirely to fading) than the Dominica moths and have a much sharper subterminal line on the forewing. The evidence at hand is insufficient to allow a decision between naming the Dominica population *cinilixa* or a new species; but in any case description of a new species would be unwarranted in the absence of male specimens.

Material.—Pont Casse, Apr. 1965, 2♀, DD; May 1965, 1♀, DD; June 1965, 1♀, DD; 0.5 mi W Pt. Lolo, 1,700′, Jan. 1965, 1♀, JC, TC.

Ancylostomia stercorea (Zeller)

Figs. 3f, 5l

Ancylostomia stercorea (Zeller). Heinrich, 1956:95–96.

Larvae are reported to feed in the pods of *Cajanus cajan* (pigeon pea, Fabaceae). The moth is abundant in southern Florida, the West Indies, and ranges from Mexico south through Central America to Colombia and Brazil.

Material.—Antrim, 1,000′, March 1956, 1♀, JC; Clarke Hall, May 1964, 1♂, OF.

Oryctometopia fossulatella Ragonot

Figs. 2g, 6b

Oryctometopia fossulatella Ragonot. Heinrich, 1956:159.

Larvae feed in the pods of *Bouhinia mexicana* (Leguminosae). The species ranges from Texas and Mexico south through Central America to Venezuela and Brazil, and is reported from Puerto Rico and St. Croix. Color and maculation are rather variable, even among the Dominica series.

Material.—Antrim, 1,000′, Mar. 1956, 1♂, JC; Cabrit Swamp, Oct. 1966, 5♀, ET; Clarke Hall, Apr. 1964, 1♀, OF; Grande Savane, June 1965, 1♀, DD; Nov. 1966, 1♀, ET; Pont Casse, Apr. 1965, 2♀, DD; May 1965, 2♂, 4♀, DD; June 1965, 1♀, DD; Rosalie, June 1965, 1♀, DD; South Chiltern,

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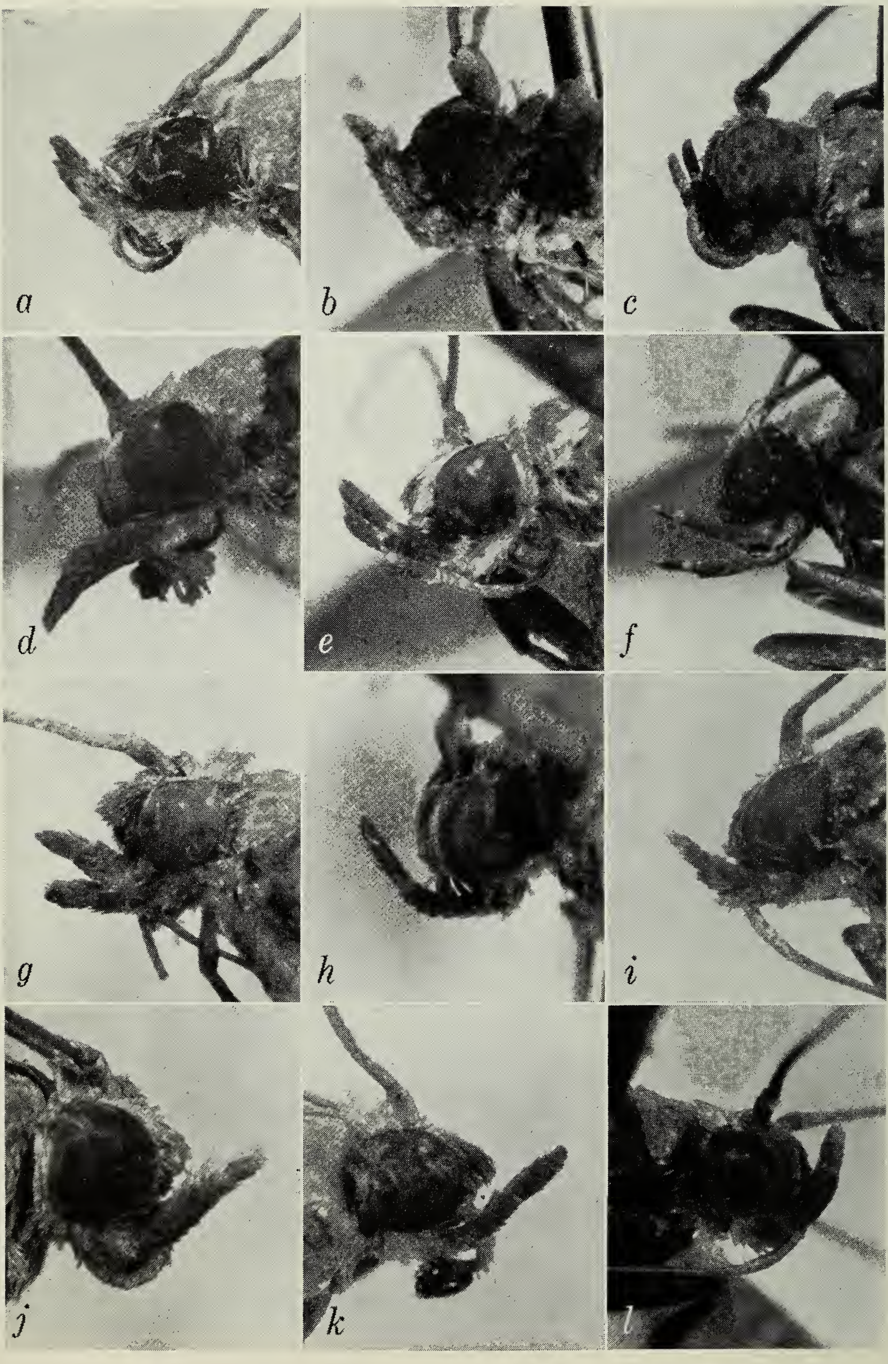
Fig. 5. a, *Hypsipyla grandella*; b, *Acrobasis caribbeana*, new species, holotype male; c, *Hypargyria definitella*; d, *Ectomyelois muriscis*; e, *Fundella pellucens*; f, *Fundella argentina*; g, *Coptarthria dasypyga*; h, *Davara caricae*; i, *Sarasota furculella*; j, *Piesmopoda dominica*, new species, holotype male; k, *Drescoma* sp.; l, *Ancylostomia stercorea*.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May 1964, 1♀, OF; May 1965, 2♂, 5♀, DD; Dec. 1964, 1♂, 1♀; PS; Trafalgar, May 1965, 3♀, DD.

Mescinia Ragonot
Figs. 3g, 6k

Mescinia Ragonot. Heinrich, 1956:212–215.

Heinrich divides this genus into three species groups recognizable on size. The wingspan range of the three Dominica specimens is from 11–14 mm. This puts them into the first species group and eliminates *peruella* Schaus, *discella* Hampson, and *indecora* Dyar from consideration. Heinrich remarks that the differences between the remaining eight species are slight and that ". . . it is almost impossible to define specific limits in this group with any certainty." The problem of identifying the Dominica material is particularly difficult as the series consists of but three female specimens, and potentially useful characters of the gnathos and aedeagus cannot be used.

Material.—Antrim, 1,000′, Mar. 1956, 1♀, JC; Cabrit Swamp, May 1965, 1♀, DD. Grande Savane, June 1965, 1♀, DD.

Bema neuricella (Zeller)
Figs. 2h, 6c

Bema neuricella (Zeller). Heinrich, 1956:218.

Larvae feed on various species of *Inga* (Fabaceae). Heinrich records the species from the Bahamas, Cuba, Puerto Rico, Virgin Islands, Guatemala, Panama, Trinidad, and French Guiana.

Material.—Antrim, 1,000′, Mar. 1956, 1♂, JC; Clarke Hall, Apr. 1964, 2♂, OF; Oct. 1964, 1♀, PS; Oct. 1966, 1♂, ET; Nov. 1964, 1♂, 1♀, PS; 1 mi E Clarke Hall, May 1965, 1♀, DD; Freshwater Lake, Nov. 1966, 1♀, ET; Grande Savane, Apr. 1965, 2♀, DD; May 1965, 1♀, DD; 2 mi NW Pont Casse, Apr. 1965, 2♂, 2♀, DD; May 1965, 1♂, 7♀, DD; South Chiltern, May 1965, 1♀, DD; Dec. 1964, 2♂, 4♀, PS; Springfield, June 1965, 2♀, DD.

Rotruda mucidella (Ragonot)
Figs. 3h, 6a

Rotruda mucidella (Ragonot). Heinrich, 1956:226–227.

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Fig. 6. a, *Rotruda mucidella*; b, *Oryctometopia fossulatella*; c, *Bema neuricella*; d, *Moodnopsis* sp.; e, *Unadilla erronella*; f, *Unadilla maturella*; g, *Ephestiodes stictellus*; h, *Varneria dubia*; i, *Erelieva quantulella*; j, *Myelois famula*; k, *Mescinia* sp.; l, *Ephestia cautella*.

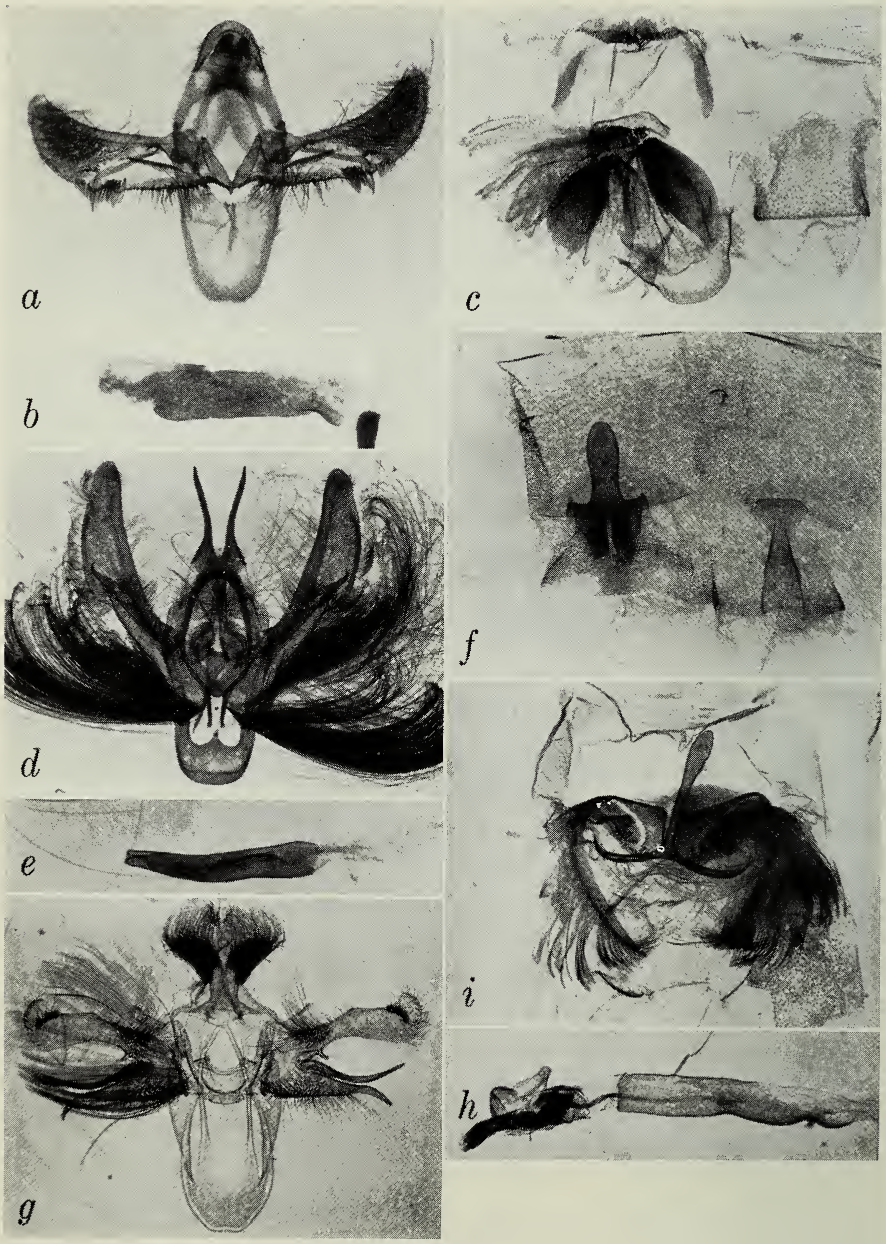


Fig. 7. a, *Acrobasis caribbeana*, new species, holotype, male genitalia; b, aedeagus; c, eighth abdominal segment; d, *Piesmopoda dominica*, new species, holotype, male genitalia; e, aedeagus; f, eighth abdominal segment; g, *Fissicera spicata*, new species, holotype, male genitalia; h, aedeagus; i, eighth abdominal segment.

Heinrich divided *mucidella* into four races (subspecies), and on the basis of geographical distribution the Dominica population should go with the *olivacella* race. I prefer not to follow this division since we know so little about this species. Heinrich himself said that . . . "The races at best are dubious entities . . ." and indicated that their apparent distinctness would likely break down under more extensive collecting.

Material.—Cabrit Swamp, Oct. 1966, 1♀, ET; 1 mi E Clarke Hall, Apr. 1965, 1♀, DD; Grande Savane, May 1965, 1♂, DD; Oct. 1966, 1♀, ET.

Unadilla erronella (Zeller)

Figs. 4a, 6e

Unadilla erronella (Zeller). Heinrich, 1956:228–229.

Material.—Cabrit Swamp, May 1965, 4♂, 1♀, DD; Nov. 1964, 1♀, PS; Grande Savane, Apr. 1965, 1♀, DD; May 1965, 1♂, 2♀, DD; 2.2 mi E of Pont Casse, May 1964, 1♀, OF.

Unadilla maturella (Zeller)

Figs. 4b, 6f

Unadilla maturella (Zeller). Heinrich, 1956:229.

The Dominica material consists of a single male specimen taken in the Central Forest Reserve on 25 April 1965, by D. R. Davis. The genitalia of this specimen differ slightly from those figured by Heinrich for *maturella* in that the apex of the uncus is rounded rather than expanded. In regard to this character the Dominica specimen is closer to Heinrich's figure of *erronella*, but in all other aspects is a good match for *maturella*.

Heinrich reports *maturella* from Colombia (type locality), Cuba, and Guatemala.

Moodnopsis sp.

Figs. 4c, 6d

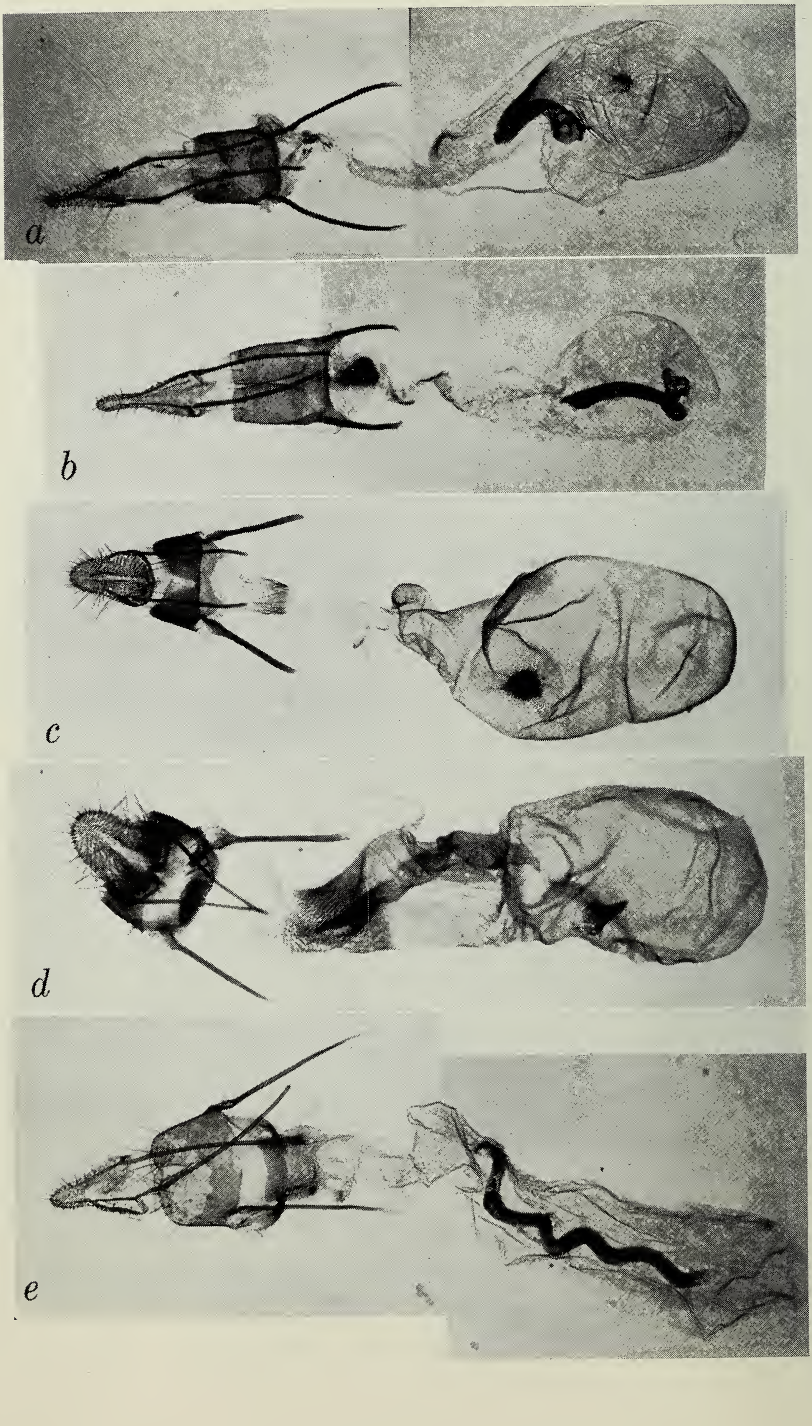
Moodnopsis Dyar. Heinrich, 1956:269–271.

I have before me a single female specimen taken at Antrim, 1,000′, on 12 March, 1956, by J. G. F. Clarke. The specimen is in excellent condition and on the basis of palpi, wing venation, and genitalia is clearly a *Moodnopsis*, but in the absence of associated males cannot be determined to species.

Ephestiodes stictella (Hampson)

Figs. 4d, 6g

Ephestiodes stictella (Hampson). Heinrich, 1956:281–282.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The Dominica material is a good match for Heinrich's description of *stictella* in all ways (including the highly distinctive female genitalia) except that the form of the vinculum is closer to that illustrated for *noniella* Dyar.

Heinrich records the species from The Bahamas (type locality; Nassau) Jamaica, Puerto Rico, and St. Croix.

Material.—Cabrit Swamp, May 1965, 1♀, DD; Grande Savane, Apr. 1965, 1♂, 8♀, DD; May 1965, 1♂, DD; June 1965, 1♀, DD; 1 mi N of Mahau, June 1964, 1♀, OF.

Ephestia cautella (Walker)

Figs. 4e, 6l

Ephestia cautella (Walker). Heinrich, 1956:303.

This is a common cosmopolitan pest found infesting a great variety of dried foods such as fruits, nuts, and grains. The Dominica survey produced one female specimen, taken at Clarke Hall, 17 February 1965, by J. F. G. and Thelma M. Clarke.

Varneria dubia Heinrich

Figs. 4f, 6h

Varneria dubia Heinrich, 1956:306.

On the basis of both male and female genital structure the Dominica material matches Heinrich's description completely. Contrary to Heinrich's description the antemedial, and to a lesser extent the postmedial, lines are well developed. Wing maculation is somewhat variable within the Dominica series.

Material.—Cabrit Swamp, May 1965, 1♂, DD; Clarke Hall, Apr. 1965, 1♀, DD; Freshwater Lake, June 1965, 2♀, DD; 2 mi NW Pont Casse, May 1965, 6♀, DD; June 1965, 1♂, DD; 2.2 mi E of Pont Casse, May 1964, 1♂, OF; 0.5 mi W Pt. Lolo, 1,600′, Feb. 1965, 4♀, JC, TC; Trafalgar, May 1965, 1♀, DD.

Erelieva quantulella (Hulst)

Figs. 4g, 6i

Erelieva quantulella (Hulst). Heinrich, 1956:308.

Heinrich records the larvae feeding on *Opuntia* (flowers), bell pepper

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Fig. 8. ♀ genitalia. a, *Acrobasis caribbeana*, new species, paratype; b, *Coptarthria dasypyga*; c, *Piesmopoda dominica*, new species, paratype; d, *Drescoma* sp.; e, *Fissicera spicata*, new species, paratype.

(ripened pods), and sorghum. The species is recorded from Texas, Puerto Rico, St. Croix, Cuba, and Haiti.

Material.—Grande Savane, Apr. 1965, 2♂, 7♀, DD; May 1965, 1♀, DD; June 1965, 1♀, DD.

[*Myelois*] *famula* Zeller
Figs. 4h, 6j

[*Myelois*] *famula* Zeller. Heinrich, 1956:312.

As Heinrich indicated, the genitalia of this species rule out placement in *Myelois.* Heinrich lacked the male specimens necessary for proper generic assignment, and the Dominica specimens I have seen are, unfortunately, all females.

Material.—Cabrit Swamp, Oct. 1966, 1♀, ET; Grande Savanne, Oct. 1966, 4♀, ET; Rosalie, June 1965, 1♀, DD.

Fissicera, new genus

Type-species.—Fissicera spicata, new species.

Diagnosis.—The male genitalia are quite distinctive, in particular the form of the valves and the development of the uncus with its dense patch of long sinuate hairs resembles that of no other phycitine genus in the Western Hemisphere.

Description.—Labial palpi similar in both sexes, rather slender, obliquely ascending, surpassing vertex. Maxillary palpus squamous, appressed to frons. Male antenna with base of shaft bearing deeply concave sinus (involving about 8 basal segments) on inner surface, distal one fifth of sinus formed by densely-packed mass of broad scales, surface of sinus varnished looking; shaft sublaminate, finely ciliate, length of cilia no more than half width of shaft over most of its length. Female antenna filiform, very finely ciliate. Tongue well developed. Ocelli well developed, black. Forewing with 11 veins; R_2 from near upper outer angle of cell, closely approximate with R_{3+5} for short distance beyond cell; R_{3+5} just over one-half length of R_5, from the angle; M_1 from near, but just below the angle; M_2 and M_3 from same point, from lower outer angle; Cu_1 from before the angle; Cu_2 from well before the angle. Hindwing with 8 veins, Sc and Rs anastomosed for about half their length beyond cell; M_{2+3} anastomosed for about half their length beyond cell, from lower outer angle; Cu_1 from very near the angle; Cu_2 from well before the angle. Male genitalia complex (Fig. 7g). Uncus of two sclerites, each apically flat, digitate in outline, in contact but unfused along midline; each caudally bearing very dense tuft of long sinuate, scale-like hairs. Gnathos small, apparently fused with subscaphium. Transtilla complete, with small rectangular medial process at gnathos, and pair of long slender arms extending anteriorly to anterior end of vinculum. Valvae with costa truncate, somewhat less than half as long as entire valve, truncated distal margin slightly concave; cucullus well developed, separate, distal margin broadly rounded, dorsodistal corner falcate, a narrow but dense patch of short blade-like scales perpendicular from its inner surface near apex; sacculus terminating in long, curved, stout spine, reaching nearly as far distally as cucullus; a pair of strong spines arising from proximal-dorsal angle of sacculus, the longer about twice as long as the shorter, and reaching nearly as far distally as cucullus. Vinculum about twice as long as wide, anterior margin rounded, mid-portion of margin slightly concave. Aedeagus cylindrical, about 6 times as long as wide, vesica with a pair of indistinct curved, plate-like cornuti.

Female genitalia (Fig. 8e) with ductus bursae less than half length of bursa, bearing weakly sclerotized subrectangular plate near ostium. Bursa unarmed, unornamented. Ductus seminalis from posterior end of bursa.

Fissicera spicata, new species

Figs. 1a, b; 7g, h, i; 8e

Diagnosis.—This is the only known species in the genus.

Description.—Labial palpi with basal segments white, a few wine red scales distally on outer sides; second segments white on inner sides, wine red on dorsal margin and distally on outer sides, brown to white elsewhere with a very few black scales on outer sides; third segments with outer sides wine red dorsally, black ventrally, a lighter wine red on inner sides. Occiput laterally deep wine red with small bars of white, olive brown dorsally. Patagia and tegulae olive-brown. Forewing with costa margined with reddish brown, margined posteriorly with broad costal band, white, sewn with reddish-brown scales; band not sharply delimited posteriorly, and not quite attaining either wing base or apex. Ground on basal half of wing olive brown, becoming gradually reddish brown toward outer margin of wing, reddish brown on outer half of wing on inner margin. In some specimens the olive-brown ground nearly replaced by reddish brown. Reddish-brown spot along costa, about one-third distance from wing base. Small reddish-brown discal spot in white costal band at junction with olive-brown ground. Antemedial line absent. Sinuate, light colored subterminal line, bordered proximally by darker line of same width, distally by dark area (especially toward wing apex where reddish-brown is more intense and sewn with black scales) extending to fringe. Terminal line of small black spots.

Holotype.—♂, No. USNM 75714, labeled: "Dominica, S. Chiltern, XII-8-10-1964, P. J. Spangler; Bredin-Archbold-Smithsonian Bio. Surv. Dominica; ♂ genitalia on slide 1074, J. C. Shaffer."

Paratypes.—Three males collected by D. R. Davis, 2 mi NW Pont Casse, dated 4, 9, and 17 May 1965. Six females collected by D. R. Davis, 2 mi NW Pont Casse, dated: 13 April, 7, 9, 18, 18 May, and 5 June, 1965.

Other specimens examined.—2 mi NW Pont Casse, 13 April 1965, 3♀, DD; 18 April, 1♀, DD; 4 May, 1♀, DD; 7 May, 1♀, DD; 18 May, 1♀, DD; 23 May, 1♀, DD; 26 May, 1♀, DD; 0.5 mi S Pont Casse, 5 April, 1♀, DD; 3 mi E Pont Casse, 22 Oct. 1966, 3♀, ET; 30 Oct. 1♀, ET; 1.3 mi E Pont Casse, 11 June 1964, 1♀, OF; Cent. For. Res., 3 May 1965, 1♀ (collector not given).

The genus falls into wing venational division I of Heinrich, but the genitalia of neither sex matches anything figured therein.

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PROC. BIOL. SOC. WASH.
91(1), 1978, pp. 27–51

THE POPULATIONS OF BOAT-TAILED GRACKLES IN THE SOUTHEASTERN UNITED STATES

Henry M. Stevenson

Abstract.—The Boat-tailed Grackle (*Quiscalus major*) was found to comprise four disjunct and somewhat distinct populations—*Q. m. torreyi*, southern New Jersey to northeastern Florida; *Q. m. westoni*, Florida Peninsula; *Q. m. alabamensis* (described herein), coast of Alabama and southeastern Mississippi; and *Q. m. major*, southwestern Mississippi to southeastern Texas. In the same geographic sequence and in both sexes the iris color of these populations is basically pale, dark, pale, and dark. Other morphological differences are the relative and absolute tail and wing length, the bill proportions, and weight. Fall females of the dark-eyed races (*westoni* and *major*) seem to be more richly colored than are the other two races. Due to the migratory tendency of some individuals, some mingling of subspecies occurs in winter.

The distribution and geographic variation of the Boat-tailed Grackle, (*Quiscalus major* Vieillot) have long been subject to controversy. That some uncertainty still exists is evidenced by the inaccurate description of the range of the species and its races as stated in the latest Checklist of North American Birds (A.O.U. 1957). The stated ranges of the two accepted subspecies, the dark-eyed southern *Q. m. major* and the light-eyed *Q. m. torreyi*, of the middle Atlantic coast, exclude part of the Florida Peninsula (where the species is a common resident) and include the Florida Keys (where there is no verifiable record of the species). Likewise, it is not made clear that any important hiatus exists in the species' breeding range, as is, in fact, the case.

There have been several reasons for such confusion. Field workers generally have not been cognizant of the Boat-tailed Grackle's migrations, with the result that statements regarding the breeding range and eye color of each population may not have been based entirely on breeding individuals. It has been recognized that the population in the middle Atlantic Coast (*Q. m. torreyi*) is migratory to some extent. Although the breeding range extends north to southern New Jersey, many northern individuals retreat in winter at least as far south as coastal Virginia (A.O.U. 1957) or Maryland (Stewart and Robbins, 1958). As to the migration of other populations, the A.O.U. Checklist states only that *Q. m. major* wanders in winter. No mention has been made to the effect that *Q. m. torreyi* winters south of its breeding range. Some Texas birds (*Q. m. major*) reach the Rio Grande in winter (Oberholser, 1974), and many individuals of the related species, *Quiscalus mexicanus*, also migrate southward in winter (Kincaid, MS). The recognition of these migratory movements is essential to an evaluation of each population's breeding range and physical characteristics.

Although the Boat-tailed Grackle is local in distribution, the extensive gaps in its breeding range have not previously been appreciated. On the east coast of Florida a hiatus of about 55 kilometers occurs between St. Augustine and the mouth of the St. Johns River. In northwest Florida there are no regular breeding or summer records from about St. Vincent Island to the Alabama line, a distance of more than 220 km, and there is not even occasional breeding over 155 km of this distance. On the Mississippi mainland I have found no evidence of breeding between Gautier and St. Louis Bay (Wolf River), which are almost 62 km apart. In each hiatus there are suitable nesting areas. For example, in northwest Florida the upper portions of Choctawhatchee and Escambia Bays have suitable habitat for nesting. Records of Boat-tailed Grackles have been made in fall, winter, or spring in each hiatus, as well as in many other localized areas where they do not regularly occur in summer. In northwest Florida breeding has been reported once near Pensacola (Weston 1965:122)—the only "intimation of probable breeding" in Weston's 48 years of observation—and Panama City, where one breeding record and three summer records are known (Hallman, journal). Since 1957 neither I nor other observers have found the species near Panama City in the breeding season.

As the Boat-tailed Grackle has a breeding range from southern New Jersey to southeastern Texas, at least near the coast, the three hiatuses described above divide the species into four geographically discrete populations (Fig. 2). Within and outside the breeding range of each of the four populations, however, the species is by no means evenly distributed, either geographically or seasonally. I have noticed this uneven distribution in southeastern Louisiana, southwestern Mississippi, coastal Alabama, and northwestern Florida. On the Mississippi coast, Burleigh (1944) saw many birds in fall, late winter, and spring and collected 15 specimens, but recorded the species in summer only at Bay St. Louis. In the Florida Panhandle, Weston (1965), near Pensacola, and Hallman (journal), Bay County, saw the species several times during the non-breeding season. On the south side of Choctawhatchee Bay, Florida, Worthington and Todd (1926:217) collected two males from a flock of 20 birds, "mostly females," on 4 and 5 May 1903, but this fact is not necessarily indicative of breeding there, especially in view of the fact that the flock was "evidently about to go to roost." On several occasions I have seen a few individuals in the first half of May at locations where I knew the species did not nest. Thus the occurrence of the species in winter and spring in areas where it is not known to breed indicates beyond doubt that populations of Boat-tailed Grackles along the Gulf Coast disperse after the breeding season.

In recent years *Q. m. torreyi* has been found in winter south of its breeding range. Light-eyed birds, usually males, have been reported at Cocoa (Robert Barber, pers. comm.) and Lakeland (John Edscorn, pers. comm.). In 1973 at St. Augustine (about 55 km south of the breeding range of *torreyi*), Geoffrey Carleton (*in litt.*) watched a small group of pale-eyed males, one of which remained as late as 19 March. Carleton and I collected a pale-eyed male there on 4 March 1972 (TT 3282) that was typical of *Q. m. torreyi* in all measurements and ratios. The fact that birds of this race migrate for some distance into Florida may account for earlier statements that adult grackles there have pale irides. However, it seems doubtful that individuals of *Q. m. torreyi* have occurred as far south as Punta Gorda (see Sprunt, 1933 and Pennock, 1931). In any event, no pale-eyed birds are known to breed or summer in Florida south of Duval County.

The question of how long the four breeding populations have been isolated is difficult to answer. In some parts of each hiatus, marshes have been drained or otherwise deleteriously altered, although in each case some suitable habitat still remains. However, I know of no evidence that Boat-tailed Grackles have ever nested in these areas. In the area of Jacksonville, Florida, the hiatus now lies farther south than it formerly did, due to a range expansion of *Q. m. torreyi* and a concurrent range contraction of the Florida form, *Q. m. westoni*. The latter form last nested in Duval County in 1932, and *torreyi* became established there in 1940, with a sporadic nesting in 1931 (Grimes, *in litt.*). With the absence of the species from suitable intermediate areas, gene flow between populations must be constrained, permitting the evolution of populations differing in iris color and other characteristics.

Morphological Methods

In 1965 Frank L. Chapman and I began a study of Boat-tailed Grackles, using specimens borrowed from various museums and collecting additional breeding adults from Florida and Alabama. After Chapman completed his portion of the study (1967), his data were lost in a fire. I resumed the study, collecting in Mississippi and southeastern Louisiana, although Chapman and others took some of the new measurements. Except for specimens collected by Selander and Giller in Texas and Louisiana, most of the labels on specimens taken prior to 1965 did not indicate the bird's weight or its iris color. Thus in each population these characters are represented by fewer individuals than are the measurements.

Except for a few specimens of *Q. m. torreyi* collected in late March, only specimens taken between 10 April and 10 July were used for morphometric comparisons, as it was assumed that nearly all individuals would be on their breeding grounds during that period. Birds collected within a given 3-month period should also show less variation in weight and measurements than those collected at various times of the year.

Care was taken to eliminate all specimens thought to represent first-year birds. It is not clear whether this procedure was followed in some previous studies of the species (e.g., Sprunt, 1934). Little difficulty was encountered in separating the dull-black younger males from the glossy breeding adults, but distinguishing first-year females from adults is at times difficult.

The following measurements were taken whenever possible: wing length (chord), tail length, bill length from nostril, bill depth at nostril, tarsal length, and, in most specimens, hind-claw length. Birds collected after 1970 were weighed to the nearest gram.

Iris color was recorded for each specimen immediately after collecting. As a rule, I made no distinctions between shades of light or dark, although the color in pale-eyed birds has been variously called white, yellow, cream, straw, lemon, etc. Such fine distinctions can hardly be made in the field, but an attempt to categorize them on a limited basis is described below. Coloration of the plumage was compared among the many specimens collected in spring and early summer. Also, 13 adult females were collected in 1975 and 1977 in order to compare fall plumage coloration among a larger number of fall-collected specimens to be borrowed from museums, but only three such specimens could be obtained.

Univariate comparisons of the means among populations were made by using the Statistical Package for the Social Sciences (SPSS; Nie et al., 1974) program t-test. This is a student's t-test procedure that produces pooled and separate variance estimates of t and an F-test for testing for equality of variances among groups. In all cases, groups were found to have equal variances ($P > .05$). Therefore pooled variance estimates of t were used.

Discriminant function analyses were used to test the ability of the mensural characters, taken together, to distinguish the populations. The SPSS program DISCRIMINANT was used. A stepwise algorithm that chooses variables so as to maximize D^2 (the Mahalanobis distance) between groups was used. Although differences in color of iris were almost absolute, *no value was entered* to represent this characteristic. (See Table 2.)

Results

Color of iris.—Selander's statement (1958:368) that "iris color is variable geographically . . . and should be carefully investigated" was a cogent observation. Probably the reason its importance had previously escaped attention (or had been misused) was the confusion resulting from erroneous

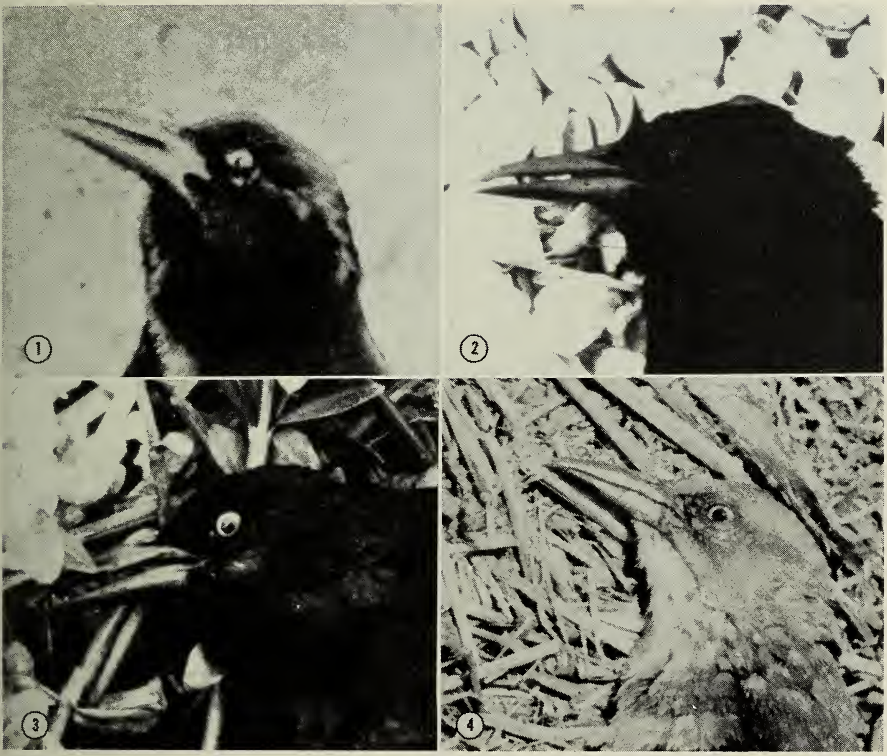

Fig. 1. Iris color of freshly collected Boat-tailed Grackles. 1. Male, *Q. m. torreyi*, Duval County, Fla.; 2. Male, *Q. m. major*, east of New Orleans; 3. Male, *Q. m. alabamensis*, Mobile Bay; 4. Female, *Q. m. alabamensis*, Mobile Bay.

statements about eye color. Some of the bases for such misunderstandings were (1) differences of eye color in adults and first-year birds, (2) examination of wintering individuals rather than those known to breed in the area, (3) light color of the nictitating membrane, which males may draw across the eye for brief periods (Chapman, 1967), (4) temporary contraction of the iris by displaying males (McIlhenny, 1937), (5) light reflection, and (6) confusion with the Common Grackle (*Quiscalus quiscula*). However, when adults were examined during the breeding season, either in life or shortly after collecting, both sexes of each population proved remarkably constant as to iris color, and this color contrasted with that of the adjacent populations as described below.

The marked difference in eye color (Fig. 1) was originally the chief basis for dividing the species into two populations. In fact, however, there are two distinct allopatric populations for each eye color, so that four population units may be separated. These are: pale-eyed birds on the Atlantic

Coast from Duval County, Florida, northward (*Q. m. torreyi*); dark-eyed birds inhabiting the remainder of the Florida Peninsula (*Q. m. westoni*); pale-eyed birds on the coast of Alabama and southeastern Mississippi (described below); and dark-eyed birds along a coastal strip from southwestern Mississippi to southeastern Texas (*Q. m. major*).

Preliminary indications are that the light-eyed and dark-eyed populations may differ in plumage coloration and weight. Most of the 8 females collected in the fall of 1975 and 1977 (5 from the range of *torreyi* and 3 from the breeding grounds of the Alabama form) were paler on the belly, less intensely brownish on the breast, and darker on the head and upper back (with some iridescent greenish on the upper back) than the 3 fall specimens of *Q. m. major* and the 6 specimens of *westoni*, even though some of the latter two groups were collected 5–37 years earlier. In most individuals of the much larger but more worn series collected in the breeding season some indication of these differences remains. The pale-eyed birds also average slightly heavier than the dark-eyed birds (but the sample size is quite small in *torreyi*), and they have thicker bills (ratio of bill depth to bill length; see Table 1).

The subject of eye color in immature Boat-tailed Grackles has been largely ignored, and my collecting efforts have been directed toward adults only. Field observations, as well as the few specimens examined, show that juvenals of all populations have dark irides. Selander (1958) indicated that first-year birds of the normally pale-eyed Great-tailed Grackle, *Quiscalus mexicanus*, are brown-eyed in juvenal plumage, but the eye color changes to yellowish from August to late winter. There is no indication that juvenals of *Q. major torreyi* and the Alabama population transform much later in the season, therefore definitive eye color should be reached in all populations of *Q. major* by the age of 10 months.

Univariate Analyses

Tail/wing ratio.—In general, tail length in *Quiscalus major* increases from east to west, being least in *Q. m. torreyi* and greatest in *Q. m. major.* However, males of the Alabama population have shorter tails than those of *Q. m. westoni.* Relative wing length in the four populations was just the reverse—greatest in *Q. m. torreyi* and least in *Q. m. major.* As a consequence, there was a strong cline in the tail/wing ratio. Measurements, weights, and ratios are summarized in Table 1.

Bill measurements and ratios.—Bill length, in both sexes, is greatest in *westoni* and least in *torreyi*, thus not clinal. Bill depth is clinal in males, being greatest in *torreyi* and least in *major*; in females, the dark-eyed populations have more slender bills than the light-eyed ones. In average ratio of depth to length, both sexes of the pale-eyed populations have higher ratios

Table 1. Summary of measurements, ratios, and standard deviations in four populations of adult Boat-tailed Grackles.

	torreyi (22)			*westoni* (47)			*alabamensis* (16)			*major* (55)		
Males	Range	mean	SD	Range	mean	SD	Range	mean	SD	Range	mean	SD
Tail length	147–175	(163.5)	7.94	151–181	(169.6)	7.31	153–179	(167.3)	6.93	155–194	(174.3)	7.91
Wing length	176–192	(181.2)	3.88	171–188	(180.4)	3.48	169–191	(177.3)	5.63	165–188	(175.6)	6.15
Tail/wing	.821–.966	(.902)	.040	.854–.989	(.939)	.032	.895–1.017	(.944)	.032	.904–1.078	(.991)	.038
Bill length	26.2–35.1	(29.82)	1.92	29.4–36.5	(32.47)	1.82	28.8–32.3	(30.48)	1.05	28.0–34.0	(31.18)	1.34
Bill depth	11.5–13.5	(12.71)	0.55	11.5–13.6	(12.56)	0.62	11.6–12.9	(12.38)	0.43	10.5–13.8	(12.25)	0.66
Bill ratio	.356–.459	(.428)	.026	.348–.432	(.387)	.024	.385–.448	(.406)	.020	.355–.450	(.398)	.022

	torreyi (19)			*westoni* (40)			*alabamensis* (16)			*major* (33)		
Females	Range	mean	SD	Range	mean	SD	Range	mean	SD	Range	mean	SD
Tail length	109–124	(118.7)	4.83	109–135	(119.6)	5.66	109–130	(121.9)	5.84	107–131	(121.3)	6.15
Wing length	131–146	(140.8)	3.58	132–147	(138.3)	3.79	130–143	(137.3)	3.46	130–148	(136.4)	4.46
Tail/wing	.787–.898	(.843)	.026	.807–.926	(.867)	.032	.826–.928	(.887)	.028	.811–.956	(.890)	.036
Bill length	22.3–25.8	(23.92)	1.07	22.8–27.7	(25.20)	1.40	23.2–25.3	(24.26)	0.67	23.2–27.5	(25.28)	1.00
Bill depth	9.7–11.5	(10.67)	0.51	9.4–11.1	(10.08)	0.36	9.7–11.3	(10.28)	0.39	9.6–10.6	(10.11)	0.30
Bill ratio	.404–.483	(.447)	.026	.365–.435	(.401)	.020	.391–.473	(.424)	.022	.358–.436	(.400)	.018

Table 2. Summary of discriminant function analyses.

Populations included	Variable	Step no.	*F* to enter	Discriminant function coefficients	
				1	2
all four, males	tail length	1	11.75122	–1.09555	.12502
	wing length	2	33.45797	1.14180	–.15146
	culmen length	3	15.99598	–.27810	–1.21348
	culmen depth	4	2.97251	.30216	.29712
all four, females	tail length	1	5.40081	–.61385	.97113
	wing length	2	7.60103	.80849	–.93508
	culmen length	3	10.57092	–.72260	–.61218
	culmen depth	4	13.81670	.85964	.38576
pale-eyed males	tail length	1	6.67007	1.01094	
	wing length	2	7.88684	–.72892	
	culmen length	3	3.85469	–.60190	
	culmen depth	4	2.70515	.47134	
pale-eyed females	tail length	1	8.71016	–1.24585	
	wing length	2	26.85724	1.49316	
	culmen length	3	3.02168	.41996	
	culmen depth	4	.67485	–.20151	
dark-eyed males	tail length	1	32.98015	–1.08357	
	wing length	2	43.20331	.95050	
	culmen length	3	10.18270	–.48391	
	culmen depth	4	.02125	–.02267	
dark-eyed females	tail length	1	4.00067	1.18172	
	wing length	2	8.02715	–1.00978	
	culmen length	3	.11138	–.12477	
	culmen depth	4	.02706	.05763	

than those of the dark-eyed populations, with *torreyi* considerably higher than the Alabama birds (Table 1).

Tarsal length.—Although mean length of tarsus in each sample tended to vary with over-all size, there were many exceptions. As the taking of this measurement is more subject to error than some others, I am not sufficiently confident of the results to use them in separating populations.

Student's t*-test.*—The results of these tests appear in Table 3, showing one or more significant differences ($P = < .05$) between any two populations (both sexes). The least significant of these is wing length among dark-eyed females ($P = .049$), but dark-eyed males differed significantly in all four measurements ($P = 0.001$–0.18).

Table 3. Significant *P*-values obtained from *t*-tests among four populations of *Quiscalus major* (BL, bill length; BD, bill depth).

Population	*torreyi*		*westoni*		*alabamensis*	
Males						
Q. m. westoni	tail	.003				
	BL	<.001				
Q. m. alabamensis	wing	.014	wing	.010		
	BD	.001	BL	<.001		
Q. m. major	tail	.001	tail	.003	tail	.002
	wing	.001	wing	<.001		
	BL	.010	BL	<.001		
	BD	.005	BD	.018		
	westoni		*alabamensis*		*major*	
Females						
Q. m. torreyi	wing	.019	wing	.006	wing	.001
	BL	.001	BD	.017	BL	<.001
	BD	<.001			BD	<.001
Q. m. westoni			BL	.013	wing	.049
Q. m. alabamensis					BL	.001

Multivariate Analyses

Discriminant function analyses.—The first analyses compared all four geographic groups, analyzing males and females separately, as to wing length, tail length, bill length, and bill depth (Table 2). The results of these analyses appear in Table 4 and are based on the same individuals that appear in Table 1. With similar sample sizes, and based on chance alone, such a test should place only 25% of the individuals in any given population, but sample size varied from 16–55. In all four races, the computer correctly assigned more than 60% of the males to the population from which they came. The "correct" assignment of females was more than 80% in *Q. m. torreyi* and more than 40% in each of the other 3 races. More females of each population were referred to the "right" population than to any of the other 3 populations.

Two other analyses were used to determine the degrees of difference between geographically disjunct populations with similar eye color. The same four measurements were entered separately for each sex of *Q. m. torreyi* and the Alabama population, then for *Q. m. westoni* and *major*. In the pale-eyed populations (Table 5) more than 85% of the individuals in

Table 4. Reclassification section of discriminant function analysis of four populations of *Quiscalus major*, based on wing, tail, and bill measurements.

	torreyi	*westoni*	*alabamensis*	*major*	Scored "right"
Males					
Q. m. torreyi	*17* (77.3%)	2 (9.1%)	3 (13.6%)	0 (0.0%)	17/22
Q. m. westoni	5 (10.6%)	*31* (66.0%)	8 (17.0%)	3 (6.4%)	31/47
Q. m. alabamensis	2 (12.5%)	2 (12.5%)	*10* (62.5%)	2 (12.5%)	10/16
Q. m. major	1 (1.8%)	5 (9.1%)	8 (14.5%)	*41* (74.5%)	41/55
Females					
Q. m. torreyi	*16* (84.2%)	2 (10.5%)	1 (5.3%)	0 (0.0%)	16/19
Q. m. westoni	3 (7.5%)	*17* (42.5%)	8 (20.0%)	12 (30.0%)	17/40
Q. m. alabamensis	3 (18.8%)	2 (12.5%)	7 (43.8%)	4 (25.0%)	7/16
Q. m. major	1 (3.0%)	6 (18.2%)	9 (27.3%)	*17* (51.5%)	17/33

each sex were scored "right" except for males of *torreyi* (81.8%). In the dark-eyed races (Table 6) more than 80% of the males were correctly assigned, but among females only about 65–70% were referred to the group from which they came.

Another discriminant function analysis added weights to the measurements previously compared among dark-eyed populations. Although the number of weighed individuals of *westoni* was relatively small, the results probably indicate a true difference among males. Among females, 11 of 15 *westoni* (73.3%) and 24 of 27 *major* (88.9%) were correctly placed. However, all but 3 specimens of *major* were collected late in the breeding season (2–10 June) and were probably underweight. Even so, the 6 females of *westoni* that were collected in June and July averaged slightly heavier than those of *major*. Among males no such disparity in dates of collection existed, as no weighed specimens of either population were collected earlier than June. Yet the average difference in weight was just as great as among females, and the computer referred all 10 specimens of *westoni* correctly and 30 of 31 *major* (96.8%).

Table 5. Reclassification section of discriminant function analysis of light-eyed populations of *Quiscalus major*, based on wing, tail, and bill measurements.

	torreyi		*alabamensis*		Scored "right"
Population	males	females	males	females	(both sexes)
Q. m. torreyi	*18* (81.8%)	*17* (89.5%)	4 (18.2%)	2 (10.5%)	35/41 (85.4%)
Q. m. alabamensis	2 (12.5%)	2 (12.5%)	*14* (87.5%)	*14* (87.5%)	28/32 (87.5%)

Table 6. Reclassification section of discriminant function analysis of dark-eyed populations of *Quiscalus major*, based on wing, tail, and bill measurements.

Population	*westoni*		*major*		Scored "right"
	males	females	males	females	(both sexes)
Q. m. westoni	*41* (87.2%)	*27* (67.5%)	6 (12.8%)	13 (32.5%)	68/87 (78.2%)
Q. m. major	9 (16.4%)	10 (30.6%)	*46* (83.6%)	*23* (69.7%)	69/88 (78.4%)

Quiscalus major torreyi Harper

Francis Harper (1934) correctly described the population along the Atlantic Coast north of Florida as differing from others of the species in having a longer wing and a "pale yellow iris." Adult males were said to be "more uniform" in the color of the back, breast, and abdomen than those of other populations, but I have been unable to substantiate this. Wing length was said to average more than 180 mm in males and more than 140 in females. Although I have not seen the type specimen (ANSP 101543), from Chincoteague, Virginia, Harper's measurements of it are well within the extremes of that population. In addition to iris color, *Q. m. torreyi* is best separated from other races by a low tail/wing ratio and a high ratio of bill depth to bill length (Fig. 7; Table 1; also note thicker bill in Fig. 3). The former ratio is somewhat clinal, averaging higher in birds from South Carolina southward.

Harper gave no indication of the number of localities from which other specimens were examined, the seasons in which they were collected, or the range of variation in *Q. m. torreyi*, but the means he gave agree well with those I obtained. The range of the subspecies was said to extend southward "to southern Florida," including "Collier County" (Gulf Coast), but without reference to time of year. Duval County, Florida, however, is presently its southern breeding limit. It is doubtful whether this form reaches south Florida even in winter. Sight records of pale-eyed birds farther south in winter could probably represent either of the pale-eyed populations. Harper's erroneous range statement was based on reports of pale-eyed birds in south Florida by Sprunt (1932, 1933) and Pennock (1931). Samuel Grimes (*in litt.*) has indicated that this pale-eyed form extended its southern breeding limit southward from Nassau County to Duval County around 1940, and these are still the only Florida counties in which it is known to breed or summer. It is virtually restricted to the coast throughout its range, but Burleigh (1958) mentioned reports of breeding in inland Brantley County, Georgia, and in the Okefenokee Swamp. Eugene Cypert (*in litt.*), however, worked in the Okefenokee National

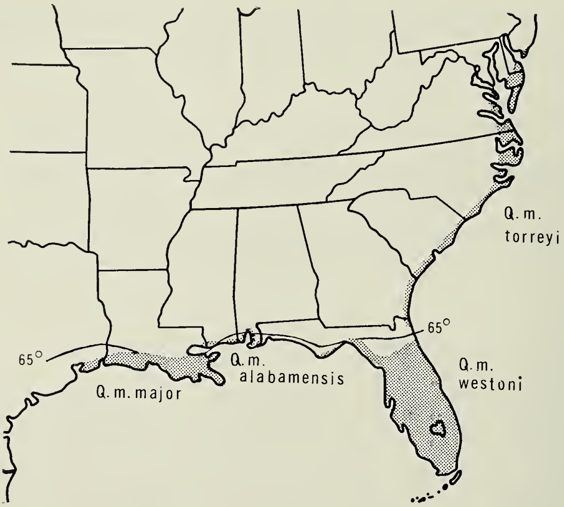

Fig. 2. Distribution of the populations of *Quiscalus major* in relation to the average minimum temperature for 21–27 May (Visher, 1954; Fig. 132).

Wildlife Refuge for years without ever encountering Boat-tailed Grackles. It is possible that such inland breeding records, if valid, may represent the dark-eyed Florida population.

Quiscalus major westoni Sprunt

The original description of this form (Sprunt, 1934) has not been widely accepted, probably because of several shortcomings in the diagnosis. In fact, the describer himself (Sprunt, *in* Bent 1958) later included the race in *Q. m. major*. Even though the type specimen (CH 256, formerly 34.86.1, a male from the St. Johns River marshes, Indian River Co., Fla.) was collected in winter, thus could have been a migrant, the fact that it had dark irides virtually eliminates the possibility that it belonged to a more northern population. Furthermore, my measurements of the specimen indicate a typical Florida bird. As my measurements (and those of Albert Sanders for the hind claws) differ from those cited by Sprunt, they are given here (mm): wing, 170; tail, 182; tarsus, 53; exposed culmen, 43; depth of bill at nostril, 12.0; bill width, 9.3; hind claw, 17.2. In tail/wing ratio (.934) the type specimen is very close to the average for males of *westoni* (.939). Sprunt also characterized *westoni* as having a "longer and more slender bill," and it would be difficult to find a more striking example of that combination than the type-specimen. In length from nostril, its 36.9 mm is by far the greatest of any specimen I examined, and the ratio of depth to length (.325) is the lowest of any (see Fig. 3). Correspondingly, the

Fig. 3. Comparative bill dimensions in *Q. m. torreyi* (right) and *Q. m. westoni*, type specimen (left); both specimens in Charleston Museum.

lowest ratio for a male of *torreyi* was .359. These same dimensions, ratios, and eye color also indicate that the bird was not a stray from Alabama. There is, in fact, no evidence that other races of Boat-tailed Grackles migrate as far south in Florida as the type locality of *westoni.*

Sprunt listed one characteristic of *Q. m. westoni* as "claws longer," citing measurements for the hind claw and middle claw of *westoni* and "*major.*" I did not find this a useful character. There is considerable individual variation in claw length within each population, the shorter claws being blunt and the longer ones sharp, strongly suggesting differential wear. Hind-claw length can hardly be considered a reliable criterion for any race of Boat-tailed Grackles.

With light-eyed populations occurring both to the north and to the west, the best characteristic of *Q. m. westoni* is the almost invariably dark irides of adults. Every individual of *westoni* I have observed in the field showed only dark pigment in the iris. Chapman, however, collected one (FSU 6860.lae) at Lake Panasoffkee, Sumter County, on 11 May 1967, and indicated on the label that the iris had a light periphery, but I had no opportunity to examine it. During the debate regarding the eye color of Florida's breeding Boat-tailed Grackles, observers who agreed that it was always dark were Brooks (1928 and 1932), Townsend (1931), Nicholson (1932), and Shannon (1934). Sprunt, after describing (1933) an anomalous distribution of coastal "yellow-eyed males" and inland "brown-eyed females" in the Florida Peninsula in February and March 1932, modified the statement later. In his description of *Q. m. westoni*, Sprunt (1934) made no reference to light-eyed birds in Florida but stated that "*major*" occurred along the coast in winter. Assertions by others (Pennock, 1931; Bailey, *in* Sprunt, 1932) that Florida's *breeding* birds had pale irides are perhaps best attributed to faulty memory. The extent to which pale-eyed birds of other races winter in Florida is still uncertain. I have rarely seen light-eyed birds in the field south of the known range of *torreyi*, but most of my work in the Peninsula has been done in summer. It seems unlikely that individuals of the pale-eyed populations would reach south Florida.

There have been some changes in the known range of *westoni* since 1939. On the Atlantic Coast, where it formerly nested north to the mouth of the St. Johns River (Grimes, *in litt.*, 17 March 1975), it now is unknown north of St. Augustine. The western limit at which dark-eyed birds are known to breed is St. Vincent Island, Franklin County. They also breed regularly in the interior as far north as Lake City and, at least occasionally, ENE of Live Oak, Suwannee County, where I found a family group within 33 km of the Georgia line, 9 July 1971, and collected an adult female (Ogden, 1971). Dark-eyed grackles occasionally reach the Tallahassee area, and one pair nested at Lake Jackson, Leon County, in 1959 (juvenal collected; Stevenson, 1959). Other records in that part of the state have involved only males and range from March to November. Eye color was not recorded for single birds near Thomasville, Georgia (55 km NE of Tallahassee), on 15 August 1959, 15 December 1964, and 26 December 1971 (Crawford and Dozier, 1973). West of Tallahassee there seem to be no inland records of this grackle.

Although the occurrence of Boat-tailed Grackles on the Florida Keys has not been proven, an occassional stray in winter seems likely. J. W. Atkins reported "a few stragglers" at Key West in September and October, 1887–88 (Scott, 1889:321), and Brodhead (1910) reported the species on the Keys "in March." Fowler (1906), however, under the heading of "*Quiscalus major.* Black Bird," stated that "several brown birds [females], apparently this species, were seen on Summerland Key in *June* 1904" (italics mine). Howell (1932:432) apparently had no personal records from the Keys, but stated, without reference to season, that this grackle was "reported from most of the Keys as far south as Key West." It is almost certain that the species has not occurred on the Keys during the breeding season in recent years. On the lower Keys, Greene (1946) had no record at any time of the year, and Hundley and Hames (1962:80) referred only to Howell's (1932) statement. The species has not been listed on any Christmas Bird Count on the Keys (Key Largo to Key West).

Quiscalus major alabamensis subsp. nov.

Holotype.—Adult male (USNM 567736); Baldwin County, Alabama (upper Mobile Bay), 4.5 km E of Mobile, 21 April 1971; Henry M. Stevenson; original number FSU 6860.3i.

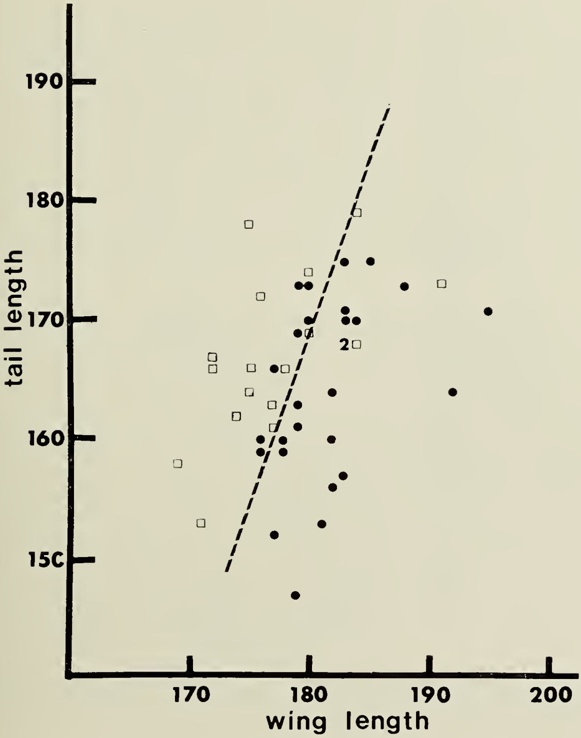

Fig. 4. Wing and tail lengths of males of *Q. m. torreyi* (●) and *Q. m. alabamensis* (□). The numeral 2 represents two specimens of *torreyi*.

Measurements of holotype.—Tail, 174 mm; wing, 180; exposed culmen, 37; bill length from anterior margin of nostril, 28.8; bill depth at mid-nostril, 12.5; bill width at mid-nostril, 9.2; tarsus, 49; hind claw (straight line from dorsal insertion), 15.6; weight, 206 g.

Allotype.—Adult female (USNM 567737); same collection data as for holotype; original number, FSU 6860.3m.

Diagnosis.—Plumage coloration of males as in other populations, of females close to that of *Q. m. torreyi*. Iris mostly pale (cream, straw, or yellowish), but with a narrow, dark margin around pupil. Tail length 89–102% of wing length in males (.934), 82–93% in females (.888). Bill deeper than in *Q. m. westoni* and *Q. m. major*, but not as deep as in *Q. m. torreyi* (depth at center of nostril .385–.448 of length from nostril in males, mean .408; .391–.473 in females, mean .424). Averaging heavier than *Q. m. westoni* and *Q. m. major*—males 187–238 g (207.8), females 96–123 g (97.9). Similar in size to *Q. m. torreyi*, but differing in a slightly smaller depth-to-length ratio of bill and a larger tail/wing ratio (Table 1 and Figs. 4 & 5). Chapman

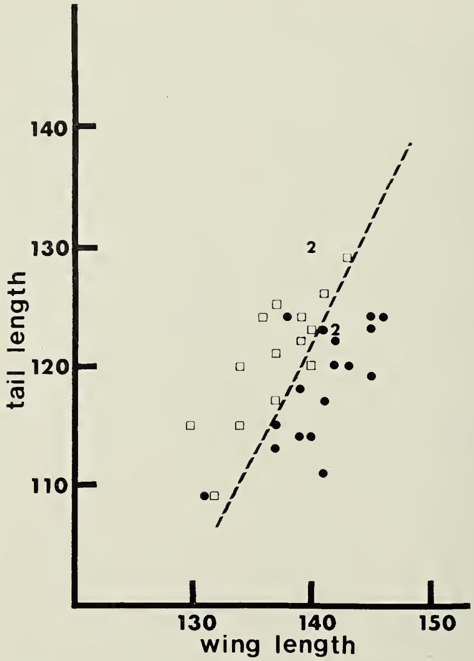

Fig. 5. Wing and tail lengths in females of *Q. m. torreyi* (●) and *Q. m. alabamensis* (☐). Numbers refer to specimens of *torreyi* (right of line) and *alabamensis* (left of line).

(1967) included this population with *Q. m. major* and did not examine specimens from west of Mississippi. (See also Taxonomic Status.)

Measurements.—Adult males (17): tail, 153–179 (167.0) mm; wing, 169–191 (177.1); bill length from nostril, 28.8–32.3 (30.48); bill depth at nostril, 11.6–13.5 (12.44); tarsus, 48–52 (50.0). Adult females (16): tail, 109–130 (121.9); wing, 130–143 (137.3); bill from nostril, 23.2–25.3 (24.26): bill depth at nostril, 9.7–11.3 (10.28); tarsus, 40–43 (40.9).

Distribution.—Resident along the coast of the mainland of Alabama and Mississippi west to Gautier, Jackson County, Mississippi; most abundant in upper Mobile Bay; also present on Horn Island, Mississippi, and probably on Petit Bois Island, Alabama; probably wanders to NW Florida and has nested there sporadically. Status on other Mississippi islands uncertain.

Adult specimens examined (breeding season).—Alabama: upper Mobile Bay, 22; "Mobile Bay," 2; Alabama Port, 1; Florida Point, 1. Mississippi: Gautier, 4; Horn Island, 3.

Remarks.—Grackles nesting along the mainland coast of Alabama to the Pascagoula area and Horn Island in Mississippi are isolated from other breeding populations. They differ from the closest breeding populations to the east and to the west in iris color, which is dark in *Q. m. westoni* and *Q. m. major.* In *alabamensis* the iris of adults is almost invariably pale, both as it appears in the field and in the hand, because the light periphery of the iris is wider than in *major* (in which it is often lacking). Only near Pascagoula and on Horn Island, where the population comes closest to dark-eyed *major* (about 62 km to the west), were partial exceptions noted. One of 4 specimens collected near Pascagoula had yellowish brown irides, and one of 2 collected on Horn Island had dark flecks in the otherwise pale irides. Four specimens collected by others in the range of *alabamensis* had no indication of iris color on the labels, but all of the remaining specimens were pale-eyed.

West of Alabama, Burleigh (1944) collected Boat-tailed Grackles on the Mississippi coast and islands, both in the breeding range of *alabamensis* and in that of *major.* He informed me (*in litt.*, 7 August 1972) that all specimens he handled were dark-eyed, but the only one collected during the breeding season (6 June 1936, Bay St. Louis) was in the breeding range of *major.* Boat-tailed Grackles nest on Petit Bois Island, Alabama (Howell, 1924) and apparently on certain islands off Mississippi. The 3 adults I have examined from Horn Island have measurements and ratios somewhat intermediate between those of *major* and of *alabamensis.* I think it probable that any Boat-tailed Grackles nesting on Horn and Petit Bois Islands will prove referable to *alabamensis*, but the identity of any that may nest on Cat and Ship Islands, Mississippi, is conjectural.

On 22 April 1974 Melford Smith and I searched the Mississippi mainland between Gautier and St. Louis Bay in areas apparently suitable for Boat-tailed Grackles and saw only one wary female near Ocean Springs, possibly a late migrant. None was found on Deer Island, but we did not visit the more distant islands. I doubt that the species breeds regularly or frequently in this mainland hiatus, even though Smith (*in litt.*, 18 Feb. 1975) noted single birds at Ocean Springs on 9 May and 1 June 1974.

Because *Q. m. torreyi* and *Q. m. alabamensis* are similar to *Q. mexicanus* in size and iris color, the question of their degree of relationship to that species might well be raised. Everything I have observed of their courtship displays, nesting habits and habitat, and vocalizations, however, leads me to consider them typical of *Quiscalus major.* Although my ear is more discriminating than that of many observers, and I am more impressed by the differences than the similarities in the vocalizations of *major* and *mexicanus*, I have noted no differences in voice among the various populations of *Q. major.*

Quiscalus major major Vieillot

As the type specimen of this race was collected in Louisiana (New Orleans?) in May, it may be assumed that it represented the race now breeding there. Measurements obtained by Chapman and me agree well with those made by Lowery (1938) and by Selander and Giller (1961) for portions of this population. The iris of specimens I collected at the eastern edge of the range (Orleans Parish, La.; Harrison Co., Miss.) appeared dark both in the field and in the hand, although surrounded by a narrow periphery of gold. This eye color is in keeping with that described by the authors listed above, and its range of variation has been depicted by Pratt (1974). The iris never shows as much light color as Pratt's figures of the Great-tailed Grackle (*Q. mexicanus*) nor as much as the specimens of *Q. major alabamensis* or *Q. m. torreyi* that I have seen. Thus Sprunt's statement (1934:3,5) that the population in Louisiana and Texas was "yellowed-eyed" is in error.

Of all the races of Boat-tailed Grackles, *Q. m. major* has the longest tail and largest tail/wing ratio. The latter value showed a mean of .991 in males and of .893 in females. Corresponding ratios obtained by Lowery (1938) in the New Orleans area were 1.000 and .939. Only 2 males of any other races attained a ratio as high as 1.000. In any case, this value averages higher than 1.000 in Texas males and decreases clinally in that sex from west to east.

Both sexes of *Q. m. major* resemble *westoni* in having a more slender bill than do the pale-eyed races, but the difference in males of *major* vs. *alabamensis* (.395 and .408) is slight.

Q. m. major weighs less than the other populations. The weights of males recorded on Selander and Giller's museum labels are very similar to those I obtained, but the females I collected were heavier. This difference may have been due either to the small size of my sample, the early dates of collections (April), or may represent an east-west cline, as mine were collected east of the Mississippi River. In any case, the small size of the Texas birds, especially, may serve as a character reinforcement where they are sympatric with the larger *Quiscalus mexicanus.*

Records in the Florida Panhandle

Observers who have seen Boat-tailed Grackles occasionally in northwest Florida, where the species has rarely nested, include Weston (1965), Hallman (journal), H. and A. Gaither (Purrington, 1970), and Stephen Stedman (pers. comm.). Of these, only Hallman referred to eye color ("males with light eyes" on four dates ranging from 9 February to 13 October). Hallman made no mention of eye color in females. Other writers, in fact, have implied that pale irides occur only in males. Females of the same races, however, also have a pale iris, but it is less conspicuous in the field than that of males.

Farther east, in the range of *westoni*, light-eyed Boat-tailed Grackles sometimes appear in the nonbreeding season. Few such grackles have been

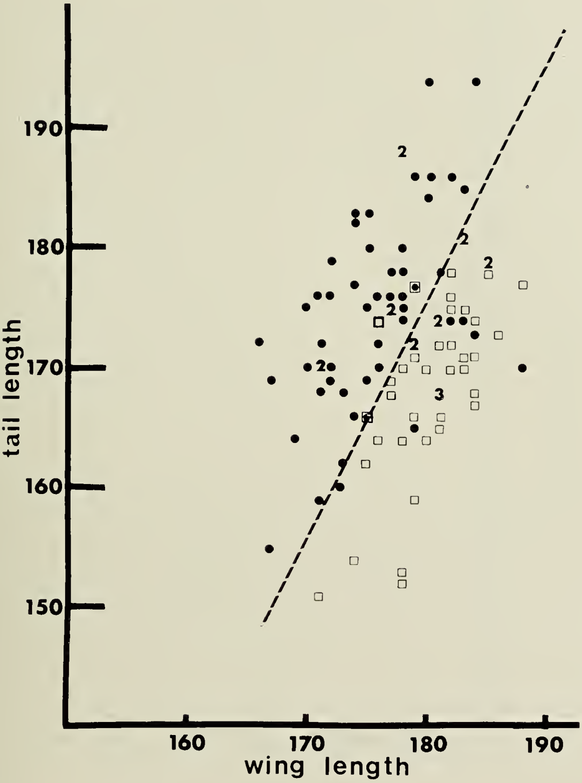

Fig. 6. Wing and tail lengths in males of *Q. m. westoni* (□) and *Q. m. major* (●). Numbers to the left of line represent *major*, those to right represent *westoni.*

collected, and they are not clearly referable to any of the populations described above. One male that appeared pale-eyed in the field (TT 3489) had a pale peripheral portion of the iris measuring 0.7+ mm in diameter as opposed to pale peripheries of 1.0+ and 1.4+, respectively, in specimens of *alabamensis* and *torreyi* collected in their breeding ranges at the same time of the year.

The probability that there is a migration of Boat-tailed Grackles into coastal areas near Tallahassee is suggested by minor changes in the relative abundance of the species at different seasons of the year.

Cumulative data for September 1946 through August 1975 showed higher "frequencies" (birds per hour afield) for the months of September–March (3.3–4.4) than for April–August (2.7–3.6). Fall nesting of this species, although reported in south and central Florida (Kale, 1975; Riddell, 1976),

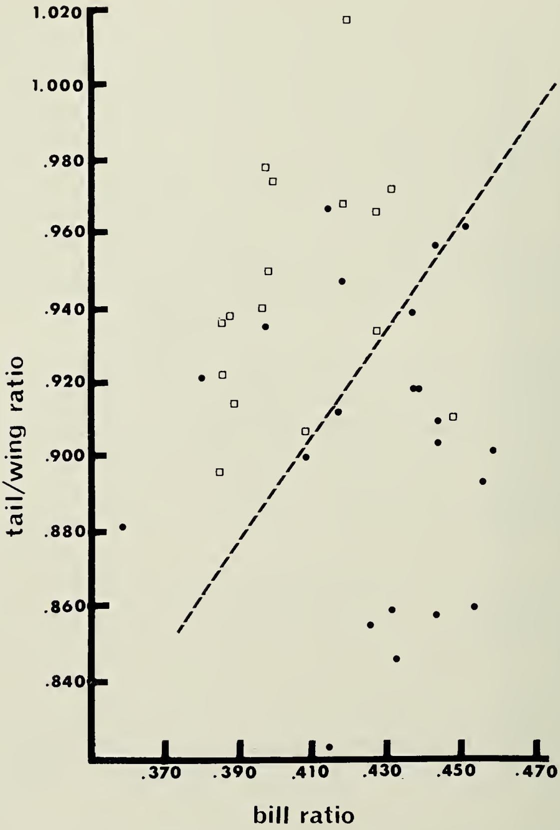

Fig. 7. Tail/wing ratios and bill ratios of pale-eyed males—*Q. m. torreyi* (●) and *Q. m. alabamensis* (□).

almost certainly does not occur along the northern Gulf coast. Most young of the species are on the wing by July, in which month a sharp increase of frequency was noted. Thus the fall increase probably reflects an influx of migrants.

Immatures

Although the results described above are based on adult birds, which were distinguished from first-year birds on the criteria of Selander (1958), it is interesting that my smaller sample of first-year specimens tends to support the same conclusions. Among males, for example, 6 specimens from Alabama and Florida are heavier than 5 from Texas and Louisiana (Selander and Giller, 1961), the respective means being 176.2 and 166.8 g, and the only female *westoni* weighed 102 g, as against an average of 96.3 g for 15 females of *major* weighed by Selander and Giller. The 9 males from Alabama and Florida averaged lower in tail/wing ratio than the 5 Texas birds. The 5 females from Alabama and Florida were correspondingly lower in this ratio than the 15 from Texas and Louisiana. The 2 first-year females of *torreyi* have a higher average bill ratio than the 3 specimens of *westoni* and *major*. Three first-year males of *torreyi* have thicker bills (mean 12.3 mm) than 5 *westoni* from north Florida (11.5). Among the three more eastern races, however, the tail/wing ratio of first-year birds does not fully support the data derived from adults. Nevertheless, the facts that these immatures, even though small in number, generally tend to corrobaorte the differences found in adults strengthens the evidence of valid morphological distinctions among the four populations.

Taxonomic Status

Are the differences among the four populations distinguished here sufficently large to warrant subspecific recognition? Mayr, Linsley, and Usinger (1953) defined subspecies as "geographically defined aggregates of local populations which differ taxonomically from other such subdivisions of a species." There can be little doubt that the four populations of grackles meet the first of these criteria, as the breeding range of each is separated from that of the next-closest population by a hiatus of at least 55 kilometers. It has also been shown that they differ taxonomically (i.e., morphologically), the only question being whether the *degree* of the difference is sufficient in each instance. Among the requisite degrees of difference that have been used in describing subspecies now accepted in the A.O.U. Checklist are the following: (1) 90% of the individuals of one population differ from 90% of those in the other, (2) 75% of one differ from 100% of the other, or (3) 75% of one differ from 75% of the other. Probably the last of these criteria is too liberal for any two populations whose ranges meet and produce a zone of intergradation, thereby greatly increasing the number of individuals that cannot be assigned to a given population. In the four populations of Boat-tailed Grackles, however, the birds that are morphologically similar as to iris color are widely separated from one another, with a race of contrasting eye color occupying an intermediate range. Both in eye color and probably in other characteristics, the light-eyed populations are subspecifically distinct from the dark-eyed ones (see pp. 31–32). Because the pale-eyed *Q. m. torreyi* and the dark-eyed *Q. m. major* are the two races presently, and justifiably, accepted, the only remaining question is whether each of these should be regarded as a single subspecies or consists of two subspecies as described above.

The case for nomenclatural recognition of *Q. m. alabamensis* is relatively strong. In both sexes, the tail averages longer than in *torreyi* and the wing shorter, making for a markedly greater mean tail/wing ratio. In Figure 4, tail length is plotted against wing length in males and a sloping line arbitrarily drawn to give the maximal separation into the two forms; 21 specimens of *torreyi* (75.0%) lie to the right of this line and only 7 to the left. Reciprocal figures for *alabamensis* are 14 (82.4%) and 3. Females proved even more distinctive for this combination of characteristics—*torreyi*, 17:2, and *alabamensis*, 15:1. Also in *alabamensis* the bill averages longer but not so deep as in *torreyi*, resulting in a lower bill depth/bill length ratio. When this ratio is plotted against the tail/wing ratio (Fig. 7; see also Table 4), 17 males of *torreyi* (77.3%) lie to the right of the line and only 5 to the left. Reciprocal figures for males of *alabamensis* are 15 (93.7%) and 1. (The smaller numbers involved in this comparison were due to the damaged bills of some specimens.) Basically the same data are presented for females in Table 5, showing that they are equally distinctive, if not more so (87.5% in *alabamensis* and 89.5% in *torreyi*). In this discriminant function analysis, it should be noted that the sample sizes are comparable—22 and 16 in males and 19 and 16 in females. Thus, based on this combination of characteristics, more than 85% of the individuals of one population can be distinguished from more than 85% of the other, except for males of *torreyi* (77.3%). I believe that these differences are an adequate basis for proposing nomenclatural recognition of *Quiscalus major torreyi* and *Q. m. alabamensis.*

The problem of distinguishing between populations of *Q. m. westoni* and *Q. m. major* lies chiefly in the relative similarity of the females. The results shown in Table 4 indicate that a high proportion of males in any population can be separated on the combination of tail, wing, and bill measurements. When wing and tail lengths are plotted for males of *westoni* and *major* (Fig. 6), 44 *westoni* (93.6%) lie to the right of an arbitrary line and only 3 to the left; reciprocal figures for *major* are 49 (89.1%) and 6. The student's *t*-tests (Table 3) also indicate four significant differences between these two races. These same sets of data show females to be less distinctive. When differences in weight in the two populations of dark-eyed males are also taken into account (p. 11) the case for distinctiveness in that sex appears even stronger, but more weights of females collected at the same time of the breeding season are needed to validate the apparent differences in that sex. Other than weight, the best characters for separating the dark-eyed females are wing length and tail length, and the combination of these will separate only about 70% of *westoni* from 70% of *major*. Therefore, the case for recognizing *Q. m. westoni* as a taxonomic entity rests on the relative distinctiveness of its males and the population's geographic separation from the other dark-eyed population.

Adult Specimens Examined
(Including specimens collected in fall)

Q. m. torreyi (55).—Delaware: 1, USNM. Maryland: 2, USNM. Virginia: 1, AMNH; 2, ANSP; 1, CM; 9, USNM. North Carolina: 3, USNM. South Carolina: 5, CH; 2, USNM. Georgia, 1, CH; 1, USNM; 1, UF; 3, UG. Florida: 1, AMNH; 1, CH; 5, FSU; 1, USNM; 14, TT; 1, USF.

Q. m. westoni (101).—Florida: 1, ABS; 1, ANSP; 7, CM; 1, CH (type specimen); 53, FSU; 5, UM; 11, USNM; 15, UF; 7, UMMZ.

Q. m. alabamensis (37).—Alabama: 2, AMNH; 1, CH; 3, FSU; 2, LSU; 6, USNM (including holotype and allotype); 15, TT; 1, USF. Mississippi: 1, CH; 5, TT; 1, V.

Q. m. major (156).—Mississippi: 1, USNM; 2, TT; 1, USF. Louisiana: 35, AMNH; 2, CH; 18, LSU; 15, USNM; 2, TT. Texas: 80, AMNH.

Q. major subsp. (7).—Florida: 2, CM; 5, TT.

Acknowledgments

During the early stages of this study, Frank L. Chapman collected, prepared, and measured many specimens and clarified the distinctions between *Q. m. westoni*, *Q. m. torreyi*, and *Q. m. major*. Others who aided in collecting or preparing specimens were C. S. Gidden, Noel O. Wamer, and James M. Stevenson. Most records in the Florida Panhandle were obtained from the journal of Roy Hallman. Curators and other personnel in the following museums made additional specimens available: Archbold Biological Station (ABS), American Museum of Natural History (AMNH), Academy of Natural Sciences of Philadelphia (ANSP), Carnegie Museum of Natural History (CM), Charleston Museum (CH), Florida State University (FSU), Louisiana State University (LSU), University of Miami (UM), Mississippi State Museum, National Museum of Natural History, Smithsonian Institution (USNM), Tall Timbers Research Station (TT), Florida State Museum, University of Florida (UF), University of Georgia (UG), University of Michigan Museum of Zoology (UMMZ), University of Mississippi (V, Vaiden coll.), University of South Florida (USF). Roger Clapp, David Ewert, and Albert Sanders made many hind-claw measurements, and Roxie Laybourne re-checked a few measurements for me. Bruce Means' help in the grouping and arranging of photographs was highly valued, and James Capone made the photograph in Figure 3. Ed Cake, Sam Chestnut, and Melford Smith provided transportation in Mississippi. Wilson Baker and Robert Crawford concurred with me regarding plumage differences among fall females. In the area of statistics my debt to Duane Meeter and Noel Wamer is enormous. Allan Phillips read an early draft of the manuscript and made many helpful suggestions. Advice on later drafts was generously provided by M. Ralph Browning, Jerome Jackson, Richard Johnston, Storrs L. Olson, and anonymous referees. Many individuals contributed to the quantitative and other field data. A grant from Florida State University (0577) enabled me to use its computer.

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THE PLANKTONIC OSTRACODS OF THE CARIACO TRENCH AND ADJACENT WATERS[1]

Georgiana B. Deevey

Introduction

The Cariaco Trench is a depression up to 1,400 m deep in the continental shelf off the north coast of Venezuela, that is anaerobic beneath 320–375 m. Oxygen disappears and sulphides appear at between 300 and 400 m. Its waters are cut off from the Caribbean below 150 m. The water is essentially isothermal at 17°C and isohaline at 36.2‰ from ca. 400 m to the bottom (Richards and Vaccaro, 1956; Richards, 1965; Kato, 1961; Heezen, Menzies, Broecker and Ewing, 1959). Zoppi (1961) studied the vertical distribution of the zooplankton of the upper 500 m of the Cariaco Trench, and found highest volumes within the upper 100 m, but the total quantity of zooplankton was not as great as in the adjacent Gulf of Cariaco. All zooplankton groups were most abundant within the upper 100 m, although ostracods, polychaetes, copepods, and some larval forms were recorded between 100 and 300 m. Few specimens were caught between 300 and 500 m. The copepods of the upper 500 m have been studied by Legare (1964), who identified 102 species, of which 50 occurred commonly. Cervigon and Marcano (1965) collected plankton samples from the Cariaco Trench and also at a station north of the Trench between La Tortuga and Blanca Islands. From Station 11 in the Trench they enumerated the copepod species down to 500 m-depths from April 1964 to June 1965, and found maximum numbers in daytime at 50–100 m; copepods were very scarce below 150 m, except in June and July. In July oxygen was detected at all depths and copepods were more abundant at 500 m. However, living copepods were taken in minimal numbers at 500 m at all times, and it was believed that a few organisms were existing under anoxic conditions, temporarily or permanently. Cervigon and Marcano also studied the total zooplankton collected in February, March, and June 1965, and reported maximal numbers at the surface, but many species present down to 300 m, the greatest depth sampled. At Station 3 north of the Trench, comparable results were obtained for the upper 100 m, but between 100 and 300 m species not taken at Station 11 were noted.

In 1967–1968 Dr. Cervigon sampled at several stations off the Venezuelan coast: at Station 11 at 10°29′N, 64°26′W in the Cariaco Trench off Cumana, At Station 63, an inshore station, at 11°14′N, 65°00′W, and at Station 76, an offshore station, at 11°45′N, 66°56′W (see Fig. 1). The samples were collected with a giant Clarke-Bumpus sampler by horizontal tows at 0, 25,

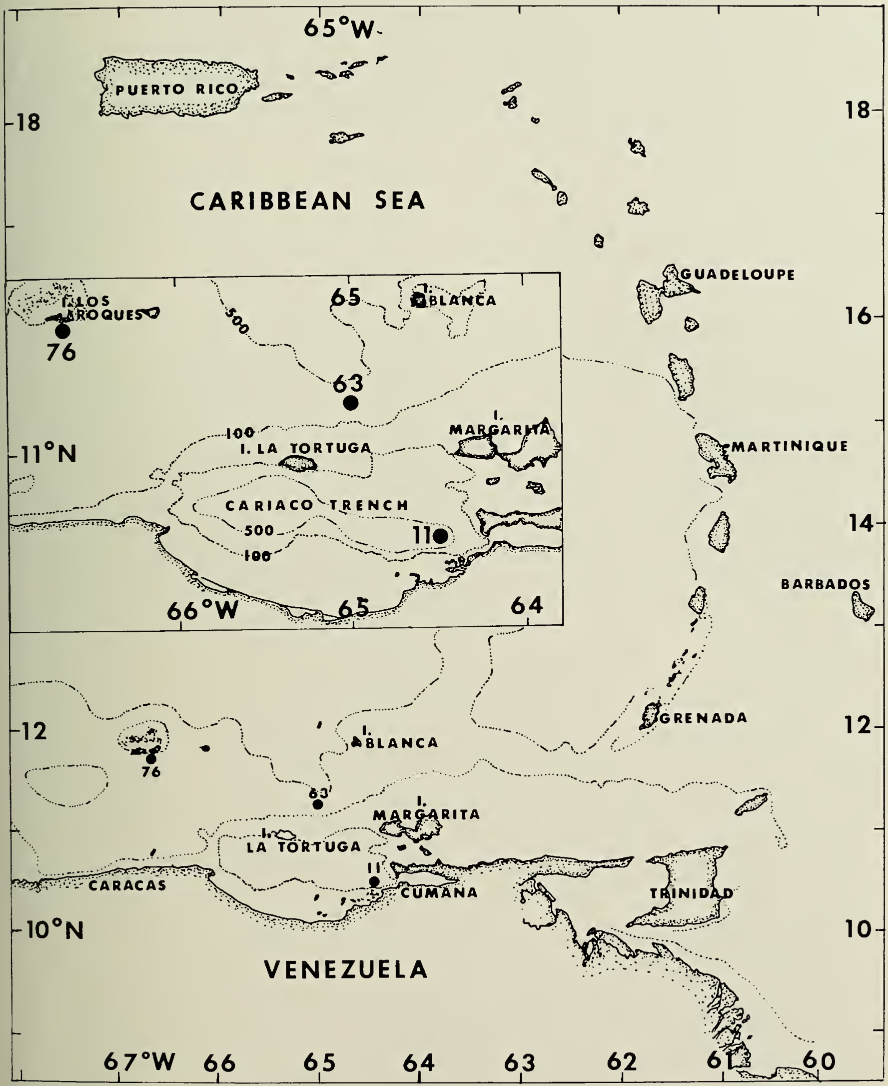

Fig. 1. Locations of Stations 11, 63, and 76 off the north coast of Venezuela. Depth contours in fathoms.

50, 100, 200, 500, and 700, 725 or 800 m; some tows were made at 1,000 or 1,200 m or from 800, 1,000, or 1,200 m to the surface. Six cruises were made to the 3 stations between September 1967 and July 1968. Dr. Cervigon very kindly allowed me to examine the ostracods in these samples, and in a visit in May 1973 to the Estacion de Investigaciones Marinas de Margarita

Table 1. Species of ostracods recorded from Station 11 in the Cariaco Trench, and from stations 63 and 76 off the north coast of Venezuela.

	Sta. 11	Sta. 63	Sta. 76
Archiconchoecia cucullata (Brady)	—	×	×
A. fabiformis, n. sp.	—	—	×
A. ventricosa Müller	—	—	×
A. striata Müller	—	×	×
Euconchoecia chierchiae Müller	×	×	×
Fellia bicornis (Müller)	—	×	×
F. cornuta cornuta (Müller)	—	×	×
Halocypris brevirostris (Dana)	—	×	×
Conchoecia acuminata (Claus)	×	×	×
C. aequiseta Müller	—	×	×
C. allotherium Müller	—	×	×
C. ametra Müller	—	×	—
C. atlantica (Lubbock)	—	×	×
C. bispinosa Claus	—	—	×
C. brachyaskos Müller	—	×	×
C. concentrica Müller	×	×	×
C. convexa Deevey	—	×	×
C. curta Lubbock	—	×	×
C. daphnoides (Claus)	—	×	×
C. dentata Müller	—	×	×
C. echinata Müller	—	×	×
C. echinulata (Claus)	—	—	×
C. aff. *edentata* Müller	—	×	—
C. elegans Sars	—	×	×
C. imbricata (Brady)	—	×	×
C. incisa Müller	—	×	—
C. inermis (Claus)	—	×	×
C. kampta Müller	—	×	—
C. lophura Müller	—	×	—
C. loricata (Claus)	—	×	×
C. macrocheira Müller	×	×	×
C. macroprocera Angel	—	—	×
C. magna Claus	—	×	×
C. microprocera Angel	×	×	×
C. mollis Müller	—	×	×
C. oblonga (Claus), Form B	×	×	×
C. parthenoda Müller	—	×	×
C. parvidentata Müller	—	×	—
C. porrecta Claus	×	×	×
C. procera Müller	×	×	×
C. pusilla Müller	—	×	×
C. reticulata Müller	—	×	×
C. rotundata Müller	×	×	×
C. rhynchena Müller	—	×	×
C. secernenda Vavra	—	×	×

Table 1. Continued.

	Sta. 11	Sta. 63	Sta. 76
C. skogsbergi Iles	—	×	×
C. spinifera (Claus)	—	×	×
C. spinirostris Claus	×	×	×
C. stigmatica Müller	—	×	×
C. subarcuata Claus	—	×	×

at Boca del Rio on Isla Margarita specimens were counted and/or removed from some of these series of samples. Unfortunately, on this brief visit it was not possible to make a quantitative study of the depth distributions of the various species, but only to note the numbers and occurrence of species at various depths at the three stations. The data presented here were obtained by examining 20 samples from various depths and times of year from Station 11, 20 samples from Station 63, and 21 samples from Station 76. I am greatly indebted to Dr. Fernando Cervigon for the pleasure and privilege of visiting this laboratory and of examining the halocyprid ostracods from the Cariaco Trench and adjacent waters.

The Ostracods

The waters of the Cariaco Trench contain an exceptionally impoverished ostracod fauna. Table 1 lists the 50 species, including one new species, recorded from the 3 stations. Of these only 10 were found at Station 11, and 5 of these (*Euconchoecia chierchiae*, *Conchoecia concentrica*, *C. porrecta*, *C. procera* and *C. spinirostris*) were numerous in the upper waters. The other 5 were represented by no more than several specimens, all recorded above 200 m, except for a single juvenile *C. macrocheira*, which was taken in a tow at 700 m. All the species noted from Station 11 normally live within the upper several hundred meters or less, and although the most abundant species were found throughout the water column, this was probably, though not certainly, due to contamination from the upper waters. Even species occurring at shallow depths at the other 2 stations were not noted in Cariaco Trench waters. For example, at 50 m-depths five species (*Archiconchoecia striata*, *Halocypris brevirostris*, *Conchoecia atlantica*, *C. parthenoda* and *C. secernenda*) were recorded, especially from Station 76, that were not taken at any depths in the Trench. Table 2 lists the species found at all depths at Station 11 together with species recorded from the upper 100 m at Stations 63 and 76, and shows that 9 species that were taken in the upper 100 m at the other stations were not found at Station 11. If the list is expanded to include the species caught within the upper 200 m at

Table 2. Ostracod species recorded from Station 11, and between the surface and 100 m from Stations 63 and 76.

	Sta. 11	Sta. 63	Sta. 76
Archiconchoecia striata	—	—	×
Euconchoecia chierchiae	×	×	×
Halocypris brevirostris	—	×	×
Conchoecia acuminata	×	×	×
C. atlantica	—	×	×
C. concentrica	×	×	×
C. curta	—	×	×
C. echinata	—	—	×
C. elegans	—	×	×
C. macrocheira	×	—	—
C. magna	—	—	×
C. microprocera	×	—	×
C. oblonga	×	×	×
C. parthenoda	—	×	×
C. porrecta	×	×	×
C. procera	×	×	×
C. rotundata	×	×	×
C. secernenda	—	×	×
C. spinirostris	×	×	×

Stations 63 and 76, 9 more species are added, including *C. macrocheira*, to make a total of 27 species, compared with the 10 from Station 11.

Table 3 compares the numbers of species recorded per depth zone from the three stations. Some contamination of the deeper samples by species from shallower depths may have occurred, since some of the presumed epipelagic species were taken in samples from 700 or 800 m. At Station 76 the numbers of species increased down to 500 m, and at Station 63 numbers increased to 725 m. At both these stations highest numbers of species were caught in the vertical tows from 1,000 or 1,200 m to the surface. At Station 76 10 species were taken only from 500 m or greater depths, whereas 14 were recorded from Station 63. Nineteen species were noted only below 500 m or in the vertical tows from Station 76, and 20 from Station 63, but only one (the juvenile *C. macrocheira*) from Station 11. There is no doubt that the anoxic conditions in the Cariaco Trench limit the numbers of species of halocyprid ostracods living in the upper waters, and even exclude species which live at shallow depths in adjacent waters. According to Heezen et al. (1959), the waters of the Trench are cut off from the Caribbean below 80 fathoms or 150 m, but are largely isolated below 45 fathoms or 80 m-depths. The commonest and most abundant species in the Cariaco

Table 3. Number of ostracod species recorded per depth zone, with number of samples examined in parentheses.

Depth, m	Station 11	Station 63	Station 76
25	6 (2)	7 (1)	5 (2)
50	6 (2)	7 (1)	12 (2)
100	7 (3)	11 (1)	17 (2)
200	7 (3)	19 (3)	23 (3)
500	5 (4)	19 (4)	28 (5)
700	7 (2)	17 (2)	1 (1)
725	3 (1)	31 (2)	2 (1)
800	–	13 (1)	12 (1)
800–0	–	–	30 (1)
1,000–0	4 (1)	39 (4)	37 (2)
1,200–0	4 (1)	33 (1)	32 (2)
No. of species only from 500 m or deeper	1	14	10
No. of species from 500 m or in vert. tows	1	20	19

Trench (*E. chierchiae*, *C. concentrica*, *C. porrecta*, *C. procera*, and *C. spinirostris*) are all species usually found within the upper 50 m, whose numbers may be constantly recruited from the open waters of the Caribbean. Except for *C. procera*, they were most numerous at 50 m; *C. procera* was the most abundant species in the Trench and occurred in highest numbers from 100 to 200 m. The conditions in the Trench apparently favored the development of the *C. procera* population, which was unquestionably far more numerous in those waters than at the other two stations, where other species were present.

Table 4 lists the percentages obtained for the several species at Station 11 in March 1968 from samples collected at 50, 100 and 200-m depths, and shows that *E. chierchiae*, *C. concentrica*, *C. porrecta*, and *C. spinirostris* were all most numerous at 50 m. These species were also present at 25 m. At 100 m *C. procera* constituted 79% of the total numbers, and increased to 96.4% at 200 m. Total numbers appeared to be highest at 200 m, although quantitative counts were not made due to lack of time. At Station 76 at the same time, *C. procera* accounted for only 12.3% of the total numbers at 200 m, and species not found at Station 11 were equally abundant. These included *Archiconchoecia striata* (11.1%), *Conchoecia curta* (16.4%), and *C. oblonga* (17.0%).

In an analysis of the vertical and geographic distributions of abundant species of planktonic ostracods in the northeast Atlantic, between 10½–11°N, 18°, 30°, 40°, 53° and 60°N, and ca. 20°W, Angel and Fasham (1975) found that highest numbers of ostracods were found at progressively deeper levels

Table 4. Percentage composition of ostracod species at 3 depths at Station 11 in March 1968.

	50 m	100 m	200 m
Euconchoecia chierchiae	14.3	6.0	0
Conchoecia acuminata	0.9	0	0
C. concentrica	20.5	7.5	0.3
C. microprocera	0	4.0	2.2
C. oblonga	0	0.5	0
C. porrecta	32.2	3.0	0.8
C. procera	1.8	79.0	96.4
C. rotundata	0	0	0.3
C. spinirostris	28.5	0	0
Unidentified juveniles	1.8	0	0

in going from lower to higher latitudes; at 10½°N the main population of ostracods was predominantly epipelagic and was found in the upper 100 m, both in day and nighttime, indicating little or no vertical diurnal migrations of the species at this latitude. It is therefore baffling that epipelagic species that presumably could have survived the conditions within the upper 200 m or so of the Cariaco Trench, and that could have been constantly carried in above the maximum sill depths of ca. 150 m, were not noted at Station 11. If there is little or no vertical migration of species at this latitude, none should have been excluded by this factor. However, the oxygenated surface waters contain minute amounts of methane, continually rising from the depths below. According to Wiesenburg (1974), the surface waters contain 10^{-4} ml of methane per liter of sea water, and below 320 m the quantity steadily increases with depth. This, together with associated conditions, may be sufficient to exclude many ostracod species from these waters.

Many more species of copepods are epipelagic. As noted, Legare (1964) listed 102 species from the upper 500 m of the Cariaco Trench. Cervigon and Marcano (1965) reported 96 species or categories of copepods. Cervigon's unpublished data on the copepods collected down to 1,000 or 1,200 m at Stations 11, 63 and 76 give totals of 83 species for Station 11, 141 for Station 63, and 123 for Station 76, with a total of 162 species for the three stations. Therefore, at Station 11, 51% of the total numbers of copepod species recorded from the region were present, compared with only 20% of the total numbers of ostracod species. Also, only 37% of the ostracod species present in the upper 200 m at Stations 63 and 76 were noted at Station 11. The copepods not recorded from Station 11 include species of genera, such as *Candacia*, *Euchirella*, *Gaetanus*, *Lophothrix*, *Metridia*, *Pleuromamma*, *Scottocalanus*, and *Undeuchaeta*, which normally live at greater depths. Apparently the epipelagic copepods are better able to thrive in the upper waters of the Cariaco Trench than are the ostracods.

The Species of Ostracods
Subfamily ARCHICONCHOECINAE

The two commonly recorded species of *Archiconchoecia*, *A. striata* Müller and *A. cucullata* (Brady), were taken at both Station 63 and 76, but not at Station 11. *A. striata* was found over a depth range of 800–50 m at Station 76 and also in a 1,000–0 m sample at Station 63, and was present throughout the year. *A. cucullata* was noted only in September 1967 and January 1968 in a 500 m and a 1,000 m sample at Station 76; at Station 63 it was found at 500 m and at 725 m in March 1968.

Two specimens of the rarely recorded *A. ventricosa*-type were caught at Station 76. One is here described as a new species. The other, a male, is redescribed as *A. ventricosa* Müller. Müller (1906) gave only a brief description of the shell and first and second antennae of *A. ventricosa*, and this male agrees with Müller's specimen in these respects. Poulsen (1969) has also described as *A. ventricosa* a 1.8 mm long female which differs from Müller's description in several details. Unfortunately, specimens of this type are rarely caught, and no others have been described, although Angel and Fasham (1975) have reported this species from 10½–53°N, ca. 20°W in the eastern North Atlantic, and Poulsen (1969) and Angel (1971/72) have listed it as occurring in the Atlantic, Pacific and Indian Oceans. Either *A. ventricosa* is very variable, or there are a number of species of very similar shape, with a strongly swollen anterior margin. In more than one instance I know the latter to be the case, since I have several as yet undescribed species from the Sargasso Sea, which have the *A. ventricosa* shape but differ from Müller's species in a variety of ways. The only way to untangle this species complex is to describe all specimens sufficiently so that the various species of this type may be clearly distinguished. It should also be noted that my brief key to the species of *Archiconchoecia* (Deevey, 1968:23) is incorrect in separating *A. ventricosa* from *A. cuneata* by the shape of the frontal organ, since rounded, pointed, and bifurcate frontal organs are found in *A. ventricosa*-shaped ostracods.

Archiconchoecia fabiformis, new species
Figs. 2 and 3

Holotype.—Female, 1.05 mm long by 0.55 mm high. One slide, deposited in the National Museum of Natural History, Smithsonian Institution, USNM 169062.

Type-locality.—Station 76: 11°45′N, 66°56′W, in the Caribbean Sea. From a 1,200–0 m tow, collected 27 March 1968.

Etymology.—The specific name is derived from the Latin "faba" plus "formis," meaning bean-shaped, and refers to the shape of the shell, viewed laterally.

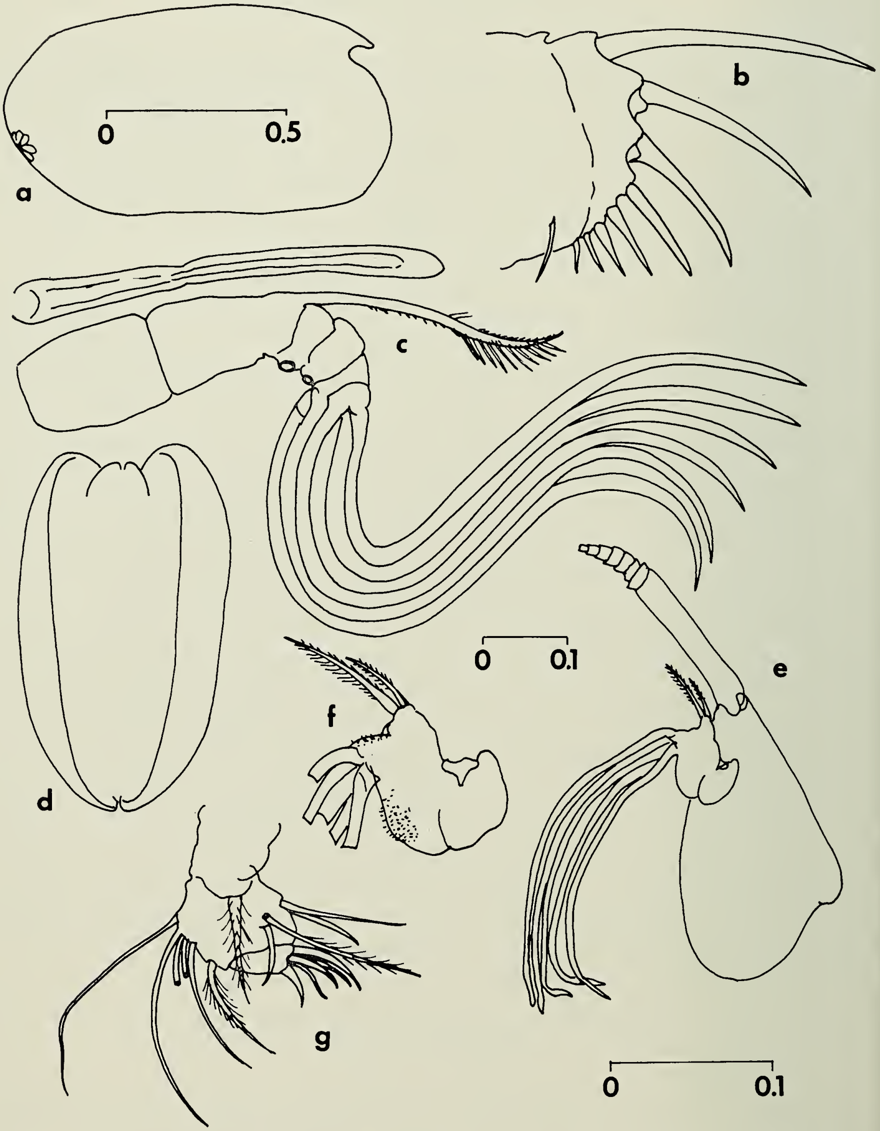

Fig. 2. *Archiconchoecia fabiformis*, female. a, Lateral view of female; b, Furca; c, Frontal organ and 1st antenna; d, Ventral view of shell; e, Second antenna, exopodite setae not drawn; f, Endopodite of 2nd antenna, setae and filaments cut off; g, Endopodite of maxilla. Scales, in mm, on a for a and d, near e for e, at bottom right for b, c, f, g.

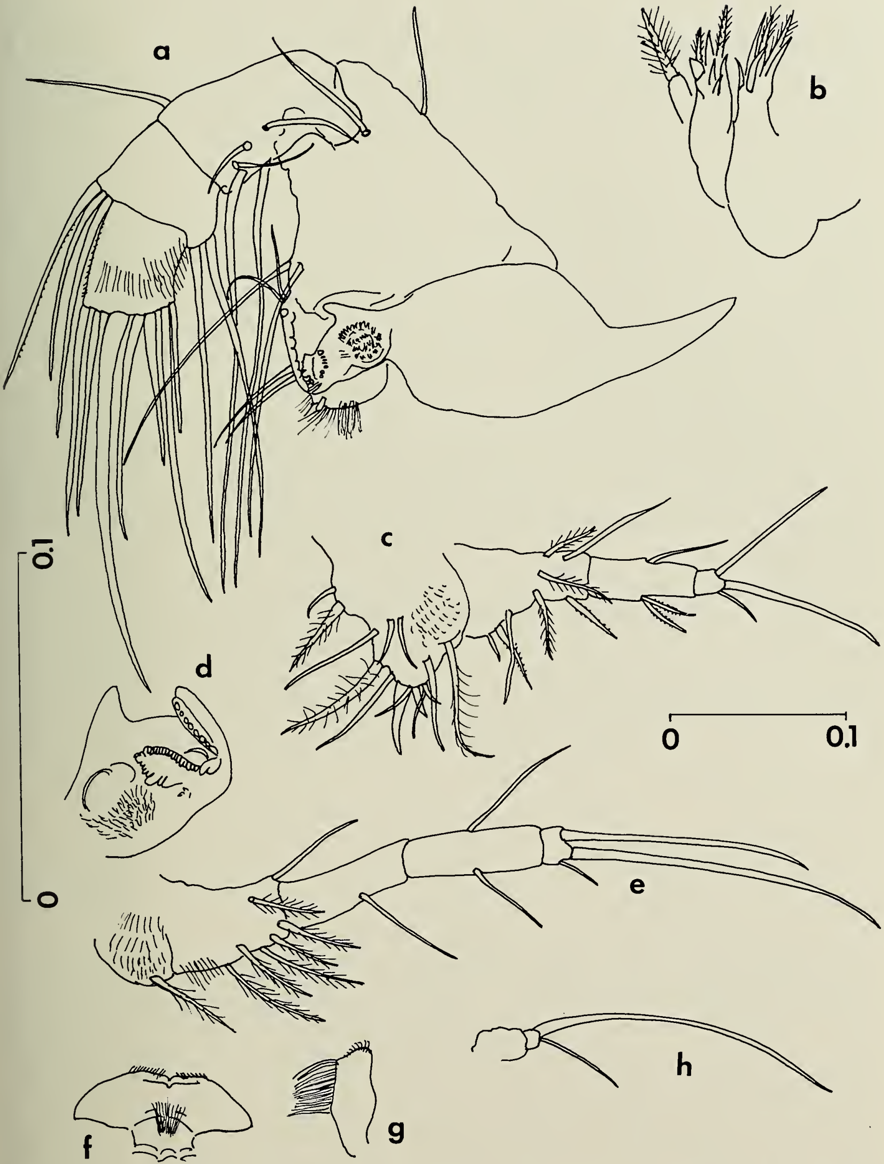

Fig. 3. *Archiconchoecia fabiformis*, female. a, Mandible; b, Basale, and coxal and precoxal endites of maxilla; c, Fifth limb; d, Tooth rows and masticatory surface of coxa of mandible; e, Sixth limb; f, Labrum; g, Paragnath; h, Seventh limb. Scale, in mm, on left margin for d, at right for a–c, e–h.

Description of female.—Shell (Fig. 2a, d): Height a little over 50% of length. Anterior margin swollen and rounded, posterior margin rounded, ventral margin almost straight. Right asymmetrical gland ca. ⅓ of the way up the posterior margin; no indication of left asymmetrical gland. Shoulder vaults not developed, shell rounded in anterior or posterior view. There is a faint indication anteriorly of lines on the shell, more or less parallel to the ventral margin.

First antenna and frontal organ (Fig. 2c): The frontal organ, rounded at the tip and bare of hairs or spinules, hardly extends beyond the distal segments of the 1st antenna. Second segment of 1st antenna bears dorsally a large seta, strongly spined distally. The 5th segment bears 2 filaments and the 6th segment 4 filaments, all of equal length and pointed at the tips. No hairs or spinules were visible on the 6 segments of the 1st antenna.

Second antenna (Fig. 2e, f): The 1st segment of the exopodite is around 60% the length of the shaft. The basal segment of the endopodite has some tiny spinules and bears 2 long, densely spined bristles on a rounded protuberance. The proximal bristle is 60% the length of the longer distal bristle. The 5 long filaments of the distal segment of the endopodite are of equal length.

Mandible (Fig. 3a, d): The incisor surface of the basale has 6 (?) finely serrated but not completely separated teeth and 2 larger teeth. There are 6 setae near the distal end of the basale and 1 near the articulation of the endopodite; the 1st segment of the endopodite has 6 setae, the 2nd segment 5 setae, and the distal segment, partially covered with hairs, has 7 setae. The coxa has a chitinized knob-like articular process; there are several tooth-rows, difficult to distinguish (Fig. 3d), and a masticatory pad of small spines.

Maxilla (Figs. 2g, 3b): The 1st segment of the endopodite has 10 setae, of which 2 are plumose. The distal segment has 2 claws and 3 short setae, 1 larger than the other 2. The coxal and precoxal endites have each at least 8 bristles, several of which are long and spinous.

Fifth limb (Fig. 3c): The protopodite and endopodite have a total of 12 setae or bristles and 2 claws. The 1st segment of the exopodite has 8 setae, of which 3 are plumose, the 2nd segment 3 setae, and the distal segment 2 long slim claw-setae and a short seta. The epipodial appendage has 3 groups of 4-4-5 setae each.

Sixth limb (Fig. 3e): The 1st segment of the exopodite has 6 plumose setae and a bare dorsal seta. There are some fine hairs on the protopodite and 1st exopodite segment. The 2nd exopodite segment has 1 seta, the 3rd 2 setae, and the distal segment 2 exceptionally long slim claw-setae and a short seta. The epipodial appendage has 3 groups of 5-5-6 plumose setae each.

Seventh limb (Fig. 3h): This has 2 setae, the shorter of which is about ⅓ the length of the longer seta.

Furca (Fig. 2b): This has 8 fairly straight claws, and a single unpaired bristle.

Remarks.—This species is similar in size and shape to Müller's (1906) female *A. ventricosa*, but differs most notably in having a rounded frontal organ and also in the relative lengths of the 2 bristles on the proximal segment of the endopodite of the 2nd antenna. Müller's female had a pointed frontal organ, and the 2 bristles on the proximal segment of the endopodite of the 2nd antenna were of about the same length, whereas in the *A. fabiformis*, n. sp., female, one bristle was noticeably longer, the shorter being 60% the length of the longer one. Unfortunately, Müller described only the shell and the 1st and 2nd antennae, and did not even mention how many claws were on the furca. Poulsen's (1969) female *A. ventricosa* was 1.8 mm long, had a pointed bifurcate frontal organ and 7 claws on the furca. One of the 2 bristles on the proximal segment of the endopodite of the 2nd antenna was almost twice as long as the other, as in *A. fabiformis*. The setation of the appendages of Poulsen's *A. ventricosa* differs in some respects from that of *A. fabiformis*. In the latter, the basale of the mandible has 2 more setae, the endopodite of the mandible is also somewhat different, as well as the setation of the 5th and 6th limbs. Two of the setae on the distal segment of the 5th limb are longer and one is shorter than in Poulsen's *A. ventricosa*; similarly, 2 of the setae on the distal segment of the 6th limb are much longer and the other seta much shorter than described by Poulsen. Poulsen's female should be ascribed to a new species, and *A. fabiformis* differs sufficiently from Müller's *A. ventricosa* to be considered a new species of the *ventricosa*-type.

Archiconchoecia ventricosa Müller
Figs. 4 and 5

Archiconchoecia ventricosa Müller, 1906:45, Pl. 7, figs. 1–6.

Material.—Male, 0.84 mm long by 0.50 mm high at the anterior end. One slide, deposited in the National Museum of Natural History, Smithsonian Institution, USNM 169063. From a 500 m horizontal tow collected in September 1967 at Station 76:11°45′N, 66°56′W.

Redescription of male.—Shell (Fig. 4a–c): Anterior margin swollen, ventral margin almost straight, posterior margin rounded. As in the male described by Müller, the height of the shell is greatest at the anterior end and decreases posteriorly to around ⅔ of the anterior height. The left asymmetrical gland, invisible on this specimen, but discernible on 3 hitherto undescribed specimens from the Sargasso Sea, is at the top of the left posterior margin, just below the hinge. The right asymmetrical gland is approximately ⅓ of the way up the posterior margin. The shell is rounded laterally, with no indication of shoulder vaults (Fig. 4c). Slight

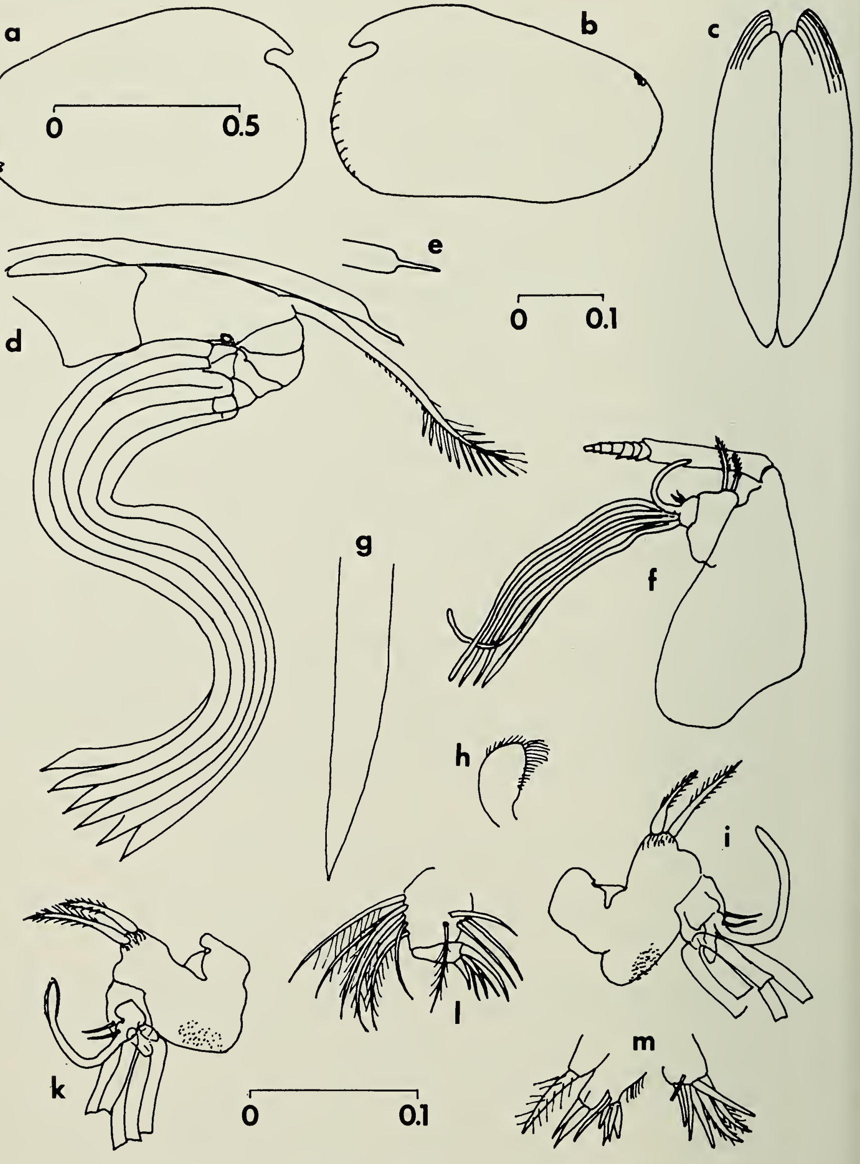

Fig. 4. *Archiconchoecia ventricosa*, male. a–c, Lateral and ventral views; d, Frontal organ and 1st antenna; e, Dorsal view of tip of frontal organ; f, Second right antenna, exopodite setae missing; g, Distal end of one of filaments of 1st antenna; h, Paragnath; i, Endopodite of right 2nd antenna, setae and filaments cut off; k, Endopodite of left 2nd antenna, setae and filaments cut off; l, Endopodite of maxilla; m, Basale, and coxal and precoxal endites of maxilla. Scales, in mm, on a for a–c, at upper right for f, at bottom for d, e, g–m.

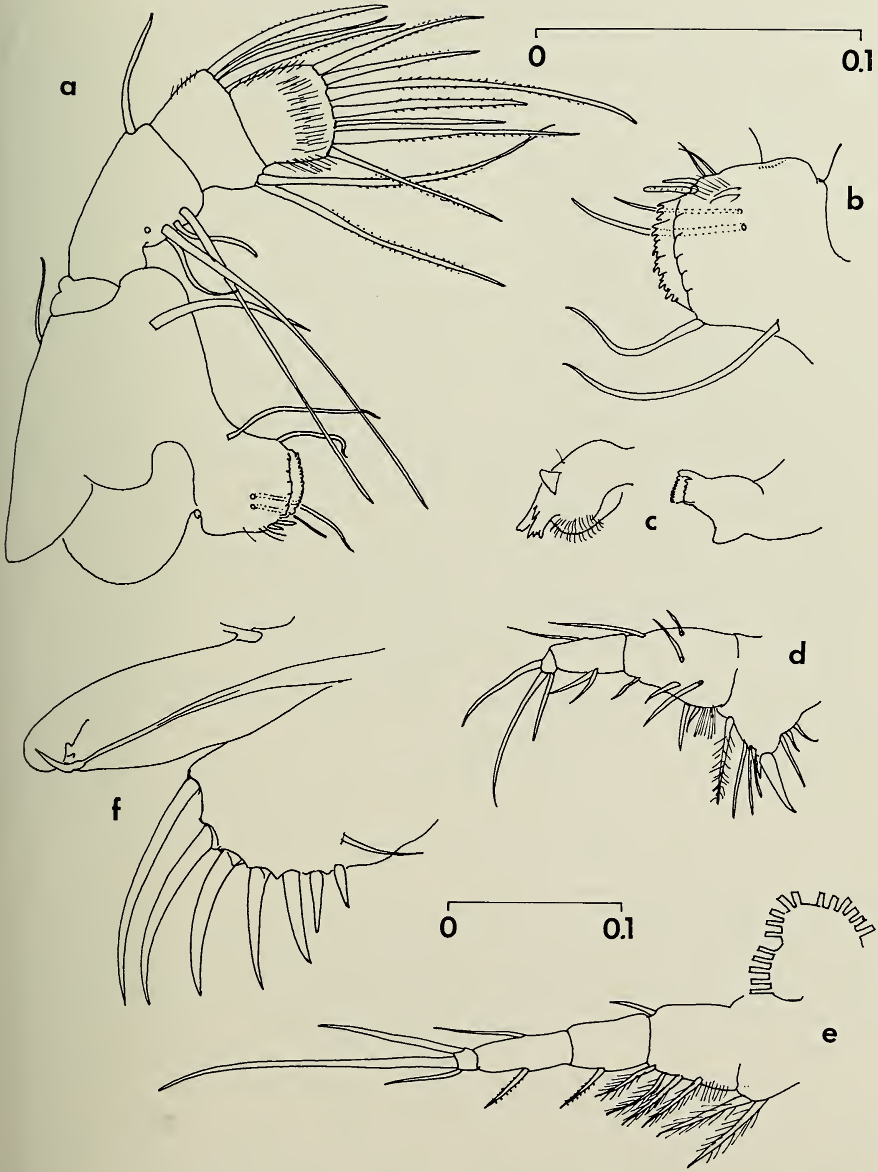

Fig. 5. *Archiconchoecia ventricosa*, male. a, Basale and endopodite of mandible; b, Incisor surface of basale of mandible; c, Two views of incisor and molar surfaces of coxa of mandible; d, Fifth limb; e, Sixth limb; f, Penis and furca. Scales, in mm, at top right for b, above e for a, c–f.

sculpturing was visible anteriorly, especially in dorsal view, as lines approximately paralleling the ventral margin (Fig. 4b, c).

First antenna and frontal organ (Fig. 4d, e, g): The frontal organ barely exceeds in length the down-curving distal segments of the 1st antenna, and has a long fine point, which in dorsal view is a long thin needle-like projection (Fig. 4e). The 1st antenna has a large strongly spined dorsal seta on the 2nd segment; the 5th segment bears 2 long filaments and the 6th segment 4, all of equal length and pointed at the tip. The filaments are quite wide (Fig. 4g). No hairs or spinules were noted on the segments of the 1st antenna.

Second antenna (Fig. 4f, i, k): The 1st exopodite segment is relatively short, 44–48% the length of the shaft. The 2 bristles on the basal segment of the endopodite are unequal in length, the proximal bristle being 73–77% the length of the distal bristle, and are coarsely spined and borne on a rounded protuberance. Ventrally there are some tiny spinules on the basal segment and also around the bases of the bristles. The right and left clasping organs are fairly similar, both slim and rounded, the right slightly larger than the left. The 5 filaments of the distal segment are almost equal in length (Fig. 4f).

Mandible (Fig. 5a–c): The incisor surface of the basale has presumably 6 finely serrated, but ill defined teeth, and 2 large long teeth (Fig. 5b). There are 4 setae near the distal end of the basale, and 1 near the articulation of the endopodite. The 1st segment of the endopodite has 5 setae, the 2nd segment 5 setae and some hairs, and the 3rd segment, partly covered with hairs, has 7 setae. The coxa has at least 2 tooth rows, very difficult to distinguish, and a masticatory pad of small spines.

Maxilla (Fig. 4m, l): The 1st segment of the endopodite of the maxilla has 10 long setae, of which 5 anterior and 1 posterior are plumose. The distal segment bears the 2 claws and 3 setae, one of which is larger, the other 2 slimmer. The coxal and precoxal endites have each at least 7 spines of varying lengths, some quite long.

Fifth limb (Fig. 5d): The endopodite has 7 bristles and 2 claws. The 1st segment of the exopodite has 8 setae and some long hairs, the 2nd segment 3 setae, and the distal segment 2 long slim claw-setae and a seta. The epipodial appendage is in 3 groups of 4-4-4 setae each.

Sixth limb (Fig. 5e): The 1st segment of the exopodite has 4 plumose ventral setae and some long hairs and a small bare dorsal seta, the 2nd segment 1 ventral seta, the 3rd segment 2 setae, and the distal segment the 2 claw-setae and a shorter seta. The shorter claw-seta is not quite half as long as the longer one. The epipodial appendage is in 3 groups of 5-5-6 long plumose setae each.

Penis (Fig. 5f): This is relatively slim and rounded at the tip.

Furca (Fig. 5f): This has only 7 pairs of claws and a single unpaired bristle.

Remarks.—This male is similar in size, shape, in the shape of the frontal organ and clasping organs, and in the relative lengths of the 2 bristles on the basal segment of the endopodite of the 2nd antenna to Müller's *A. ventricosa* male. Although the left asymmetrical gland was not visible on this specimen, and in general is much less developed than the right gland, on the 3 specimens (2 females and 1 male) from the Sargasso Sea which agreed in every other detail, this gland was at the left postero-dorsal corner, as described by Müller. Unfortunately, Müller did not mention the number of claws on the furca, but all 4 specimens were mature, and had only 7 pairs of claws. *A. ventricosa* differs from *A. fabiformis*, n. sp., and from the other as yet undescribed *ventricosa*-shaped forms in the shape of the frontal organ, the setation of some of the appendages, and in having 7 claws on the furca. It differs from Poulsen's (1969) female *A. ventricosa* also in the shape of the frontal organ and the setation of some of the appendages. In general, the *ventricosa*-shaped species differ most notably from each other in the shape of the frontal organ, in the relative lengths of the basal segment of the exopodite to the shaft, and of the 2 bristles of the 2nd antenna, and in the lengths of the setae of the distal segments of the 5th and 6th limbs. There is little sexual dimorphism, males differing somewhat in shape from females, and in having clasping organs and a penis. *A. ventricosa* is a small species. Müller's female was 1.0 mm long, his males 0.80–0.85 mm in length. The 2 females from the Sargasso Sea were 0.90 and 0.94 mm long, the male 0.80 mm in length. The 3 specimens were all caught between 500 and 1,000 m-depths.

Distribution.—Müller's specimens were caught between 0°20′N and 2°36′N in the Atlantic, and at 7°N in the Indian Ocean. The present data extend the range to 11°45′N in the Caribbean Sea and to 32°10′N in the Sargasso Sea off Bermuda.

Subfamily EUCONCHOECINAE

Euconchoecia chierchiae Müller occurred throughout the year at all 3 stations, and was caught at every depth and over every depth range sampled. As already noted, it was numerous in the upper waters at Station 11. This is a shallow-living species and constituted over 80% of the total numbers taken at 25 m at Station 76 in March 1968.

Subfamily HALOCYPRINAE

Halocypris brevirostris (Dana) was also recorded over a wide depth range at Stations 76 and 63, but was most common in the upper waters at Station 76 from January to July 1968. Both species of *Fellia*, *F. bicornis* (Müller) and *F. cornuta cornuta* (Müller), were taken at Stations 76 and 63, usually in the deeper tows or in the 1,000 or 1,200–0 m hauls. *Fellia cornuta* was found from January to July 1968 and *F. bicornis* also in September 1967. *Fellia bicornis* was noted more frequently at Station 76 and *F. cornuta* at

Station 63. *Fellia cornuta* females were 3.4–3.7 mm long, *F. bicornis* females 2.0 mm in length. Most of the specimens noted were juveniles.

Subfamily CONCHOECINAE

Poulsen (1973) divided the genus *Conchoecia* into 17 genera. In this report, Müller's (1906) system of grouping species together into more or less natural groups of related forms will be followed, and Poulsen's genera will be listed in parentheses as subgenera.

Spinifera Group Müller

Seven species of this group were recorded, all of which Poulsen put in the genus *Paraconchoecia*. *Conchoecia spinifera* (Claus) was found year-round at Stations 76 and 63 over all depths below 100 m; it did not occur at Station 11. *Conchoecia oblonga* (Claus) also was found throughout the year at Stations 76 and 63, over all depths below 100 m, and was also recorded once in March 1968 at 100 m at Station 11. Only Form B specimens (Angel, 1969), with the right asymmetrical gland moved forward on the ventral margin, were present. Females were 1.66–1.70 mm long, males 1.44–1.54 mm in length. A single male *C. allotherium*, 1.54 mm long, was identified from a 725 m sample collected at Station 63 in March 1968. It is virtually impossible to distinguish females of this species from female *C. oblonga*, but a specimen, probably a female *C. allotherium*, 1.60 mm long, was caught at Station 76 in a 800–0 m haul in September 1967. All the specimens of *C. oblonga* noted had the right asymmetrical gland moved forward on the ventral margin, but this specimen had the gland at the postero-ventral corner as in *C. allotherium.*

Conchoecia echinata Müller was noted year-round at Stations 76 and 63, but only as occasional specimens, usually in the deeper samples although a juvenile specimen was taken at 100 m in May. It did not occur at Station 11. *Conchoecia inermis* (Claus) was found in January and March 1968 in samples from below 500 m at Stations 76 and 63, and was also taken in an 800–0 m haul in September 1967. *Conchoecia aequiseta* Müller was recorded throughout the year at Station 63 in samples from 700 m or deeper; at Station 76 it was recorded from January to May from 500 m or from 1,000 or 1,200–0 m hauls. Females and males were present, although females were more frequently noted. *Conchoecia reticulata* Müller was taken year-round in the deep vertical tows at Stations 76 and 63. Most of the specimens were juveniles, but a male was 3.1 mm long.

Elegans Group Müller

Specimens of *C.* (*Paraconchoecia*) *elegans* Sars, 1.2–1.35 mm long, were caught throughout the year at Stations 76 and 63, over most of the depths sampled below 100 m. None were recorded from Station 11.

Procera Group Müller

Several species of this group were noted, all of which belong in Poulsen's genus *Paraconchoecia. Conchoecia procera* Müller and *C. microprocera* Angel occurred year-round over a wide depth range at Stations 63 and 76, and were also taken at Station 11, where, as previously noted, *C. procera* was the most abundant species. *Conchoecia macroprocera* Angel was noted only once, in a 1,000–0 m sample collected in July 1968 at Station 76. A female was 1.34 mm long, a male 1.24 mm in length. The male had 30–31 pairs of long slim teeth on the principal seta of the first antenna, as described by Angel (1971). *Conchoecia brachyaskos* Müller was taken throughout the year at Stations 76 and 63 at 500 m-depths or deeper or in the 1,000 or 1,200–0 m tows. Males were 1.25–1.30 mm long, females 1.35–1.40 mm in length, as recorded from the Sargasso Sea (Deevey, 1968). Several specimens of a recently described species, *C. convexa* Deevey (1977), which seems most closely related to this group, were noted at Stations 76 and 63, in hauls from 800–0 m, 1,000 or 1,200 m or 1,000 or 1,200–0 m. Females were 1.55–1.70 mm long, a single male 1.40 mm long, and 2 juveniles were 1.05 and 1.30 mm in length.

Dentata Group Müller

Several specimens of *C.* (*Paraconchoecia*) *dentata* Müller were noted. This species was recorded only once from Station 76 from a 1,000–0 m haul in July 1968, but it occurred for most of the year in the deep tows from Station 63, from 700 m, 1,000–0, and 1,200 m tows. Females were 1.85–2.0 mm long, males 1.80–1.85 mm in length.

Acuminata Group Müller

Occasional specimens of *C.* (*Conchoecetta*) *acuminata* (Claus) were noted year-round at Stations 63 and 76, from the upper waters and from the 1,000–0 m tows. *Conchoecia acuminata* was also taken in 3 samples from Station 11, in a 50 m tow in March and in 25 and 50 m samples in July 1968, so this is one of the few species taken in the Cariaco Trench. A female was 3.2 mm long, a male 2.4 mm in length.

Rotundata Group Müller

Poulsen (1973) placed the members of this group in the genus *Metaconchoecia. Conchoecia pusilla* Müller occurred year-round at Stations 63 and 76 in the samples collected at 500 m or deeper or in the vertical tows from 1,000 or 1,200–0 m. The other 2 species of this group, *C. rotundata* Müller and *C. skogsbergi* Iles, are the forms I described from the Sargasso Sea (Deevey, 1968). A revision of the *rotundata–skogsbergi* species complex has been made (Gooday, personal communication), and these forms have been separated into a number of different species. Until this work is published, it is necessary to refer to these forms as previously described. Two sizes of *C. rotundata* were present; males were 0.90–0.95 mm long and also larger, 1.1 mm long. The specimens of *C. skogsbergi* were similar to those from the Sargasso Sea, 1.1–1.3 mm long. *Conchoecia skogsbergi* occurred year-round, especially at Station 63, at all depths below 200 m. *Conchoecia rotundata* was more numerous than *C. skogsbergi*, and was present throughout the year at depths below 50 m at Stations 76 and 63. A single male was caught in a 200 m sample at Station 11 in March 1968.

Bispinosa Group Müller

Three common species belonging to this group, which Poulsen (1973) put in the genus *Orthoconchoecia*, were noted. *Conchoecia bispinosa* Claus was taken only at Station 76 in four tows from 200, 800, 1,000 and 1,200–0 m. Females were 1.9 mm long, males 1.75–1.80 mm in length. *Conchoecia secernenda* Vavra occurred year-round at all depths below 50 m at Stations 63 and 76. *Conchoecia atlantica* (Lubbock) was also commonly recorded, except in July 1968, at both these stations at all depths below 50 m. Females were 3.1–3.2 mm long, males 3.2–3.4 mm long.

Curta Group Müller

Poulsen placed the members of this group in the genus *Microconchoecia*. *Conchoecia curta* Lubbock was the most abundant member of this group, and was taken year-round at Stations 76 and 63, over all depths below 100 m. The very similar species, *C. echinulata* (Claus), was noted only once, in a 200 m sample from Station 76, collected in March 1968. *Conchoecia stigmatica* Müller was recorded throughout the year from 500 m and deeper and in the vertical tows, although juvenile specimens were noted from 100 and 200 m depths. The first 2 species are small, ca. 0.8–0.9 mm long; *C. stigmatica* is larger, 1.0–1.2 mm in length.

Edentata Group Gooday

Gooday (1976) has separated the *edentata* forms from *C. gaussi* and *C. incisa*, all of which Poulsen (1973) put in the genus *Gaussicia*, and which were previously placed in the *Gaussae* Group Skogsberg. A single male, 1.5 mm long, of *C.* aff. *edentata* Müller was caught in a 1,000 m sample at Station 63 in January 1968.

Gaussi Group Skogsberg

A single immature female of *C.* (*Gaussicia*) *incisa* Müller, 2.0 mm long, was taken in a 1,200 m tow at Station 63 in March 1968.

Loricata Group Müller

Occasional specimens of *C.* (*Loricoecia*) *loricata* Müller were noted throughout the year at Stations 63 and 76, in samples from 500 m or greater depths or the deep vertical tows. Males were 1.8–1.9 mm long, females 1.9–2.0 mm in length.

Serrulata Group Skogsberg

Conchoecia (*Pseudoconchoecia*) *concentrica* Müller was one of the few species that occurred in some numbers at Station 11 in the Cariaco Trench, and also was found year-round at depths below 25 m at Stations 63 and 76.

Magna Group Müller

Eight members of this group were recorded, of which 3 were found at Station 11. *Conchoecia* (*Conchoecia*) *magna* Claus was noted year-round at Stations 63 and 76, at 100 m and greater depths. Two size ranges were mm and 2.0–2.25 mm long, and males were 1.60 mm and 1.90 mm in length. noted, but few of the smaller specimens were seen. Females were 1.75 *Conchoecia* (*Conchoecia*) *lophura* Müller was caught only at Station 63 at 500 and 725 m depths in March 1968. *C.* (*Conchoecia*) *macrocheira* Müller was taken from September to May at Station 76 and from March to July at Station 63 at 100 m and greater depths. A single juvenile of this species was noted at Station 11 in a 700 m sample collected in July 1968. One female *C.* (*Conchoecia*) *parvidentata* Müller, 2.75 mm long, was recorded only from a 1,000 m sample from Station 63 in January 1968. *Conchoecia* (*Conchoecia*) *subarcuata* Claus was taken in September and March at Station 76 and in January and July at Station 63, usually in the deep or vertical tows, although it was recorded at 200 m in March. *Conchoecia* (*Spinoecia*) *parthenoda* Müller occurred throughout the year at Stations 76 and 63 at all depths below 100 m. *Conchoecia* (*Spinoecia*) *porrecta* Claus and *C.* (*Spinoecia*) *spinirostris* Claus were common throughout the region and were present year-round at all 3 stations at 25 m and greater depths.

Mollis Group Müller

Conchoecia (*Mollicia*) *mollis* Müller was recorded year-round from the deeper waters and vertical tows at Stations 76 and 63. Females were 3.10–3.25 mm long, males 2.8–3.1 mm in length. A single male, 2.8 mm long, of *C.* (*Mollicia*) *kampta* Müller was taken at Station 63 in July in a 1,000–0 m tow. Several specimens of *C.* (*Paramollicia*) *rhynchena* Müller were noted from March to July at Station 76 and in March at Station 63 at 500 m and greater depths. Females were 2.55–2.60 mm long, the one male 2.4 mm in length.

Imbricata Group Müller

A single juvenile of *C.* (*Conchoecissa*) *ametra* Müller was recorded from a 1,000–0 m tow at Station 63 in July 1968. *Conchoecia* (*Conchoecissa*) *imbricata* (Brady) was found year-round except in May at Stations 76 and 63 in samples from 200 m or deeper or in the vertical tows. Females were 3.0 mm long, males 2.4 mm in length.

Daphnoides Group Müller

Conchoecia (*Conchoecilla*) *daphnoides* (Claus) was recorded infrequently, in September and July at Station 76 and in March and July at Station 63 in a 725 m sample and in the deep vertical tows. A female was 5.05 mm long, a male 2.86 mm in length.

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Footnote

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A REVISION OF THE GENUS *PSAMMORYCTIDES* (OLIGOCHAETA: TUBIFICIDAE) IN NORTH AMERICA

Michael S. Loden

The genus *Psammoryctes* was erected by Vejdovský (1876) for *Saenuris barbata* Grube, 1861; the name was amended to *Psammoryctides* by Hrabě (1964) due to prior use of the original. Since Hrabě's (1950) revision of the genus, there have been few changes in the parameters of the generic definition. The genus is found in Europe and North America, with seven or eight European species (depending on the acceptance or rejection of synonymies). Species of *Psammoryctides* are recent additions to the North American fauna. Three species previously described and reported are *P. californianus* Brinkhurst, 1965, *P. minutus* Brinkhurst, 1965, and *P. curvisetosus* Brinkhurst and Cook, 1966.

Examinations of serial sections and whole-mount specimens of *P. convolutus* n. sp. (described herein) led me to a reexamination of the North American species and a subsequent reevaluation of their relationships based on the characteristics of the efferent portion of the male ducts. Subgenera are proposed to indicate the close kinship among the North American species and their separation from their European cogeners. Partially dissected specimens of *P. californianus* were made available to me by D. R. Spencer of NUS Corporation. Type-series of the three previously described species were borrowed from the U.S. National Museum of Natural History, Smithsonian Institution.

Types of *Psammoryctides californianus*, *P. minutus*, and *P. curvisetosus* were in unsatisfactory condition. Dissected and whole-mount specimens were in a macerating mounting medium. Cells were dissolved, tissues fused, and the bases of many setae partly obscured. Configurations of the male ducts were accurately determined only by phase microscopy at magnifications to 1,000 diameters. One paratype of *P. minutus*, infiltrated with air that had entered under the coverslip, was of little worth.

Genus Psammoryctides Hrabě, 1964

Hrabě (1964) described the distal portion of the male efferent system of *P. barbatus*, the generic type, as illustrated by Vejdovský (1876), to have 4 parts: a small atrium, a narrowed proximal portion of the ejaculatory duct, a distal swollen portion of the ejaculatory duct, and a penial bulbus with a penis. Brinkhurst's (1971) definition of the genus added only that the penes are eversible and bear sheaths.

North American species possess a fifth part: a thin-walled portion of the ejaculatory duct distal to the swollen part and proximal to the penis. This character was apparently unnoticed by Brinkhurst (1965) in his description of *Psammoryctides californianus* and *P. minutus*. Because these two species and *P. convolutus* n. sp. form such a closely related complex independent from the European species of *Psammoryctides*, I propose that subgenera be erected for the separation of the North American and European forms. The generic definition is amended to read as follows:

> Male efferent duct with a somewhat globular atrium and compact prostate gland; ejaculatory duct with swollen, glandular portion separated from atrium by a narrow tubular portion. Eversible penes with thin cuticular penis sheaths. Genital setae frequently present. No coelomocytes.

The reclassification of the genus is as follows:

Subgenus *Psammoryctides* Hrabě, 1964. New Status.

Swollen glandular portion of ejaculatory duct terminating in a penis. Subgeneric type: *Psammoryctides* (*Psammoryctides*) *barbata* (Grube, 1861). Distribution: Europe.

Subgenus *Spencerius*, subgen. nov.

Ejaculatory duct comprised of 3 portions: proximal thin-walled tube, median thick-walled glandular portion, distal thin-walled tube terminating in a penis. Subgeneric type: *Psammoryctides* (*Spencerius*) *californianus* Brinkhurst, 1965. Distribution: North America.

Etymology.—Named for Douglas R. Spencer, who provided specimens of *P. californianus* that led to this study.

Psammoryctides (*Spencerius*) *californianus* Brinkhurst, 1965

Fig. 1

Description.—Length 7.5–12 mm. Forty–seventy segments. Anterior dorsal bundles with 2–5 finely serrate hair setae, 372–459 μm long, and 2–4 pectinate setae, 75–93 μm long; pectinates slightly palmate, with fine intermediate teeth. Posterior dorsal bundles with 1–2 hairs, 312–336 μm long, and 1–2 pectinate setae, 72–79 μm long, similar in shape to those located anteriorly. Anterior ventral setae all bifid crochets, 3–4 per bundle, 81–86 μm long, distal tooth longer and thinner than proximal. Posterior ventral setae 2–3 per bundle, 63–72 μm long, distal tooth longer and thinner than proximal.

Male reproductive tract with all structures paired. Vasa deferentia of

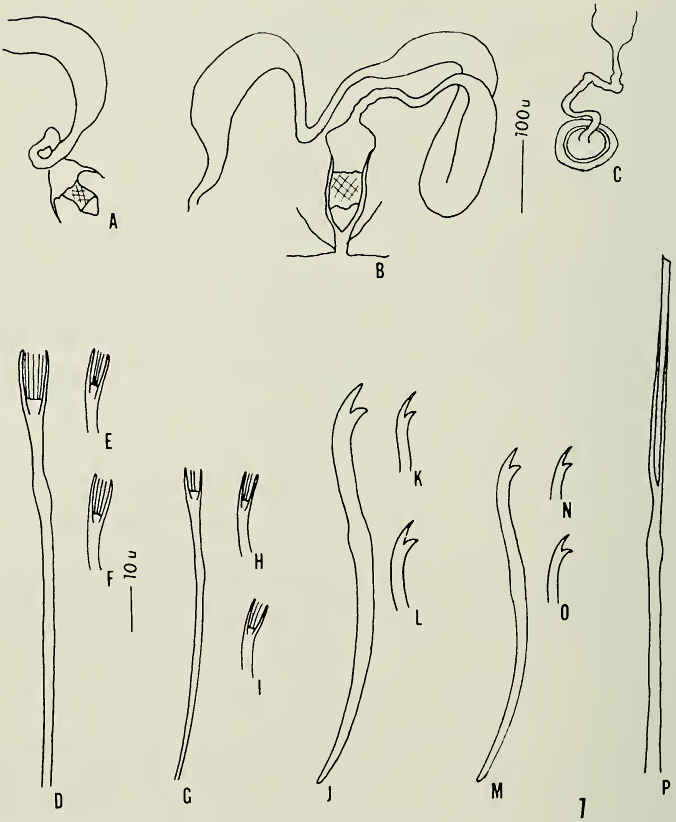

Fig. 1. *Psammoryctides californianus.* A–C, Male duct: A, Holotype; B, Michigan; C, New York. D–F, Anterior dorsal setae: D, Holotype; E, Michigan; F, New York. G–I, Posterior dorsal setae: G, Holotype; H, Michigan; I, New York. J–L, Anterior ventral setae: J, Holotype; K, Michigan; L, New York. M–O, Posterior ventral setae: M, Holotype; N, Michigan; O, New York. P, Spermathecal seta.

undetermined length, 21 μm diameter. Atrium 39–43 μm wide, 119 μm long. Prostate gland 71 μm wide, 214 μm long, location of junction with atrium undetermined. Ejaculatory duct with thin-walled proximal portion 24 μm diameter, thick-walled median portion 45–52 μm diameter, and thin-walled distal portion 11–24 μm diameter. Penes 33–47 μm wide, 95 μm long; thin cuticular penis sheath 33–47 μm wide, 42–55 μm long, encircling penis medially. Spermethecal ampulla globular, 165 μm diameter; duct 215 μm long. Spermathecal setae one per bundle ventrally in X, 117–125 μm long; teeth fused to form a groove.

Specimens examined.—Holotype (USNM 32662). California: Santa Clara

Co., Coyote Creek (No paratypes).—D. R. Spencer coll.: Michigan: St. Clair Co., Black River, 1 specimen. New York: Cayuga Lake, 1 specimen.

Remarks.—Examination of the holotype and specimens from the Spencer collection revealed a distal narrowing of the ejaculatory duct. Spencer's material differed from the holotype only in some measurements of the genitalia, an exaggeration in lengths of the teeth of ventral setae, and in the slightly smaller distal end of pectinate setae. The above redescription is based on characters from the holotype and more recently collected material. A summer breeding season for the species is indicated by sexual maturity in California and Michigan specimens collected in May and New York material in August.

Psammoryctides (*Spencerius*) *minutus* Brinkhurst, 1965. New Status.

Fig. 2

Description.—Length 7–12 mm. Forty–eighty-four segments. Anterior dorsal bundles with 3–5 finely serrate hair setae, 331–493 μm long, and 3–5 pectinate setae, 90–118 μm long; pectinates varying in form from having the lateral teeth parallel and somewhat palmate to sigmoid setae with the distal tooth thinner and slightly longer than the proximal; setal variation without any segmental sequence, often in the same bundle. Hair setae absent from posterior bundles (usually from XIII–XVI, although one specimen with hairs to XXVIII). Posterior dorsal setae all bifid crochets, 1–2 per bundle, 80–109 μm long, distal tooth shorter and thinner. Anterior ventral setae 4–6 per bundle, 71–85 μm long, teeth subequal to distal longer. Posterior ventrals 2 per bundle, 56–75 μm long, the distal tooth shorter and thinner than the proximal.

Male reproductive tract with all structures paired. Vas deferens of undetermined length, 18 μm diameter, ciliated. Atrium 80 μm wide, 163 μm long. Prostate not observed. Ejaculatory duct composed of 3 sections: proximal narrow tube, 160 μm long, 20 μm diameter; medial swollen portion, 275–300 μm long, 70–85 μm diameter; distal narrow portion 165 μm long, 20–28 μm diameter. Cuticular penis sheath thin, 117–140 μm long, 85–120 μm basal diameter, 54–70 μm distal diameter.

Penial setae 3–4 per bundle, 147 μm long, 8 μm wide. Spermathecal ampullae ovoid, 215 μm wide, 400 μm long; ducts 35 μm wide, 285 μm long. Spermatozeugmata up to 380 μm long, 70 μm wide, narrowing at one end.

Specimens examined.—Holotype (USNM 32639): Lake Tahoe, California/Nevada.—Paratypes (USNM 32640): Same locality, 6 specimens.

Remarks.—Brinkhurst (1971) judged this species to be a *species incerta sedis* possibly from some uncertainty concerning the distal narrowing of the ejaculatory duct. His dissected specimens clearly showed the similarity of the ejaculatory duct to that of the other North American species of

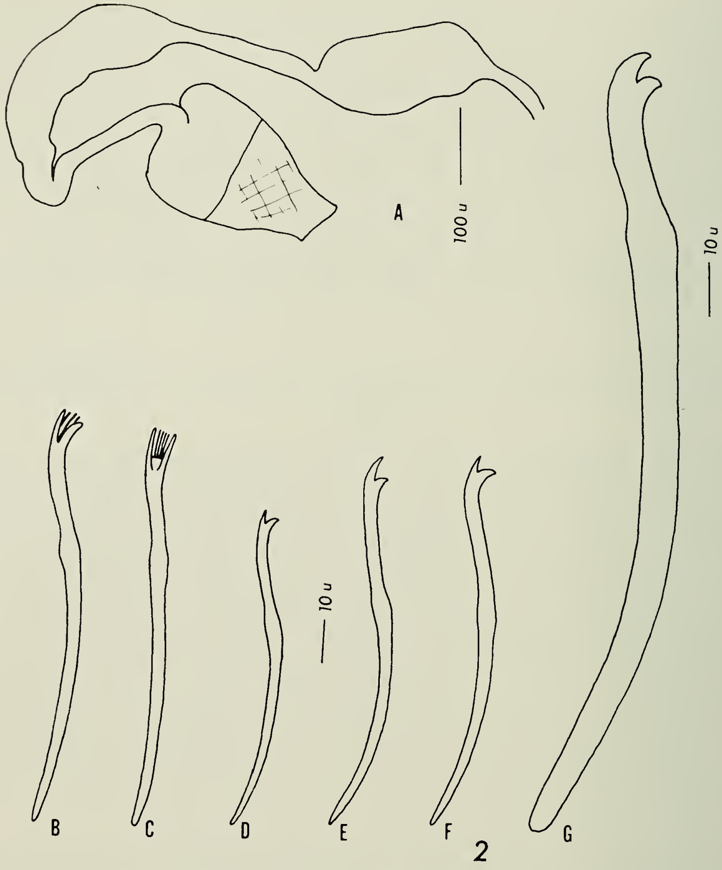

Fig. 2. *Psammoryctides minutus.* A, Male duct; B, C, Anterior dorsal setae; D, Posterior dorsal seta; E, Anterior ventral seta; F, Posterior ventral seta; G, Penial seta.

Psammoryctides (Fig. 2A). I therefore recommend that it be removed from the *species incerta sedis* status and reinstated as a valid species of *Psammoryctides.*

Psammoryctides (*Spencerius*) *convolutus* n. sp.
Fig. 3

Holotype.—NMNH 54463. Louisiana: Ascension Parish; swamp at Sorrento Oil Dome; 4.1 km ESE Sorrento, 30°10′18″N, 90°47′05″W, 27 September 1976, M. S. Loden.—Paratypes: NMNH 54464. Same locality and date, 4 specimens. LSU 1828; same locality and date, 5 specimens (1 serially sectioned). Additional collections: LSU 1826. Mexico: Hidalgo; 2 km

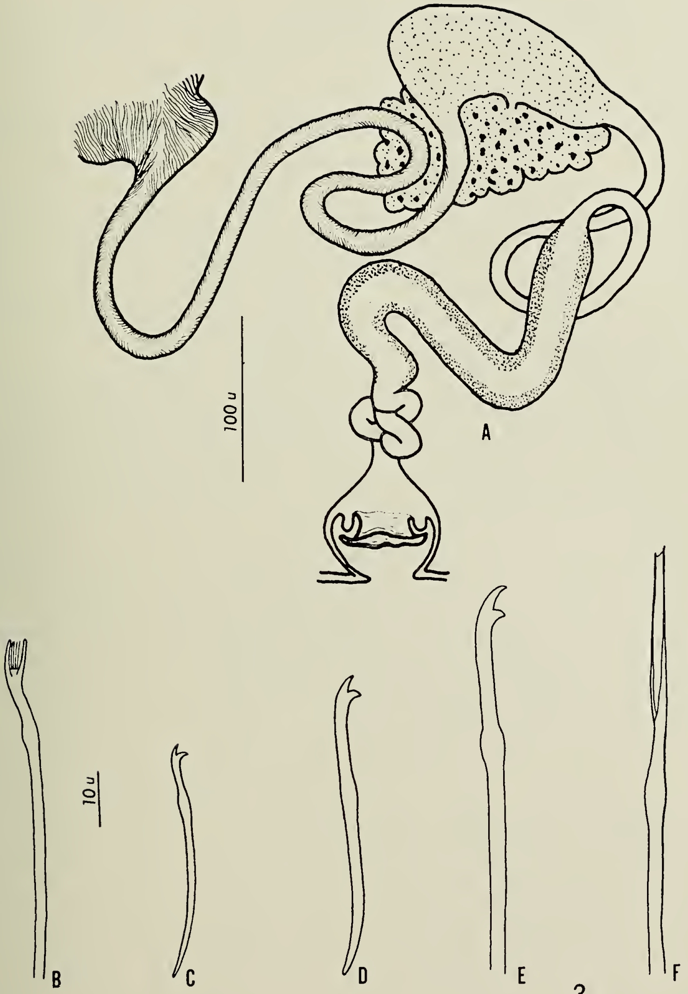

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Fig. 3. *Psammoryctides convolutus.* A, Male duct; B, Anterior dorsal seta; C, Posterior dorsal seta; D, Anterior ventral seta; E, Posterior ventral seta; F, Spermathecal seta.

NE Metepec. (Central Plateau), 6 May 1974, M. A. Tidwell, 1 specimen. LSU 1827. Florida: Collier Co.; Canal and marsh along US 41; 1.0 mi E Paolita, 1 November 1976, W. J. Harman and M. S. Loden, 6 specimens.

Etymology.—"*convolvere*" L. "to roll together." Refers to the convoluted distal end of the ejaculatory duct.

Description.—Sixty-six to 88 segments. Length 10–25 mm (preserved). Diameter at anterior end 0.2 mm, 0.26 mm at segment XI, 0.2 mm at posterior end. Prostomium rounded, as long as width at peristomial junction. Clitellum extending from 10/11 to XII/2.

Anterior dorsal bundles consisting of hair setae and pectinate setae to XIII or XIV (occasionally to XV), posteriorly only bifid crochet setae. Hairs 1–3 per bundle, serrated or non-serrated, 117–175 μm in II, reaching maximum size in VI–VIII of up to 485 μm long, 2.2 μm basal diameter, decreasing in length posteriorly to 90–100 μm maximum length in their posteriormost bundles. Pectinate setae 1–3 per bundle, 39–58 μm long, 2.0 μm thick; lateral teeth parallel, 5–8 μm long, the proximal tooth slightly longer; intermediate teeth fine, numerous. Posterior dorsal setae 1–3 per bundle (usually 2), 44–51 μm long, 1.7 μm thick; teeth equally long or distal slightly shorter; proximal tooth slightly thicker; nodulus distal.

Anterior ventral setae bifid, 3–4 per bundle, 39–58 μm long, ca. 2 μm thick; teeth equally long or distal slightly longer; teeth equally thick; nodulus distal. Beyond the clitellum ventral setae becoming gradually thicker and longer; those of pre-periproct region 1–2 per bundle, up to 81 μm long, 3.6 μm thick; distal tooth more than twice as long as proximal, and thicker; nodulus distal.

Male genital system with all structures paired. A conical male funnel on septum 10/11. Vas deferens ca. 550 μm long, 20 μm diameter, lined with cilia throughout its length. Atrium 90 μm long, 40 μm wide, joined at the median concave surface by a compact prostate, 120 μm long, 80 μm maximum width. Ejaculatory duct in three portions: a thin-walled proximal portion ca. 100 μm long, 23 μm diameter; a thick-walled glandular central portion 90 μm long, 30 μm diameter; a convoluted thin-walled distal portion 11 μm diameter, length undetermined, but occupying a space of 40 μm. Cuticular penis sheath 20 μm long, 27 μm basal diameter, with a reflexed head 51 μm diameter. Penis sac ovoid, 70 μm maximum diameter. Male pores ventrolateral on XI, in the setal plane. Spermathecae paired in segment X. Ampullae globular, 85 μm diameter; duct 130 μm long, 20 μm diameter. Spermatozeugmata ca. 155 μm long; basal expansion present or absent, varying in diameter from 15–45 μm; distal end tapered. Modified spermathecal setae in X, adjacent to spermathecal pores, one per bundle, 84–105 μm long. Teeth elongate, fused, forming a groove.

Remarks.—Psammoryctides convolutus was the most common oligochaete among the roots of emergent aquatic vegetation where more than 100 specimens were collected over a period of 3 months. Swamp habitats ranged from mixed hardwood and bald cypress to a pure cypress stand. The swamp substrate was a fine, organic mud. Additional worms of this species were found in samples from the Florida everglades, again in a fine, organic mud substrate. A single specimen was present in a collection from a roadside ditch in east-central Mexico. Sexually mature worms were collected in Louisiana from September to December, with the greatest number found in November. *Psammoryctides convolutus* likely has a continuous distribution throughout the swamps of the Gulf coastal plain of the southeastern United States and eastern Mexico.

Peloscolex curvisetosus (Brinkhurst and Cook, 1966), comb. nov.

Fig. 4

Brinkhurst and Cook (1966) mentioned in their description that the swelling of the ejaculatory duct just proximal to the penis of *P. curvisetosus* was "not so marked as in some species." The diameter of the narrow portion of the ejaculatory duct in the holotype was 32 μm, and that of the swollen part was 44 μm; therefore the swelling was weak. The "swollen" part in the holotype (Fig. 1A; Brinkhurst and Cook, 1966, Fig. 6M) overlies the integument and associated body wall musculature; the tissues had fused somewhat due to the mounting medium, possibly creating a more exaggerated expansion than was actually present. The swelling of this portion of the ejaculatory duct is likely a normal expansion prior to its termination in a penis; this feature is almost identical to those illustrated by Brinkhurst (1971) for many tubificid species not having the expended ejaculatory duct characteristic of *Psammoryctides*.

The penis sheath of *P. curvisetosus* was described by Brinkhurst (1971) as being scarcely thicker than the body wall cuticle. Due to the vertical position of the penis on the slide, no detectible thickening of the cuticle to form a penis sheath was seen. A second sexually mature individual of *P. curvisetosus* (M. S. Loden coll.) also showed no penis sheath of a greater thickness than integumentary cuticle.

The configuration of the male duct of *P. curvisetosus* was almost identical to that of *Peloscolex tenuis* Hrabě, 1931. Both had a prostate joining a curved atrium on its anterior concave surface, and long, narrow ejaculatory ducts. They differ in that in *P. tenuis* a distinct penis sheath and body wall papillae are present and genital setae are lacking, while in *P. curvisetosus* there is no distinct penis sheath, papillae and hair setae are lacking, and spermathecal setae are present. Thickened, recurved posterior ventral setae and hair setae are characteristic of *P. tenuis* (Hrabě, 1931, 1964) and *P. curvisetosus* (Fig. 1F, G).

Because of similarity in male reproductive anatomy of *Psammoryctides curvisetosus* to *Peloscolex tenuis*, and therefore its agreement with Brinkhurst's (1971) definition of *Peloscolex*, I can see no alternative to a generic transfer of this species. A papillate or thickened body wall, an earlier requirement for the placement of a species into *Peloscolex* (Hrabě, 1964), is no longer regarded as diagnostic (Pickavance and Cook, 1971; Erséus, 1976).

In addition to the type-locality (Lake Erie), *P. curvisetosus* has been

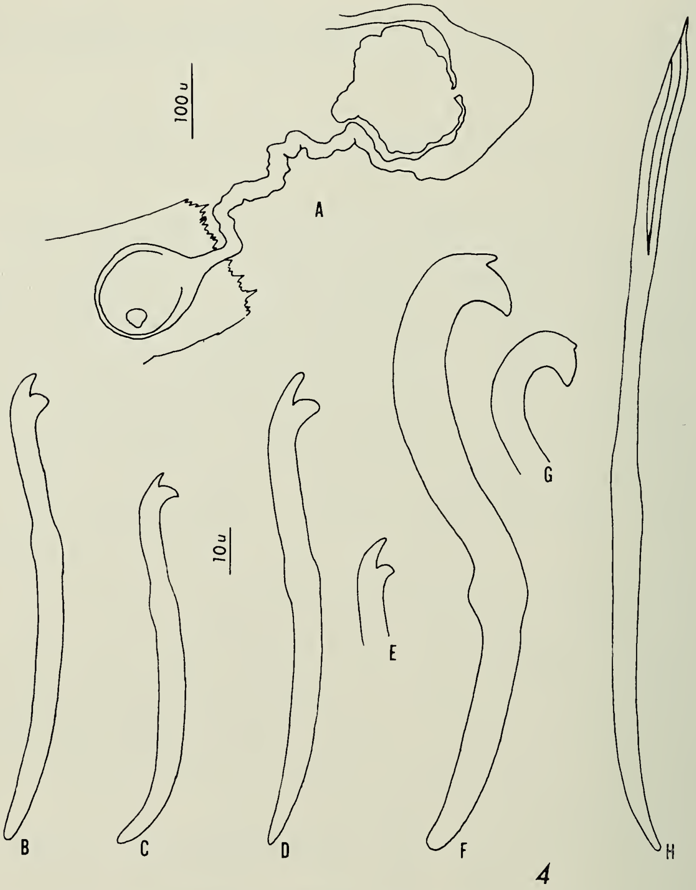

Fig. 4. *Peloscolex curvisetosus,* holotype. A, Male duct; B, Anterior dorsal seta; C, Posterior dorsal seta; D, E, (Alabama), Anterior ventral setae; F, G, (Alabama), Posterior ventral setae; H, Spermathecal seta.

collected from Pennsylvania (LSU 1868), Indiana (LSU 1876), North Carolina (LSU 1878), and Alabama (LSU 1877), all from small rocky streams. Sexual maturity in specimens outside the Great Lakes has been observed only in winter collections. Some slight variations in the shape of the setae were found in specimens from the various localities (Fig. 1).

Discussion

The 3 North American species of *Psammoryctides* differ in both genital and somatic setal characters (summarized in Table 1). *Psammoryctides minutus* is unique in having penial setae and lacking spermathecal setae.

Table 1. Summation of some characters for *Psammoryctides* species of the subgenus *Spencerius*. +: present; –: absent.

	P. (*S.*) *californianus*	*P.* (*S.*) *minutus*	*P.* (*S.*) *convolutus*
Penial setae	–	+	–
Spermathecal setae	+	–	+
Posterior hair setae	+	–	–
Enlarged posterior ventral setae	–	–	+
Pectinate posterior dorsal setae	+	–	–

The anterior dorsal setae of the 3 species bear some similarity: all 3 have pectinate setae with rather long, parallel lateral teeth, and intermediate teeth arising from a portion of the seta some distance from the bases of lateral teeth. Posterior dorsal setae differ among the three; *P. californianus* has hair setae throughout the length of the worm and has posterior pectinates of a shape similar to that of anterior pectinates. Posterior dorsal bundles of *P. minutus* and *P. convolutus* lack hair setae; the posterior dorsal crochets of *P. minutus* have the distal tooth shorter and thinner than the proximal and those of *P. convolutus* have the teeth subequal and the proximal tooth only slightly thicker.

Anterior ventral setae of the 3 species are similar: those of *P. californianus* have the distal tooth longer and thinner than the proximal; *P. minutus* often has the distal tooth longer, but with the teeth equally thick; and *P. convolutus* has subequal teeth of equal thickness. The posterior ventrals of the 3 species differ considerably: those of *P. convolutus* are thicker and longer than the ventral setae of the anterior segments, and with a long, thick distal tooth; *P. californianus* has posterior ventrals of a smaller size than its anterior ventrals, and a distal tooth longer, but thinner than the proximal; in *P. minutus* the posterior ventrals are generally shorter than the anterior ventrals, with a thinner, shorter distal tooth.

Except for the differences in measurements and the location of the sheaths on the penes, the male genitalia of the 3 species are almost idential; *P. convolutus* differs from the others in that the distal portion of the ejaculatory duct is convoluted. The penis sheath of *P. convolutus* (Fig. 3A) is located at the base of the penis and is reflexed at the head. That of *P. californianus* (Fig. 1A, B, C) is located medially on the penis and is simple. The penis sheath location of *P. minutus* was difficult to determine from the dissected type-specimens, but appeared not to be basal (Fig. 2A); it was a simple structure having much greater dimensions than that of *P. californianus*.

It is probable that additional species of *Psammoryctides* will be found in North America. One specimen of an immature tubificid (M. S. Loden coll.) with pectinate setae of the same form as those described for the 3 known species probably represents a fourth species.

Acknowledgments

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AN EVALUATION OF THE NEW SPECIES AND SUBSPECIES PROPOSED IN OBERHOLSER'S *BIRD LIFE OF TEXAS*

M. Ralph Browning

Abstract.—Thirty-six newly described and 10 revived names proposed by Oberholser (1974) for North American birds are evaluated. Of these, only three of the new subspecies are, in the author's judgment, taxonomically distinct.

Harry C. Oberholser's *Bird Life of Texas*, published posthumously in 1974, represents the culmination of nearly 75 years of research. The manuscript was edited and updated by Edgar B. Kincaid, but the taxonomy and nomenclature were unaltered from that employed by Oberholser. Although the two-volume set of Oberholser's work available to me was postmarked from Austin, Texas, on 21 August 1974, the book was released from the University of Texas Press, Austin on 23 September 1974 (John W. Aldrich, pers. comm.), which should stand as the publication date for purposes of priority.

A genus and species of hummingbird and 36 subspecies were described as new in the book. Ten additional subspecies were also proposed for the first time, but for these Oberholser revived names already in the literature.

During his career, Oberholser contributed a wealth of information on the taxonomy and nomenclature of North American birds and many of the taxa he described are recognized today. The purpose of this paper is to review the various new or revived taxa appearing in his 1974 book. Browning (1974) has previously reviewed the western races treated in that work. Oberholser's use of generic names is not discussed.

Except for the hummingbird, *Phasmornis mystica*, all of the holotypes are in the collections of the National Museum of Natural History and the Cleveland Museum of Natural History. Type series were reassembled as closely as possible following Oberholser's original data sheets preserved in the files of the Bird Section of the National Fish and Wildlife Laboratory, U.S. Fish and Wildlife Service. These sheets were also used to reassemble series of other races used by Oberholser in his comparisons. Most specimens in these series were collected before 1940. Additional specimens, including some collected more recently, were also examined.

At the beginning of each of the following accounts the scientific name and page number on which it was first proposed by Oberholser (1974) is cited. This is usually followed by the name that I regard as having priority and the reasons for my conclusions. Standard measurements of specimens are in millimeters (mm). Bill measurements are from the anterior edge of the nostril to the tip, except where otherwise specified. Student's *t*-test was applied for determining the statistical significance of differences between means.

Many of the new forms described by Oberholser were from populations intermediate between currently recognized races. I consider only three of the 36 new subspecies as valid. These are *Lampornis clemenciae phasmorus, Agelaius phoeniceus stereus,* and *Agelaius phoeniceus zastereus.* The latter two races are recognized pending a comprehensive review of the species.

Species Accounts

Leucophoyx thula arileuca, p. 106 = *Egretta thula brewsteri* Thayer and Bangs, 1909

Oberholser applied the name *arileuca* to birds breeding in the Great Basin and central California, which he described as intermediate in size between the western race *brewsteri* and nominate *thula* of eastern North America. Specimens from the ascribed range of *arileuca* are within the range of individual variation in size of *brewsteri* (see Browning, 1974; Bailey, 1928).

Anas platyrhyncha neoboria, p. 154 = *A. platyrhynchos platyrhynchos* Linnaeus, 1758

Oberholser named the New World populations *neoboria,* which he described as larger than nominate *platyrhynchos* of the Old World. The New World birds represent the upper end of a cline, being slightly larger than those of the Old World (Browning, 1974).

Planofalco mexicanus polyagrus (Cassin, 1854), p. 977 = *Falco mexicanus* Schlegel, 1851

Cassin (1854) named the birds of the western United States *Falco polyagrus*, but admitted (*in* Baird et al., 1858) that *mexicanus* Schlegel, 1851 (type-locality = Mexico) might apply to the same species. Coues (1866), noting Cassin's reservations, stated that although *polyagrus* and *mexicanus* are similar, *polyagrus* has pale, dull blue legs whereas *mexicanus* has yellow legs. Ridgway (*in* Baird et al., 1874) and other authorities did not mention this difference, but Ridgway considered *polyagrus* to be paler in plumage than *mexicanus.* Nevertheless, *polyagrus* was not recognized as a race of *F. mexicanus* in the A.O.U. Check-list (1886).

Although *polyagrus* had originally been applied to all birds north of Mexico, Oberholser used the name for the populations of southwestern British Columbia and the northwestern United States, and *mexicanus* for the remainder of the species' range. Despite Stone's (1899) statement that the type of *polyagrus* came from the source of the Platte, Oberholser stated without explanation that the name was "based evidently on a specimen from California belonging to this form." Oberholser's subdivision and concurrent new concept of the races of *F. mexicanus* are qualified only by his remark that he examined the plumage of specimens; however, no characterizations are given. I can find no geographic variation in the species.

Coprotheres pomarinus camtschatica (Salvin, 1896), p. 374 = *Stercorarius pomarinus* (Temminck, 1815)

Oberholser applied the name *camtschatica*, based on *avis camtschatica major* of Pallas, 1811, to the populations of *S. pomarinus* breeding from eastern Siberia to western North America, and characterized the race as darker and slightly larger than *pomarinus* of eastern North America, Europe, and western Asia. As Oberholser correctly stated, in using the word *camtschatica*, Pallas was not proposing a name for a race of *S. pomarinus.* Oberholser credited Salvin (1896) as author of the name *camtschatica* but actually Salvin listed the name as a synonym of *S. pomarinus.* Oberholser's claim that Salvin's listing of *camtschatica* in the synonymy of *pomarinus* thereby made this name available, with Salvin as author, does not satisfy Article 11(d) of the International Code of Zoological Nomenclature. Therefore, the name *camtschatica* had no status in nomenclature until it was used by Oberholser.

As pointed out by Oberholser, the differences in size between the two alleged races are minor. I do not believe that they justify the recognition of races of *S. pomarinus.*

Geococcyx californianus dromicus, p. 439 = *G. californianus* (Lesson, 1829)

G. californianus ranges from northern California south to Baja California, east through Nevada, southern Utah, parts of Kansas, Oklahoma, Arkansas, and Louisiana, south to Arizona, New Mexico, and central Mexico. No races have previously been recognized. Oberholser named the roadrunners from central Texas and western Arkansas south to central Nuevo Leon and central Veracruz as *G. c. dromicus*, which he described as smaller than *californianus*, but with larger white spots on the outermost rectrices.

The means of measurements of adult males collected near the type locality of *G. californianus* are not significantly greater ($P < 0.05$) than those of the type series of *dromicus.* Specimens from Arizona also are similar in size both to the California sample and to the type series of *dromicus* (Table 1). The mean of the wing chord of the type series (173.5 mm) actually is larger

Table 1. Measurements (mm) of male *Geococcyx californianus* from three geographic samples.

		Wing chord		Tail		Culmen from nostril	
Sample	*n*	range	mean ± SD	range	mean ± SD	range	mean ± SD
californianus[1]		163.6–189.0	174.5	260.1–300.0	278.4		
dromicus[1]		154.9–168.9	163.3	243.1–277.1	254.3		
Texas	8	163–191	173.5 ± 11.597	259–314	273.5 ± 16.918	31.1–37.7	35.1 ± 2.214
Arizona	12	165–181	172.5 ± 5.377	269–298	284.5 ± 7.399	29.6–39.1	36.1 ± 2.544
California	4	167–179	173.5 ± 5.545	269–316	288.5 ± 18.117	35.6–41.4	37.6 ± 2.380

[1] From Oberholser (1974).

than that reported by Oberholser (163.3 mm). The size of the tail spots is subject to great individual variation and is not a useful character in separating the alleged forms.

At best, the geographic variation in length of tail and culmen appears to be clinal (Table 1), with the extremes at either end poorly differentiated and not warranting nomenclatural recognition.

Chordeiles minor divisus, p. 472 = *C. m. hesperis* (Grinnell, 1905)

Four races of *C. minor* occur in southeastern Montana, Wyoming, and eastern Utah and western Colorado: a dark race, *C. m. hesperis*, breeds from eastern Oregon and California, Nevada, Idaho, and western Montana south to Utah; a paler race, *sennetti*, breeds from southern Saskatchewan south to eastern Montana, Wyoming, and north-central Colorado and northeastward to southwestern Minnesota; a buffy race, *howelli*, breeds in central and eastern Colorado, northeastern Utah, and north-central Texas; and a fourth race, *henryi*, similar to *hesperis* but browner and less intensely black, breeds from southwestern Utah south through Arizona and New Mexico to extreme western Texas and to southern Durango, Mexico (A.O.U., 1957). Intergradation occurs between *hesperis* and *sennetti* in southern Saskatchewan and central Montana; between *hesperis* and *howelli* in south-central Wyoming and northwestern Colorado; between *henryi* and *howelli* in northeastern Utah and western Colorado; between *henryi* and *hesperis* in southeastern Utah; and between *sennetti* and *howelli* in northeastern Colorado (see Selander, 1954).

Oberholser delimited the range of his new race, *divisus* (type-locality = Loveland, Larimer Co., Colorado) as including parts of the zones of intergradation between the four races listed above except that between *henryi* and *hesperis*. He described *divisus* as paler buff than *howelli* but did not differentiate the new form from any other races of *C. minor*.

The type-series of *divisus* is highly variable and includes examples of intergrades between several of the western races. Selander (1954:76) reported that specimens from Larimer County, Colorado, resemble those from Chaffee and Gunnison counties, of which some are closer to *hesperis* than to *howelli*. The fate of the name *divisus* thus rests on the identiifcation of the holotype. I find that the holotype of *divisus* is darker and less buffy than the holotype of *howelli*. However, the holotype of *divisus* cannot be separated from most specimens of *hesperis* from eastern Oregon, Idaho, and elsewhere in the Great Basin.

Phasmornis mystica, p. 485 = ?

Phasmornis mystica was described by Oberholser (1974) as a new genus and species of hummingbird. The name is based on the unique holotype, for which Oberholser, unfortunately, gave no museum number or collector's number, and to date the whereabouts of the type-specimen remains unknown.

Cornelius Muller (surname changed from Mueller in 1937), who reportedly collected the holotype, collected eight specimens of hummingbirds at Boot Springs, Texas, in the 1930's (*in litt.*, 22 January 1975). These are housed at the University of Texas, Austin. Hoping that one of these might be the missing holotype of *P. mystica*, I examined the entire series. Three of the eight (two *Selasphorus platycercus* and one *Lampornis clemenciae*) have collection data identical to that given by Oberholster for the holotype of *P. mystica*. None of the eight specimens, four of which bear the initials "HCO," however, conforms in the mensural or color characters given by Oberholser in the original description of *P. mystica*.

Phasmornis mystica was described as similar to the female plumage of *Archilochus alexandri*, but smaller and more metallic green on the pileum. The detailed description and measurements given by Oberholser provide no clues to the identity or sex of the type. Although regarded as probably being a male by Oberholser, it was considered by Kincaid (*in* Oberholser, 1974) to be perhaps a mutant or hybrid. Kincaid was unsuccessful in locating the holotype. The holotype of *P. mystica* may represent a hybrid, an immature of some known species, a mutant, or a mislabeled skin from some locality other than the Chisos Mountains.

Lampornis clemenciae phasmorus, p. 493 = *L. c. phasmorus* Oberholser, 1974

Lampornis clemenciae was first subdivided by Oberholser (1918), who gave the name *bessophilus* to the form breeding from Arizona east to the Chisos Mountains in Texas, and south to Durango and Sinaloa, Mexico. Birds breeding from the Central Plateau and the Sierra Madre Oriental of Mexico south to Oaxaca were assigned to the nominate race, *clemenciae* Lesson, 1829 (type-locality = "Mexico"). *Lampornis c. bessophilus* was described as having a shorter bill and being duller above and grayer below than the nominate race.

The racial identity of the birds breeding in the Chisos Mountains has been subject to much controversy, some authors (Oberholser, 1918; Todd, 1942) referring this population to *bessophilus* and others (e.g., Van Tyne, 1929) to *clemenciae*. Oberholser has named the birds of the Chisos Mountains as a new race, *phasmorus*. This race is said to differ from the nominate race by its shorter bill and tail, with the rectrices having narrower white tips, and from *bessophilus* in being more green (less bronze) above and more gray (less brown) below.

I find that the coloration of *bessophilus* is similar to that of *clemenciae*, although slightly duller (less bronze), especially on the rump. The ventral

Table 2. Bill measurements (mm) of adult male specimens of *Lampornis clemenciae.*

	exposed culmen			bill width		
	n	range	mean, SD	*n*	range	mean, SD
phasmorus	12	20.2–22.2	21.55 ± 0.48	9	2.4–3.1	2.78 ± 0.22
bessophilus	13	21.8–23.2	22.45 ± 0.48	8	2.0–3.0	2.70 ± 0.33
clemenciae	15	22.1–24.3	23.19 ± 0.66	9	2.8–3.1	2.97 ± 0.17

color of *bessophilus* is very slightly paler than in the nominate race. The type series of *phasmorus* is noticeably more green above than either *bessophilus* or *clemenciae.* The breast and abdomen of *phasmorus* are decidedly gray, whereas in *bessophilus* and *clemenciae* they are grayish-brown. Iridescent feathers on the sides of the upper breast are green in specimens of *phasmorus,* and greenish-bronze in the other two races. The amount of white on the outer rectrices of *phasmorus* appears to be similar to that of nominate *clemenciae,* both races having more white than *bessophilus.*

Nominate *clemenciae* is slightly larger than *bessophilus* (Oberholser, 1918). The length of the exposed culmen of *phasmorus* is significantly smaller than that of *bessophilus* ($t = 4.60$, $P < 0.0001$; see Table 2). Although *bessophilus* is intermediate between the two other races in length of bill, the difference between *bessophilus* and nominate *clemenciae* is also highly significant ($t = 3.40$, $P < 0.001$). Nominate *clemenciae* is larger than *phasmorus* in width of bill ($t = 2.531$, $P < 0.02$). *Lampornis c. bessophilus* is intermediate between the other two races in width of bill (Table 2), but is significantly smaller than nominate *clemenciae* ($t = 3.132$, $P < 0.001$). Specimens of *clemenciae* and *bessophilus* were collected from the southern and northern portions of their respective ranges and may possibly represent extremes. *Lampornis c. phasmorus* is intermediate between the two other races in wing chord and tail length, but the differences between the three races in this case are not significant.

The breeding range of *phasmorus* is imperfectly known. Based on two specimens from Santa Catarina in central-western Nuevo Leon, Oberholser stated that the southern part of the range of the race is on the northeastern edge of the Mexican Plateau. These two specimens are similar to nominate *clemenciae* in ventral coloration, but one (USNM 183701) has iridescent green feathers on the upper breast and neck and, therefore, closer to typical *phasmorus.* This specimen is also decidedly green dorsally, but its exposed culmen is 23.4 mm, or closer to that of *clemenciae* (Table 2). The second specimen (USNM 183702) is identical to *clemenciae* in dorsal color, but its exposed culmen is 21.1 mm, or closer to that of *phasmorus* (Table 2). The two specimens thus appear to be examples of intergrades between *clemenciae* and *phasmorus.*

I conclude that there are three distinct races of *L. clemenciae*: a slightly dull greenish-bronze race, *bessophilus*, breeding from Arizona and New Mexico south to Durango and Sinaloa; a slightly brighter greenish-bronze race, *clemenciae*, with a longer and heavier bill, which breeds from the Central Plateau and the Sierra Madre Oriental of northern Mexico south to Oaxaca; and a bright green, short-billed race, *phasmorus*, breeding in the Chisos Mountains of Texas, southeast probably to central-western Nuevo Leon.

Balanosphyra formicivora phasma, p. 516 = *Melanerpes f. formicivorus* (Swainson, 1827)

Previous to Oberholser (1974), *M. formicivorus* in the United States had been divided into three races: *bairdi* Ridgway, 1881, breeding from Oregon to southern California; *aculeatus* Mearns, 1890 (type-locality = Squaw Peak, central Arizona) breeding in the southwestern United States south to northern Mexico; and *formicivorus* Swainson, 1827 (type-locality = Temascaltpec, Mexico) breeding in southcentral Texas south to Oaxaca. Oberholser subdivided *formicivorus*, naming a new race, *phasma*, said to range from the southern part of the Trans-Pecos in Texas, south to Coahuila and southern Tamaulipas.

Ridgway (1914) considered *bairdi* to be larger than *aculeatus* and to have a more uniform and extended black upper breast band and more yellow lower throat. He did not state how *bairdi* differs from nominate *formicivorus*, but his measurements reveal that females of *bairdi* average larger than females of *formicivorus*. Mearns (1890) described *aculeatus* as smaller than *formicivorus* and *bairdi*, and as having a more slender bill than the other two races. *Melanerpes f. aculeatus* was recognized by van Rossem (1934a, 1945) but the name was placed in the synonymy of *formicivorus* by Peters (1948). Phillips (*in* Phillips et al., 1964) recognized *aculeatus* as a distinct race based on its slender bill. Oberholser (1974) recognized *aculeatus* and considered it to be smaller than nominate *formicivorus* in wing, tail, bill, and middle toe. Oberholser distinguished a new race, *phasmus*, from *aculeatus* and nominate *formicivorus* by its shorter wing and tail and longer bill and middle toe. Oberholser found no appreciable difference in the black breast band between *phasmus* and *formicivorus* and found only a slight difference in this character between *formicivorus* and *aculeatus*.

I measured 55 adult males and 48 females (Tables 3 and 4) in order to assess the status of *aculeatus* and *phasmus*. There were too few specimens available from north-central Mexico (north of 24° latitude) for statistical treatment. Specimens of *bairdi* from California are included for comparison.

Specimens from the range of *aculeatus* from New Mexico and western Texas (mostly from the Davis Mountains) are larger than those from Arizona

Table 3. Measurements (mm) of adult male *Melanerpes formicivorus*.

	Wing chord	Tail	Bill length	Bill width	Middle toe
bairdi (Calif.)	136.9–147.2 142.2 ± 4.1 10	76.4–84.5 80.3 ± 2.6 10	21.2–24.8 22.7 ± 1.1 10	7.3–8.9 8.1 ± 0.4 15	16.7–18.9 17.7 ± 0.7 10
aculeatus (Arizona)	129.1–142.5 136.0 ± 3.9 12	65.0–80.5 74.2 ± 4.8 12	18.3–21.8 19.5 ± 1.3 10	6.3–7.5 7.0 ± 0.3 14	15.3–17.3 16.7 ± 0.7 6
aculeatus (New Mex., W. Tex.)	135.0–144.3 138.6 ± 3.6 5	69.6–83.2 78.3 ± 5.3 5	19.5–24.7 21.4 ± 2.0 5	7.0–7.5 7.2 ± 0.2 5	15.7–18.5 17.1 ± 1.3 5
phasmus (Chisos Mtns.)	127.0–137.0 133.2 ± 3.8 9	63.0–82.3 73.5 ± 6.4 9	20.6–23.9 21.7 ± 0.9 9	6.3–7.6 6.9 ± 0.5 9	16.2–18.2 17.2 ± 0.7 9
phasmus (Nuevo Leon)	135.2–135.3 135.3 3	74.3–77.9 75.7 3	22.4–24.0 23.0 3	—	16.9–17.7 17.4 3
formicivorus (Vera Cruz-Hidalgo)	136.3–139.9 138.2 4	72.5–83.0 76.9 4	18.6–21.6 20.4 4	—	16.7–19.7 17.9 4
formicivorus (Guerrero, Michoacan)	135.6–148.1 139.0 ± 4.6 6	71.0–79.7 75.5 ± 3.2 6	19.3–20.9 19.9 ± 0.7 6	—	16.4–17.5 16.9 3
formicivorus (Jalisco)	134.2–147.0 139.7 ± 4.6 6	71.2–77.7 74.1 ± 3.1 6	19.1–21.7 20.3 ± 0.9 6	—	16.5–17.8 17.2 ± 0.5 6
formicivorus (S. cent. Mex.)	—	—	—	7.1–8.1 7.6 ± 0.3 9	—

in all the characters examined except in width of bill in males (Table 3) and length of bill in females (Table 4). I do not agree with Oberholser that *aculeatus* may be separated from *formicivorus* by mensural differences of wing, tail, bill and middle toe. Differences between the means for width of bill in males, however, is highly significant ($t = 4.65$, $P < 0.001$) between *aculeatus* from Arizona and nominate *formicivorus* from south-central Mexico. Nevertheless, it seems inadvisable to recognize *aculeatus* on the basis of differences in bill width alone, at least until a series from north-central Mexico is examined.

The mensural differences between *phasmus* and the nominate race do not conform to those stated by Oberholser except in wing chord (Tables 3 and 4). The mean of wing chord of males and females of *phasmus* from the Chisos Mountains was found to be statistically significant ($P < .05$) from that of both "*aculeatus*" and nominate *formicivorus*. Males of *phasmus*

Table 4. Measurements (mm) of adult female *Melanerpes formicivorus.*

	Wing chord	Tail	Bill length	Bill width	Middle toe
bairdi (Calif.)	136.9–147.2 140.9 ± 3.9 10	76.4–84.5 83.6 ± 4.4 10	21.2–24.8 21.5 ± 1.1 10	7.3–8.3 7.7 ± 0.4 13	16.7–18.9 17.6 ± 0.8 10
aculeatus (Arizona)	132.5–142.0 138.5 ± 3.2 8	74.0–82.6 79.9 ± 2.9 8	17.4–20.9 19.9 ± 1.3 6	6.2–7.5 6.9 ± 0.4 14	14.4–16.5 15.9 ± 0.8 6
aculeatus (New Mex., W. Tex.)	135.0–142.2 139.1 ± 2.4 10	75.8–84.9 79.9 ± 2.6 9	18.3–21.6 19.9 ± 1.0 9	6.8–7.5 7.2 ± 0.4 8	15.6–20.9 16.7 ± 0.7 9
phasmus (Chisos Mtns.)	131.3–138.5 134.9 ± 2.8 7	71.4–84.6 77.3 ± 4.8 7	19.2–22.6 20.6 ± 1.4 5	6.7–8.0 7.2 ± 0.4 7	15.9–17.1 16.6 ± 0.4 5
phasmus (Nuevo Leon)	128.7–131.0 130.8 ± 1.0 6	65.5–74.4 70.8 ± 3.4 6	17.0–21.5 19.7 ± 1.6 6	—	15.7–18.3 16.9 ± 0.9 6
formicivorus (Jalisco)	128.2–144.4 139.1 ± 5.1 8	64.6–77.0 72.2 ± 4.5 8	17.7–19.8 18.9 ± 1.1 8	—	13.4–17.1 15.9 ± 1.3 7
formicivorus (S. cent. Mex.)	—	—	—	6.8–7.9 7.3 4	—

have significantly smaller means for width of bill ($t = 3.38$, $P < 0.001$) than *formicivorus* and are statistically larger in length of culmen than "*aculeatus*" and nominate *formicivorus*. Width of bill is greater in female specimens of *phasmus* than in those from samples of "*aculeatus*" ($t = 2.24$, $P < 0.02$). The coloration of the specimens from different samples listed in Tables 3 and 4 does not reveal consistent geographical variation.

The differences between specimens from the Chisos Mountains and Nuevo Leon and specimens of nominate *formicivorus*, although statistically significant for certain characters, are small and it seems best to consider the name *phasmus* as a synonym of nominate *formicivorus*.

Empidonax oberholseri spodius, p. 558 = *E. oberholseri* Phillips, 1939

Oberholser divided *E. oberholseri* into two races on the basis of differences in size and coloration. *E. o. spodius*, considered to be the race breeding from northwestern British Columbia to southwestern Saskatchewan south to southern Oregon does not warrant recognition since geographic variation in the species is virtually negligible (Browning, 1974). Oberholser restricted the range of the nominate race to southeastern Idaho, east to northwestern South Dakota and south to northwestern California and central New Mexico. Curiously, the type-locality of *spodius*, Gray, Bonneville Co., Idaho, is in the breeding range of nominate *oberholseri*, further negating the validity of this supposed race.

Iridoprocne bicolor vespertina (Cooper, 1876), p. 989 = *I. bicolor* (Vieillot, 1807)

The name *vespertina* was proposed for the western populations of *Iridoprocne bicolor* by Cooper, who considered these birds to be larger and bluer than the eastern populations. Ridgway (1904) did not recognize *vespertina* and his measurements reveal that western birds are actually slightly smaller than those of eastern samples.

Oberholser revived the name *vespertina* for birds from California, which he considered to be "decidedly" smaller than other populations of the species. Birds from Oregon and Washington, according to Oberholser, are slightly larger than *vespertina*, but are referable to the nominate race.

I measured a series of adult *I. bicolor* taken during the breeding months and find little geographic variation. Measurements of wing chord are given in Table 5. Few specimens from California were available but both males and females have smaller means than those of all other samples. Nonetheless, the differences between the samples are minor in *I. bicolor*; the measurements of the California birds are entirely within the extremes of samples from elsewhere in the species' range (Table 5). The putative difference in size between specimens from California and other specimens compared by Oberholser may have been caused by his sampling technique. The measurements given by Oberholser (1974) are strongly biased by his failure to confine himself to include only breeding specimens. Oberholser measured six males and five females from California. Only one male and one female were taken during the breeding season; all other specimens were collected in the late fall, winter, or early spring. The two probable breeding specimens both have wing chords that exceed the means of the respective sexes of *vespertina*. Oberholser is also incorrect in considering specimens from Washington and Oregon to be intermediate in size between birds from California and the remaining portion of the range of the species. There is no statistically significant difference between the means of any of the geographic samples.

Petrochelidon pyrrhonota albifrons (Rafinesque, 1822), p. 579 = *P. p. pyrrhonota* (Vieillot, 1817)

Petrochelidon pyrrhonota lunifrons (Say, 1823), p. 579 = *P. p. pyrrhonota*

Oberholser considered the populations of *P. p. pyrrhonota* (*sensu* A.O.U. Check-list 1957) from east of the Rocky Mountains to consist of three races.

Table 5. Variation (mm) in wing chord of adult *Iridoprocne bicolor.*

	Males				Females			
	n	range	mean	SD	*n*	range	mean	SD
Alaska	15	113.0–123.6	118.21	3.08	4	114.8–122.1	118.88	3.04
British Columbia	18	110.5–121.3	115.53	2.95	9	106.6–117.9	112.64	3.95
Washington–Oregon	8	116.3–120.9	119.21	1.55	6	112.8–120.7	118.43	2.91
California	4	114.2–119.7	116.73	2.31	3	108.6–114.9	111.37	3.17
Alberta	6	117.1–121.5	119.13	1.95	8	110.3–118.8	115.33	3.03
Ontario–Quebec	8	114.0–123.5	118.30	3.46	11	111.2–117.5	115.14	1.93
Newfoundland	10	113.9–125.9	118.78	3.67	7	111.9–120.3	115.94	2.79
New Jersey	11	111.1–124.1	117.54	4.84	4	112.7–122.9	117.48	4.63

According to Oberholser, the name *albifrons* applies to the populations breeding from northwestern Manitoba and central Ontario south to Missouri and Tennessee, and the name *lunifrons* to the populations from North Dakota south to central New Mexico and northern Texas. He restricted the range of nominate *pyrrhonota* to the northeastern United States. *Petrochelidon p. lunifrons* was said to be paler on the rump, nape, forehead, and underparts, and to have a shorter middle toe than *albifrons*. Nominate *pyrrhonota* was said to have a darker forehead than *albifrons*, the only distinction between the two races given by Oberholser.

The names *lunifrons* (based on specimens from the Rocky Mountains) and *albifrons* (based on specimens from Kentucky and Indiana) have been considered synonyms of nominate *pyrrhonota* for many years. Oberholser's recognition of *albifrons* and *lunifrons* as distinct races was supported by very weak characters and was based upon very small series. According to Oberholser's measurement sheets, only two males of *albifrons* were examined, and his largest sample was a group of only 11 specimens, which he has assigned to *lunifrons*. I examined larger series from several areas east of the Rocky Mountains and found that there is a great amount of individual variation in these birds. The degree of variation and the lack of consistent geographic variation in these populations certainly does not permit the recognition of additional races.

Aphelocoma coerulescens mesolega, p. 589 = *A. c. suttoni* (Phillips, 1964)

The Rocky Mountain populations of *A. coerulescens* are subdivided into a dark northern form, *woodhouseii* Baird, 1858 (type-locality = San Francisco Mountains, Coconino County, Arizona), and a paler southern race, *texana* Ridgway, 1902 (type-locality = near the head of the Nueces River, Edwards County, Texas). Phillips (1964) examined the type specimen of *woodhouseii*, which Pitelka (1951) did not see, and referred the specimen to the pale populations of the Great Basin. According to the A.O.U. Check-list (1957), birds from the Great Basin are the race *nevadae* Pitelka, 1945. Phillips placed the name *nevadae* in the synonymy of *woodhouseii* and named a dark eastern population *suttoni* (type-locality = Scroogs' Arroyo, 35 km S Pueblo, Colorado).

The racial identity of the birds from the Trans-Pecos of Texas has been a subject of much controversy. Some authors considered this population to consist of intergrades between *suttoni* (*woodhouseii* of Pitelka, 1951) and *texana* (Oberholser, 1917), but closer to the former (Oberholser *in* Van Tyne and Sutton, 1937; Pitelka, 1951). Smith (1917) referred specimens to "*woodhouseii*" but Oberholser (1920) and Hellmayr (1934) referred specimens to *texana*.

Oberholser named the birds of southeastern New Mexico and the Trans-Pecos of Texas as a new race, *mesolega* (type-locality = Ft. Davis, Jeff Davis Co., Texas), said to be paler above and darker below than *texana*, and "less bluish" above and paler below than *suttoni*. The type series of *mesolega* represents a population somewhat intermediate between *suttoni* and *texana*, but more similar to *suttoni*. I agree with Pitelka (1951) and others that specimens from the Davis Mountains are referable to the dark northern race now know as *suttoni*. The name *mesolega* is here considered to be a synonym of *suttoni*.

Baeolophus bicolor floridanus (Bangs, 1898), p. 609 = *Parus bicolor* Linnaeus, 1766

In the original description of *floridanus*, Bangs (1898) limited the range of this race to Florida. He described *floridanus* as smaller and paler and gave measurements of only two males of *floridanus* and two males and one female of *bicolor*. Oberholser revived the name *floridanus* for a race that he considered to breed from northern Texas and Georgia and south to central Texas and central Florida. He characterized the race as smaller, paler, and grayer than the nominate race found in the remainder of the species' range. Oberholser does not give comparative measurements.

Upon comparing size and coloration between specimens from the extreme northern part of the range of *P. bicolor* and birds from Florida and southern Texas, I find little difference between the alleged races. This is also borne out by Oberholser's own measurement sheets of the two forms; the means of the different measurements of his samples are virtually identical. Dixon (1955) examined portions of the western populations and found that there is minor clinal variation from large in the north to smaller in the south.

Certhia familiaris iletica, p. 627 = *C. f. montana* Ridgway, 1882

The populations of *Certhia familiaris* breeding from southern Alaska south through the Rocky Mountains to western Texas are generally recognized under the name *montana* (see Burleigh and Lowery, 1940; A.O.U. 1957). Oberholser considered the birds breeding in the northern part of the Trans-Pecos of Texas to be distinct from *montana* and named his new form *iletica*. He defined the range of *montana* as including southern Alaska south through the Rocky Mountains to central Arizona and southern New Mexico, essentially the range given by Ridgway (1882). *Certhia f. iletica* was said to be smaller than *montana*, with shorter tail, culmen, and middle toe. According to Oberholser the two races show very little overlap in these measurements, the greatest difference being in length of tail.

Only 6 of the 13 specimens in the type series of *iletica* were available for comparison. All but two specimens in the total series were collected during the breeding months. One of these two non-breeding birds has the buffy superciliary stripe characteristic of the eastern race, *americana* and was collected in December at Del Rio, Texas, where *americana* is known to winter (cf. A.O.U. Check-list, 1957). The remaining specimens that I examined are adult males and all have the white superciliary line characteristic of the race *montana.* The range of variation in length of tail in these specimens falls within that of adult males of *montana* collected in the Rocky Mountains. The length of tail of the holotype of *iletica,* a female, is 59.8 mm and is also within the range of nine female specimens from the Rocky Mountains (59.0–69.3 mm). Likewise, the measurements of type-series of *iletica* do not differ from those of birds collected within the range ascribed to *montana.* The name *iletica* is here considered a synonym of *montana.*

Telmatodytes palustris canniphonus, p. 640 = *T. p. dissaeptus* (Bangs, 1902)

Telmatodytes palustris cryphius, p. 641 = *T. p. iliacus* Ridgway, 1903

Here, I follow the treatment of *T. palustris* advocated by Parkes (1959), who recognized four races of Long-billed Marsh Wrens breeding east of the Rocky Mountains and north of the Carolinas. These are *T. p. palustris* (Wilson), 1807, a brownish race that is less reddish than the other three forms and that breeds in the coastal regions from Rhode Island south to Virginia; *dissaeptus* Bangs, 1902, a reddish brown race that breeds from New Brunswick, southern Maine and southern Ontario south in inland regions to western Virginia, south-central Pennsylvania, and Ohio; *iliacus* Ridgway, 1903 (type-locality = Wheatland, Knox County, Indiana), paler brown and more reddish than *dissaeptus*, breeding from southwestern Michigan, western Indiana and western Ontario south to southern Missouri and eastern Kansas, and west through the Dakotas and Manitoba; and *laingi* Harper, 1926 (type-locality = Athabaska Delta, 9 miles above mouth of Main Branch, Alberta), a pale brown race that breeds east of the Rocky Mountains in Alberta and most of Saskatchewan. Discussion of areas of intergradation and more detailed breeding ranges may be found in Parkes (1959).

Parkes examined approximately 670 skins of *T. palustris*, a much larger sample than that seen by Oberholser, according to his sheets of measurements. Parkes did not find the recognition of more than four subspecies to be warranted within the northeastern portion of the species' range.

Birds from the range of *dissaeptus* (*sensu* Parkes) were considered by Oberholser to be referable to two races, a dark, less rufescent (more sooty) form, *canniphonus*, breeding from southeastern Ontario and southeastern Michigan south to Pennsylvania and Ohio, and *dissaeptus*, a more rufescent form breeding in southwestern Quebec, southern Maine, and south to Connecticut and Rhode Island. The wing chord of *canniphonus* was said to be greater than in examples of his *dissaeptus.*

I compared the type series of *canniphonus* with specimens taken from several localities within the range of *dissaeptus*, and find that both series are identical in color, and that there is no difference in wing chord between the two series. Parkes (1959) listed measurements revealing a greater difference in the mean of wing chords between two series of geographically separate representatives of *laingi* than is evident between Oberholser's *dissaeptus* and *canniphonus.* The name *canniphonus* is here considered a synonym of *dissaeptus.*

Briefly, the taxonomic history concerning the birds described as *cryphius* (type-locality = Blackmer, Richland County, North Dakota) by Oberholser (1974) is as follows. Todd (1937) noted differences between the holotype of *iliacus* and other specimens collected nearby in southwestern Indiana, and attributed the differences to post-mortem changes in color. Aldrich (1946) suggested that the holotype of *iliacus* was a migrant from the range of the race known by the more recent name *laingi.* The holotype of *iliacus* (USNM 90199), was not listed by Deignan (1961).

Oberholser, following Aldrich's suggestion, held that the holotype of *iliacus* was a migrant representative of *laingi*, thereby leaving the prairie population nameless. The name *cryphius* was proposed by Oberholser for this population and the name *iliacus* was applied to the form in Alberta and Manitoba (= *laingi*, *sensu* Parkes). If this treatment of the type of *iliacus* were correct, Oberholser's action would have been justified. However, Parkes (1959) concluded that the holotype of *iliacus* is indeed representative of the prairie population. This being the case, the name *cryphius* becomes a synonym of *iliacus.* It may be noted that in color, the type of *cryphius* is well within the range of individual variation of *iliacus*, and is noticeably darker than *laingi* and paler than *dissaeptus.*

Turdus migratorius aleucus, p. 662 = *T. m. propinquus* Ridgway, 1877

Oberholser subdivided *propinquus* Ridgway, 1877, into two races, naming the race from Oregon, California, and western Nevada as a new form, *aleucus*, said to be similar in color to *propinquus* but smaller. Variation in length of wing in *propinquus* (*sensu* A.O.U. Check-list, 1957) is clinal with birds having shorter wings in the west (see Browning, 1974).

Hylocichla mustelina densa (Bonaparte, 1854) = *H. mustelina* (Gmelin, 1789)

Oberholser applied the name *densa* to the Wood Thrushes that breed from central Oklahoma, southern Indiana, and South Carolina south to southeastern Texas and northern Florida. He considered the birds breeding to the north of this region to be nominate *mustelina.* According to Oberholser, *densa* differs from *mustelina* in its shorter wing and tail, and duller, more olivaceous (less rufescent) upperparts.

Specimens of *H. mustelina* from New Jersey are slightly more rufescent above than birds from Georgia and Alabama but the variation in this character is clinal. Geographic variation in size is also slight and clinal with larger birds breeding in the north. Means from measurements of wing chord of males are as follows: New Jersey ($n = 10$) 108.15, Maryland–Virginia ($n = 10$) 107.64, North Carolina ($n = 6$) 106.13, South Carolina ($n = 2$) 104.15, and Georgia–Alabama ($n = 7$) 104.82. The ranges of these samples overlap considerably and the differences between the means of the samples also are statistically similar.

Anthus spinoletta ludovicianus (Gmelin, 1789), p. 685 = *A. s. rubescens* (Turnstall, 1771)

Oberholser considered the race *rubescens* to be divisible into two distinct races and applied the name *ludovicianus* Gmelin to the birds from the Hudson Bay region and the name *rubescens* to birds from northern Ungava, Labrador, and Newfoundland. Oberholser characterized *ludovicianus* as grayer (less rufescent) on its upper parts and less deeply buff on its lower parts than *rubescens.*

As Oberholser (1919) pointed out, there is considerable variation in *A. s. rubescens.* Todd (1963) considered the amount of individual variation in *rubescens* to be "excessive" and did not divide the birds breeding from Hudson Bay east to Labrador. Parkes (*in litt.*, 1976) compared a series collected in May from Seven Islands, Quebec, the Belcher Islands, Hudson Bay, and Churchill, Manitoba, and found that individual variation in color exceeded any possible trends in geographic variation. Upon examining specimens of *A. spinoletta* for geographic variation in several museums, I agree with Todd and Parkes that individual variation in the race *rubescens* is considerable, and I conclude that there are no grounds for the recognition of additional races from eastern Canada. The name *ludovicianus* was based on a migrant taken in Louisiana and its description most closely resembles the less rufescent individuals of *rubescens.*

Lanivireo flavifrons sylvicola (Wilson, 1808), p. 997 = *Vireo flavifrons* Vieillot, 1807

Oberholser applied the name *sylvicola* to the northern populations of *V. flavifrons,* and considered the birds breeding to the south, from central

Texas and northern South Carolina south to southeastern Texas and northeastern Florida to be referable to nominate *flavifrons*. According to Oberholser the northern race, *sylvicola*, is distinct from *flavifrons* by its larger size and less golden or orange-yellow anterior underparts.

Hamilton (1958) found no geographic variation in color in *V. flavifrons* and did not mention any differences in size between samples of the species. I too find no geographic variation in color in *V. flavifrons*. There is clinal variation in wing chord between northern and southern birds, but this variation is very slight. Measurements in wing chord of males is as follows: New York–New Jersey ($n = 10$) 77.71, Virginia–Maryland ($n = 11$) 75.74, Georgia–Florida ($n = 11$) 74.47. Measurements of females from these samples are, respectively, as follows: ($n = 6$) 77.28, ($n = 3$) 76.76, and ($n = 5$) 74.24. Thus geographic variation in the species is not sufficient to justify recognition of races in *Vireo flavifrons*.

Solivireo solitarius jacksoni, p. 709 = *Vireo s. plumbeus* Coues, 1866

The western populations of *V. solitarius* have traditionally been divided into two races, *plumbeus* Coues, 1866 (type-locality = Ft. Whipple, Arizona), a gray form breeding throughout most of the Great Basin in the Rocky Mountains from southeastern Montana to western Texas, and *cassinii* Xantus, 1858, a yellow and green form breeding in the remainder of western North America. Both races breed in Montana, with *cassinii* occurring in the northwestern part of the state, and *plumbeus* breeding in the southeastern part of the state.

Oberholser considered *plumbeus* to be a composite of two races. The form breeding in New Mexico and the Trans-Pecos of Texas (*plumbeus*) was characterized by its small bill and grayish coloration. Oberholser named a race *jacksoni*, said to have a larger bill and to be more olivaceous than *plumbeus*, and alleged to breed from northeastern Sonora and Arizona north to Montana. The holotype of *plumbeus* was collected within the range of so-called *jacksoni*, but Oberholser regarded it as a migrant from the east. Whether or not the holotype of *plumbeus* is a migrant is of little importance, because the race *jacksoni* is not recognizable. The length of bill of adult male specimens from Texas ($\bar{x}$ 7.55 mm, $n = 8$) is practically identical to that of males from central Arizona ($\bar{x}$ 7.94 mm, $n = 7$). In addition, Hamilton (1958:318) showed that there is very little difference in length of culmen between samples of specimens from southeastern Arizona and from Colorado. Furthermore, I cannot separate specimens of *jacksoni* from those of *plumbeus* (*sensu* Oberholser, 1974) on the basis of the alleged differences in color of the two forms. The holotype of *jacksoni* is well within the range of individual variation of *plumbeus*.

Melodivireo gilvus petrorus, p. 715 = *Vireo gilvus leucopolius* (Oberholser, 1932)

Oberholser named a race *petrorus*, said to breed from southern British Columbia and southern Alberta southward to northern Sonora and the Trans-Pecos of Texas. He described *petrorus* as darker and more olivaceous above than eastern *gilvus*, and larger and more grayish above than a northwestern race, *swainsonii*. Oberholser did not mention *leucopolius*, a large gray race that he described in 1932 from the Warner Valley in Oregon. According to the A.O.U. Check-list, *leucopolius* has a range that would include most of that of *petrorus*. Although not so stated, Oberholser (1974) limited the range of *leucopolius* to the Warner Valley. Specimens of *leucopolius* (*sensu* Oberholser, 1932) and *petrorus* are similar both in coloration and in size (Browning, 1974).

Dendroica petechia hypochlora, p. 737 = *D. p. sonorana* Brewster, 1888

The western populations of *D. petechia* are divided into a dark northern race *morcomi* Coale, 1887, breeding from western Washington and western Montana south to northern Arizona and central New Mexico, and a pale southwestern race, *sonorana* Brewster, 1883, breeding from central Arizona and southwestern New Mexico to Zacatecas in Mexico. According to Phillips (*in* Phillips et al., 1964) intergradation between *morcomi* and *sonorana* occurs in northern and northeastern Arizona. Intergradation between these two races was also reported to occur in New Mexico (Hubbard, 1971) and in Colorado (Brewster, 1888). Oberholser named a new race *hypochlora*, the range of which includes most of this area of intergradation. *Dendroica p. hypochlora* was said to be similar to *morcomi*, but with the males more yellowish, darker above, and with finer streaks of chestnut below than in *sonorana*. Females were described as paler than *morcomi* and both sexes were said to be smaller than either *sonorana* or *morcomi*.

I find that the differences in size between the three forms are too small to distinguish any of the populations. Most of the specimens in the type-series of *hypochlora* are pale and therefore closer to *sonorana* than to *morcomi*. The holotype of *hypochlora* is definitely referable to *sonorana*.

Dendroica dominica axantha, p. 758 = *D. d. albilora* Ridgway, 1873

Ridgway (1873) divided *D. dominica* into two races, the nominate race with yellow lores, and *albilora*, a shorter-billed race having a white superciliary line. The race *albilora* was said to breed in the Mississippi Valley south to the Gulf states and *dominica* was said to breed in the remaining eastern part of the species' range. Nominate *dominica* was later subdivided by Sutton (1951), who named *stoddardi*, a long-billed race with yellow lores, breeding in the coastal regions of northwestern Florida.

Oberholser (1974) described *axantha* as a new race breeding in the upper Mississippi Valley, limiting *albilora* to central Texas east to Mississippi. He described *axantha* as similar to *albilora*, but with a shorter bill and wing chord, and a less deeply orange throat, and to have reduced white on the outer rectrices. This new race is described as having less white in the rectrices than either *albilora* or nominate *dominica*, and to differ from the nominate race in its shorter bill, more yellow-orange throat and white lores.

I find that the coloration of the throat is subject to considerable individual variation and cannot be used to separate *axantha* from other races of *D. dominica.* The amount of white in the outer rectrices appears to be similar in all populations of *D. dominica* breeding in North America. Although Ridgway (1902) considered *albilora* to have larger white areas on the rectrices than nominate *dominica*, specimens at hand do not show this character to be particularly useful. Oberholser considered *albilora* to have a longer wing chord than nominate *dominica* or *axantha.* The latter race was said to have the shortest wing. Measurements of the type-series of *axantha*, and samples of the other North American races of *D. dominica* (*sensu* Oberholser), including *stoddardi*, are all very similar ($\bar{x}$ 65.37 for *axantha*, $n = 11$ to 65.99 for *albilora*, $n = 12$).

Length of bill in males of *axantha* is slightly less (8.8–9.9, $\bar{x}$ 9.17 ± 0.313, $n = 11$) than both *albilora* (8.5–10.1, $\bar{x}$ 9.62 ± 0.501, $n = 12$) or nominate *dominica* (8.7–11.5 $\bar{x}$ 9.82 ± 0.739, $n = 26$). Surprisingly, the length of bill of *axantha* is significantly smaller than that of *albilora* ($t = 2.920$, $P < 0.001$) or of nominate *dominica* ($t = 3.003$, $P < 0.001$). Although these differences are statistically significant, I do not believe that recognition of *axantha* is warranted. Most of the specimens of "*axantha*" used in calculating length of bill were from Illinois and Indiana, which may have shorter bills than birds taken elsewhere in the range of the supposed race. Even within the range of nominate *dominica* geographic variation in bill length is readily apparent. For example, six males from Virginia and Maryland (10.5–11.5 $\bar{x}$ 10.9) are similar to *stoddardi* (10.3–11.8 $\bar{x}$ 11.1, $n = 8$). Sutton (1951) found that three males from St. George's Island, Maryland, are long billed; although I agree with Sutton that similar northern specimens are not slender-billed enough to be identified as *stoddardi.* The long-billed specimens from the northern range of nominate *dominica* are otherwise similar to examples of *dominica* taken to the south.

Specimens referred to *axantha* are separable from *albilora* (*sensu* Oberholser, 1974) only on the basis of their slightly shorter bill. I do not consider this difference sufficient to justify a new subspecies from the upper Mississippi Valley.

Oporornis formosus umbraticus, p. 1001 = *O. formosus* (Wilson, 1811)

Oporornis formosus was regarded as monotypic until Oberholser (1974) divided it into a northern and a southern race. He considered *umbraticus*, the northern race, to be larger and less yellowish olive-green above, and paler yellow below than the southern race, *formosus*. The breeding range of *umbraticus* was said to be from northeastern Iowa, southern Michigan, and Connecticut south to northern Missouri, southern Ohio, and Virginia. Nominate *formosus* was said to occupy the remaining part of the species' breeding range.

The differences in color between the alleged races are apparent only in the series compared by Oberholser. Specimens from the type-series of *umbraticus* were collected mostly in the 1880's, while the series of nominate *formosus* was collected mostly in the 1930's or later. Specimens of similar museum age collected in the northeastern United States are not paler than birds collected elsewhere. I attribute these color differences described by Oberholser to fading of the older skins. The greatest difference in size between *umbraticus* and nominate *formosus* was said to be in wing chord (Oberholser, 1974). I find that the differences in wing chord are not sufficient to warrant recognition of subspecies in *O. formosus* (see Table 6).

Icteria virens danotia, p. 789 = *I. v. virens* (Linnaeus, 1758)

Two races of *I. virens* are currently recognized (Lowery and Monroe, 1968): a greenish-backed eastern race, *virens* Linnaeus, 1758 (type-locality = South Carolina), and a longer tailed, grayish-backed western race, *auricollis* Deppe, 1830 (type-locality = City of Mexico, Mexico).

Oberholser named a race *danotia* (type-locality = 20 mi W Mountain Home, Kerr Co., Texas), stating that it breeds from central and southern Texas south to northeastern Coahuila, an area that is geographically between the ranges of *auricollis* and *virens*. According to Oberholser, *danotia* is intermediate in size between *virens* and *auricollis* and grayer than either race. I find that in coloration and in size specimens from the type-series of *danotia* collected from the western part of its supposed range are similar to *auricollis*, and that specimens from the eastern part of its range are similar to *virens*. Most specimens in the type-series of *danotia* are morphologically intermediate between *auricollis* and *virens*. The holotype of *danotia* and specimens collected nearby are most similar to the nominate race in dorsal coloration, wing chord, and length of tail. On the basis of the

Table 6. Variation (mm) in wing chord of specimens of *Oporornis formosus.*

	Males			Females		
Sample	*n*	range	mean	*n*	range	mean
Pennsylvania	12	66.3–75.7	70.11	5	65.0–71.4	67.78
Virginia	12	67.8–72.3	70.41	2	66.9–69.1	68.00
North Carol.	3	67.4–69.6	68.50	3	65.5–67.1	66.36
S.C.–Ga.	8	66.0–69.5	68.30	8	62.4–69.2	66.42
Illinois	6	67.8–70.7	69.33	5	64.4–66.4	65.34
Kentucky	4	67.2–70.9	69.35	5	62.0–65.8	64.54
Tennessee	5	68.8–71.7	70.14	2	64.4–65.9	65.15
Mississippi	6	65.6–69.4	67.73	2	60.8–62.7	61.75
Kansas	3	67.5–71.7	69.43	4	62.2–63.3	62.6

characters of the holotype the name *danotia* is here considered a synonym of *virens.*

Passer domesticus plecticus, p. 801 = *P. d. domesticus* (Linnaeus, 1758)

Oberholser proposed the name *plecticus* for House Sparrows breeding in western North America. This race was said to be grayer and paler than nominate *domesticus.* Upon examination of the type-series of *plecticus,* I agreed (Browning, 1974) with Johnston and Selander (1964) that recognition of races of *P. domesticus* in North America is premature. Furthermore, recent work by Johnston and Selander (1973) demonstrate that *P. domesticus* in the New World has not diverged sufficiently from the Old World populations of nominate *domesticus* to warrant recognition of American races.

Agelaius phoeniceus stereus, p. 812 = *A. p. stereus* Oberholser, 1974

The birds breeding in North Dakota west to the east slope of the Rocky Mountains in Montana south to Colorado have been included by most authorities in the range of *A. p. arctolegus* Oberholser, 1907. Oberholser considered the birds from the above portion of the range of *arctolegus* to represent a recognizable race which he named *stereus.* This race was described as intermediate between *arctolegus,* the race breeding to the northeast, and *fortis* Ridgway 1901, the breeding bird of the central Great Plains. Oberholser considered *stereus* to be similar to *arctolegus,* but browner in female plumage and with a longer tail and wing chord. The new race was also said to have a shorter culmen than either *arctolegus* or *fortis*, and to be further separable from the latter race by its darker color in female plumage. Oberholser also named the breeding birds of Idaho and western Montana and Wyoming as a new subspecies. That new race, named *zastereus* is a recognizable race (Browning, 1974), and has a shorter tail and more slender bill than *stereus*; *zastereus* is treated separately (see below).

I find that the characters ascribed by Oberholser to *stereus* are sufficient to justify recognition of the race. Females are noticeably browner and have longer wings and tails (cf. Oberholser, 1974) than females of *arctolegus*. A series from eastern Montana and North Dakota are much browner than specimens collected in south central Canada and Minnesota. Specimens from the range of *zastereus* have noticeably more slender bills than *stereus*.

The differences between *stereus* and *fortis*, however, are slight. Oberholser has defined the range of *fortis* as southwestern South Dakota south to central Oklahoma and northwestern Texas. I find that the specimens from the range of *fortis*, as defined by Oberholser, are separable from *stereus* collected north of Colorado, but that intergradation between *stereus* and *fortis* makes subspecific identification of Colorado birds difficult, particularly in males. This is unfortunate since the type-locality of *stereus*, Barr, Adams Co., Colorado, is near this zone of intergradation. The holotype of *stereus* has a noticeably more slender bill than does the holotype of *fortis* and is more similar in bill dimension to specimens from eastern Woyming and Montana than to birds from Colorado. The bill measurements given by Power (1970) reveal that the culmens of birds from Colorado are shorter than that of *fortis* (*sensu* Oberholser, 1974), which supports Oberholser's description of the new form. Also, the length of culmen in birds from eastern Colorado approaches that of birds from central Colorado and the type-locality of *stereus* (Power, 1970). The width of the upper mandible, length of the tail and wing chord are greatest among specimens from Colorado and eastern Wyoming and Montana, especially in females (cf. Power, 1970).

Identification of specimens from Colorado is further complicated by the present concept of the breeding range of *fortis*. According to the A.O.U. Check-list (1957), *fortis* ranges from western Montana, eastern Idaho and eastern Utah, southward to northern Arizona and east to northwestern Texas, western Kansas and Nebraska. I find this range to include four recognizable races: *utahensis* Bishop, 1938 (type-locality = near Saltair, 4,200 ft, Salt Lake County, Utah; not recognized by the A.O.U. Check-list (1957), but see Behle, 1940), a brownish (in females), slender billed race of Utah and parts of adjoining states; *zastereus*, a darker, longer tailed and more slender billed race found breeding in Idaho, and western Montana and Wyoming; *stereus*, a shorter tailed race of eastern Montana and Wyoming, and North Dakota south to central Colorado; and *fortis*, a heavier and longer billed race of western Nebraska and Kansas, eastern Colorado south to northwestern Texas, New Mexico, and probably northeastern Arizona.

A comprehensive review of the species is needed. However, in the absence of such a review, the taxonomic treatment of the races discussed herein best reflects the morphological variation of the subspecies.

Agelaius phoeniceus zastereus, p. 812 = *A. p. zastereus* Oberholser, 1974

The populations of *A. phoeniceus* breeding in Idaho and western Montana were named *zastereus* by Oberholser and are sufficiently distinct to merit subspecific status (Browning, 1974). Compared to the races contiguous with its breeding range, *A. p. zastereus* has a more slender bill than *stereus* or *fortis*, but larger billed than *nevadensis* or *utahensis*. In females, the coloration of *zastereus* is blacker than in *fortis* and browner than in *utahensis*. The mean of wing chord for *zastereus* is greater than in *nevadensis* and the length of tail is greater than in *stereus*.

Agelaius phoeniceus heterus, p. 812 = *A. p. fortis* Ridgway, 1901

The birds breeding in northern Arizona and New Mexico have traditionally been known by the name *fortis* Ridgway, 1901. Behle (1940) demonstrated that *utahensis* Bishop, 1938 (type-locality = near Saltair, 4,200 feet, Salt Lake County, Utah), is a recognizable race and that it intergrades with *sonoriensis* Ridgway, 1887, in northern Arizona. *Agelaius p. sonoriensis* (type-locality = Mazatlan, Sinaloa, Mexico; see Deignan, 1961:572) is a pale reddish-brown (in females) and thin-billed race found breeding from southeastern California, southern Nevada, most of Arizona, and south to Baja California, and Sonora.

Oberholser applied the name *heterus* to populations from northern Arizona and New Mexico. He described the new race as having a shorter wing chord and a slightly thicker bill than *fortis*. The females of *heterus* were described as paler and more brown (less black) than *fortis*, and males were said to have more deeply colored wing coverts than in *fortis*.

I cannot separate specimens of *heterus* collected in New Mexico from specimens of *fortis* taken in eastern Colorado and northern and western Texas. The bill of the holotype of *heterus* is smaller and more slender than that of most of the type series of *heterus* and the holotype of *fortis*, but otherwise these specimens are very similar. The smaller size of the bill of specimens from New Mexico may be due to gene flow from the smaller-billed races *sonoriensis* and *utahensis*. Specimens from northern Arizona assigned to *heterus* by Oberholser are intermediate between *sonoriensis* and *utahensis* in bell size and coloration. Although the putative range of *heterus* includes several intermediate populations, the holotype of *heterus* is closest to *fortis*.

Icterus bullockii eleutherus, p. 827 = *I. galbula bullockii* (Swainson, 1827)

Icterus galbula (Linnaeus), 1758, of eastern North America and *I. bullockii* (Swainson), 1827, of western North America and Mexico were traditionally regarded as distinct species, but are now known to interbreed freely in the Great Plains and are considered conspecific (Sibley and Short, 1964). The form *bullockii* was subdivided by van Rossem (1945) who, on the basis of wing length, named the populations from California *parvus* (type-locality = Jacumba, San Diego Co., California). Rising (1970) studied geographic variation in *bullockii* and concluded that *parvus* did not warrant recognition.

The Northern Orioles of western Oklahoma and northern Texas, south to northern Tamaulipas, were described by Oberholser as a new race, *eleutherus*. This race was said to be identical to *bullockii* (*sensu* Rising, 1970) in size and pattern, but much deeper orange on the underparts and rump in males and darker above in females. I find that dorsal coloration in females of both populations is identical. The holotype and certain other male specimens from the type-series of *eleutherus* average slightly more orange (less yellow) than most western birds, but there are individuals in the western series that are more orange than any of the specimens of *eleutherus*. Males of *bullockii* are, on the average, more yellow than the eastern form *galbula*, which is more orange. That males from the range ascribed to *eleutherus* are fairly consistently orange yet are otherwise identical to typical *bullockii*, suggests the likelihood of gene flow from nominate *galbula* (L. L. Short, *in litt.*). The holotype of *eleutherus* has black edges on the outer webs of the three lateral rectrices, but is otherwise phenotypically "pure" *bullockii* according to the hybrid index of Sibley and Short (1964). The characters of the race *eleutherus* can be explained by the effects of individual variation and minor introgression of the *galbula* phenotype. Therefore, I consider the name *eleutherus* to be a synonym of *bullockii*.

Euphagus cyanocephalus brewerii (Audubon, 1844), p. 832 = *E. cyanocephalus* (Wagler, 1829)

Oberholser recognized four races of *E. cyanocephalus*. Two of these, *aliastus* and *minusculatus*, both based on western populations, have previously been evaluated in the literature and are not recognized as valid races (A.O.U., 1957). The birds found to the east in the Rocky Mountains and in the Great Plains, assigned to nominate *cyanocephalus* by authors such as Oberholser (1932), were further divided by Oberholser (1974). He revived the name *brewerii* and applied it to the populations of the Great Plains, considering *brewerii* to differ from *cyanocephalus* by being much darker grayish-brown (less rufescent) above and below in females and slightly more bluish-green in males.

I cannot discern the alleged differences in coloration between samples of both old and more recently collected specimens representing *brewerii* and *cyanocephalus*. Individual variation, particularly in females, is apparent throughout the range of the species, including the Rocky Mountains and the Great Plains. Geographic variation throughout the range of the species is too slight to justify the recognition of races.

Piranga ludoviciana zephyrica, p. 847 = *P. ludoviciana* (Wilson, 1811)

Piranga ludoviciana was considered monotypic until Oberholser (1974) proposed the name *zephyrica* for birds breeding from northwestern British Columbia, southern MacKenzie, and central Saskatchewan south through the Rocky Mountains to southeastern Arizona and the Trans-Pecos of Texas. The nominate form was said to breed from southwestern British Columbia and southeastern Idaho south to Baja California and central Utah. *Piranga l. zephyrica* was described as larger, with the ventral coloration of males brighter while adult females were said to be paler both above and below. The greatest mensural differences between the two races were said to be the length of wing, tail, and exposed culmen of males, the same measurements being less variable in females (cf. Oberholser, 1974).

In my opinion, the variation observed in *P. ludoviciana* does not justify the recognition of races. Males from eastern Arizona and New Mexico average larger than birds collected elsewhere, but a series from the southwest is well within the range of individual variation of a series from western Oregon and Vancouver Island (Table 7). There is no consistent geographic variation in size in the breeding range of males, nor are there even any trends. Measurements of females indicate even less variability.

I examined 175 adult males for variation in color. Despite considerable individual variation in this series, there was no evident geographic pattern. The same was true of a series of 92 adult females, although dorsal coloration tends to be darker in birds from the Pacific states, the Southwest and Alberta, and paler in the remainder of the range of the species. Ventral coloration in females is subject to more individual variation than in males. A series from Alberta averages paler below, less yellow and more gray, than most other specimens. The variation in females is not consistent with that described by Oberholser, nor does the variation justify naming any population of *P. ludoviciana*.

Table 7. Measurements (mm) of male specimens of *Piranga ludoviciana* with comparison of largest and smallest of the populations sampled and comparison of measurements of samples from Oregon.

		Wing chord		Tail		Bill length		Bill width	
	n	$\bar{x}$	range	$\bar{x}$	range	$\bar{x}$	range	$\bar{x}$	range
Arizona–New Mexico	17	96.47	90.4–100.6	71.85	66.6–75.2	11.65	10.1–12.0	6.43	6.2–7.0
Vancouver, B.C.	15	93.30	89.7–97.2	69.14	65.9–73.2	11.38	10.5–12.6	6.56	5.9–7.1
Montana	9	94.37	91.5–97.6	69.63	67.2–72.2	10.86	10.3–11.5	6.54	6.0–7.1
Utah	8	94.93	93.5–96.8	70.76	69.1–73.9	11.41	10.9–11.7	6.32	6.1–6.6
Western Oregon	17	94.96	91.2–97.6	70.28	65.4–73.9	11.45	10.6–12.0	6.55	6.0–7.0
Eastern Oregon	18	95.74	91.2–102.6	70.27	66.7–75.1	11.34	10.3–12.7	6.44	6.2–6.8

Guiraca caerulea mesophila, p. 862 = *G. c. caerulea* (Linnaeus, 1758)

In their revision of *G. caerulea*, Storer and Zimmerman (1959) recognized six races, three of which occur in the northeastern part of the range of the species to be considered here. These are: *G. c. caerulea* (Linnaeus), 1758, in the eastern United States, *eurhyncha* Coues, 1874, in northern Mexico, and *interfusa* Dwight and Griscom, 1927, in the southwestern United States. These forms differ in both size and coloration (Storer and Zimmerman, 1959), *eurhyncha* being similar to nominate *caerula* in color but with a larger bill and *interfusa* being the palest of the three races and intermediate in size.

Dwight and Griscom (1927:3) remarked that specimens from the Rio Grande Valley are intermediate between *interfusa*, *eurhyncha*, and *caerulea*. Storer and Zimmerman (1959) considered the birds from Cameron County, Texas, to be near the size of *interfusa* and near the color of *caerulea*. All of these authors assigned the birds of the lower Rio Grande Valley (including Cameron County) to *caerulea*.

The breeding birds of central South Dakota south through the central United States to northeastern Mexico, the general area of contact between *interfusa* and *caerulea*, were considered by Oberholser to form a new race, *mesophila* (type-locality = Lipscomb, Lipscomb Co., Texas) described as larger and paler than nominate *caerulea*, and smaller than either *interfusa* or *eurhyncha*. In color *mesophila* was said to be somewhat darker than *interfusa*.

As noted by Oberholser, specimens from the type-locality in southeastern Texas are more similar to *interfusa* in color (*contra* Storer and Zimmerman, 1959). The holotype of *mesophila*, however, is dark ventrally and thus more closely resembles *caerulea* from the Atlantic seaboard states, with which it also resembles in size (wing chord 86.3, length of tail 66.9, and length and width of bill, 12.6 and 6.5, respectively). Dorsally, the type is pale, resembling specimens of *interfusa* from New Mexico and Arizona.

Thus the holotype appears to be an intermediate between *interfusa* and *caerulea*. Because it shares more characters with the latter the name *mesophila* is here considered a synonym of *caerulea*.

Erythrina mexicana anconophila, p. 879 = *Carpodacus mexicanus frontalis* (Say, 1823)

Carpodacus mexicanus, in the modern sense, was first divided in 1823 when Say proposed the name *frontalis*, for a pale northern form with a grayish-brown back that breeds throughout most of North America north of Mexico. Griscom (1928) named an additional northern race, *potosinus*, described as darker and brownish-backed and as breeding from the middle of the Rio Grande Valley of Texas, west to Chihuahua and south to southwestern Tamaulipas.

Moore (1939) suggested that the birds breeding in the Trans-Pecos of Texas were intermediate in color and size between *frontalis* and *potosinus*. Oberholser considered birds from the southwestern part of the Trans-Pecos to be distinct from both *frontalis* and *potosinus*, and named a new race, *anconophilus*, described as paler above and more suffused with red than *frontalis*.

The holotype of *anconophilus* differs somewhat from the rest of the type-series and is not strictly comparable, since it was collected earlier in the year (1 April) and may represent a migrant from a more northern population. The red areas of the rump, crown, and throat of most of the males in the type-series of *anconophilus* are similar to those of *potosinus* in being less purple (more red) than in *frontalis*, whereas the holotype is similar to *frontalis* in this respect. In dorsal coloration, I find the holotype of *anconophilus* to be more similar to *frontalis* than to *potosinus*. Dorsal coloration in the rest of the type-series ranges from grayish-brown (*frontalis*) to brownish (*potosinus*) with northern examples being less brown than examples from the southern part of the alleged range of *anconophilus*.

The mensural differences between *frontalis*, *potosinus*, and *anconophilus* are small and are of no taxonomic significance. Most birds assigned to *anconophilus* by Oberholser are well within the range of variation of *frontalis*. I have not examined breeding birds from Chihuahua, but three males collected in October are referable to *potosinus*.

The type-series of *anconophilus*, excluding the holotype, is composed of intergrades between *frontalis* and *potosinus*. The holotype, however, is similar to examples of the more northern populations of *frontalis*.

Hortulanus fuscus aimophilus, p. 899 = *Pipilo fuscus texanus* van Rossem, 1934

Pipilo fuscus, in the modern sense, was first divided by Baird, 1854, who proposed the name *mesoleucus* for the birds breeding from central Arizona and northern New Mexico south to northern Sonora and western Texas. *Pipilo f. mesoleucus* was divided by van Rossem (1934b) who described a new race, *texanus* (type-locality = Kerrville, Kerr Co., Texas), characterized as paler and less brown with a shorter tail than *mesoleucus*. In naming *texanus*, van Rossem (1934b) restricted *mesoleucus* to extreme western Texas and Arizona, and considered the birds from the central Trans-Pecos of Texas to be intermediate between *texanus* and *mesoleucus*. Davis (1951) concurred that the central Trans-Pecos is a region of intergradation between *texanus* and *mesoleucus*. Oberholser considered the birds of that region and adjacent Mexico to merit subspecific recognition and named a new race, *aimophilus*, described as slightly darker and with a shorter tail than *mesoleucus*, and to be paler with a longer tail than *texanus*.

In comparing the type-series of *aimophilus* with specimens of *texanus* and *mesoleucus*, I took particular care to use skins of similar museum age, since *P. fuscus* is subject to extreme post-mortem color changes (Davis, 1951). Davis did not consider color as a reliable character in separating *texanus* and *mesoleucus* and relied on the size differences between these races. I too find the differences in coloration between the two races to be very slight and discernible only in large series. In ventral color the type of *aimophilus* is most similar to *texanus*. Individual variation in the type-series of *aimophilus* is greater than that in the comparative series of *texanus* or *mesoleucus*.

The best mensural character separating *texanus* and *mesoleucus* is length of tail (Davis, 1951). The type-series of *aimophilus* has a length of tail intermediate between the two races.

The type-locality of *aimophilus* (Ft. Davis, Jeff Davis Co., Texas) is included in what Davis (1951) considered to be the breeding range of *texanus*. I concur that the birds breeding in the Fort Davis region are referable to *texanus*.

Chondestes grammacus quillini, p. 915 = *C. g. strigatus* Swainson, 1827

Two races of *C. grammacus* are currently recognized by most authorities. *Chondestes g. grammacus* (Say), 1823, a dark race, breeds in the eastern part of North America. A pale, western race, *strigatus* Swainson, 1827, breeds as far east as Oklahoma (Sutton, 1967).

Oberholser named a new race, *quillini*, said to breed from western Nebraska and central Arkansas south to southern Coahuila and central Tamaulipas. This race was characterized as having a shorter wing and tail than in either *grammacus* or *strigatus*, and as being intermediate in color between those two races. The mean of measurements of wing chord for males of *grammacus* (86.35, $n = 17$), *strigatus* (86.07, $n = 9$), and *quillini* (86.05, $n = 10$) are similar. The means of the length of tail of six males of *strigatus* (69.7) and six of *quillini* (68.7) are similar. Most of the specimens in the type-series of *quillini* are quite worn, perhaps accounting for the slightly smaller measurements reported by Oberholser. Coloration of the type-series of *quillini*, and that of fresher material from the stated range of *quillini*, are well within the range of variation of *strigatus*.

Amphispiza bilineata dapolia, p. 923 = *A. b. opuntia* Burleigh and Lowery, 1939

The populations of *A. bilineata* north of Mexico were first subdivided into a western, reddish-brown race, *deserticola* Ridgway, 1898, and a small, brown, eastern race, nominate *bilineata* Cassin, 1850. Burleigh and Lowery

(1939) subsequently divided *deserticola* and named a race *opuntia* (type-locality = Guadalupe Mountains, Culberson County, Texas) that included populations from southeastern Colorado and northwestern Oklahoma south through New Mexico and western Texas to northwestern Coahuila. *Amphispiza b. opuntia* is a pale gray race and is slightly larger than *deserticola* or *bilineata.* A fourth race, *grisea* Nelson, 1898 (type-locality = Tula, Hidalgo), a small gray race breeds to the south in ranging from southern Coahuila, central Chihuahua, and south to Hidalgo (Miller, 1954).

Oberholser divided *opuntia* and named a race *dapolia,* for the populations from southern Trans-Pecos south to northwestern Coahuila, the breeding range of *opuntia* being defined as the Guadalupe Mountains of southeastern New Mexico to northern Trans-Pecos in Texas. Oberholser described *dapolia* as larger and paler (more gray) above than nominate *bilineata,* smaller and darker (more gray) than *opuntia,* and smaller, paler and "still more grayish" than *grisea.* On the basis of average dorsal coloration and wing chord, I consider that the populations named *deserticola, opuntia, bilineata,* and *grisea* are indeed valid races.

Reconstruction of the type-series of *dapolia* reveals that this race is a composite of the above four races. Most specimens in this series are similar to *opuntia,* and the holotype of *dapolia* is nearly identical to the type of *opuntia.* Therefore, the name *dapolia* should be considered a synonym of *opuntia.*

Junco oreganus eumesus, p. 929 = *J. hyemalis shufeldti* Coale, 1887
(*sensu* Phillips, 1962)

Miller (1941b) reviewed the geographic variation of *J. hyemalis.* Phillips (1962) using specimens in comparable plumages, found that the holotype of *shufeldti* Coale, 1887, a migrant taken in New Mexico, is referable to the populations from southeastern British Columbia and southeastern Alberta southward to northeastern Oregon. Thus, the name *montanus* Ridgway, 1898, becomes a synonym of *shufeldti* (*contra* Miller, 1941b). The race having a range from southeastern British Columbia south to western Washington and west-central Oregon, incorrectly called *shufeldti* by Miller, was renamed *simillimus* by Phillips (1962). Therefore, by Phillips' nomenclature, Oberholser has described a race that in coloration is intermediate between *shufeldti* and *simillimus.* The geographic range of *eumesus* is similar to that occupied by *shufeldti.* As might be expected, there is no variation that would suggest the recognition of a new race (Browning, 1974), and the name of *eumesus* is a synonym of *shufeldti.*

Spizella pusilla perissura, p. 941 = *S. p. arenacea* Chadbourne, 1866

Spizella pusilla vernonia, p. 941 = *S. p. arenacea* Chadbourne, 1886

The nominate eastern race of *Spizella pusilla* breeds in eastern North

America to central Minnesota, and to eastern Texas. A western race, *arenacea* Chadbourne, 1886, breeds from northern North Dakota to Texas and west to the Rocky Mountains. *Spizella p. arenacea* has a longer tail and wing chord and is paler brown and grayer above than *pusilla* (Wetmore, 1939).

The two races interbreed at several localities. Minor geographic variation within the two races and variability within the intergrading populations led Wetmore (1939:241) to conclude that, "To give the series of intermediates a separate name would serve in my opinion only to complicate the picture, with no useful result because of the definitely mixed character of the populations concerned." Nevertheless, Oberholser conferred new names on two geographically intermediate populations. He defined the range *arenacea* as the region from eastern Montana south to South Dakota, and named a new race *perissura* (type-locality = Valentine, Cherry Co., Nebraska) said to breed from southeastern South Dakota to Nebraska, and *vernonia* (type-locality = Japonica, Kerr Co., Texas) said to breed in the southern Plains. Although Oberholser did not so state, his restriction of *arenacea* indicates his belief that the holotype, collected in November in southern Texas, was a migrant. The type-series of *perissura* includes specimens referable to *arenacea* and *pusilla* as well as intergrades between those two races. In size and color, however, the holotype and most of the type-series of *perissura* are best considered to be referable to *arenacea*.

Spizella p. vernonia was said by Oberholser to be distinct from *pusilla* by its grayer (less rufescent) underparts, and from *arenacea* by its more rufescent (less grayish) upperparts and shorter wing and tail.

I agree with Wetmore (1939) that the color differences separating *arenacea* and nominate *pusilla* (*sensu* A.O.U., 1957) are considerable. Most birds in the type-series of *vernonia* are similar in color to *arenacea*, but in wing chord they are more similar to *pusilla*. This series also includes some specimens that are more similar in color to *pusilla*. The fate of the name *vernonia*, therefore depends upon the identification of the holotype. The holotype is similar to bird specimens identified as *arenacea* by Wetmore (1939) from San Angelo, Texas, 120 miles northwest of the type-locality of *vernonia*. *Spizella p. veronia* is here considered a synonym of *S. p. arenacea*.

Zonotricha leucophrys aphaea, p. 947 = *Z. l. leucophrys* (Forster, 1772)

Oberholser subdivided *Z. l. oriantha* Oberholser, 1932, into two races: *oriantha*, ranging from southeastern Oregon south to central California and northern and southwestern Nevada and Utah; and a new race, *aphaea*, said to breed in Idaho and northwestern Wyoming. *Zonotrichia l. aphaea* was characterized as being darker and more gray than *oriantha* and browner above and more buffy below than nominate *leucophrys*. Comparison of the type-series of both *aphaea* and *oriantha* with other specimens of *Z. leucophrys* reveals that *aphaea* is indistinguishable from nominate race (Browning, 1974). *Zonotrichia l. oriantha* is a recognizable race (Miller, 1941a; Godfrey, 1965; *contra* Banks, 1964) and has a range as restricted by Oberholser (1974).

Melospiza melodia callima, p. 957 = *M. m. melodia* (Wilson, 1810)

Populations of the Song Sparrow breeding from the Atlantic coast east of the Appalachian Mountains were referred to nominate *melodia*, until Thayer and Bangs (1914) described *acadica*. The authors gave Nova Scotia as the breeding range of *acadica*, which was said to differ from nominate *melodia* by being paler. Todd (1930) considered *acadica* a synonym of nominate *melodia*. A third race, *atlantica*, was described by Todd (1924) as duller (more grayish-brown) and larger billed than nominate *melodia*. The breeding range of *atlantica* is the salt marshes from Long Island south to North Carolina. According to Hubbard and Banks (1970) the name *rossignolli* Bailey, 1936, is a synonym of *atlantica*.

Oberholser divided nominate *melodia* and named a new race *callima*, said to have a range from northern and eastern Massachusetts south to southeastern New York and New Jersey. The race *callima* was said to be similar to nominate *melodia*, but with a somewhat smaller bill and with the upper parts decidedly paler and less rufescent (more grayish).

I compared the type-series of *callima* with a series of specimens from Nova Scotia ("*acadica*") and with birds from Pennsylvania and Virginia. There is no appreciable difference in coloration between the three series. Thayer and Bangs (1914) compared their type-series of "*acadica*" with specimens from Massachusetts and, although they considered "*acadica*" darker than the Massachusetts series, they referred the sample from Massachusetts to nominate *melodia*. Todd (1963) also compared specimens of *M. melodia* from locations similar to those in this study and did not detect any differences between them.

The alleged small difference in the length of exposed culmen between *callima* and *melodia* (*sensu* Oberholser, 1974) does not justify recognizing another race of *M. melodia*. The races of *M. melodia* east of the Appalachian Mountains are nominate *melodia*, a dark rufescent race, and *atlantica*, a dull grayish-brown littoral race, as recognized by the A.O.U. (1957).

Melospiza melodia melanchra, p. 958 = *M. m. euphonia* Wetmore, 1936

The first described eastern race of *M. melodia* (other than the nominate race) is *juddi* Bishop, 1896 (type-locality = Rock Lake, Towner Co., North

Dakota), a pale grayish race breeding in the central prairie states west to the Rocky Mountains. A second race, *beata*, Bangs, 1912 (type-locality = Enterprise, Florida) was considered by Todd (1930) to breed in the northeastern part of the Mississippi Valley. Bangs (1912) described *beata* as darker and grayer than nominate *melodia*. He makes no mention of *juddi*, mistakenly believing his race to be a breeding form of Florida. Wetmore (1936) found that the holotype of *beata* is a winter specimen of *juddi* and not an example of the breeding birds of the upper Mississippi Valley. The birds breeding in the eastern part of the upper Mississippi Valley and of the Appalachian Mountains were named *euphonia* by Wetmore (1936). This race was said to be darker and grayer than nominate *melodia*. Wetmore implied that *euphonia* is darker and more rufescent than typical specimens of *juddi*.

Oberholser described *melanchra* as similar to *euphonia*, but decidedly darker above (more sooty; less rufescent). He recognized "*beata*" as a midwestern race ranging east of *juddi*. He described *melanchra* as much darker above and having a longer wing chord and tail than "*beata*." The breeding range of *melanchra* was said to be from southeastern Ontario and western New York south to southeastern Kentucky and western Pennsylvania.

The differences between *euphonia* and *juddi* are apparent in series taken at the extremes of their breeding ranges. The type-series of *melanchra* is not darker than typical *euphonia* and the series is more rufescent than *juddi*. The race *melanchra* is clearly referable to *euphonia*. Wetmore's initials appear on several specimens of the type-series, which he identified as *euphonia*. Specimens from Wisconsin (= *euphonia* in A.O.U. (1957)) Check-list appear to be intergrades between *juddi* and *euphonia*. I hesitate to assign such specimens to either race. Mengel (1965) met with difficulty in working out the races breeding in Kentucky and also remarked that a tendency toward localized homogeneity exists as discussed by Fleming and Snyder (1939:4) that may have produced geographic variation similar to that found around San Francisco Bay (e.g., see Marshall, 1948).

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THE VOICE AND RELATIONSHIP OF THE TREEFROG *HYLA HOBBSI* (ANURA: HYLIDAE)

William F. Pyburn

Abstract.—The vocal signal of *Hyla hobbsi* consists of two types of calls: one call type is a single prolonged note with little frequency variation; the other is a frequency modulated three-note call. The two call types probably have different functions. There are basic differences in call, color, and habitat between *Hyla hobbsi* and *H. punctata*, a species with which *hobbsi* has been confused.

Introduction

Cochran and Goin (1970) described the treefrog *Hyla hobbsi* from six specimens collected along Caño Guacayá, Amazonas, and the Río Apaporis, Vaupés, Colombia. They called attention to the black dorsal spots, glandular dorsolateral folds and other structural features of the preserved frogs and concluded that *Hyla hobbsi* was not closely related to other known members of the genus *Hyla*. Duellman (1974) examined the holotype of *H. hobbsi* (MCZ 28052) and decided on the basis of morphological similarities that it was an example of *Hyla punctata*, a widespread and well-known neotropical species. Nonmorphological data were not given by these authors and apparently neither Cochran and Goin nor Duellman had seen live specimens of *Hyla hobbsi*. My objectives herein are to characterize the voice, habitat and habitus of *Hyla hobbsi* and to clarify its relationship with *Hyla punctata*. The voice recordings were made at night with a Uher 4000 Report L tape recorder at a tape speed of 19 cm/s and analyzed in the laboratory with a Key Elemetrics Sonagraph, model 6061 B.

Voice

In June 1973 J. K. Salser and I recorded calls (air temperature, 24.5 C) and collected 12 specimens of *Hyla hobbsi* on Wacará Creek, Vaupés, Colombia. The frogs called from widely separated shrubs along the stream and each shrub usually held only one frog. Perched over water, the frogs were reluctant to jump even when the shrubs were bumped by our canoes. Other specimens of *H. hobbsi* were brought to us from time to time by Caqua Indians, whose village is near Wacará Creek.

The calls of *Hyla hobbsi* are given in long sequences interrupted by pauses of several seconds. A sequence usually consists of two types of calls (Fig. 1): a plaintive whistle (type A) and a three-note call of variable

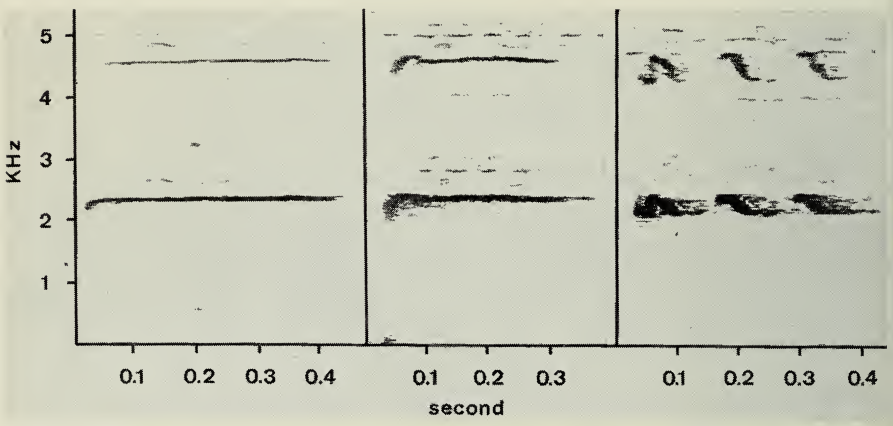

Fig. 1. Sound spectrograms of calls of *Hyla hobbsi*. Left, type A call; center, transitional type A call; right, type B call.

pitch (type B). Calling is not random. Chorusing begins when one frog utters a type A call and is answered with a type A call by a nearby frog. The two call alternately several times, then others join in. Early in the chorus there seems to be little overlap of calls given by individuals close to each other. After a few minutes the singers fall silent, then begin again as before. I have heard similar, apparently coordinated, chorusing by *Osteocephalus taurinus* in a flooded gallery forest on the Colombian llanos.

The following description is based on a sequence of 47 calls given by one male *Hyla hobbsi*. In this sequence the first 15 calls were type A and 29 of the remaining 32 were type B. The voice of this individual seemed typical of other members of the chorus, some of which can be heard on the same tape.

The single notes of 15 type A calls have a mean duration of 0.49 s (range, 0.35–0.65) and a repetition rate of 25.7 calls per min. There is a dominant frequency band, apparently the 10th harmonic, at 2,490 Hz (2,080–2,625 Hz) and a weak secondary band, possibly the 19th harmonic, at 4,830 Hz (4,580–5,000 Hz), as measured at the midpoint of the bands. The first two type A calls are almost pure tones with a maximum dominant frequency band width of 250 Hz, after which there is an increase in maximum band width due to a rise in frequency at the beginning of each note (Fig. 2).

Type B calls of *H. hobbsi* are trills consisting of 3.1 (3–5) notes per call. The call duration is 0.46 (0.39–0.65) s and each note lasts about 0.12 s with poorly defined silent intervals between notes within a call. Mean frequencies of the dominant and secondary bands are the same as in type

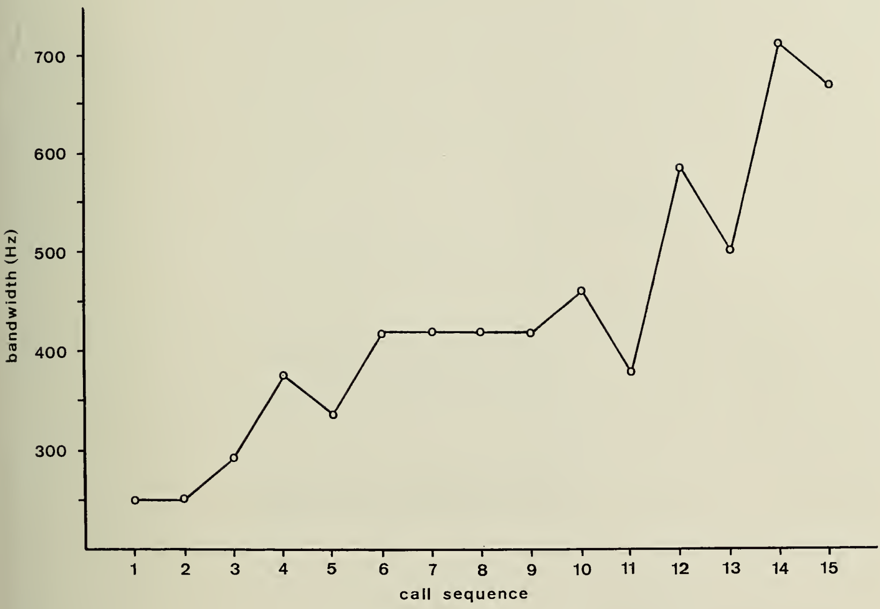

Fig. 2. Increase in maximum dominant frequency bandwidth with call sequence.

A calls. Maximum width of the dominant frequency band is constant within a call but varies irregularly between calls from 420–875 ($\bar{x}$, 645) Hz. The frequency of the first note in each call rises and falls, after which each note decreases in frequency from beginning to end of note. Repitition rate of type B calls is 103.4 per min and the note repetition rate, excluding intervals between calls, is 7.1 notes per s.

Recordings of vocalizations by *Hyla punctata* 12 km NNE of Villavicencio, Colombia (Fig. 3; see also Hoogmoed, 1973) show that the voice of this species is quite unlike that of *Hyla hobbsi.* The frogs were calling near the ground in grass at the edge of a swamp (air temperature, 22.6 C). Thirty trilled calls of six individuals consist of 3–10 ($\bar{x}$, 5.4) short, evenly spaced notes in which the energy is broadly distributed through the frequency spectrum. There is a poorly defined emphasized band at about 1,400 Hz and lesser bands ranging up to 5,000 Hz. The call repetition rate is 16.6 (7.0–25.7) per min, the duration 0.30 (0.18–0.48) s and the note repetition rate is 19.1 (16.7–22.2) per s. An individual recorded near Puerto Lleras, Colombia, called much more rapidly (80.9 calls per min; air temperature, 24.4 C), but otherwise its calls were like those recorded near Villavicencio. The fast-calling Puerto Lleras specimen was accompanied by *Hyla wandae*

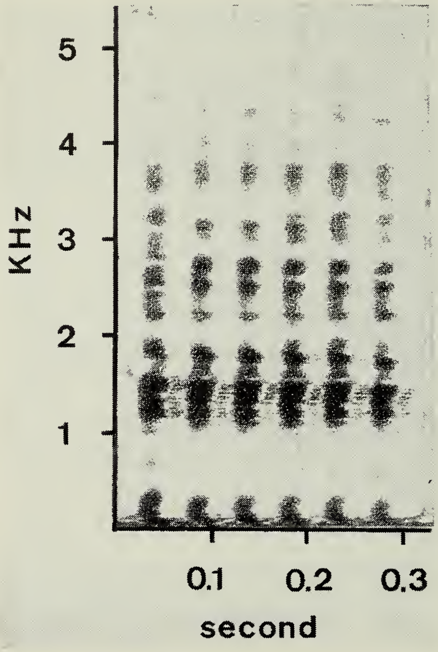

Fig. 3. Sound spectrogram of call of *Hyla punctata.*

and *Hyla mathiassoni* but not by other *H. punctata,* whereas the Villavicencio specimens were part of a chorus of *punctata.*

I cannot make precise quantitative comparisons of the voices of *Hyla hobbsi* and *Hyla punctata* because I have recordings of only one *hobbsi* that are suitable for analysis; however gross differences in the voices of the two species are apparent (Figs. 1 and 3). *H. punctata* produces one type of call, a poorly tuned series of short, rapidly repeated notes. Vocalizations of *H. hobbsi* consist of two types of calls: type A is a single prolonged note in which most of the energy is confined to a narrow dominant frequency band; type B consists of three short, frequency modulated notes.

Morphology

The type series of *Hyla hobbsi* consists of two adult females, two adult males and two juveniles. One juvenile and all of the adults were collected 14 May 1952, at which time at least one of the females (MCZ 28052) had mature ovarian eggs. The males have large vocal slits, sharp prepollical spines and are about 38 mm in snout–vent length. The females are about 42 mm snout-to-vent and have no prepollical spines or vocal slits. All of the specimens are distorted as a result of bad positioning at the time of preservation. The dorsum varies from light gray to brown, with small, discrete, black spots. Dorsolateral glandular folds are variably in evidence, having been adversely affected by preservation in some specimens. Other than differences associated with sex or age, the preserved series of *H. hobbsi* from Wacará agrees in detail with the type series of *hobbsi* and with the description by Cochran and Goin (1970). Measurements in mm of 26 adult males from Wacará are ($\bar{x}$ followed by range): snout–vent, 38.7 (37.4–40.1); head length, 14.3 (13.0–15.3); head width, 13.7 (12.7–14.4); eye length, 4.8 (4.3–5.1); ear diameter, 2.1 (1.6–2.5); shank length, 20.1 (19.2–21.0); width third finger disc, 1.8 (1.4–2.1).

In life (Fig. 4) the dorsum of 17 specimens of *Hyla hobbsi* from Wacará varied from pale green through shades of gray and tan to medium and dark brown. Small black spots were irregularly spaced over the dorsum, as in the preserved animals. A pale cream stripe extended from the tip of the rostrum along the canthus rostralis and edge of upper eye lid, over the tympanum, and dorsolaterally on the body to the groin. Lateral aspects of the head and body (below the cream line) were the same color as the dorsum, becoming paler where the color of the side merged with the lighter ventral surface. The skin of the venter was greenish white, translucent, and the iris was yellow. Anterior and posterior surfaces of the thigh and lower side of the shank were brownish to mustard yellow.

Preserved specimens of *Hyla punctata* and *H. hobbsi* are structurally similar but may be distinguished by the absence of black spots and general loss of color in *punctata*. *H. hobbsi* does not fade to white in preservative and retains the black dorsal spots that are conspicuous in the live animal.

Live *Hyla punctata* undergo a remarkable day–night color change that does not occur in *H. hobbsi*. At night *punctata* are yellow, orange or red with bright red spots and dorsolateral lines. (See color photographs in Hoogmoed, 1972 and Crump, 1977); during the day they are green. Specimens of *hobbsi* kept alive by me for several days to more than a year changed color among shades of gray, green and brown but were never yellow, orange or red and metachrosis was not correlated with the day–night cycle.

Habitat

Hyla hobbsi is known only from the Amazonian forest of southeastern Colombia. All of the live specimens I examined (UTA-3793–94, 3796–97, 3799, 3800–08, 3810, 3899, 3900–10; USNM 198548–49) were taken along Wacará Creek, a clear, brown, sand-bottomed stream that flowed through virgin rain forest to the Vaupés River. The stream was about 5 m wide and 1 m deep at a point near the village of Wacará on 5 June 1973, but the depth varies greatly with rainfall.

Hyla punctata probably does not breed in the clear streams of undis-

Fig. 4. Live specimen of *Hyla hobbsi*; from color transparency by Harry Greene.

turbed rain forest. In Colombia, *H. punctata* frequents open savanna and the savanna, scrub-forest ecotone where males call from grasses and herbs at the margins of lakes and swamps. Hoogmoed (1973) reported it in similar habitat in Surinam where the frogs called from the leaves of *Montichardia* sp. in a swamp and Lescure (1976) found *H. punctata* to be common in prairie marshes in French Guyana. In Trinidad, Kenny (1969) found *punctata* "usually in grasses or bushes, and almost always over slowly moving water . . . in choked ditches or rivers," generally in open country. Near Leticia, Colombia, Goin and Layne (1958) found *punctata* "most abundant in wet open pasture lands" and collected one specimen on a bush in the water of a stream cove.

Discussion

Preserved specimens of treefrogs are often deceptively similar and great care should be taken in forming conclusions about species relationships based solely on structural features. In the present instance differences in life colors, habitat and breeding call show that *Hyla punctata* (Schneider) and *Hyla hobbsi* (Cochran and Goin) are different species, not conspecifics as Duellman (1974) concluded. Furthermore the mating calls of *punctata* and *hobbsi* are so distinctly different that close relationship between the two species is doubtful.

Aside from its systematic implications, the unique call of *H. hobbsi* is of interest in attempting to explain the functions of anuran vocalization. The non-random calling sequence and separation of individuals in different shrubs along the stream at Wacará indicate that male *hobbsi* maintain a territorial hierarchy by vocal signaling. Hierarchical calling was discovered by Goin (1949) in *Hyla crucifer* and has since been found in several other anurans (Duellman, 1967). When two types of calls are given, as in *H. hobbsi* and some other species (Straughan and Heyer, 1976; Narins and Capranica, 1976), the signals may have different meanings for the two sexes. Thus the latter authors found that territorial males of *Eleutherodactylus coqui* produce a two-note call in which the first note functions in interactions between males and the higher-pitched second note serves to attract females. Whether one call type of *H. hobbsi* is sexual and the other territorial is not known, but in view of the complexity of the signal and behavior of males at the breeding site it seems likely that both territorial and species identity information are conveyed by the calls.

It has been established that in several species of anurans gravid females are attracted to the mating calls of males (Martin, 1972; Blair and Littlejohn, 1960; Littlejohn et al., 1960). Furthermore the anuran ear is tuned to particular frequency bandwidths (Loftus Hills and Johnstone, 1970) apparently in most cases to the dominant frequency of the mating call (Straughan, 1973). A basic design feature of anuran calls that would increase efficiency by minimizing interference from other sound sources is a restricted frequency bandwidth (Straughan, 1973), as in the type A call of *Hyla hobbsi*. The type A call is a prolonged, relatively unmodulated tone with virtually all of the energy limited to a very narrow dominant frequency band. The precise source of this type of sound is very difficult to locate (Nelson, 1973), but because of the lack of interference from other sounds type A calls should carry well and possibly be heard by females at great distances from the chorus, as well as by distant males along the stream. Thus the type A call may serve as an orienting signal to distant receivers, indicating the general location and species identity of the transmitter. The type B call of *H. hobbsi*, consisting of short notes with wider bandwidth than A calls, would be less effective at long distances because of interference, but should make the transmitter easy to locate by females that have gotten within close range. Type B calls may also be important in maintenance of the hierarchical calling sequence among nearby males.

By reducing the dominant frequency bandwidth selection may have increased the range of the species identity component at the expense of a location component that would require a wider bandwidth (see Straughan, 1973:324). Perhaps retention of both types of information was accomplished by separating the signal into two call types. The transitional nature of some calls of *H. hobbsi* shows that in this species the differentiation of calls is not complete.

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REVIEW OF THE INDO-PACIFIC PIPEFISH GENUS *HIPPICHTHYS* (SYNGNATHIDAE)

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Abstract.—The syngnathine pipefish genus *Hippichthys* Bleeker, 1849 [type-species: *H. heptagonus* Bleeker (= *Syngnathus djarong* Bleeker)] is resurrected from synonymy, diagnosed and shown to be a senior synonym of *Bombonia* Herre, 1927. Descriptions, illustrations, key, nomenclatural discussion and distribution data are given for the three species recognized: *H. heptagonus*, *H. spicifer* and *H. cyanospilus*.

The genus *Hippichthys* Bleeker has historically been confused with other pipefish genera and has been variously treated as valid or relegated to the synonymy of *Syngnathus* Linnaeus, *Corythoichthys* Kaup or *Ichthyocampus* Kaup. This problem has been mentioned briefly in recent reports (Dawson, 1977, 1977a) and I here review *Hippichthys*, including therein three species commonly referred to *Syngnathus* or *Bombonia* Herre. This constitutes one of a series of reviews of tropical pipefish genera which will hopefully provide a foundation for rational analyses of their relationships and distribution.

In *Hippichthys*, point of dorsal-fin origin ranges from center of penultimate trunk ring to center of the 3rd tail ring. Point of dorsal-fin origin, estimated to nearest ¼ of ring length, is recorded (Table 3) in ¼ ring intervals before (+) and after (–) anterior margin of 1st tail ring (O-point). Paired or equivalent pectoral-fin ray counts (Table 2) represent equal counts in right and left fins. Measurements of standard length (SL) or total length (TL) were made to the nearest 0.5 millimeter (mm); trunk depth is the greatest distance between outer margins of superior and median ventral trunk ridges; other counts and measurements follow Dawson (1976). Materials examined are listed by general localities from west to east and roughly north to south; the map delineates general distribution and may not show all collection sites in immediate vicinity of symbols.

Abbreviations for repositories of examined material: AMNH—American Museum of Natural History; AMS—Australian Museum, Sydney; ANSP—Academy of Natural Sciences of Philadelphia; BMNH—British Museum (Natural History); BOC—Bingham Oceanographic Collection, Peabody Museum; BPBM—Bernice P. Bishop Museum; CAS—California Academy of Sciences; CAS-SU—former Stanford University specimens now housed at CAS; FMNH—Field Museum of Natural History; GCRL—Gulf Coast Research Laboratory Museum; HUJ—Hebrew University, Jerusalem; MCZ—Museum of Comparative Zoology, Harvard University; MNHN—Muséum

National d'Histoire Naturelle, Paris; QM—Queensland Museum, Brisbane; RMNH—Rijksmuseum van Natuurlijke Historie, Leiden; RUSI—J. L. B. Smith Institute of Ichthyology, Rhodes University; SMF—Natur-Museum und Forschungs-Institut "Senckenberg," Frankfurt; UMMZ—Museum of Zoology, University of Michigan; USNM—National Museum of Natural History, Smithsonian Institution; UZMK—Universitetets Zoologiske Museum, Copenhagen; ZMA—Zoölogisch Museum, Universiteit van Amsterdam; ZSI—Zoological Survey of India, Calcutta.

Hippichthys Bleeker

Hippichthys Bleeker, 1849:15 (type-species by original designation: *Hippichthys heptagonus* Bleeker, 1849).

Parasyngnathus Duncker, 1915:79 (in part: as subgenus of *Syngnathus*; type-species by original designation: *Syngnathus argyrostictus* Kaup, 1856).

Bombonia Herre, 1927:274 (type-species by original designation: *Bombonia luzonica* Herre, 1927 equals *Hippichthys heptagonus* Bleeker).

Diagnosis.—Superior trunk and tail ridges discontinuous near rear of dorsal fin; lateral tail ridge ends near anal ring; lateral trunk ridge deflected ventrad near anal ring to terminate just above, or unite with, the continuous inferior trunk and tail ridges (Figs. 1 and 4); subadults and adults with deep trunk, venter distinctly V-shaped, usually with prominent median ventral ridge, scutella with or without longitudinal keel; median dorsal snout ridge low, entire; lateral snout ridge present or absent; opercle with complete median longitudinal ridge and low striae radiating above and below; pectoral-fin base not strongly protruding laterad, crossed by two low ridges; body ridges distinct but not deeply notched or indented between rings, margins entire to finely denticulate; devoid of spines, serrae, dermal flaps or papillae; dorsum of trunk and tail flat to somewhat depressed between superior ridges; dorsal-fin base not elevated; dorsal-fin membrane closely bound to fin rays. Head length (HL) 6.9–12.7 in SL; snout length 1.3–2.8 in HL; length of dorsal-fin base 0.8–1.8 in HL; trunk rings 12–16; rings total 45–57; subdorsal rings 4.25–6.25, mostly on tail; dorsal-fin rays 20–30; pectoral-fin rays 13–18; anal fin present; caudal-fin rays 10. Brood pouch under tail, with pouch protective plates; brood-pouch eggs in up to 10–11 transverse rows (typically in single layer), not in continuous gelatinous matrix, and covered by protective folds which meet or overlap on ventral midline; brood-pouch closure the everted type of Herald (1959). Without odontoid processes in jaws (Dawson and Fritzsche, 1975); nares 2-pored bilaterally. Maximum size at least 170 mm SL. Indo-Pacific.

Comparisons.—The *Hippichthys* configuration of principal body ridges is not shared with other genera of syngnathine (tail pouch) pipefishes.

Lateral trunk ridge is deflected to or near the continuous inferior trunk and tail ridges in the superficially similar monotypic genus *Ichthyocampus* Kaup (type-species: *Syngnathus carce* Hamilton Buchanan), but superior trunk and tail ridges are confluent and lateral tail ridge is absent (superior ridges discontinuous, lateral tail ridge present in *Hippichthys*). Lateral trunk ridge may end with deflection of 10–15° in *Bhanotia* Hora but ridge is never strongly deflected as in *Hippichthys*. Specimens of *Hippichthys* have occasionally been referred in error to *Micrognathus* Duncker which also has a lateral tail ridge and deflected lateral trunk ridge. In *Micrognathus*, however, inferior trunk and tail ridges are interrupted near anal ring (continuous in *Hippichthys*) and lateral trunk ridge is confluent with inferior tail ridge. The *Hippichthys* body ridge configuration occasionally occurs as a unilateral (infrequently bilateral) anomaly in the west African *Syngnathus pulchellus* Boulenger (Clausen, 1956; pers. obs.), but caudal-fin rays are typically 9 and lateral trunk ridge typically ends without deflection (caudal rays 10, lateral trunk ridge deflected in *Hippichthys*).

Remarks.—Degree of lateral trunk ridge deflection is variable but the ridge ends just above inferior ridge in most specimens (Figs. 4 and 6), and infrequently reaches and unites with the inferior ridge (Fig. 1).

Brood-pouch eggs of large males are oval, crowded in irregular rows across upper part of pouch folds and dorsum of pouch, with long axes directed toward center of pouch; advanced larvae are often present in pouch of preserved specimens. Among examined material, the smallest egg-bearing male is 75 mm SL, smallest male with developing pouch folds is 59 mm SL, and maximum number of brood-pouch rings is 22. Fielder (1967) described reproductive behavior of aquarium specimens of *H. heptagonus*.

Anal fin small, typically narrow and rays difficult to enumerate; counts range from 2–4 and appear to be modally 2 in *H. heptagonus* (12 counts) and modally 3 in *H. spicifer* and *H. cyanospilus* (17 and 39 counts, respectively).

Ground color of all species tan to dark brown in alcohol, markings brown to nearly black.

Weber and de Beaufort (1922), Duncker and Mohr (1925) and others have reported *H. heptagonus* (as *Syngnathus djarong*) and *Hippichthys spicifer* from estuarine and river habitats, but there are few records of *H. cyanospilus* from low salinity environments. Collections examined here suggest that *H. heptagonus* and *H. spicifer* are euryhaline, whereas *H. cyanospilus* appears restricted to coastal marine or brackish waters. Nineteen samples with reliable data show these species to be taken within the 0–2 m depth range; young of each species have been taken in inshore night-light samples. Although widely distributed (Fig. 3), I have seen neither young nor adults from oceanic collections.

Discussion.—Bleeker (1849) originally described *Hippichthys* as lacking anal fin and included *H. heptagonus* Bleeker and *Syngnathus spicifer* Rüppell within the genus. Later (1853) he synonymized *Hippichthys* with *Syngnathus*, noted the presence of an anal fin in redescribing the holotype of *heptagonus* and described *Syngnathus djarong* from an unpublished figure by van Hasselt. Kaup (1856), without access to Bleeker's material, incorrectly synonymized *Hippichthys heptagonus* with *Ichthyocampus ponticerianus* Kaup (= *Syngnathus carce* Hamilton Buchanan). As a consequence of this error, *Hippichthys* has been employed as a senior synonym of *Ichthyocampus* by a number of later authors (for further discussion see Dawson, 1977a). Günther (1870) questioned Kaup's action, noting that Bleeker (1859) still considered *Syngnathus heptagonus* as distinct from *Ichthyocampus*, and suggested that *heptagonus* (as *pentagonus* sic) was "one of the varieties of *S. spicifer*." It should here be noted that Bleeker's unpublished manuscript revision of the 'Enumeratio' (see Whitehead et al., 1966:13) has an entry (No. 1994) for "*Ichthyocampus heptagonus*" changed in Bleeker's script to read "*Syngnathus heptagonus*." Thus there seems little doubt that Bleeker recognized *heptagonus* as being distinct from *Ichthyocampus carce*.

Duncker (1915) evidently failed to note Günther's (1870) remarks and retained *Hippichthys heptagonus* without comment in the synonymy of *Ichthyocampus carce*. At the same time he also established *Parasyngnathus* (as a subgenus of *Syngnathus*) and included therein two species groups with differing body ridge configurations. One (including *Syngnathus djarong*, *S. spicifer* and *S. cyanospilus*) was characterized as having lateral trunk ridge subcontinuous with inferior ridge, whereas the other (including the type-species, *S. argyrostictus* Kaup) had lateral trunk ridge subcontinuous with superior tail ridge. Subsequently Herre (1927) described *Bombonia* (*type-species*: *B. luzonica* [= *Syngnathus djarong*]) and Herald (1959) considered this genus (including *S. djarong*, *S. spicifer* and, questionably, *S. cyanospilus*) intermediate between *Syngnathus* and *Micrognathus*. Smith (1963) and most later authors have nevertheless continued to refer these species to *Syngnathus*.

My examination of the Auction Catalogue specimen of *Hippichthys heptagonus* (Hubrecht, 1879), Bleeker's topotypes of *Syngnathus djarong* and Bleeker's unpublished Atlas figure of *S. djarong* shows these forms to be conspecific. Thus *heptagonus* is the senior subjective synonym of *djarong* and *Hippichthys* Bleeker has priority over *Bombonia* Herre.

Pending further study, I consider *Hippichthys* most closely related to *Ichthyocampus*. Among other characters these genera share the complete opercular ridge, deflected lateral trunk ridge, confluent inferior ridges and everted brood-pouch closure. Dorsal-fin origin is typically on 1st–3rd tail ring in *I. carce*, *Hippichthys heptagonus* and *H. spicifer*. Furthermore, all included species commonly occur in coastal, estuarine or low salinity waters rather than open reef environments. Although lateral ridge configuration is intermediate between *Syngnathus* and *Micrognathus*, I do not believe this character is sufficient to substantiate the phylogenetic relationships implied by Herald (1959).

Key to the genus *Hippichthys*

1. Trunk rings 14–16 (modally 15); total rings 51–57; dorsal-fin origin usually (99%) on tail 2
– Trunk ridges 12–14 (modally 13); total rings 45–48; dorsal-fin origin always on trunk *cyanospilus*
2. Scutella without longitudinal ridge; lateral snout ridge usually prominent (Fig. 1); dorsal-fin origin usually (94%) in advance of 2nd tail ring; HL averages 10 in SL *heptagonus*
– At least some scutella with distinct ridge (Fig. 4); lateral snout ridge vestigial or obsolete; dorsal-fin origin usually (98%) on or posteriad of 2nd tail ring; HL averages 8 in SL *spicifer*

Hippichthys heptagonus Bleeker
Fig. 1

Hippichthys heptagonus Bleeker, 1849:15 (original description; Madura Is., Indonesia).

Syngnathus heptagonus: Bleeker, 1853:5, 23 (new combination).

Syngnathus djarong Bleeker, 1853:22 (original description; Java).

Syngnathus helfrichii Bleeker, 1855:428 (original description; Bandjermasin, Borneo).

Syngnathus spicifer var. *rivalis* Peters, 1869:276 (diagnosis; Philippine Is.).

Syngnathus parviceps Ramsay and Ogilby, 1887:475 (original description; Clarence River, New South Wales, Australia).

Corythroichthys pullus Smith and Seale, 1906:75 (original description; Rio Grande, Mindanao, Philippine Is.).

Syngnathus spicifer var. *djarong* Duncker, 1910:32 (diagnosis).

Syngnathus (*Parasyngnathus*) *djarong*: Duncker, 1915:80 (new combination).

Corythroichthys matterni Fowler, 1918:12 (original description; Philippine Is.).

Syngnathus matterni: Fowler, 1922:442 (new combination).

Bombonia luzonica Herre, 1927:275 (original description; Lake Taal, Luzon, Philippine Is.).

Bombonia uxorius Herre, 1935:395 (original description; Waigiu Is., Indonesia).

Syngnathus djarong luzonica Aurich, 1935:98 (original description; Lake Taal, Luzon, Philippine Is.).
Bombonia djarong: Herald, 1953:232 (new combination).

Diagnosis.—Scutella not keeled; lateral snout ridge usually well developed in subadults and adults; rings total 51–57; pectoral-fin rays modally 15; dorsal-fin origin usually (99%) on tail.

Description.—Dorsal-fin rays 23–30 ($\bar{x}$ = 26.6); pectoral-fin rays 13–16 (14.8); rings 14–15 + 36–42 = 51–57 (54.4); total subdorsal rings 5.0–6.25 (5.6); dorsal-fin origin usually (93%) on 1st tail ring. Proportional data based on 45 specimens 71.5–139.0 ($\bar{x}$ = 96.7) mm SL follow: HL in SL 8.6–12.7 (10.17); snout length in HL 1.9–2.8 (2.40); snout depth in snout length 2.6–4.4 (3.37), 29 fish; length of dorsal-fin base in HL 0.8–1.4 (1.08); anal ring depth in HL 3.1–4.7 (3.92), 19 fish; trunk depth in HL 2.0–2.8 (2.36); pectoral-fin length in HL 5.8–7.1 (6.55), 13 fish. See Tables 1–4 for additional counts and measurements.

Lateral snout ridge distinct in most subadults and adults; scutella without longitudinal keel.

Color in alcohol variable (Fig. 2), often without distinctive markings. Ground color tan to dark brown; dorsum of head brownish; lower half of snout and venter of head often pale, with or without irregular row of brown spots or blotches on side of snout; some specimens with dark stripe on side of snout and diagonal dark bar crossing opercle from rear margin of orbit; sides and dorsum of body plain, mottled, or with indications of irregular pale bars; venter of trunk most commonly dusky brown, shading to near black on median ridge, infrequently with faint indications of brownish bars crossing venter; dorsal fin not distinctly spotted, usually hyaline but infrequently with rays streaked with brown; pectoral fin hyaline or streaked with brown; caudal fin brown with narrow pale margin.

Comparisons.—*Hippichthys heptagonus* is most readily separated from congeners by characters in key. At lengths above 70 mm SL, head length is relatively shorter than that of either *H. spicifer* or *H. cyanospilus* (Table 4). Dorsal-fin origin on 1st tail ring and modally 15 pectoral rays permit ready separation of most juvenile *H. heptagonus* from young *H. spicifer* wherein dorsal fin usually originates on 2nd tail ring and pectoral rays are modally 17.

Types.—Bleeker's (1849) description of the holotype of *Hippichthys heptagonus* (101 mm TL) notes the presence of 50–55 rings, 23 dorsal, 12 pectoral and 10 caudal-fin rays; anal fin is stated to be absent and lack of comment on brood pouch suggests that the specimen was a female. In redescribing this specimen, Bleeker (1853) recorded 14 trunk and 39 tail rings, noted the presence of 3–4 anal-fin rays and changed his count of pectoral-

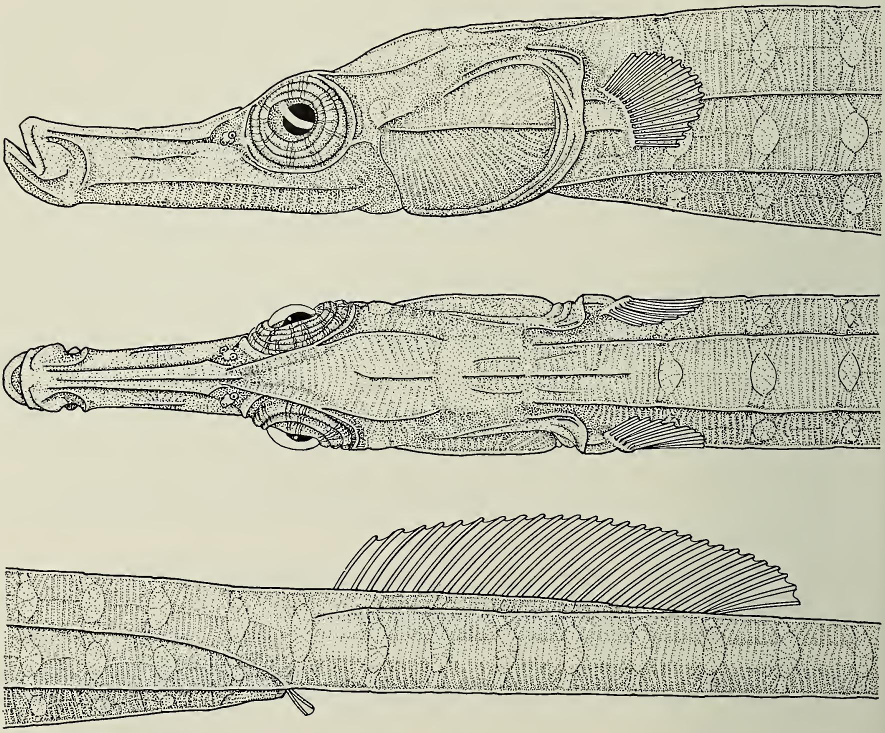

Fig. 1. *Hippichthys heptagonus.* Top and middle: Lateral and dorsal aspects of head and anterior trunk rings. Bottom: Section of body illustrating ridges, dorsal and anal fins. From 96 mm SL female, GCRL 15529.

fin rays to 15; dorsal fin was stated to originate on the 3rd tail ring and end on the 8th. Bleeker subsequently reported *H. heptagonus* (as *Syngnathus heptagonus*) from Java (1858) and Bali (1858–59) but failed to mention numbers or lengths of specimens and did not add to his earlier descriptions. Although Bleeker appears to have had at least three specimens of *Hippichthys heptagonus*, Günther (1870) stated that the holotype was not received at the British Museum. Hubrecht (1879) listed only one specimen (A series) in the Auction Catalogue and the fate of other specimens is unknown.

The Auction Catalogue specimen (RMNH 7234) lacks the distal third of caudal fin, and dorsal fin and dorsum of anterior subdorsal ring are damaged. I estimate total length at about 94–95 mm and dorsal rays about 23. Both pectoral fins are damaged, only rudiments of anal fin persist, there are 10 caudal-fin rays and 15 + 41 rings; dorsal fin evidently originated near anterior fourth of 1st tail ring and ended near posterior margin of 6th tail ring (subdorsal rings total ca. 5.75). This fish is about 5 mm shorter

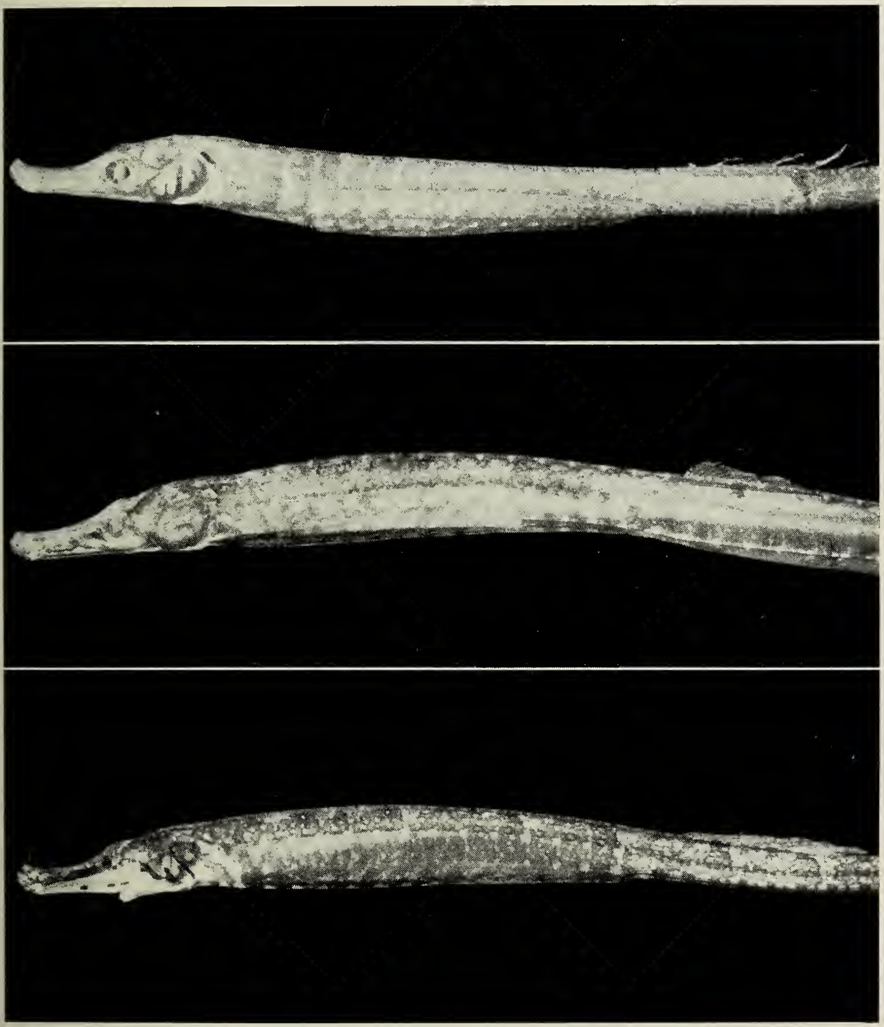

Fig. 2. *Hippichthys heptagonus* Bleeker. Top: RMNH 7234 (91.5 mm SL, female, neotype). Middle: Male, 103 mm SL. Bottom: Female, 96 mm SL (both GCRL 15529; New Guinea).

than the holotype of *heptagonus* and further differs from Bleeker's (1853) description in having more rings (56 versus 53) and in dorsal-fin origin on 1st tail ring rather than on 3rd. None of the extant Bleeker specimens, here referred to *Hippichthys*, have 14 trunk rings, this count is infrequent in other examined material (Table 1) and the holotype of *H. heptagonus* may well have had 15 rather than the described 14 trunk rings; adjustment for this would place dorsal-fin origin on 2nd rather than 3rd tail ring. These differences indicate that the Auction Catalogue specimen is not the holotype and evidently originated from the Bali or Java collections. In the absence of syntypic material I designate this fish (RMNH 7324) as the neotype of *Hippichthys heptagonus* Bleeker, 1849. Measurements (mm) of this 91.5 mm SL female (Fig. 2) follow: head length 10.2, snout length 4.6, minimum snout depth 1.2, anal ring depth 2.2, trunk depth 3.6.

Bleeker (1853) described *Syngnathus djarong*, without mention of brood pouch, from an unpublished 94 mm figure by van Hasselt. Bleeker's (1854) redescription, including reference to pouch location, was based on two topotypes (75 and 95 mm TL) from Panimbang, Java. Known Bleeker specimens of *S. djarong* now include BMNH 1867.11.28.346, a badly damaged fish about 80 mm SL erroneously referenced as the holotype by Duncker (1915), and two Auction Catalogue specimens (RMNH 7233). One of these (estimated at about 70 mm SL) is in pieces and part of the tail is missing, the other is a 90 mm SL male. Since a male is included and lengths are in close agreement, I consider these to be Bleeker's Panimbang specimens. This male would also appear to be the model for the 97 mm illustration (plate 450, fig. 7) of *S. djarong* in the unpublished Bleeker Atlas; the van Hasselt figure is evidently lost.

Two fish (103 and 133 mm TL) were included in the original description of *Syngnathus helfrichii*. There is a Bleeker specimen (99 mm SL) labeled "type" in the British Museum (BMNH 1867.11.28.348) and there are two Auction Catalogue specimens (107 and 129 mm SL) in the Rijksmuseum (RMNH 7232). The smaller of these does not agree with Bleeker's original length range and I consider the 129 mm fish and the British Museum specimen to be syntypes of *S. helfrichii*; the smaller Auction Catalogue specimen may have come from Sumatra (Bleeker, 1859–60).

Duncker (1915) and Munro (1958) tentatively referred *Syngnathus parviceps* to the synonymy of *S. djarong*. Ramsay and Ogilby (1887) described 14 pectoral and 7 caudal-fin rays in the holotype of *S. parviceps* (AMS I.191) and stated that "egg-pouch is rather more than half the length of the tail" and "dorsal fin commences on the first, and extends over seven caudal rings." I have examined the single specimen now in AMS I.191 and find it to be a 101.5 mm SL female with 10 caudal rays, 15 rays in each pectoral fin and dorsal fin located on 0 + 6 rings. This fish is conspecific with *Hippichthys heptagonus*, it agrees with the original description in number of dorsal-fin rays, ring counts and total length, but absence of brood pouch suggests that it may not be the holotype of *Syngnathus parviceps*. Ramsay and Ogilby may have had more than one specimen, thus accounting for remarks on brood pouch but this is not stated in their description. Despite this apparent discrepancy, the description of *S. parviceps* indicates no differences from *Hippichthys heptagonus* and I consider these forms to be conspecific.

The type-material of *Bombonia luzonica* was destroyed during World War II (Herre, 1953) and types were apparently not designated for nominal varieties or subspecies; I have examined the types of all other species included in the synonymy.

Duncker (1915) and Weber and de Beaufort (1922) tentatively referred *Microphis tenuis* Blyth to the Synonymy of *Hippichthys spicifer*. Blyth (1859:272) based his description on two specimens, less than 4 inches long, from the Andaman Is. Ridge configurations were not described and there was no illustration. The reported combination of dorsal-fin location on 1st seven tail rings, counts of 16 + 36 rings, "24?" dorsal, "16?" pectoral and "9?" caudal-fin rays and somewhat banded color pattern is applicable to several Indian Ocean pipefishes. In the absence of type-material (evidently lost), diagnostic description or illustration I treat *Microphis tenuis* as a nomen dubium.

Remarks.—Sixteen egg-bearing males (78–129 mm SL) had brood pouches developed beneath 14–17 rings; thirty-two other males (73–140 mm SL) had pouches below 13–20 ($\bar{x}$ = 15.7) rings. A 103 mm fish contained eggs in single layer of up to 6 transverse rows and there were 61 eggs in outer right row of the 16 ring pouch.

Eighteen fish from Lake Taal (= Lake Bombon), Luzon Is. (FMNH 47470; UMMZ 100341–2) have tail ring counts of 36–38 ($\bar{x}$ = 36.9), whereas this count is 39–41 (39.8) in 29 specimens from other Philippine localities. In other features, the Lake Taal material agrees with other samples of *H. heptagonus* and I consider these populations conspecific. Study materials show no other significant geographic variations in meristics or coloration.

On the basis of examined material, *H. heptagonus* is presently known from the east coast of Africa to the Solomon Is. (Fig. 3). This species commonly occurs in rivers, streams, estuaries and harbors and it has been taken with *H. spicifer* in some Philippine collections.

Material examined.—136 specimens, 46–140 mm SL, including neotype.

Neotype.—RMNH 7234 (91.5 mm SL, female), Indonesia.

Other material.—INDIAN OCEAN—East Africa (St. Lucia, S. Afr. and Kenya): RUSI 5730. Ceylon: RMNH 20892. USNM 217537–38, 217546. Indonesia: ZMA 102.049, 113.267, 114.944, 114.950, 114.952. PACIFIC OCEAN—Singapore: FMNH 47194. Philippine Is. ANSP 47484 (holotype of *Corythroichthys matterni*). FMNH 47470. RMNH 27593. UMMZ 100341–42. USNM 55621 (holotype of *C. pullus*), 139066–68, 139073, 139078, 139081, 139083, 139085, 139087, 139091, 139093, 139098, 139100. Indonesia: BMNH 1867.11.28.346, 1867.11.28.348 (syntype of *Syngnathus helfrichii*). CAS-SU 25764 (paratype of *Bombonia uxorius*). FMNH 17493 (holotype of *B. uxorius*). MCZ 30477. RMNH 7232 (2, including 129 mm SL syntype of *Syngnathus helfrichii*), 7233. USNM 217547. ZMA 113.265, 114.946, 114.951. New Guinea: ANSP 81569. BPBM 15834. GCRL 15529. RMNH 27537, 37585.

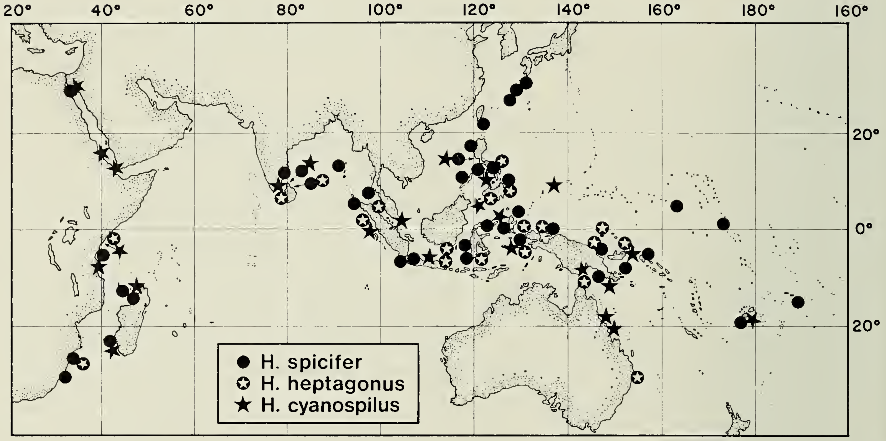

Fig. 3. Distributions of species of *Hippichthys* as determined from material examined.

USNM 217472–74, 217536. Admiralty Is.: USNM 143632. Bismarck Arch., New Britain: USNM 217480. Australia, Queensland: QM I.437. New South Wales: AMS I.191 (putative holotype of S. *parviceps*), I.19341-001. Solomon Is., Guadalcanal: USNM 217523.

Hippichthys spicifer (Rüppell)
Fig. 4

Syngnathus spicifer Rüppell, 1838:143 (original description; Tor, Red Sea).
Syngnathus gastrotaenia Bleeker, 1852:713 (original description; Wahai, Ceram).
Syngnathus tapeinosoma Bleeker, 1854a:375 (original description; Anjer, Java).
Syngnathus hunnii Bleeker, 1860:70 (original description; Tandjong, Sumatra).
Syngnathus gracilis Steindachner, 1903:458 (original description; Ternate).
Corythroichthys spicifer: Jordan and Seale, 1907:9 (new combination).
Syngnathus spicifer var. *gastrotaenia* Duncker, 1910:32 (diagnosis).
Syngnathus (*Parasyngnathus*) *spicifer*: Duncker, 1915:79 (new combination).
Hippichthys spicifer: Jordan, Evermann and Clark, 1930:243 (new combination).
Micrognathus suvensis Herre, 1935:396 (original description; Suva, Fiji Is.).
Doryichthys suvensis: Herald, 1953:232 (new combination).
Bombonia spicifer: Herre, 1953:204 (new combination).

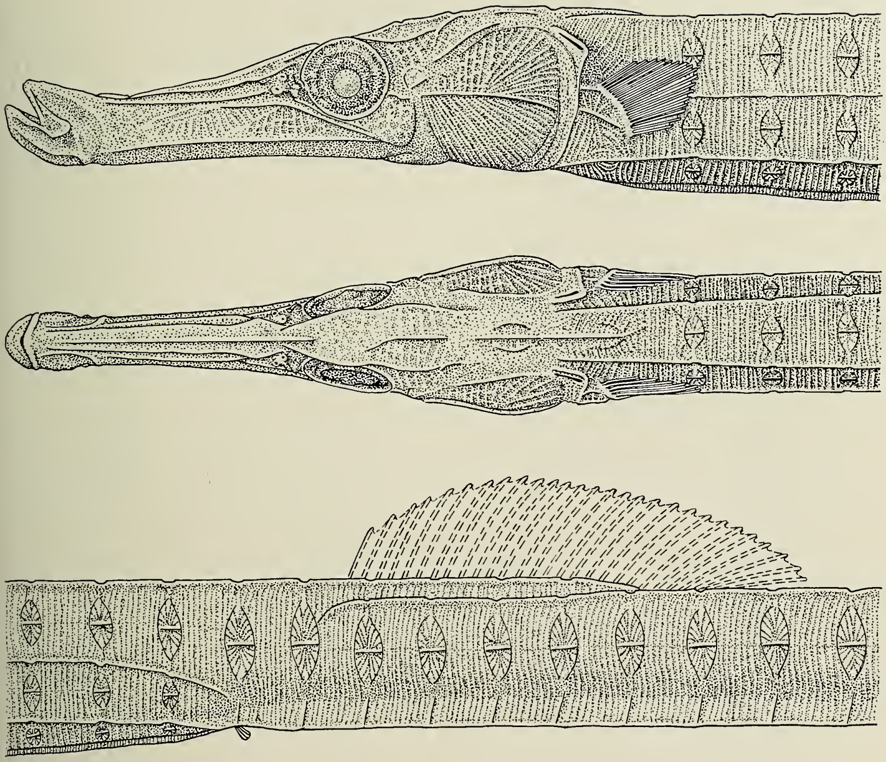

Fig. 4. *Hippichthys spicifer.* Top and middle: Lateral and dorsal aspects of head and anterior trunk rings. Bottom: Section of body illustrating ridges, dorsal and anal fins. Note longitudinal ridges on scutella. From 130 mm SL male, GCRL 15530.

Diagnosis.—Scutella keeled in subadults and adults; lateral snout ridge vestigial or obsolete; rings total 51–56; pectoral-fin rays modally 17; dorsal-fin origin always on tail.

Description.—Dorsal-fin rays 25–30 ($\bar{x}$ = 27.8); pectoral-fin rays 15–18 (17.1); rings 14–16 + 36–41 = 51–56 (53.5); total subdorsal rings 5.0–6.0 (5.6); dorsal-fin origin usually (93%) on 2nd tail ring. Proportional data based on 63 specimens 80.5–170.5 ($\bar{x}$ = 110.9) mm SL follow: HL in SL 6.9–10.3 (8.09); snout length in HL 1.8–2.1 (1.99); snout depth in snout length 3.6–5.7 (4.64), 47 fish; length of dorsal-fin base in HL 1.1–1.8 (1.41); anal ring depth in HL 3.1–6.0 (4.65), 40 fish; trunk depth in HL 2.3–4.1 (2.94), 39 fish; pectoral-fin length in HL 6.2–8.6 (7.44), 23 fish. See Tables 1–4 for additional counts and measurements.

Lateral snout ridge usually obsolete; scutella typically with a low but distinct longitudinal ridge (Fig. 4).

Table 1. Frequency distributions of trunk, tail and total rings in species of *Hippichthys.*

	Species		
Character	*heptagonus*	*spicifer*	*cyanospilus*
Trunk rings			
12			1
13			168*
14	3	5	5
15	123*	178	
16		1	
Tail rings			
32			11
33			90
34			63*
35			10
36	4	4	
37	11	17	
38	5	66	
39	36	69	
40	47	27	
41	21*	1	
42	2		
Total rings			
45			10
46			90
47			62*
48			12
49			
50			
51	4	4	
52	11	17	
53	6	69	
54	35	67	
55	48	26	
56	20*	1	
57	2		

* Primary type.

Color in alcohol tan to dark brown; dorsum of head, opercle and upper half of snout plain or mottled; lower half of snout usually pale, often flecked or rather distinctly spotted with brown. Body variably plain brownish, mottled or with prominent brown bars crossing lower half of side and venter of trunk (Fig. 5); trunk bars sometimes present in small specimens (ca. 80 mm SL), absent or obscured by generally dark ground color in some adults.

Table 2. Frequency distributions of dorsal and pectoral-fin rays and paired (equivalent) pectoral ray counts in species of *Hippichthys.*

Character	Species *heptagonus*	 *spicifer*	 *cyanospilus*
Dorsal-fin rays			
20			2
21			3
22			52
23	2		95*
24	1		24
25	17	2	2
26	36	9	1
27	34	49	
28	18	76	1
29	5	31	
30	1	8	
Pectoral-fin rays			
13	2		15
14	42		115*
15	104	2	130
16	20	55	19
17		140	
18		80	
19			
Paired pectoral counts			
13			5
14	6		46
15	25	1	50
16		16	7
17		45	
18		22	

* Primary type.

Dorsal and pectoral fins hyaline or flecked with brown, not distinctly spotted; caudal fin brown, with narrow pale margin.

Comparisons.—Hippichthys spicifer is readily separated from subadult and adult congeners by characters in the key and diagnosis. The keeled scutella, present on at least some rings in specimens as small as 66 mm SL, are unusual among syngnathine (tail-pouch) pipefish and materially aid in identification of this species. Head length of subadults and adults is relatively longer than that of congeners (Table 4). Juveniles are superficially similar to young *H. heptagonus* but differences in counts of pectoral

Table 3. Frequency distributions for point of dorsal-fin origin and total subdorsal rings in species of *Hippichthys*. Plus (+) indicates dorsal-fin origin in advance of O-point (anterior margin of 1st tail ring); minus (–) indicates origin behind O-point.

	Species		
Character	*heptagonus*	*spicifer*	*cyanospilus*
Point of dorsal-fin origin			
+1.50			3
+1.25			13
+1.00			89
+0.75			67
+0.50			12*
+0.25	1		3
0.00	35		
–0.25	26		
–0.50	47		
–0.75	17	4	
–1.00	8	12	
–1.25		57	
–1.50		83	
–1.75		27	
–2.00		6	
–2.25		2	
–2.50		2	
Total subdorsal rings			
4.25			1
4.50			2
4.75			27*
5.00	3	8	82
5.25	14	27	49
5.50	46	86	22
5.75	45	55	3
6.00	24	17	1
6.25	2		

* Primary type.

rays and dorsal-fin position (see Comparisons under *heptagonus*) permit identification of most individuals.

Types.—I have seen only one Rüppell specimen of *Hippichthys spicifer* but the original description and figure (Rüppell, 1838, Pl. 33, fig. 4) adequately characterize the species. Figured configuration of body ridges is clearly that of *Hippichthys*, and the slender snout and described abdominal bars are characteristic of specimens here referred to *H. spicifer* rather than *H. heptagonus*. Rüppell's ring count of 56 and figured dorsal-fin origin on tail prevent referral of his specimen to *H. cyanospilus* wherein there are 45–

Table 4. Measurements (mm) and regression equations for head length against standard length and snout length against head length in species of *Hippichthys*. ($\bar{x}$ = mean; σ = standard deviation; r = coefficient of correlation).

		Standard length			Head length				
Species	N	Range	$\bar{x}$	σ	Range	$\bar{x}$	σ	r	Regression equation
heptagonus	45	71.5–139.0	96.7	15.4	7.5–15.3	9.6	1.8	0.8878	$y = -0.3589 + 0.1263x$
spicifer	63	80.5–170.5	110.8	19.5	8.4–21.9	13.9	3.2	0.9502	$y = -3.4406 + 0.1568x$
cyanospilus	56	47.5–156.0	107.1	23.1	5.7–16.4	12.2	2.5	0.9662	$y = 1.1476 + 0.1036x$
		Head length			Snout length				
		Range	$\bar{x}$	σ	Range	$\bar{x}$	σ		
heptagonus	45	7.5–15.3	9.6	1.8	2.8– 7.9	4.0	1.1	0.9862	$y = -1.7642 + 0.6079x$
spicifer	63	8.4–21.9	13.9	3.2	4.0–11.5	7.0	1.8	0.9950	$y = -0.9272 + 0.5726x$
cyanospilus	56	5.7–16.4	12.2	2.5	2.5– 7.6	5.6	1.2	0.9549	$y = -0.0540 + 0.4639x$

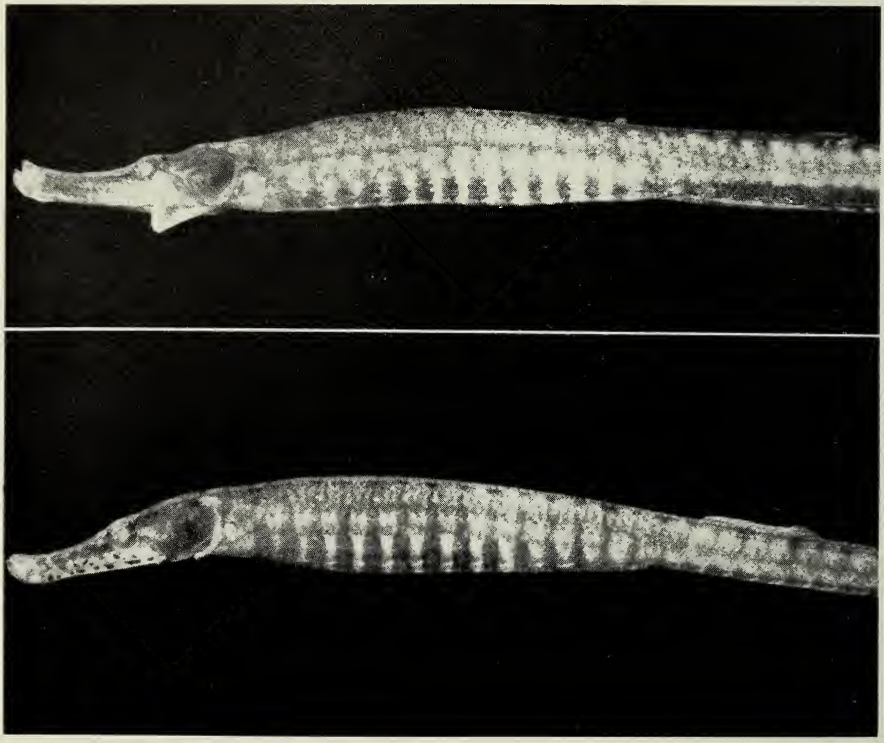

Fig. 5. *Hippichthys spicifer* (Rüppell); New Guinea. Top: USNM 217539, male, 170.5 mm SL. Bottom: USNM 217540, female, 110.5 mm SL.

48 rings and dorsal-fin origin is always on trunk. Rüppell's count of 16 trunk rings and statement that dorsal-fin origin is opposite anus are probably errors in observation. His figure shows dorsal fin originating at anterior margin of 1st tail ring (a position not found in other *spicifer*) and 16 trunk rings occur in only 3 percent of specimens examined here. The figured specimen is a male and careful examination is often required to correctly locate the anus and anal ring in relation to pouch plates, pouch folds and dorsal-fin origin. It seems likely that this fish actually had 15 trunk rings and this count would place dorsal-fin origin on 2nd tail ring, the usual location in *H. spicifer*. A pencil-marked 135 mm SL male syntype (SMF 4908) has 15 + 39 rings, 28 dorsal-fin rays and 6 subdorsal rings beginning at anterior margin of 2nd tail ring. I have not seen a second Rüppell specimen in the SMF collection.

Bleeker (1852) described *Syngnathus gastrotaenia* from five apparently female fish (102–125 mm TL) from Ceram and subsequently reported additional specimens from Borneo (1861), Halmahera (1867) and New Guinea

(1878). Known Bleeker specimens now include a 110 mm SL male (BMNH 1867.11.28.347) and five fish in RMNH 7230. The latter, possibly the combination of the 4 specimens in A series and the single B series specimen in the Auction Catalogue, included two egg-bearing males (100.5–133.5 mm SL) and three females (100–120 mm SL). The males are evidently not syntypes, the fate of Bleeker's smallest specimen (102 mm TL) is unknown, and the three Leiden females (100–120 mm SL) are presumably the only extant syntypes.

Syngnathus tapeinosoma was described from a single, presumably female, specimen (99 mm TL) and there is no evidence that additional specimens were obtained by Bleeker. The single Auction Catalogue specimen (RMNH 7229) is in poor condition, but it generally agrees with the description and is here considered the holotype. Similarly, *Syngnathus hunnii* was described from a single male (140 mm TL), and the 133 mm SL male Auction Catalogue specimen (RMNH 7231) is without doubt the holotype.

Type-material of *Micrognathus suvensis* includes the 89 mm SL holotype (FMNH 17229) and one 84 mm SL paratype (CAS-SU 24432). These juveniles are largely faded but keeled scutella are present and they are clearly conspecific with *Hippichthys spicifer*. I have not seen the holotype of *Syngnathus gracilis* but Steindachner's (1903) description and figure (Pl. 18, fig. 1) are clearly based on a young *Hippichthys spicifer*.

Remarks.—Thirteen egg-bearing males (99–170 mm SL) had brood pouches developed beneath 18–21 rings; twenty-six other males (91–147 mm SL) had pouches beneath 12–22 ($\bar{x} = 18.0$) rings. A 130 mm fish contained eggs in single layer of up to 10 transverse rows, and there were 90 eggs in the outer right row along 18 rings of the 20-ring pouch. I find no significant geographic variation in meristics or coloration in studied specimens.

Although originally described from the Red Sea, I have seen but two specimens from that area and there are apparently only two other Red Sea records of *H. spicifer* (and *Syngnathus tapeinosoma*); Klunzinger (1871) from Kosseir, and Picagalia (1894) from Assab. Regan's (1908) record from Tehuantepec (Mexico) is without doubt erroneous; I have been unable to locate his specimens in the BMNH collections.

Whitehead and Talwar (1976) list two ZSI catalog numbers (2623, 7163) for possible type-specimens of *Microphis bleekeri* Day [= *Oostethus brachyurus* (Bleeker)]. Dr. Talwar advises (pers. comm.) that ZSI 7163, model for the illustration of *Microphis bleekeri* (Day, 1878, Pl. 174, fig. 3), is presently not traceable in the ZSI collection. My examination of ZSI 2623 shows it to be a badly damaged egg-bearing male *Hippichthys spicifer*. Day's (1865) description of *Microphis bleekeri* is clearly diagnostic and it would appear that a curatorial error occurred when this specimen was originally registered in October 1879.

Materials examined (Fig. 3) range from the Red Sea to Samoa. This species has not been found in studied Australian collections, but it should be expected to occur in Queensland and along the northern coast. Examined specimens are from coastal, estuarine and river habitats; *H. spicifer* has been taken with *H. heptagonus* and *H. cyanospilus* in separate Philippine collections.

Material examined.—261 specimens, 59–170 mm SL, including one syntype.

Syntype.—SMF 4908 (135.0 mm SL, male), Red Sea, Gulf of Suez, Sinai, Tor.

Other material.—RED SEA.—Egypt, Kosseir: SMF 964. INDIAN OCEAN.—South Africa, Natal: ANSP 64051, 64053. RUSI 5719. Mozambique: RUSI 5716, 74–78. ZMA 110.038. Zanzibar: MCZ 52495. MNHN 6137. Comoro Is.: USNM 217491. Madagascar: GCRL 14823. MNHN 0710, 91673, 1965-348. UMMZ 185427, 185467, 185843. USNM 217485–87. India, Pondichery: MNHN 6136. ZSI 2623 (registered as possible type of *Microphis bleekeri*). Ceylon: GCRL 15530. USNM 217542–43. Andaman Is.: RMNH 8819. Thailand, Phuket: USNM 217483–84. Indonesia: RMNH 7229 (holotype of *Syngnathus tapeinosoma*), 7231 (holotype of *S. hunnii*). ZMA 114.945. PACIFIC OCEAN.—Taiwan: USNM 217548. Philippine Is.: CAS-SU 27681. USNM 56280, 112912, 137281–84, 139065, 139069, 139071, 139074–75, 139077, 139080, 139082, 139084, 139086, 139088–90, 139092, 139095–97, 139101, 139104, 139106, 217513–15. Indonesia: BMNH 1867.11.28.347. BPBM 19440. FMNH 23474–79. RMNH 4426, 7230 (in part, syntypes of *S. gastrotaenia*), 21093. USNM 137285, 139107. ZMA 104.666, 108.360, 113.266. Japan, Ryukyu Is.: GCRL 15550–51. USNM 132789. Tanagashima: GCRL 15549. New Guinea: BPBM 15830. GCRL 15545. RMNH 25093, 27536, 27589. USNM 217468–71, 217539–41. Solomon Is., Bougainville: USNM 217488. Caroline Is., Kusaie: USNM 65806. Gilbert Is., Tarawa: BPBM 10437. Fiji Is.: ANSP 81601. BPBM 14548. CAS-SU 24432 (paratype of *Micrognathus suvensis*). FMNH 17229 (holotype of *M. suvensis*). GCRL 13196, 14245. USNM 217489–90. Samoa Is.: AMNH 18110.

Hippichthys cyanospilus (Bleeker)
Fig. 6

Syngnathus cyanospilos Bleeker, 1854b:114 (original description; Indonesia, Banda Neira).

Syngnathus mossambicus Peters, 1855:277 (original description; Mozambique).

Syngnathus kuhlii Kaup, 1856:34 (original description; based on Indonesian specimens collected by Kuhl and van Hasselt).

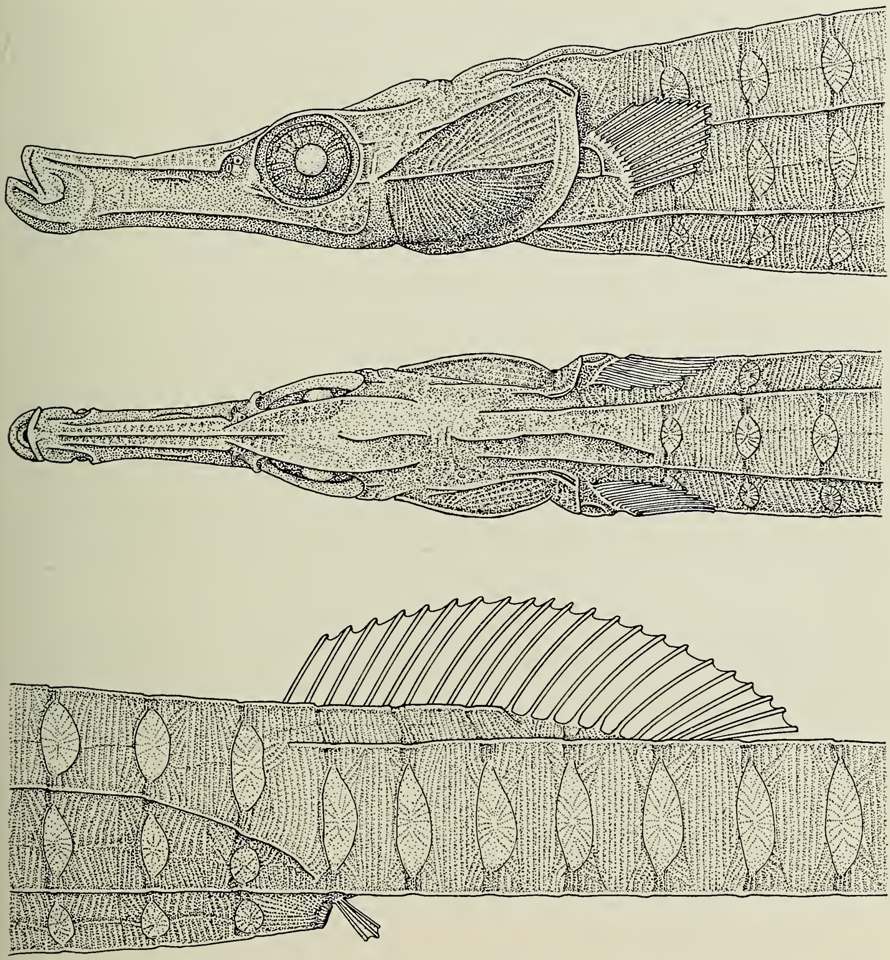

Fig. 6. *Hippichthys cyanospilus.* Top and middle: Lateral and dorsal aspects of head and anterior trunk rings. Bottom: Section of body illustrating ridges, dorsal and anal fins. From 123 mm SL female, GCRL 14822.

Doryichthys spaniaspis Jordan and Seale, 1907:10 (original description; Cavite, Philippine Is.).

Syngnathus (*Parasyngnathus*) *cyanospilus*: Duncker, 1915:81 (new combination).

Parasyngnathus wardi Whitley, 1948:77 (original description; Lindeman Is., Queensland, Australia).

Syngnathus wardi: Munro, 1958:83 (new combination).

Diagnosis.—Scutella not keeled; lateral snout ridge usually distinct; rings total 45–48; pectoral-fin rays modally 15; dorsal-fin origin always on trunk.

Description.—Dorsal-fin rays 20–28 ($\bar{x}$ = 22.8); pectoral-fin rays 13–16 (14.6); rings 12–14 + 32–35 = 45–48 (46.4); total subdorsal rings 4.25–6.0 (5.1); dorsal-fin origin on 0.25–1.5 (0.9) trunk rings. Proportional data based on 56 specimens 47.5–156.0 ($\bar{x}$ = 107.1) mm SL follow: HL in SL 7.5–9.8 (8.73); snout length in HL 1.3–2.6 (2.19); snout depth in snout length 3.0–5.4 (3.63); length of dorsal-fin base in HL 1.0–1.6 (1.27); anal ring depth in HL 2.3–5.2 (3.02), 47 fish; trunk depth in HL 1.8–2.8 (2.26), 46 fish; pectoral-fin length in HL 4.8–7.4 (5.90), 38 fish. See Tables 1–4 for additional counts and measurements.

Lateral snout ridge distinct in most subadults and adults; scutella not keeled.

Ground color in alcohol tan to dark brown. Lower portion of snout usually pale (Fig. 7); dorsum and sides of body and head plain, mottled or blotched; venter of trunk without transverse bars, often brownish, shading to near black along median ridge; pectoral fins hyaline or spotted; dorsal fin typically with 3–4 prominent brown spots on each ray; caudal fin brown with narrow pale margin.

Comparisons.—Relative head length of *H. cyanospilus* is roughly intermediate between that of *H. heptagonus* and *H. spicifer* (Table 4). The modal trunk ring count of 13 and total ring count of 45–48 clearly distinguish *H. cyanospilus* from congeners wherein these counts are 15 and 51–57, respectively. It shares a modal count of 15 pectoral rays with *H. heptagonus* (modally 17 in *spicifer*) but *H. cyanospilus* usually has fewer dorsal-fin rays (modally 23) than either congener (modally 26 or 27). Dorsal-fin origin on 1st or 2nd trunk ring further separates *H. cyanospilus* from all *H. spicifer* (origin always on tail) and most *H. heptagonus* (99% on tail). The strongly spotted dorsal-fin rays of *H. cyanospilus* are not found in either congener, and this species lacks the bars on venter and sides of trunk occurring in many *H. spicifer* and some *H. heptagonus.*

Types.—The holotype of *Syngnathus cyanospilus* (RMNH 7228) is a faded 115.5 mm SL male with pouch folds below 15 rings; pencil marks suggest that this fish was the model for the illustration (plate 450, fig. 6) of *S. cyanospilus* in the unpublished Bleeker Atlas. Measurements (mm) follow: HL 13.7, snout length 6.7, snout depth 1.6, length of dorsal-fin base 9.9, anal ring depth 5.0, trunk depth 5.6; see Tables 1–4 for counts.

Kaup's (1856) description of *Syngnathus kuhlii* was based on a male fish from Java in the Paris Museum and seven specimens in the Leiden collection; Kaup listed S. *variegatus* Kuhl and van Hasselt Ms. as a junior synonym. Search of the Rijksmuseum collection has failed to locate the Leiden specimens mentioned by Kaup. There are now only two Kuhl and van Hasselt

Fig. 7. *Hippichthys cyanospilus* (Bleeker). GCRL 14822, New Guinea. Top: Male, 109.5 mm SL. Bottom: Female, 123 mm SL.

specimens of "*S. variegatus*" (RMNH 3862) and these are conspecific with *S. acus* L. A 98 mm SL male in Paris (MNHN 6138) is apparently the only extant syntype of *S. kuhlii*.

I have examined the holotype (AMS IB.1911) and six paratypes of *Parasyngnathus wardi* and all are conspecific with *Hippichthys cyanospilus*. Whitley (1948) reported 9 caudal rays and 14 + 36 rings in the holotype but I count 10 caudal rays in all specimens and 13 + 35 rings in the holotype.

I have not seen the holotype of *Syngnathus mossambicus* but Peters (1855) description of 13 trunk rings, 47 total rings, 23 dorsal rays and dorsal-fin origin on last trunk ring is diagnostic of *Hippichthys cyanospilus*.

Remarks.—Sixteen egg-bearing males (75–156 mm SL) had brood pouches developed below 14–17 rings; thirteen other males (59–134 mm SL) had pouches beneath 11–17 ($\bar{x} = 14.5$) rings. A 109 mm fish contained eggs in single layer of up to 10 transverse rows and there were 70 eggs in outer right row along 14 rings of the 16 ring pouch.

Two fish (89 and 106 mm SL) from unspecified Thailand localities (ANSP 62184, 62185) have high counts of dorsal-fin rays (26 and 28, against 20–25 in other specimens). With this possible exception, I find no evidence of significant geographic variation in study material.

Examined materials (Fig. 3) range from the Red Sea coast of Israel to Fiji. Most collections are from coastal habitats but one (USNM 217516) is from a brackish Philippine river. This species has occurred in the same collection with *H. spicifer* but I have not seen samples including both *H. cyanospilus* and *H. heptagonus.*

Material examined.—189 specimens, 36.5–156.0 mm SL, including holotype.

Holotype.—RMNH 7228 (115.5 mm SL), Indonesia, Banda Is., Banda Neira (Bandaneira).

Other material.—RED SEA.—Israel: HUJ F.4370. Ethiopia: HUJ E.62-642. Loc. uncertain: HUJ E.62-1303, E.62-3636. INDIAN OCEAN.—Parim: MNHN 95-146. Kenya: BOC 1722. Mozambique: RUSI 5734. Zanzibar: MCZ 52497. MNHN 2409, A.2004. Madagascar: MNHN 1965-347. UMMZ 185664, 185985. USNM 217482. India, Madras: FMNH 75865. GCRL 15261. Ceylon: USNM 217544. UZMK P.39476. PACIFIC OCEAN.—Singapore: CAS-SU 34958. Thailand: ANSP 62184–5. Philippine Is.: CAS-SU 9240 (holotype of *Doryichthys spaniaspis*). USNM 102583, 102555, 102802, 102803, 102859, 135689, 139072, 139076, 139094, 217516–19. Indonesia: MNHN 6138 (syntype of *Syngnathus kuhlii*), 1969–45. UZMK P.39475. ZMA 114.947–949. Caroline Is., Yap Is.: CAS 39089. New Guinea: GCRL 14822. USNM 217467, 217545. Bismarck Archipelago, New Britain: BPBM 15720. Australia, Queensland: AMS IB.1911 (holotype of *Parasyngnathus wardi*), IB.1912 (paratypes (5) of *P. wardi*). QM I.11257 (paratype of *P. wardi*), I.7660. Fiji Is.: USNM 217481.

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THE SOUTH AMERICAN FISH GENUS *ELACHOCHARAX* MYERS WITH A DESCRIPTION OF A NEW SPECIES (TELEOSTEI: CHARACIDAE)

Stanley H. Weitzman and Robert H. Kanazawa

Abstract.—*Elachocharax geryi*, a new species of characid of the subfamily Characidiinae is described from Lago Paricatuba (60°30′W, 3°7′S), Rio Negro, Amazonas, Brazil and from Caño Muco, of the Río Vichada, Vichada, Colombia. The new species is closest to *Elachocharax pulcher* Myers (1975) which is redescribed from many specimens from the Amazon basin of Brazil and the Orinoco basin of Colombia and Venezuela. Previously *Elachocharax pulcher* was only known from near Caicara in the Orinoco basin of Venezuela. *Elachocharax georgiae* Géry (1965) is considered a synonym of *E. pulcher*. *Elachocharax* Myers (1927) is redefined and its possible relationships to the characidiin genera *Klausewitzia* Géry (1965) and *Geisleria* Géry (1971) are discussed. Although *Elachocharax* is probably phylogenetically close to these two genera more information is needed about certain of the species in both genera before hypotheses about the relationships of the three genera can be adequately tested.

Elachocharax Myers (1927) was described from two specimens of a new species, *Elachocharax pulcher* Myers (1927), taken during 1925 from the Caño de Quiribana, near Caicara in the Orinoco River system of Venezuela. Myers (1927) allied *Elachocharax* with *Crenuchus* Günther, but suggested that *Elachocharax* may be related to *Characidium* Reinhardt. No other examples of *Elachocharax* were discovered and made known until Géry (1965) described an apparent new species, *Elachocharax georgiae*, from eight specimens collected during 1960 from Igarapé Préto, State of Amazonas, Brazil, about 60 km downstream from Leticia, Colombia and Tabatinga, Brazil on the Rio Solimões. A related genus and species, *Geisleria junki* Géry (1971) was described from the Rio Novo, a tributary of the Rio Jamari about 45 km east of Porto Velho on the Rio Madeira, State of Guaporé, Brazil.

Géry (1971) hypothesized that *Geisleria* is more closely related to *Elachocharax* than to any other genus related to *Characidium*, but that the two genera differ from each other at the subfamily level. He proposed recognition of the three related subfamilies, the Characidiinae, the Elachocharacinae, and the Geisleriinae, all placed in the family Charadidiidae, a characoid family of uncertain relationships but differing from the Crenuchidae of Géry (1963). Weitzman and Kanazawa (1976) have tentatively rejected the Elachocharacinae and Geisleriinae. Instead they adopted the hypothesis that the characid genera *Klausewitzia* Géry, *Ammocryptocharax* Weitzman and Kanazawa, *Characidium*, *Jobertina* Boulenger, *Elachocharax* and *Geisleria* all belong to the Characidiinae, the affinities of which are uncertain at present.

Characidium has been thought allied with *Nannostomus* Günther and these two genera have been placed in what is the current equivalent of the Anostomidae by Eigenmann and Eigenmann (1891), following Steindachner (1876) who placed *Nannostomus* in relation to *Anostomus*. Regan (1911) presented osteological evidence that *Characidium* and *Nannostomus* were related and placed them in the Nannostominae, a subfamily he considered belonging to the Hemiodontidae. Weitzman (1964) reviewed the history of these placements in more detail than is presented here and found morphological evidence for placing *Nannostomus* in what is now the Lebiasinidae; see Weitzman and Cobb (1975). Weitzman (1964:143–144) found that the characters used by Regan (1911) to relate *Nannostomus* and *Characidium* were erroneously described by Regan and excluded *Characidium* and its relatives from the Lebiasinidae. Weitzman did not try to relate the Characidiinae to other characoids and this group has yet to receive any substantial morphological study to provide evidence for testing hypotheses of its possible phylogenetic relationships. Weitzman and Kanazawa (1976) note that they have this currently under study. The following account of *Elachocharax* is presented as another preliminary step towards the accomplishment of that investigation and one attempting to test hypotheses of the phylogenetic relationships of the genera of the Characidiinae.

The abbreviations below refer as follows: California Academy of Sciences (CAS); Indiana University Museum of Zoology (IUM), now as CAS; Field Museum of Natural History, Chicago (FMNH); Museo de Biologia, Instituto de Zoologia Tropical, Universidad Central de Venezuela (MBUCV-V); Museu de Zoologia da Universidade de São Paulo (MZUSP); Natur-Museum und Forschungs-Institut, Senckenberg, Frankfurt (SMF); Museum of Comparative Zoology, Harvard University (MCZ); and National Museum of Natural History, Washington, D.C. (USNM). The abbreviation EPA refers to the Expedicão Permanente da Amazonia, a Brazilian program for studying Amazonian biota.

The following persons have loaned us specimens for examination. Heraldo A. Britski and Naercio A. Menezes (MZUSP), Jamie Thomerson, Southern Illinois University, Francisco Mago Leccia (MBUCV), William Eschmeyer (CAS), and Wolfgang Klausewitz (SMF). Marilyn Weitzman provided technical assistance and William L. Fink assisted in the preparation of photographs. Sara Fink prepared figures 5, 6, 7, 11, 12, and 13.

Paulo Vanzolini (MZUSP) allowed the senior author to survey the collection in his charge and the Fundacão de Ampara a Pesquisa do Estado

São Paulo supported the collection of specimens by the Expedicão Permanente do Amazonia under Vanzolini's direction. Financial support for examining the collections at MZUSP was provided by the Smithsonian Institution Amazonian Ecosystems Research Program directed by Clifford Evans. Assistance in sorting and examining specimens in the collections of the Museu de Zoologia São Paulo was provided by Marilyn Weitzman, William L. Fink and Sara H. Fink.

Elachocharax Myers

Elachocharax Myers, 1927:114, original description, type by monotypy *Elachocharax pulcher* Myers (1927).

Elacocharax Weitzman and Kanazawa 1976:328, misspelling for *Elachocharax.*

Diagnosis.—The following character will distinguish *Elachocharax* from all other genera of the Characidiinae: total number of dorsal-fin rays 17–22. Only *Jobertina* has member species with as many as 14 dorsal-fin rays.

Other characters of importance for recognizing *Elachocharax* are lateral line incomplete, perforated scales 5–9; scales in a lateral series 26–30; mouth terminal; teeth tricuspid or conic in premaxillary and outer row of dentary; all other teeth conic; teeth absent on maxillary and mesopterygoid; present on ectopterygoid; two rows of teeth on dentary; vertebrae 29–32, including Weberian apparatus and terminal half centrum; branchiostegal rays 4–5; adipose fin present or absent.

Elachocharax appears to be a genus of the Characidiinae as shown by Géry (1965 and 1971) and not related to the characid genus *Crenuchus* as thought possible by Myers (1927). There appear to be several species of small to pygmy members of the Characidiinae usually less than 25 mm in standard length (SL), having relatively short bodies, narrow elongate pectoral fins and perhaps with swimming habits somewhat like those of the North American pygmy sunfishes, *Elassoma.* See Weitzman and Kanazawa (1977) for observations on live specimens of one of these fishes.

Members of this group of tiny fishes are currently placed in the genera *Jobertina*, for example *J. eleotroides* Géry (several species of *Jobertina* are not miniature), *Klausewitzia*, *Elachocharax*, and the questionable *Geisleria.* The relationships, if any, among the members of this group are not understood and are in serious need of a penetrating evaluation. Evolutionary trends in most of these small fishes are often reductive and include simple reduction of orbital-bone ossification and loss of the adipose fin. Innovative trends which are not reductive or only partially reductive include the low-placed but narrow pectoral fins with relatively elongate rays, pectoral-fin rays which tend to be unbranched and few in number, an increase in dorsal-fin ray number in some species, and development of relatively short, deep bodies. It is possible that these species of tiny fishes will eventually be recognized as a tribe, the Elachocharacini, representing one of the lines of evolution within the Characidiinae. If an analysis of the characters in these fishes leads to an unrefuted hypothesis of phylogenetic relationships among them, then a change in generic names of at least those currently placed in *Jobertina* will be necessary.

The relationships of *Geisleria* are here brought into further question than was considered by Géry (1971). He separated *Geisleria* from *Elachocharax* by two characters which he was able to observe with confidence and by two or three others about which he was uncertain of his observations. The first of the former characters was teeth tricuspid in *Elachocharax* and conic in *Geisleria*. As pointed out below, the teeth in the two closely related species of *Elachocharax* recognized here are a mixture of tricuspid and conic in one species, *E. pulcher*, and all conic in the second, *E. geryi*. In our view this character does not serve to distinguish fishes related to *Characidium* at the generic or the subfamily level. See Weitzman and Fink (in press) for a fuller discussion of the use of teeth as characters in characoid fishes. Another character Géry (1971) observed with confidence was the cranial fontanel absence in *Geisleria* and its presence in *Elachocharax*. We cannot comment about the presence or absence of a fontanel in *Geisleria junki* since specimens of this species are unavailable to us, but we would point out that in the pygmy or small fishes under discussion, the fontanels we have seen are restricted to the posterior part of the cranium and it may simply be that the fontanel's absence in *Geisleria* is a continuation of a well-developed reductive trend in the Characidiinae, not a remarkable difference "worthy" of subfamily or generic separation.

Géry (1971) notes in his table, p. 162, that *Geisleria* lacks orbital bones and that these are reduced in *Elachocharax*. In his text, p. 154, he appears uncertain that the orbital bones were totally absent in *Geisleria*. We too find orbital bones reduced in *Elachocharax* but suspect that at least the first orbital bone (circumorbital one) is present in *Geisleria*. Orbital bones posterior to the first would, in *Geisleria*, probably be reduced to poorly ossified laterosensory tubes as they are in *Elachocharax*. These structures are difficult to detect except in cleared and stained specimens and cannot be detected by gross dissection as being ossified in specimens left more than a few weeks in acid, unbuffered formalin. The rather heavily ossified first orbital should be detectable in unstained specimens. We would note that all these bones and even the vertebrae do not stain in specimens of *Elachocharax pulcher* from the Rio Branco, MZUSP 13236–13238, collected by T. Roberts in 1969 and maintained in unbuffered formalin for a few years. If a similar occurrence happened with the holotype and only known specimen of *G. junki* all of its orbital bones would be undetectable except by histological examination. Of the other questionable characters used by Géry (1971), he was unsure of the absence of "pterygoid" teeth in *Geisleria.* Even if absent, this too is simply a continuation of a reductive trend found in *Elachocharax.* We note below that *E. geryi* has fewer ectopterygoid teeth than *E. pulcher* and we would not consider this loss in a third, related species, to warrant the generic separation of that species. Géry (1971) was uncertain as to whether his specimens of *Geisleria* had teeth on the maxillary on one side and he was certain of their absence on the other side. We are very sympathetic with his difficulties in this regard and would agree that only when specimens are cleared and stained with alizarin and the jaw bone is dried, is it possible to be certain of this character. In view of the closeness in other characters of *Geisleria* to *Elachocharax* we would be very surprised if maxillary teeth are present in *G. junki.* If present, this might indicate some kind of relationship with *Klausewitzia aphanes* Weitzman and Kanazawa which has such teeth, but far fewer dorsal-fin rays. Assuming that *Klausewitzia,* because of its maxillary teeth, can be considered a primitive genus of the pygmy "group" then if *Geisleria* is related to *Klausewitzia* as a sister group, the hypothesis that *Geisleria* evolved its high dorsal-fin ray count independent of *Elachocharax* might be worthy of consideration. We suspect, however, that the maxillary teeth of *Geisleria* are absent and that the synapomorphy of a high number of dorsal-fin rays in *Geisleria* and *Elachocharax* indicates a sister group status for these two genera. Until further information is available about *Geisleria,* its relationships must be considered enigmatic, although we consider it probable that *Geisleria* will be found either synonymous with or very closely related to *Elachocharax.*

Elachocharax pulcher Myers
Figs. 1–8, Tables 1 and 2

Elachocharax pulcher Myers, 1927:115, original description, Venezuela, Caño Quiribana near Caicara.—Mago Leccia, 1970:71, listed from Venezuela.—Géry, 1965:206, comparison, based on Myers (1927), with *E. georgiae.*

Elachocharax georgiae Géry, 1965:204, original description, Brazil, Igarapé Préto, 60 km downstream from the border zone between Peru, Colombia, and Brazil.

Material examined.—See Fig. 8 for distribution map. Holotype, IUM (now at CAS) 17676, 16.0 mm SL, Venezuela, State of Bolivar, Caño de Quiribana, near Caicara (66°10′W, 70°39′N), May 1925, Carl Ternetz.—MBUCV-V-7295, (3), 16.9–17.3 mm SL, Venezuela, Territorio Federal de Amazonas, laguna near San Fernando de Atabapo (67°22′W, 4°4′N), 15 April 1973, F. Mago Leccia.—USNM 216921, (3), 15.6–16.9 mm SL (2

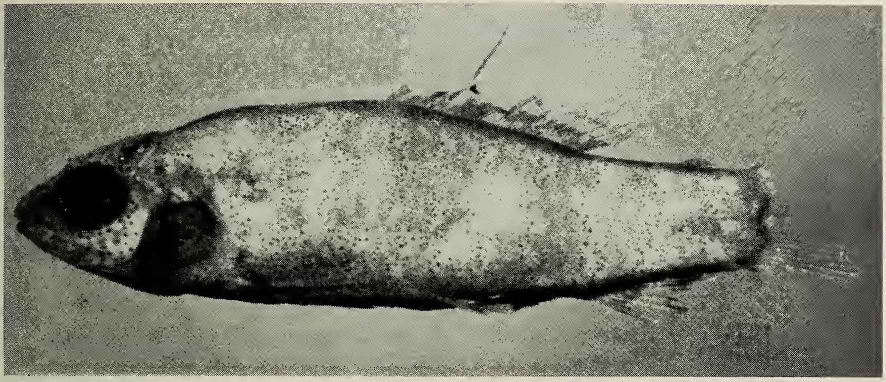

Fig. 1. *Elachocharax pulcher* Myers, CAS(IUM)17676, SL 16.5 mm, holotype, Caño de Quiribana near Caicara, Rio Orinoco, Venezuela, May 1925.

specimens, 16.3 and 16.9 mm, cleared and stained), same locality data as MBUCV-V-7295.—USNM 216925, (3), 14.3–14.5 mm SL, Venezuela, Territorio Federal de Amazonas, Río Pacia Grande about 22 km from Puerto Ayacucho toward San Mariapo (67°30′W, 5°38′N), 12 January 1975, J. E. Thomerson, D. C. Hicks, D. Taphorn and H. Lopez.—FMNH 83831, (1), 15.4 mm SL, Colombia, State of Meta, Caño Muco between 70°20′W, 4°15′N and 71°58′W, 4°98′N, tributary of Río Vichada, about 15 km west of Puerto Gaitan, J. E. Thomerson, D. C. Hicks and J. E. Vaques, 2 April 1974.—USNM 217558, (1), 16.0 mm SL, some locality data as FMNH 83831.—MZUSP 13242–13244, (3), 13.2–15.0 mm SL, Brazil, State of Amazonas, Rio Negro, São João, near Tapurucuara (65°2′W, 0°24′S), from an igarapé of varzea with many fallen logs, P. Vanzolini, EPA, 24 October, 1972.—Following 4 lots have same locality data as MZUSP 13242: USNM

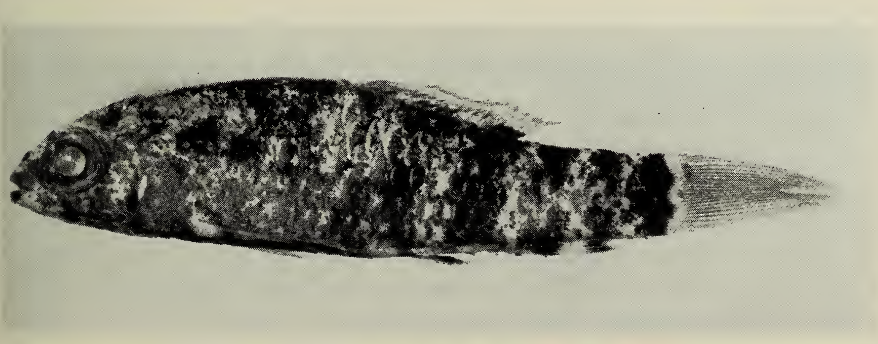

Fig. 2. *Elachocharax pulcher* Myers, USNM 217558, SL 16.0 mm, Caño Muco, Río Vichada, Colombia, April 1974.

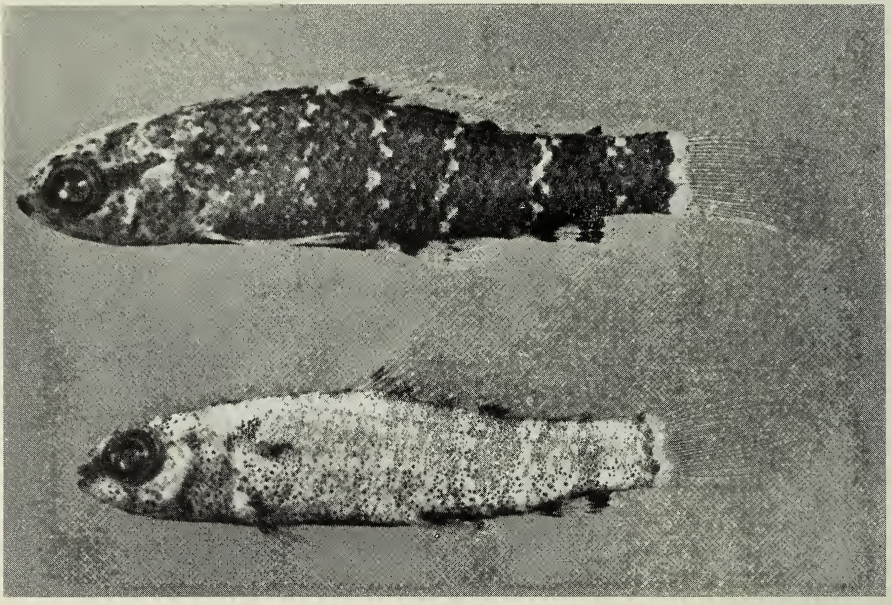

Fig. 3. *Elachocharax pulcher* Myers, MZUSP 7479, SL 14.0 mm for lower specimen, 17.0 for upper specimen, Rio Sanabani, near Silves, State of Amazonas, Brazil, December 1967.

216919, (13), 12.8–21.0 mm SL.—MCZ 52468, (2), 14.3–14.5 mm SL.—ANSP 138013, (3), 13.1–15.0 mm SL.—BMNH 1977.4.25.7–8, (2), 13.3–15.9 mm SL.—MZUSP 13233–13234, (2), both 14.5 mm SL, Brazil, State of Amazonas, Lago Miua (62°10′W, 3°45′S), north of Codajas, 25 September 1963.—MZUSP 7441, (2), 14.8–15.4 mm SL, Brazil, State of Amazonas, Rio Sanabani near Silves (58°27′W, 2°52′S), H. Britski, EPA, 8 December 1967.—MZUSP (no number), (33), (not measured), Brazil, State of Amazonas, Rio Sanabani near Silves, H. Britski, EPA, 7 December 1967.—USNM 216920, (25), 12.9–16.6 mm SL, 3 cleared and stained, same locality as MZUSP (unnumbered) above.—MZUSP 7123, (1), 13.8 mm SL, Brazil, State of Amazonas, an igarapé on right bank of Rio Canumã at Canumã (59°5′W, 4°3′S), H. Britski, EPA, 28 November 1967.—MZUSP 13236–13238, (3), 13.5–14.3 mm SL, Brazil, Territory of Roraima, an igarapé about 1 km north of Caracarai, Rio Branco (61°8′W, 1°50′N), T. Roberts, 5 February 1969.—MZUSP 13241, (1), 15.8 mm SL, Brazil, State of Pará, Igarapé Acu, Aveiro (55°4′W, 3°12′S), Rio Tapajos, EPA, 30 October 1970.—SMF 7216–9, (4), (paratypes of *Elachocharax georgiae*), 16.0–17.5 mm SL, Brazil, State of Amazonas, Igarapé Préto, 60 km downstream from the border zone between Perú, Colombia, and Brazil, Harald Schultz, December 1960.

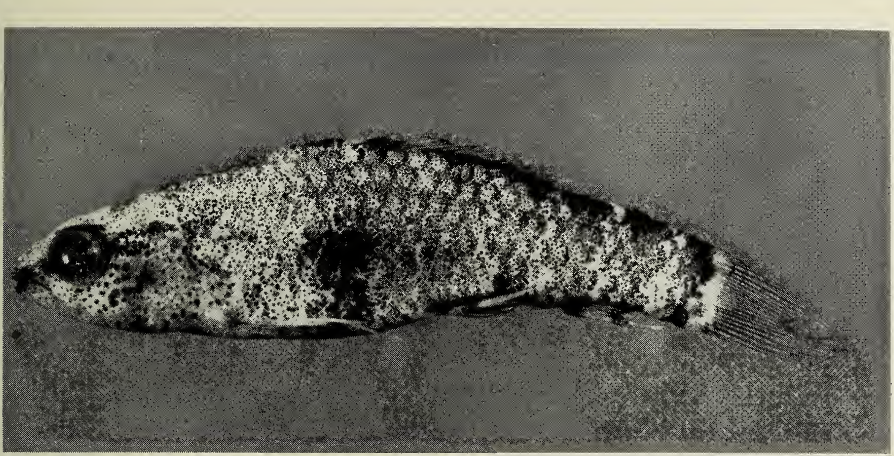

Fig. 4. *Elachocharax pulcher* Myers, USNM 216919, SL 21.0 mm, São João near Tapurucuara, Rio Negro, State of Amazonas, Brazil, October 1972.

Diagnosis.—Anterior teeth of premaxillary and dentary tricuspid or bicuspid. Adipose fin present. Scale rows around caudal peduncle 12. Body with about 7 or 8 vertical dark bars. Caudal fin with 1, or sometimes 2, narrow vertical bars near base. Anal fin with one dark blotch and a vertical bar posterior to blotch. Pelvic fin with a dark blotch near its base and a narrow dark stripe distally. Branchiostegal rays 5.

Description.—In description morphometrics (expressed as percentages of standard length) are given first for holotype followed in parentheses by

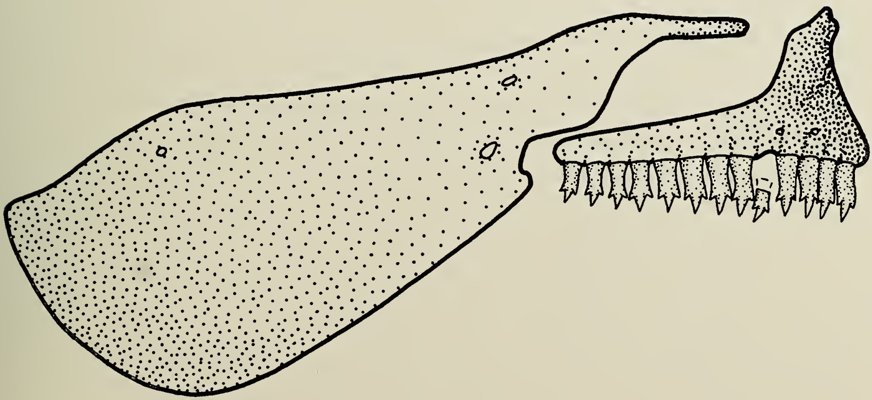

Fig. 5. *Elachocharax pulcher* Myers, USNM 216921, SL 16.3 mm, laguna near San Fernando de Atabapo, Territorio Federal de Amazonas, Venezuela, April 1973. Lateral view of premaxillary and maxillary bones of right side. Anterior is to the right.

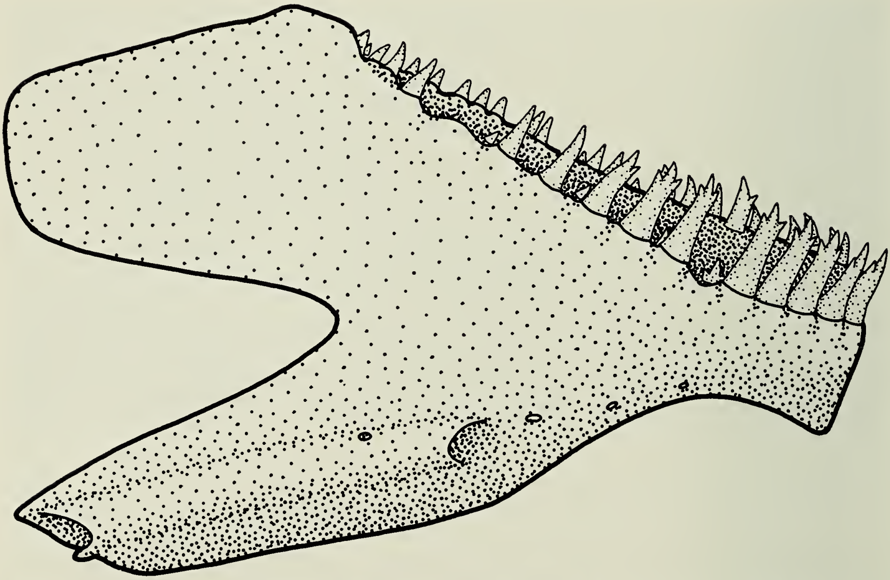

Fig. 6. *Elachocharax pulcher* Myers, USNM 216921, SL 16.3 mm, laguna near San Fernando de Atabapo, Territorio Federal de Amazonas, Venezuela, April 1973. Lateral view of right dentary bone. Note that outer tooth row lies in a deep groove and that the replacement teeth develop in that groove. The inner row teeth may be seen posterior to the ridge behind the groove. Anterior is to the right.

range and mean for all specimens. Table 1 separately presents ranges and means of morphometrics for population samples from several widely separated localities.

Body relatively short in comparison to most members of the Characidiinae; greatest depth 26.7 (23.8–29.7, $\bar{x}$ = 26.4). Tip of snout to anterior dorsal-fin origin 49.7 (49.7–57.7, $\bar{x}$ = 53.4). Profile of head and back from snout tip to dorsal-fin origin gently convex. Dorsal-fin origin in advance of pelvic-fin origin. Tip of snout to anterior anal-fin origin 77.6 (73.8–83.9, $\bar{x}$ = 79.1). Anal-fin origin below or somewhat posterior to posterior termination of dorsal-fin base. Tip of snout to anus 72.1 (69.7–79.9, $\bar{x}$ = 74.6). Tip of snout to pelvic-fin origin 57.6 (55.9–65.0, $\bar{x}$ = 59.5). Profile of ventral surface of head gently convex. Belly slightly concave to very gently convex from region of isthmus to pelvic-fin origin. Profile of body between pelvic-fin origin and anal-fin origin slightly concave to nearly straight. Length of caudal peduncle 17.6 (14.4–18.0, $\bar{x}$ = 16.5). Both dorsal and ventral profiles of caudal peduncle nearly straight to very slightly concave. Least depth of caudal peduncle 13.3 (12.5–16.0, $\bar{x}$ = 13.8).

Head moderately long, 32.1 (32.1–36.9, $\bar{x}$ = 34.8). Mouth terminal; snout

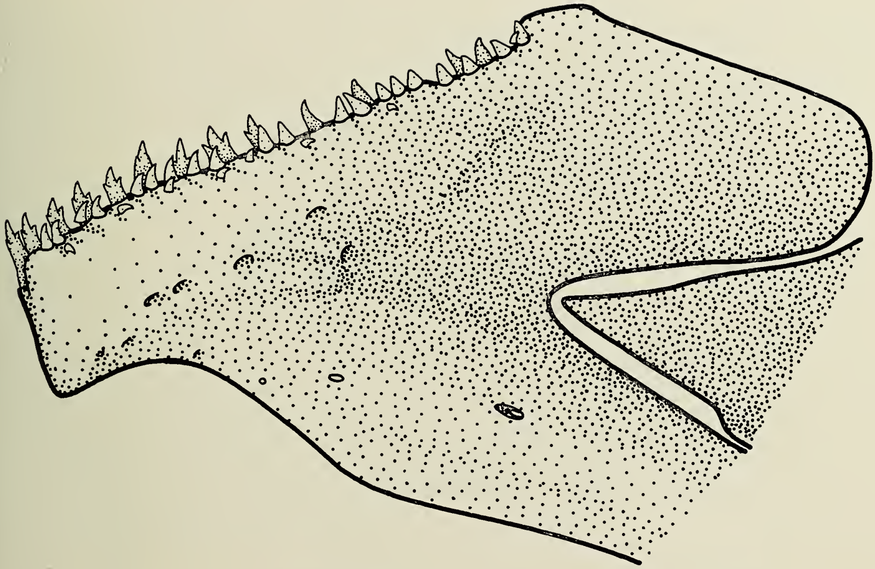

Fig. 7. *Elachocharax pulcher* Myers, USNM 216921, SL 16.3 mm, laguna near San Fernando de Atabapo, Territorio Federal de Amazonas, Venezuela, April 1973. Medial view of right dentary bone. Note 7 small replacement teeth appear posterior medial to inner row of conic teeth which are attached to dentary ridge behind outer tooth row. Anterior is to the left.

blunt, 6.7 (6.1–8.6, $\bar{x} = 7.3$). Eye large, horizontal diameter 9.1 (8.5–12.4, $\bar{x} = 10.6$). Least bony interorbital width 5.5 (4.8–6.2, $\bar{x} = 5.5$).

Tooth counts for holotype given first followed by those in parentheses for 16.3 (see Figures 5–7) and 16.9 mm SL cleared and stained specimens, USNM 216921, from San Fernando de Atabapo, Venezuela, and in brackets for 3 cleared and stained specimens 14.0, 14.5, and 16.0 mm SL, USNM 216920, from Rio Sanabani, Brazil. Both teeth and empty "sockets" of teeth in process of being replaced are counted. Tooth cusps are counted for teeth in place and for those of replacing teeth not yet ankylosed in "sockets." Teeth tricuspid, bicuspid, or conic. Two rows on dentary, outer (anterior and lateral) row with damaged (8 tricuspid, 1 bicuspid, 4 conic, $n = 13$; 9 tricuspid) [7 tricuspid, 7 conic, $n = 14$; 10 tricuspid, 2 conic, $n = 12$; 10 tricuspid, 2 conic, $n = 12$]. Inner (posterior and medial) dentary row with all conic teeth, damaged (23; 20) [14; 22; 24]. Premaxillary with a single row of tricuspid, bicuspid or conic teeth, 12, apparently tricuspid (13; 14, both with all teeth tricuspid) [7 tricuspid, 6 conic, $n = 13$; 4 tricuspid, 4 bicuspid, 1 tricuspid and 4 conic, $n = 13$; 14 irregularly tricuspid, bicuspid, and conic teeth, anteriormost teeth tricuspid and posteriormost teeth conic].

Fig. 8. Localities reported for *Elachocharax pulcher* Myers. 1. Type locality, Caicara, Venezuela; 2. Río Pacia Grande, Venezuela; 3. San Fernando de Atabapo, Venezuela; 4. Caño Muco, Colombia; 5. Tapurucuara, Brazil; 6. Rio Préto, Brazil; 7. Lago Miua, Brazil; 8. Caracarai, Brazil; 9. Rio Sanabani, Brazil; 10. Rio Canumã, Brazil; 11. Aveiro, Brazil.

Maxillary toothless. Ectopterygoid with conic teeth in a single row, cleared and stained specimens only (7; 9) [9; 10; 10].

Branchiostegal rays 5 in all alizarin specimens and in holotype; 3 slender rays on ceratohyal followed by one broad ray on ceratohyal and another broad ray on epihyal. Gill rakers 5/8 (4/8; 5/8) [4/7; 4/7; 4/7]. Frontal-parietal foramen reduced, bounded by posterior medial borders of frontals, medial borders of narrow parietals, and posteriorly by supraoccipital. First (anterior) circumorbital bone large, well ossified, with a narrow antorbital bone dorsal and posterolateral to posterior dorsal portion of first circumorbital. First circumorbital with an anterior process extending dorsal and anterior to anterior dorsal slender process of maxillary bone. Second circumorbital bone a narrow bony laterosensory tube. Remaining circumorbitals when present (in larger specimens) simple, laterosensory bony tubes.

In scale and fin-ray counts below, those for holotype given first followed in parentheses by those for specimens from San Fernando de Atabapo, then those for specimens from Tapurucuara, followed by those for specimens from Rio Sanabani in brackets. Those from Igarapé Préto (paratypes of *E. georgiae*) given last.

Table 1. Morphometrics of *Elachocharax pulcher*. Standard length is expressed in mm. Other measurements are percentages of standard length.

	Venezuela near Caicara	Venezuela near San Fernando de Atabapo		Brazil near Tapurucuara		Brazil Rio Sanabani		Brazil Rio Tapajos	Brazil, Igarapé Préto paratype of *E. georgiae*	
	(holotype)	($n = 6$)	$\bar{x}$	($n = 8$)	$\bar{x}$	($n = 14$)	$\bar{x}$	($n = 1$)	($n = 4$)	$\bar{x}$
Standard length	16.5	15.6–17.3		13.1–21.0		14.1–17.3		16.2	16.0–19.1	
Greatest depth	26.7	26.7–28.8	27.9	25.4–29.7	27.5	23.8–27.6	25.5	26.3	24.6–25.6	24.8
Snout to dorsal-fin origin	49.7	50.3–55.5	52.5	52.4–57.7	54.6	50.0–55.7	53.3	53.8	50.9–52.4	52.1
Snout to anal-fin origin	77.6	77.0–81.9	79.1	78.7–83.9	80.5	73.8–83.6	79.6	75.6	76.0–78.1	77.4
Snout to anus	72.1	72.0–77.5	74.1	73.1–79.9	75.9	71.3–80.0	74.5	75.0	69.7–73.1	72.0
Snout to pelvic-fin origin	57.6	59.4–65.0	60.1	58.7–62.1	60.0	55.9–63.6	59.4	56.3	56.0–59.5	58.6
Length of caudal peduncle	17.6	14.8–17.1	16.5	15.4–19.2	16.5	15.6–18.0	16.8	16.5	14.4–15.8	15.3
Least depth of caudal peduncle	13.3	13.1–14.4	13.6	13.9–16.0	14.7	12.5–15.0	13.6	13.1	12.5–13.3	12.9
Head	32.1	32.7–36.9	34.7	33.3–36.9	35.4	33.7–36.6	34.9	32.5	32.6–35.6	34.1
Snout	6.7	6.1–7.1	6.7	6.7–7.7	7.3	7.3–8.6	7.6	6.3	7.3–7.5	7.39
Eye	9.1	8.5–10.3	9.6	8.6–10.8	9.9	9.7–12.4	11.4	10.6	10.5–11.9	11.2
Interorbital width	5.5	5.1–5.8	5.5	4.8–5.4	5.2	5.3–6.2	5.7	5.6	5.1–5.6	5.4
Pectoral-fin length	—	28.1–32.2	29.6	28.6–32.3	31.8	27.6–33.5	30.3	34.4	31.3–35.8	33.1
Pelvic-fin length	—	20.6–22.6	21.5	20.0–23.1	21.8	21.2–23.3	22.4	24.4	21.7–24.2	22.5

Table 2. Number of scales in a lateral series of *Elachocharax pulcher*.

	26	27	28	29	30
Caicara (Holotype)		1			
Caño Muco		1			
San Fernando de Atabapo	1	4		1	
Tapurucuara	1	3	2	3	
Igarapé Préto			1	3	
Lago Miua				1	
Rio Sanabani		2	6	5	1
Aveiro			1		

Scales cycloid with 4–6 radii on exposed field. Lateral line with ?, 5 or 6 according to Myers (1927) (5–8, $\bar{x} = 6.4$) 6–7, $\bar{x} = 6.8$ [7–9, $\bar{x} = 7.8$] 6–9, $\bar{x} = 8$ perforated scales. Scales in a lateral series 27 (26–29, $\bar{x} = 27.1$) 26–29, $\bar{x} = 27.8$ [27–30, $\bar{x} = 28.5$] 28–29, $\bar{x} = 28.8$. Scale rows between dorsal and anal fins 8 in all specimens. Scale rows around caudal peduncle 12 in all specimens. Predorsal scales ? (11–11, $\bar{x} = 11$) 10–11, $\bar{x} = 10.4$ [9–11, $\bar{x} = 10$] 11 in all specimens. Area on belly anterior to pectoral fin with scales.

Dorsal fin variable in number of unbranched and branched fin rays. Total ray number ranges from 17–20 with $\bar{x} = 18.5$, $n = 38$. Dorsal-fin ray counts as follows for holotype and larger population samples: 19, fin damaged (iii,14 in one; ii,15 in one; ii,16 in two; iii, 16 in one, ii,17 in one, $\bar{x} = 18$) iii,15 in one; ii,16 in two; ii,16 in five; ii,17 in one, $\bar{x} = 18.7$ [ii,15 in one; iii,15 in six; iv,15 in one, ii,16 in two, iii,16 in three; ii,17 in one; iii,17 in three, $\bar{x} = 18.7$] iv,14 in one; iii,16 in two; one with total of 19, fin damaged, $\bar{x} = 18.5$. Adipose fin present in all specimens. Anal-fin rays somewhat variable in number of unbranched and branched rays. Total ray number 8–10 with $\bar{x} = 8.5$, $n = 38$. Anal-fin ray counts as follows for holotype and larger population samples: 9, fin damaged (ii,6 in five, ii,7 in one, $\bar{x} = 8.2$) ii,5,i in one; ii,6 in four; ii,6,i in three; ii,7 in one, $\bar{x} = 8.4$ [ii,6 in two; ii,6,i in one; ii,7 in thirteen; ii,8 in one, $\bar{x} = 8.9$] ii,6 in three; ii,7 in one, $\bar{x} = 8.3$. Pectoral fin inserted low on body, but narrow and not broad at base to provide flat surface against substrate as in certain species of *Characidium*. Pectoral fin elongate, reaching nearly to or slightly beyond origin of pelvic fin. Pectoral-fin rays nearly always with unbranched rays but one specimen from Río Muco, Colombia had a count of iii,5 and two from Igarapé Préto, Brazil had counts of iii,4. Total count 6–9; 6 in three; 7 in thirteen, 8 in twenty-one, and 9 in one with $\bar{x} = 7.5$, $n = 38$. Pectoral-fin ray count as follows for holotype and larger population samples; 9 (8 in six) 6 in two; 7 in four; 8 in three [6 in one; 7 in three; 8 in ten] 7 in three; 8 in one. Pelvic fin usually i,7: i,7 (i,7 in all specimens) iii,4,i in one; iii,5,i in one; i,6 in one; i,6,i in two; i,7 in four [i,6 in one; i,6,i in five; i,7 in eleven] i,7 in four. Pelvic fin relatively short, reaching anus but usually not reaching anal-fin origin. Caudal fin forked with principal ray count 9/8 in all specimens.

Total number of vertebrae including Weberian apparatus and terminal half centrum 30 (30 in all specimens) 30 in twenty-one; 31 in two [30 in one; 31 in twenty-four] 31 in four specimens. Note also that in three specimens from Río Pacia Grande, Venezuela one specimen had 29 vertebrae and two had 30. Supraneural bones 4.

Color in alcohol.—Background color pale yellowish brown to nearly white with dark brown chromatophores relatively dense in nearly all areas of body of some specimens except for space occupied by 7–8 usually narrow vertical pale bars. Exposed border areas of scales often more densely covered with dark brown chromatophores than central scale areas. This shows especially well in Figure 4. Body color often dark, as in upper specimen of Figure 3 in which chromatophores are dense and expanded, or sometimes pale, as in lower specimen in which chromatophores are less dense and are contracted (both from Rio Sanabani, Brazil). Pale color phase due to contraction of dark chromatophores which when expanded produce dark color phase. Dark "shoulder" blotch present on body just dorsal to opercle with a circular or somewhat elongate dark blotch just posterior to it. These spots show best in Figs. 2 and 3. They correspond to similar blotches on *E. geryi*. Between nape and dorsal-fin origin broad dark vertical bars occur separated by 3 narrow pale bars. Appearance and clarity of these and following bars variable depending on dark, intermediate, or light color phases. Fourth and fifth broad dark vertical bars on body ventral to dorsal fin with posterior termination of dorsal fin in mid area of a sixth dark vertical bar. Two more dark vertical bars, numbers 7 and 8, occur before a bright white vertical bar which covers root of caudal fin. All vertical bars extend from dorsal body profile to ventral body profile. White vertical bar at caudal-fin root due to fat deposits, not white pigment. No obvious small dark spots along sides of body at junction of hypaxial and epaxial muscles.

Top of head and snout pale, often nearly white except for a dark band across top of head just dorsal to posterior border of eye. Another narrower band across narrowest portion of interorbital and a final small band or spot between nares. Anterior tips of upper and lower jaws dark brown; upper jaw pigment extending as a broad stripe to anterior border of eye. Dark brown chromatophores ventral to eye sometimes organized into one or two short vertical bars. Opercle with scattered chromatophores which are often more dense on ventral half to three fourths of opercle. Ventral surface of head pale but often spotted with small dark brown chromatophores.

Caudal fin essentially without bars but dark pigment near white at base may form one or two vertical bars. Dorsal fin mostly hyaline, but with a narrow horizontal stripe, mostly on fin rays extends nearly length of fin at about one-third to one-half height of fin above its base. Distal tips of all dorsal-fin rays dusky (Fig. 2) or nearly hyaline (Fig. 3). Basal portion of dorsal fin very dark, often black where dorsal fin joins dark pigment of broad vertical bars. Anal fin hyaline except for two dark vertical bars, one near anterior base of fin, other placed about two-thirds of fin length from fin base. Pelvic fins hyaline but with two dark blotches or stripes, a large one near fin base and a narrow blotch or stripe more distally placed. Pectoral fin hyaline but with scattered small dark chromatophores, especially near its base.

Color in life unknown.

Variation.—Color variation within population samples (see Fig. 3 for extremes in one population sample) is too great to detect variation between population samples. However, some variation does occur in meristic data. Table 1 shows very little variation among sampled populations in morphometric data but in meristic data for example, vertebral counts may differ, there being 30 in twenty-one and 31 in one specimen from Tapurucuara, Rio Negro, Brazil and 30 in one and 31 in twenty-four specimens from Rio Sanabani, Rio Amazonas, Brazil. Some variation between populations perhaps also occurs in the total number of scales in a lateral series as noted can be seen in Table 2 which suggests that the population samples from the Rio Negro in Brazil and those from the Río Orinoco basin may tend to have one or two fewer scales than those from the Rio Amazonas and its tributaries exclusive of the Rio Negro.

Comments on synonymy.—Géry (1965:206), in separating his new species *E. georgiae* from *E. pulcher*, states the following: "Le pattern des deux espècies semble voisin à en juger par la description no figurée de *E. pulcher*." He goes on to state that [although the color pattern is not known to be different] the two essentially differ by their squamation. Citing and comparing Myers' (1927) data with his own he notes the following for *E. pulcher* and *E. georgiae* respectively. Lateral line scale 5–6 versus 7–8, scales in a lateral series 25 versus 28–31 and scales in a transverse series 6 versus 8. The difference in the transverse series count is due to a difference in method of counting. Myers counted the large principal scales whereas Géry also counted the small scales at the dorsal and anal fins. Counting all scales as Géry we obtained 8 scales in all specimens examined including the holotype of *E. pulcher* and four paratypes of *E. georgiae*. The difference in scales in a lateral series is again perhaps due to a somewhat different method of counting. We obtained a count of 27, not 25, on the holotype of *E. pulcher* and found a range of 26–30 in the 38 specimens counted in our study. It is no longer possible to count lateral-line scales on the holotype of *E. pulcher*, but both Géry's count for *E. georgiae* and that of Myers for *E. pulcher* are within the range we found in a count of 29 specimens, 5–9, $\bar{x} = 7.4$. Thus there appears to be no significant differences in scale counts between type specimens of these two nominal species.

Géry (1965) further separated *E. georgiae* from *E. pulcher* by comparing head length in standard length and depth in standard length. For the former measurement he found *E. georgiae* to have a head length 2.88–3.35 in the standard length whereas Myers (1927) recorded 3.5 for *E. pulcher*. We find the head length of the holotype of *E. pulcher* to be 3.11 in the standard length and our other specimens ($n = 38$) including four paratypes of *E. georgiae* to be from 2.71–3.11, $\bar{x} = 2.86$. We find no great difference in head length between the holotype of *E. pulcher* and other specimens we have at hand that we refer to *E. pulcher* including the four paratypes of *E. georgiae*. The holotype of *E. pulcher* is at one end of the range, while the paratypes of *E. georgiae* cluster in the median area of the range for head length in standard length for all specimens. In a similar fashion Géry (1965) recorded the difference between *E. pulcher* and *E. georgiae* of the depth in standarad length to be 3.5 and 4.06–4.50 respectively. We find the holotype of *E. pulcher* to have a depth of 3.75 and the range of the other specimens, including four paratypes of *E. georgiae*, to be 3.37–4.21, $\bar{x} = 3.78$. Again we find no significant differences in these morphometric characters serving to distinguish the nominal *E. georgiae* from *E. pulcher*.

Elachocharax geryi new species
Figs. 9–14, Table 3

Holotype.—MZUSP 13249, SL 19.0 mm, Brazil, State of Amazonas, Rio Negro, Lago Paricatuba (60°30′W, 3°7′S), 11 November 1972, P. Vanzolini for EPA.

Paratypes.—2, MZUSP 13253–13254, SL 13.0–13.5 mm.—1, ANSP 138029, SL 12.5 mm.—2, USNM 216558, SL 14.5–15.5 mm, all lots with same data as holotype.

The following specimens are not types: 1, USNM 215288, SL 12.5 mm, Colombia, State of Vichada, Caño Muco (between 70°2′W, 4°15′N and 71°58′W, 4°98′N), a tributary of Río Vichada, 24 April 1974, J. E. Thomerson, D. L. Hicks and J. F. Vaques.—1, FMNH 83830, SL 12.5 mm, with same data as preceding specimen.

Diagnosis.—Anterior teeth of premaxillary and dentary simple, conic. Adipose fin absent. Scale rows around caudal peduncle 14. Body with about 11 vertical dark bars. Caudal fin with 13–14 narrow vertical bars, completely covering fin. Anal fin with a single dark blotch. Pelvic fin with a dark blotch near its base. Branchiostegal rays 4.

Description.—In the description, morphometrics (expressed as percentages of standard length) are given first for holotype followed in parentheses by ranges and means of morphometrics of specimens from Lago Paricatuba,

Fig. 9. *Elachocharax geryi*, new species, MZUSP 13249, SL 19.0 mm, holotype, Lago Paricatuba, Rio Negro, State of Amazonas, Brazil, November 1972.

Brazil and Caño Muco, Colombia. Table 3 separately presents ranges and means of morphometrics for population samples from Lago Paricatuba and Caño Muco.

Body relatively short for a member of Characidiinae; greatest depth at anterior dorsal-fin origin 24.2 (24.2–29.2, $\bar{x}$ = 27.5). Tip of snout to anterior dorsal-fin origin 50.5 (46.9–52.8, $\bar{x}$ = 50.4). Profile of head and back from snout tip to dorsal-fin origin gently convex. Dorsal-fin origin in advance of pelvic-fin origin. Tip of snout to anterior anal-fin origin 78.9 (73.8–80.0, $\bar{x}$ = 74.4). Anal-fin origin below posterior termination of dorsal-fin base. Tip of snout to anus 70.0 (69.7–75.4, $\bar{x}$ = 71.5). Tip of snout to pelvic-fin origin 57.9 (55.2–60.0, $\bar{x}$ = 57.0). Profile of ventral surface of head gently and convexly curved. Belly slightly concave to very gently convex from region of

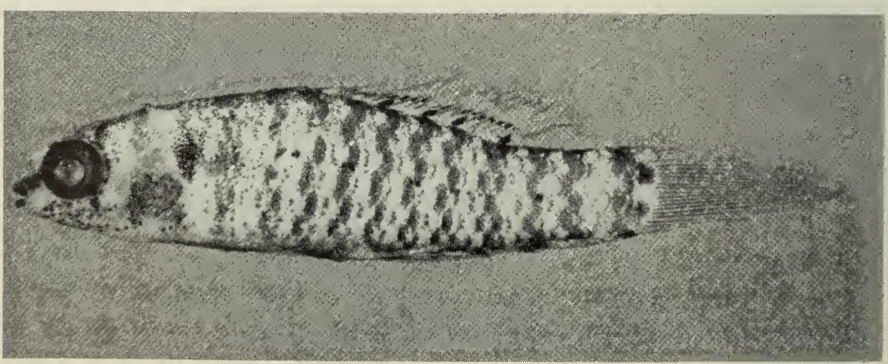

Fig. 10. *Elachocharax geryi*, new species, FMNH 83830, SL 12.5 mm, Caño Muco, Rio Vichada, State of Vichada, Colombia, April 1974.

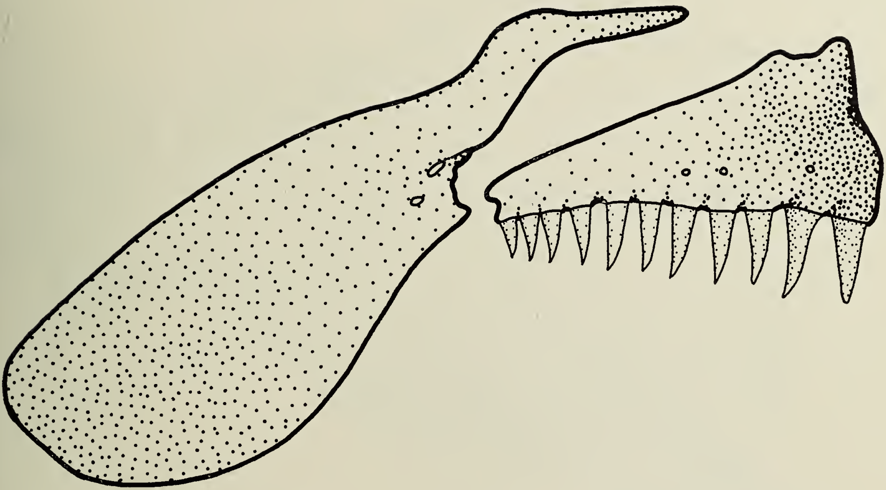

Fig. 11. *Elachocharax geryi*, new species, from a paratype, USNM 215288, SL 12.5 mm, Lago Paricatuba, Rio Negro, State of Amazonas, Brazil, November 1972. Lateral view of premaxillary and maxillary bones of right side. Anterior is to the right.

isthmus to pelvic-fin origin. Profile of body between pelvic fin and anal-fin origin slightly concave to nearly straight. Length of caudal peduncle 18.4 (16.0–19.2, $\bar{x}$ = 17.7). Both dorsal and ventral profiles of caudal peduncle nearly straight or slightly concave. Least depth of caudal peduncle 12.1 (12.1–16.0, $\bar{x}$ = 14.6).

Head moderately long, 26.3 (26.3–33.6, $\bar{x}$ = 32.3). Mouth terminal; snout blunt, 6.3 (6.3–7.7, $\bar{x}$ = 7.1). Eye large, horizontal diameter 9.5 (9.5–12.0, $\bar{x}$ = 10.4). Least bony interorbital width 5.3 (5.2–5.6, $\bar{x}$ = 5.4).

Tooth counts of cleared and stained jaws of right side of holotype given first and of stained specimen, USNM 215288 (Figs. 11–13), from Colombia, given second in brackets. Both teeth and empty "sockets" of teeth in process of being replaced are counted. All teeth conic. Dentary with 2 rows; outer (anterior and lateral) row with 13 [11] and inner (posterior and medial) row with 16 [13] teeth. Maxillary toothless. Premaxillary with one row of 11 [11] teeth. Ectopterygoid with 5 [3 plus a fourth poorly developed] teeth.

Branchiostegal rays 4 in alizarin preparation, USNM 215288, all other specimens appear to have 4 but absolute determination difficult. Ceratohyal with 3 rays, posterior fourth ray articulated with epihyal. Gill rakers 3/7 in USNM 215288, not counted in holotype. Frontal-parietal foramen relatively large compared to that of *E. pulcher*. Its anterior and medial borders bounded by posterior medial border of frontals, medial border of parietals.

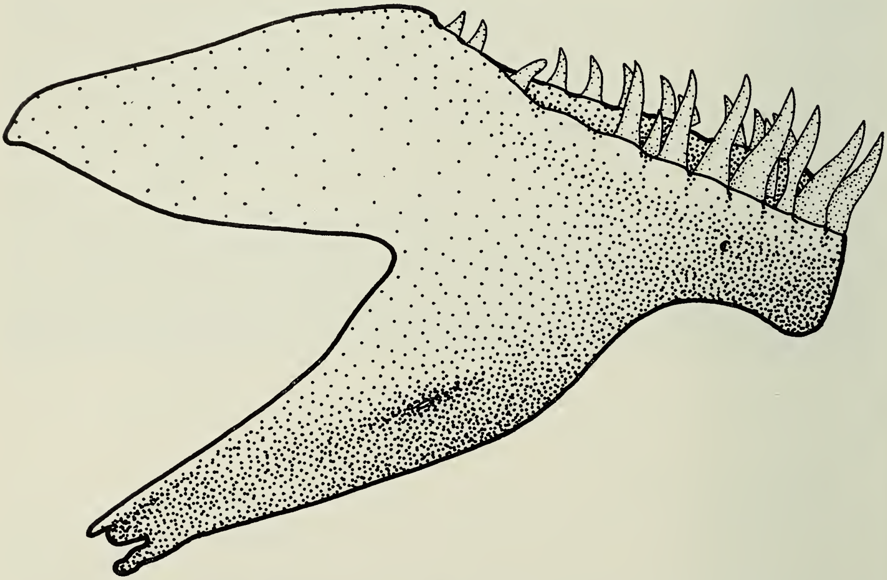

Fig. 12. *Elachocharax geryi*, new species, from a paratype, USNM 215288, SL 12.5 mm, Lago Paricatuba, Rio Negro, Brazil, November 1972. Lateral view of right dentary bone. Note third tooth from anterior-median border of dentary is being eroded at its inner base, preparatory to being shed. A small replacement tooth posterior to it is forming and can be seen partly obscured by the fourth tooth. Anterior is to the right.

Posterior border of fontanel bounded by supraoccipital. First (anterior) circumorbital bone large, well ossified with a slender antorbital bone dorsal and lateral to posterior part of dorsal border of first circumorbital. First circumorbital with a dorsoanterior process extending dorsal and anterior to anterior dorsal slender process of maxillary bone. Second circumorbital bone small, present as a laterosensory bony tube sometimes not ossified. Remaining orbital bones apparently not ossified.

In scale and fin-ray counts below, those for holotype given first followed by remaining specimens from Brazil in parentheses followed by specimens from Colombia in brackets.

Scales cycloid with 2–6 radii on exposed field. Lateral line of 6 (6 in three and 7 in one specimen) [6 in two specimens] perforated scales. Scales in a lateral series 28 (27 in two; 28 in one; 29 in two) [27 in two]. Scale rows between dorsal and anal fin 8 in all specimens. Scale rows around caudal peduncle 14 in all specimens. Predorsal scales 9 (8 in one; 9 in two; 10 in two) [9 in two]. Area on belly anterior to pectoral-fin base fully squamated.

Dorsal fin variable in number of unbranched and branched fin rays.

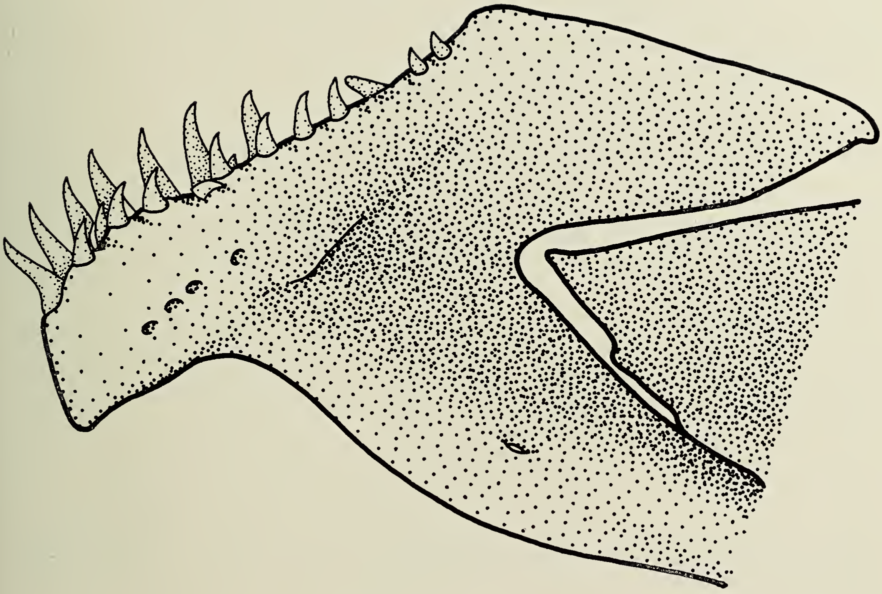

Fig. 13. *Elachocharax geryi*, new species, from a paratype, USNM 215288, SL 12.5 mm, Lago Paricatuba, Rio Negro, Brazil, November 1972. Median view of dentary of right side. Anterior is to left.

Total ray number ranged from 20–22 with two specimens having 20, two 21, and four 22, $\bar{x} = 21.3$. Actual dorsal-fin ray counts as follows: vi,15 (iii,19; x,11; xi,10,i, xiii,8 and xiii,7) [xiv,7,i and xvi,5]. Adipose fin absent. Anal-fin rays somewhat variable in number of unbranched and branched rays but always total 8 or 9 rays, $\bar{x} = 8.1$. Actual counts as follows: ii,5,i (ii,6 in four and iii,6 in one) [iii,3,ii and iii,4,i]. Pectoral fin inserted low on body, narrow and not broad at base to provide a flat surface against substrate as in some species of *Characidium*. Pectoral fin elongate, reaching to or slightly beyond origin of pelvic fin. Pectoral-fin rays all unbranched, vi (vii in three, viii in one) [vi in two]. Pelvic-fin rays relatively short, usually not reaching to anal-fin origin, i,6,i (i,6 in three and i,7 in two) [iii,2,ii and i,5,i]. Caudal fin forked, with principal ray count 9/8 in all specimens except one paratype from Lago Paricatuba, Brazil with 7/7.

Total number of vertebrae including Weberian apparatus and terminal half centrum, in specimens from Lago Paricatuba, Brazil, 31 in two, 32 in four. Specimens from Caño Muco, Colombia, 31 in two. Supraneural bones 4.

Color in alcohol.—Body pale yellowish brown with brown chromatophores moderately dense in all but exposed border areas of scales. In areas of

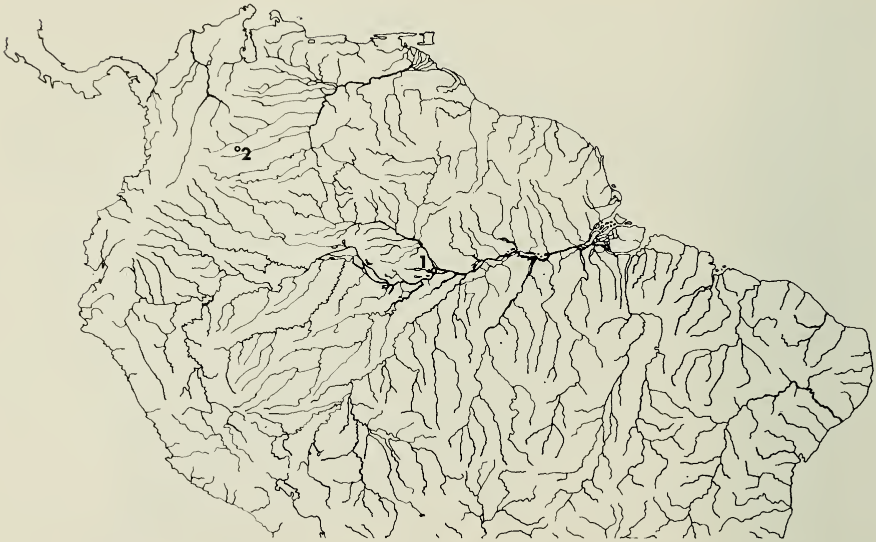

Fig. 14. Localities reported for *Elachocharax geryi*, new species. 1. Type locality, Lago Paricatuba, Brazil; 2. Caño Muco, Colombia.

vertical dark body bars (described below) this same color much darker, each dark brown chromatophore containing more pigment as well as there being a higher number of chromatophores per scale. Resulting dark scales with pale posterior borders organized into 10 or 11 vertical bars along body length. Anterior vertical bar a short, very dense, nearly black, triangular "shoulder" blotch with long angle of triangle extending ventrally. Shoulder blotch confined to area immediately posterior to head and dorsal to dorsoposterior border of opercle. Between shoulder spot and dorsal-fin origin are 3 vertical bars, posterior one originating dorsally at or just anterior to dorsal-fin origin. These bars extend from dorsal body profile to ventral body profile. Three or four similar vertical bars occur ventral to dorsal fin, most posterior bar being ventral to posterior termination of dorsal fin. Caudal peduncle with 3 similar vertical bars, most posterior bar being at root of caudal fin on caudal peduncle. Basal area of caudal fin posterior to terminal vertical bar white (due to visible fat deposits, not to pigment in skin) with a very dark scale-sized spot at base of dorsal and ventral caudal-fin lobes. At junctions of hypaxial and epaxial muscles, along midside along length of body occur irregularly distributed small very dark dense spots (see Figs. 9 and 10).

Top of head dark brown, especially in area above posterior part of brain where brown color organized into a fine reticulate pattern. Superficial to this anatomically deep reticulate pattern, dark brown chromatophores

Table 3. Morphometrics of *Elachocharax geryi*, new species. Standard length is expressed in mm. Other measurements are percentages of standard length.

	Brazil, Rio Negro, Lago Paricatuba		Colombia, Rio Vichada, Caño Muco	
	$n = 6$	$\bar{x}$	$n = 2$	$\bar{x}$
Standard length	13.2–19.0		12.5–12.5	
Greatest depth	24.2–29.2	27.4	28.0–28.0	28.0
Snout to dorsal-fin origin	46.9–51.9	49.8	52.0–52.8	52.4
Snout to anal-fin origin	73.8–80.0	77.8	76.0–76.8	76.4
Snout to anus	69.7–75.4	71.5	71.2–72.0	71.6
Snout to pelvic-fin origin	55.2–60.0	57.1	55.2–57.6	56.4
Length of caudal peduncle	16.0–18.7	17.4	18.4–19.2	18.8
Least depth of caudal peduncle	12.1–15.6	14.3	15.2–16.0	15.6
Head	26.3–30.8	28.9	32.0–33.6	32.8
Snout	6.3–7.7	7.1	7.2–7.2	7.2
Eye	9.5–10.8	10.1	11.2–12.0	11.6
Interorbital width	5.2–5.6	5.4	5.6–5.6	5.6
Pectoral-fin length	27.4–36.0	32.5	38.4–39.2	38.8
Pelvic-fin length	21.1–26.9	24.4	22.4–26.4	24.4

occur scattered over dorsal surface of entire head and otherwise pale dorsal surface of snout. Anterior tip of upper and lower jaws dark brown; upper jaw pigment extending as a broad stripe to anterior border eye. Brown chromatophores ventral to eye sometimes organized into one or two short vertical bars. Opercle with scattered chromatophores, especially dense at junction of opercle and preopercle ventral to hyomandibular joint with opercle. Ventral surface of head pale yellow with small scattered brown chromatophores which continue posteriorly on belly to anal area.

Caudal fin with 13–14 relatively narrow dark vertical bars. Dorsal fin mostly hyaline but with a narrow dark horizontal stripe mostly on interradial membranes extending length of fin and about one-third to one-half height of fin above its base. Distal tips of all dorsal-fin rays dusky. About 4–6 very dark spots on interradial membranes proximal to elongate horizontal stripe. These spots sometimes continuous with pigment of vertical body bars, but sometimes continuous with pale area between vertical body bars. Anal fin hyaline except for dark blotch or stripe extending from third anal-fin ray about one-third distally along fin's length to posteriormost ray near its base. Anterior anal-fin ray dark at its base. Pelvic fins hyaline except for a dark blotch near basal one-third of fin rays. Pectoral fin hyaline but with scattered small dark chromatophores.

Color in life unknown.

Etymology.—This fish is named for Jacques Géry whose enthusiasm for the study of characoid fishes of South America has been especially expressed in his publications on members of the Characidiinae.

Relationships.—Elachocharax pulcher, E. geryi, and *G. junki* are the only members of the Characidiinae to have 17 or more dorsal-fin rays. Characters shared by *E. pulcher* and *E. geryi* in addition to the large number of dorsal-fin rays and the several other characters discussed above under the generic diagnosis, include the following, a similar color pattern of alternating dark and pale vertical bars over the body and a closely similar pattern of dark and light pigment on the dorsal fin and head (compare Figs. 1–4 with 9–10). Tables 1 and 3 indicate a close similarity in morphometrics between *E. pulcher* and *E. geryi.* Furthermore, except for the counts mentioned below these two species have scale counts such as lateral line and lateral series counts and fin-ray counts closely similar or the same.

Differences between these two species have been outlined above under the species diagnoses and notably include the presence of anterior tricuspid teeth in the premaxillary and outer row of dentary in *E. pulcher* (conic in *E. geryi*), 12 scale rows around the caudal peduncle in *E. pulcher* (14 in *E. geryi*), body with 7–8 vertical dark bars in *E. pulcher* (10 or 11 in *E. geryi*), caudal fin with one or two narrow vertical bars at its base in *E. pulcher* (13 or 14 over entire fin in *E. geryi*), and anal and pelvic fins with two prominent dark marks in *E. pulcher* (one in *E. geryi*). An adipose fin is present in *E. pulcher*, absent in *E. geryi.*

Tooth counts tend to be higher in *E. pulcher.* For example *E. pulcher* has 14–24 teeth in the inner dentary row whereas *E. geryi* has 13–16 teeth in a range of specimens of similar standard length. The premaxillary of *E. pulcher* also tends to have one or two more teeth than that of *E. geryi.* In the jaws of these fishes the larger specimens usually have more teeth than smaller specimens. The ectopterygoid teeth in *E. pulcher* range from 7–10 and only 3–5 in *E. geryi.* The total number of dorsal-fin rays in *E. geryi* appears to be somewhat higher, 20–22, $\bar{x} = 21.3$, whereas in *E. pulcher* it is 17–20, $\bar{x} = 18.5$.

Resumo

Elachocharax geryi, uma nova espécie de characideo da subfamilia Characidiinae é descrita do Lago Paricatuba (60°30′W, 3°7′S), Rio Negro, Estado do Amazonas, Brasil e do Rio Vichada, Caño Muco, Estado de Vichada, Colombia. A nova espécie se aproxima bastante de *Elachocharax pulcher* Myers (1927) e as semelhanças e diferenças entre ambas são discutidas. *E. pulcher* é redescrita com base em abundante material coletado em várias localidades do Rio Amazonas, Rio Solimões, Rio Negro e parte superior do Rio Orinoco. Esta espécie era conhecida apenas pelos ex-

emplares-tipo provenientes de uma localidade situada próximo à Caicara (60°10′W, 7°39′N), na Bacia do Rio Orinoco, Venezuela.

São feitas também comparações entre *Elachocharax pulcher* e quatro parátipos da espécie nominal *Elachocharax georgiae* Gery (1965). Ficou provado que *Elachocharax georgiae* é um sinônimo de *E. pulcher.*

O gênero *Elachocharax* é redefinido com base nas descrições de *E. pulcher* e *E. geryi* e para sua pronta identificação pode ser caracterizado como um membro da subfamília Characidiinae que possui 17–22 raios na nadadeira dorsal e uma fontanela craniana posterior limitada pelas partes posteriores dos ossos frontais, partes marginais medianas dos estreitos ossos parietais e pelo supraoccipital. Sugere-se ainda que o gênero nominal *Geisleria* Gery (1971) provavelmente seja sinônimo de *Elachocharax* que então seria representado por três espécies. Como os autores não puderam examinar exemplares de *Geisleria*, a inclusão definitiva deste gênero como sinônimo de *Elachocharax* dependerá de estudos posteriores.

Elachocharax pulcher, E. geryi e *Geisleria junki* Gery (1971) são comparadas e consideradas muito mais relacionadas entre si do que a quaisquer outros representantes da subordem Characoidei. A semelhança de carcteres morfométriocos (tabelas 1 e 2), padrão de colorido (presença de barras escuras e claras no corpo), colorido da nadadeira dorsal (presença de listas basais escuras contínuas com as barras do corpo e uma lista horizontal mais estreita acima e distal às listas basais escuras), indicam que *Elachocharax pulcher* e *E. geryi* são intimamente relacionadas. Além disso, estas duas espécies apresentam muitos caracteres merísticos semelhantes. Elas diferem basicamente porque *E. pulcher* possui nadadeira adiposa (ausente em *E. geryi*), 7 a 8 barras verticais escuras e largas no corpo (10 a 11 barras verticais escuras e estreitas em *E. geryi*), uma ou duas barras verticais estreitas restritas à base de nadadeira caudal (13 ou 14 barras estreitas dispostas por toda a nadadeira caudal em *E. geryi*) e duas manchas escuras grandes e conspícuas nas nadadeiras pélvicas e anal (apenas uma mancha nas pélvicas e anal de *E. geryi*). As contagens de dentes tendem a ser mais elevadas em *E. pulcher*, aparecendo, por exemplo, 14 a 24 (um pouco mais nos exemplares maiores) dentes na série interna do osso deantário (13 a 16 em *E. geryi* e a nadadeira dorsal tende a apresentar um número menor de raios em *E. pulcher* (17–20, $\bar{x} = 18{,}5$) do que em *E. geryi* (20–22, $\bar{x} = 21{,}3$).

Elachocharax geryi e *E. pulcher* são em conjunto comparadas com *Geisleria junki* que, aparentemente, não apresenta não apenas a fontanela craniana que distingue (atualmente) *Geisleria* de *Elachocharax*, mas também seguramente não possui o padrão de colorido caracterizado pela presença de barras verticais no corpo. Além disso, *G. junki* parece ter a nadadeira anal situada bem mais à frente, sua origem estando anteriormente bem distante da parte final da nadadeira dorsal. Em ambas as espécies de

Elachocharax, a origem da nadadeira anal se situa verticalmente abaixo ou é posterior à parte final da nadadeira dorsal.

A história das relações hipotéticas dos Characidiinae é revista sumariamente. Elachocharacinae e Geislerinae não são aceitas como subfamílias distintas, embora seja sugerido que Elachocharacina possa vir a se constituir em um nome aceitável para uma tribo formada por um grupo de espécies de Characidiinae de temanho reduzido. Isto poderia ocorrer se estudos posteriores mostrarem, como melhor hipótese, que os membros da subfamília Characidiinae de tamanho reduzido atualmente incluídos nos gêneros *Klausewitzia*, *Jobertina* (que também engloba espécies de tamanho maior), *Elachocharax* e *Geisleria* são muito mais relacionados entre si do que a quaisquer outros membros de Characidiinae.

É observado ainda que, embora as relações dos Characidiinae com outros Characoidei não estejam esclarecidas, é possível afirmar que o grupo certamente não se relaciona com as famílias Lebiasinidae e Erythrinidae.

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THE GENUS *LEPTAGONIATES* (PISCES: CHARACOIDEI) WITH A DESCRIPTION OF A NEW SPECIES FROM BOLIVIA

Richard P. Vari

Abstract.—A new species of the genus *Leptagoniates* having a highly modified swimbladder is described and the type-species of the genus, *L. steindachneri*, is redescribed.

Introduction

Boulenger (1887) established the genus *Leptagoniates* to contain one species, *L. steindachneri*, briefly described from a single Ecuadorian specimen. Since Boulenger the species appears to have only been collected twice and all systematic references to the genus and species have been based on the original description. During examination of characoid material from Peru and Bolivia in the collection of the American Museum of Natural History, further specimens of *L. steindachneri* were uncovered and a distinctive cheirodontine characoid with a peculiarly shaped swimbladder was found. Within the subfamily Cheirodontinae (Eigenmann, 1915) the tricuspidate teeth, elongate body and long anal fin of this species place it in the assemblage formed by the genera *Leptagoniates*, *Phanagoniates*, *Xenagoniates* and *Paragoniates* (see Eigenmann, 1915 and Myers, 1942). In this assemblage its possession of a complete lateral line and an adipose fin along with a lack of ectopterygoid teeth place it in the genus *Leptagoniates*. However, the monophyletic nature of the genus defined by the above characters, which occur in various combinations in other cheirodontine genera, is open to question. Furthermore, as pointed out by Fink and Weitzman (1974) the Cheirodontinae may not constitute a monophyletic group in the Hennigian sense of the term. Until the relationships within the subfamily Cheirodontinae are resolved on the basis of shared derived characters, this species is assigned to *Leptagoniates* following the traditional limits of the genus.

Leptagoniates, Boulenger 1887

Leptagoniates Boulenger, 1887:291 (type-species *L. steindachneri* Boulenger by monotypy).
Leptogoniates (error): Jordan, 1920:437.
Leptagoniatus (error): Fowler, 1943:353.

Etymology.—The generic name, *Leptagoniates*, from λεπτός, thin, and *Agoniates*, a genus of South American characoids, refers to the laterally flattened body form of the members of the genus.

Diagnosis.—The genus *Leptagoniates* is distinguished from all other cheirodontine characoids by its elongate anal fin with 48–70 rays (in contrast to 40 or fewer for all other genera except *Paragoniates*, *Phanagoniates* and *Xenagoniates*), a complete lateral line (in contrast to an incomplete lateral line in *Paragoniates* and *Phanagoniates*), the presence of an adipose fin (in contrast to its absence in *Phanagoniates*) and an edentulous ectopterygoid (in contrast to a cuspidate ectopterygoid in *Xenagoniates*).

Included species.—Two species are included in the genus, *Leptagoniates pi*, a new species described from the Río Mamoré of Bolivia, and *L. steindachneri* from the Marañón and Napo drainages of Ecuador and the Ucayali drainage of Peru.

Key to the Species of *Leptagoniates*

1. Species markedly elongate; anal with iii,64–67 rays; lateral line scales 44–49 *Leptagoniates steindachneri* Boulenger
– Species only slightly elongate; anal with iii,45–48 rays; lateral line scales 33–38 *Leptagoniates pi* new species

Leptagoniates pi, new species
Fig. 1

Holotype.—American Museum of Natural History (AMNH) 35952 (29.2 mm SL), Bolivia, Río Mamoré, 10 km west of San Pedro, lagoons communicating with river, September 17, 1965, S. Anderson.

Paratypes (collected with holotype).—AMNH 35953 (3 specimens, 27.2–31.0 mm SL); British Museum (Natural History) (BMNH) 1977.6.9.138 (1, 28.0).

Etymology.—The trivial name, *pi*, refers to the shape of the swimbladder which has the form of the Greek letter π.

Diagnosis.—As previously noted, although the question of interrelationships of cheirodontine characoids is not satisfactorily resolved, within the framework of traditional diagnostic characters this species is assignable to *Leptagoniates* on the basis of its possession of the characters diagnostic for the genus (see generic diagnosis). Within the genus, *Leptagoniates pi* is distinguished by its anal fin-ray count (iii,45–48 in contrast to iii,64–67 in *L. steindachneri*), lateral line count (33–38 in contrast to 44–49), number of maxillary teeth (5 in contrast to 11 or 12), and body depth (2.77–3.08 in SL in contrast to 3.9–4.1). Finally it possesses a distinctive form of swimbladder (see description below) which from available information appears to be unique to this species among characoids.

Description.—Body moderately deep, very compressed, elongate; greatest depth just anterior to dorsal-fin origin, 2.77–3.08 in SL; dorsal profile of head distinctly convex at snout, slightly concave behind orbit, then straight to dorsal-fin origin; dorsal-fin base straight, distinctly slanted posteroventrally; dorsal body profile from rear of dorsal-fin base to caudal peduncle straight; distance from snout to dorsal-fin origin 2.12–2.19 in SL; ventral profile gently convex from tip of lower jaw to anal-fin origin; distance from tip of lower jaw to anal-fin origin 2.15–2.24 in SL; base of anal fin straight; length of anal-fin base 1.76–2.08 in SL; head length 5.17–5.44 in SL; eye width 1.95–2.3 in HL; interorbital convex, 2.5–2.75 in HL; nostrils separated by a fold of skin; anterior nostril small, round; posterior nostril crescent shaped, twice size of and folding around anterior nostril; mouth small; maxillary strongly posteroventrally slanted, non-tooth-bearing section gently convex; posterior edge of maxillary reaching to vertical through anterior edge of eye and to horizontal through ventral border of eye; third infraorbital in contact with preopercle ventrally, leaving slight naked area posteriorly; infraorbitals above this narrow, forming a tube for sensory canal; frontal fontanel triangular; parietal fontanel elongate, continuing as a median groove on supraoccipital; overall body form angular.

Dorsal fin pointed, long, when fin depressed anterior rays reach one-half distance to adipose fin which is small; pectoral fins pointed, reaching well beyond origin of pelvic fins which are pointed, short, reaching only one-half distance to anal-fin origin; anal fin long, first three rays originating from a single proximal pterygiophore which is slightly enlarged basally; anal-fin base straight; third to sixth anal-fin rays slightly elongate, otherwise anal-fin margin straight; caudal fin emarginate; about 12 weak procurrent rays present dorsally and 7 ventrally.

Scales cycloid, thin; lateral line complete, with 33–38 scales; 7 or 8 scales above lateral line to dorsal-fin origin; 4 scales below lateral line to anal-fin origin; scales not extending onto fins; dorsal fin ii,7 or 8; pectoral fins i,11 or 12; pelvic fins i,4 or 5; anal fin iii,45–48; no indication of sexual dimorphism in fins; 15 abdominal vertebrae including those of Weberian apparatus and 25 or 26 caudal vertebrae including first fused preural and ural centrum as one element (vertebral counts from radiographs).

Teeth in a single row in each jaw, tricuspidate with small lateral cusps; premaxillary small, triangular, with 8 teeth; maxillary with 5 teeth; dentary with 10 teeth; replacement teeth of varying degrees of development present internal to functional rows on premaxillary and dentary.

Slight pigmentation present behind orbits; interorbital region heavily pigmented; scattered dark chromatophores on dorsal, caudal and anal fins and on body above anal fin.

Remarks.—On the basis of present knowledge of characoid swimbladder morphology the form of the posterior chamber of the swimbladder in this species would appear to be unique. Rather than the globular or tubular posterior swimbladder chamber that characterizes most characoids, the posterior

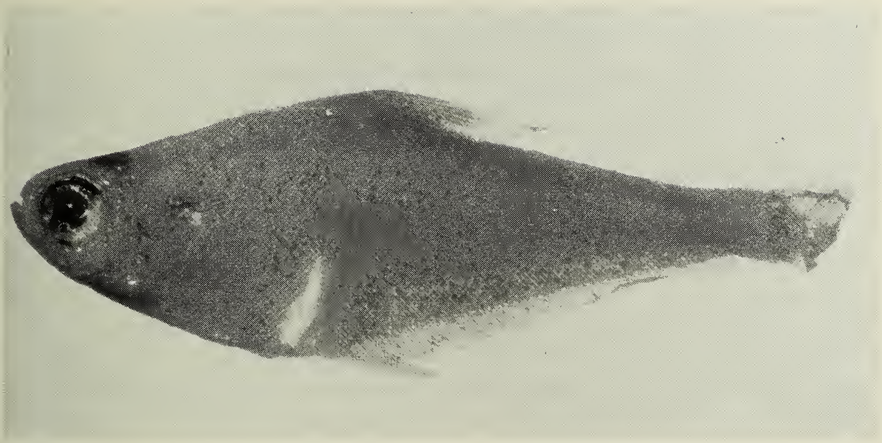

Fig. 1. *Leptagoniates pi*, holotype, AMNH 35952, 29.2 mm SL.

chamber of the swimbladder in this species is vertically subdivided (Fig. 2). This results in two independent, vertically elongate subchambers completely separated except at their dorsal point of contact, but in free communication with each other at that point. Lateral to the posterior swimbladder chamber the myotomes are reduced, with this thinning most pronounced lateral to the posterior subchamber which is overlain solely by a thin layer of muscle and skin. This reduction of the body wall is visible in Fig. 1 as the translucent vertical band anterior and dorsal to the anal-fin origin.

Distribution.—Known only from the type-locality in the Río Mamoré, Bolivia.

Leptagoniates steindachneri, Boulenger 1887

Leptagoniates steindachneri Boulenger, 1887:282, pl. 23, fig. 3 (original description, Sarayacu, Ecuador); Eigenmann and Eigenmann, 1891:57 (citation); Eigenmann, 1910:441 (citation), 1915:42, pl. 4, fig. 3 (on Boulenger); Fowler, 1940:287 (citation); Eigenmann and Allen, 1942:270 (citation); Schultz, 1949:310 (citation); Fowler, 1948:188 (compiled); Sterba, 1962: 165, fig. 225 (on Boulenger); Ovchynnyk, 1968:247 (citation); Saul, 1975: 108 (Santa Cecilia, Ecuador).

Leptogoniates steindachneri (error): Jordan, 1920:437 (citation).

Leptagoniatus steindachneri (error): Fowler, 1943:353 (citation), 1945: 134 (citation).

Material examined.—BMNH 1880.12.5.252 (76 mm SL) holotype, Sarayacu, Ecuador; AMNH 25699 (2 specimens, 64–73.5) Río Ucayali, Pucallpa, Peru;

Academy of Natural Sciences, Philadelphia (ANSP) 130577 (1, 65) Santa Cecilia, Ecuador.

Diagnosis.—*Leptagoniates steindachneri* is distinguished by its anal fin-ray counts (iii,64–67 in contrast to iii,45–48 in *Leptagoniates pi*), lateral line count (44–49 in contrast to 33–38), number of maxillary teeth (11 or 12 in contrast to 5), and body depth (3.9–4.1 in SL in contrast to 2.77–3.08).

Description.—Body slender, very compressed, elongate; greatest depth at vertical through anal-fin origin, contained 3.9–4.1 in SL; dorsal profile slightly concave between tip of snout and end of supraoccipital process, concave from there to dorsal-fin origin; dorsal-fin base distinctly slanted posteroventrally; dorsal-body profile straight from rear of dorsal-fin base to caudal peduncle; distance from tip of snout to dorsal-fin origin 1.83–1.97 in SL; ventral profile rounded to anal-fin origin; region from point below vertical through pectoral-fin origin to anal-fin origin with a slight median keel; distance from tip of lower jaw to anal-fin origin 2.9–3.0 in SL; base of anal fin straight; length of base of anal fin 1.49–1.6 in SL; head length 5.6–6.0 in SL; snout short, 3.95–4.2 in HL; eye width 3.0–3.3 in HL; upper jaw 3.0–3.8 in HL; nostrils separated by a distinct flap; nostrils located above vertical through dorsal border of eye; mouth small; maxillary strongly slanted posteroventrally, denticulate along upper three-quarters of anterior border; posterior border of maxillary falling short of vertical through anterior of eye and of horizontal through lower border of eye; infraorbital series completely covering cheek; third infraorbital large, fourth and fifth smaller, fourth about two-thirds size of fifth; frontal fontanel short, triangular; parietal fontanel long, extending medially onto supraoccipital.

Dorsal fin obtusely pointed, second ray longest; dorsal-fin origin about equidistant from snout tip and hypural joint, above 22nd to 24th anal ray; adipose fin small, distinctly closer to hypural joint than to rear of dorsal-fin base; pectoral fins long, extending to pelvic-fin tips and anal-fin origin; anal-fin origin far in advance of vertical through dorsal-fin origin; anal fin very long, base straight, third to sixth rays slightly elongate, otherwise anal-fin margin straight. First to third anal-fin rays originating from a single enlarged proximal pterygiophore; caudal deeply emarginate, about 11 weak procurrent rays along dorsal border of peduncle and 5 ventrally.

Scales cycloid, thin; lateral line complete; 44–49 scales in lateral line; 6 or 7 scales above lateral line to dorsal-fin origin; 6 or 7 scales below lateral line to anal-fin origin; a row of scales overlying base of anal fin; scales extending a short distance onto caudal-fin base; dorsal fin ii,7 or 8; pectoral fins i,10 or 11; pelvic fins i,6 or 7; anal fin iii,64–67; no indication of sexual dimorphism in fins; 12 abdominal vertebrae including those of Weberian apparatus and 35 or 36 caudal vertebrae including first fused preural and ural centrum as one element (vertebral counts from radiographs).

Teeth in a single row in each jaw, distinctly tricuspidate, with central

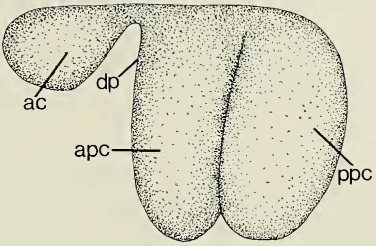

Fig. 2. Semidiagrammatic drawing showing the swimbladder form in *Leptagoniates pi.* ac—anterior chamber of swimbladder, apc—anterior section of posterior chamber of swimbladder, dp—point of exit of ductus pneumaticus, ppc—posterior section of posterior section of swimbladder.

cusp larger; teeth of lower jaw fitting posterior to those of upper jaw when mouth closed; premaxillaries with 7 or 8 teeth; maxillary with 11 or 12 teeth; dentary with 7 or 8 teeth; dorsalmost teeth on maxillary and anterior teeth on dentary with side cusps more developed.

Overall coloration in alcohol pale yellow; in holotype a somewhat silvery stripe runs from rear of skull to caudal-fin base, stripe underlain by dark chromatophores; other specimens with a dark stripe beginning above 10th anal-fin ray and increasing in intensity to caudal peduncle; interorbital region dark; lateral margin of pectoral fin pigmented; dorsal fin with spots of pigment on anterior rays; anal fin with pigmentation along length of second ray and scattered on rest of fin; caudal fin with ventral lobes slightly pigmented; maxillary and lateral border of dentary pigmented.

Distribution.—Known from the Marañón and Napo drainages of Ecuador and the Ucayali River of Peru. The latter locality is the first record of the species from that country and is about a 750 km range extension southward. Earlier citations of this species from Peru, starting with Eigenmann (1910) have been based on the belief that Sarayacu, the type-locality for the species, was in Peru (see Eigenmann, 1915:42). However, the locality was and is in Ecuador.

Acknowledgments

The specimens of *Leptagoniates pi* which served as the basis of this study were collected during the American Museum-Bolivian Expedition of 1965 supported by Grant no. DA-MD-49-193-G82 of the United States Medical Research and Development Office of the Surgeon General, and the National Geographic Society. The American Museum specimens of *L. steindachneri* were collected by Sr. Hernán Ortega of the Universidad Nacional de San Marcos, Pucallpa, Peru. His generous donation of these and other specimens to the author along with loans and other assistance by Dr. D. E. Rosen (AMNH), Dr. J. Böhlke and Mr. W. Saul (ANSP) and Dr. P. H. Greenwood and Mr. G. Howes (BMNH) are gratefully acknowledged. Research associated with this paper was carried out at the American Museum of Natural History and the British Museum (Natural History) supported by a NATO Postdoctoral Fellowship. Drs. P. H. Greenwood and S. H. Weitzman and Mr. G. Howes read earlier drafts of the paper and provided helpful suggestions.

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SERRANUS INCISUS, NEW SPECIES FROM THE CARIBBEAN SEA (PISCES: SERRANIDAE)

Patrick L. Colin

Abstract.—A new species of *Serranus* is described from Jamaica and Puerto Rico which has the dorsal fin more deeply incised than other Atlantic species. The fish occurs with other particulate-plankton feeders in deep reef areas and seems most similar to the western Atlantic S. *luciopercanus.*

Introduction

During investigation of reef fish communities on outer reef faces a new species of small seabass was observed in mixed schools of small, particulate plankton-feeding fishes. This undescribed species is most closely related to the *Serranus* complex, but unlike the other members of the complex it is adapted for a particulate plankton-feeding existence. The species is superficially similar to other zooplanktivores, such as *Schultzea beta*, and may be one reason it has not been noted before.

Serranus incisus new species
Figs. 1–3

Diagnosis.—A small species, largest known specimen 28.2 mm standard length (SL). Dorsal fin X,10, last ray split to base; anal fin III,7, last ray split to base; pectoral fin 17-17; pelvic fin I,5; gill rakers 26; branchiostegals 7 (4 + 3); vertebrae 10 + 14. Central opercular spine curved upward, upper spine reduced. Dorsal fin deeply incised at rear of spinous portion with black mark at outer end of spines 2–4. Body with two dark parallel stripes; upper stripe originating behind opercle, lower on belly, ending as separate spots at base of caudal fin.

Description.—Various measurements of the holotype, 28.2 mm SL (in parentheses) and their range in the paratypes (23.4, 18.9 and 12.6 mm SL) in percent of standard length are as follows; head length (33) 34–35, eye diameter (11) 12–13, predorsal length (38) 37–44, preanal length (56) 57–64, depth anal-fin origin (28) 20–23, minimum depth caudal peduncle (12) 12–14, interorbital distance (9) 10–12, pectoral-fin length (22) 22 (2 specimens) and pelvic-fin length (19) 18 (2 specimens).

Third dorsal-fin spine longest, 8th shortest, first relatively short, about length of 7th spine. The segmented dorsal-fin rays become progressively shorter posteriorly, all branched near their tips.

Second anal-fin spine strongest; 3rd spine is slightly longer, but less ro-

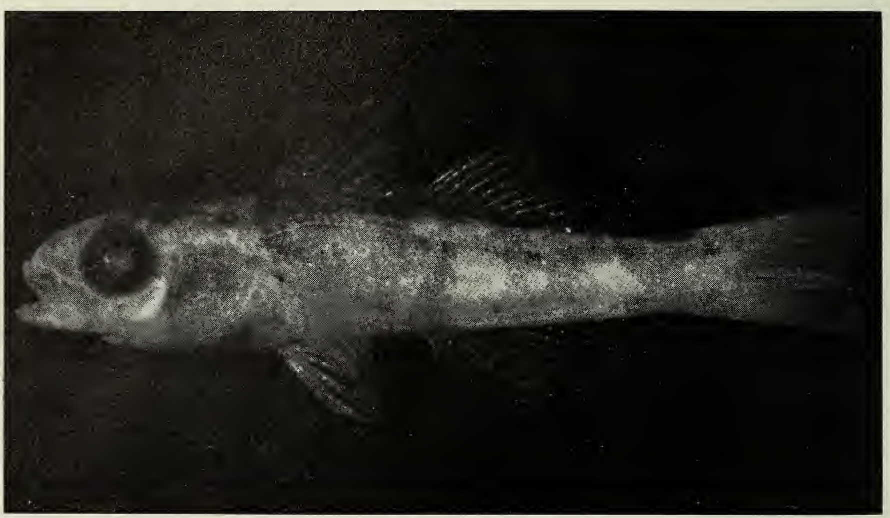

Fig. 1. Holotype of *Serranus incisus*, ANSP 137657, 28.2 mm SL, collected at Piedra de Carabinero, Mona Island, Puerto Rico.

bust. Segmented rays become progressively shorter posteriorly, all branched near tips. Rear margins of both anal and dorsal fins rounded.

Caudal fin with 17 principal rays, 9 on upper lobe, 8 on lower; procurrent caudal rays 8–9 both dorsally and ventrally. Only upper and lowermost principal rays are unbranched. Third and 15th caudal rays longest. Posterior edge of fin emarginate.

Outermost and anteriormost pelvic-fin ray longest. All rays branched near midlength or closer to base. Third through 13th from dorsalmost pectoral-fin rays branched near tips. Third or 4th and 12th or 13th pectoral rays longest among adjacent rays, near margin of fin slightly emarginate.

Opercle bears three spines, uppermost reduced, somewhat embedded in skin covering opercle margin; middle spine by largest by far, curves strongly upwards; lower spine flattened, projecting posteriorly. Preopercle margin serrate with fewer serrations on its lower limb.

Body and chest densely covered with small ctenoid scales. Scales on preopercular ctenoid, becoming cycloid beneath eye and cover this area, nape scaled with scales becoming cycloid where they project as anterior V over occiput; no scales visible at base of dorsal, anal or pelvic fins; few rows of small, cycloid scales on pectoral-fin base; several rows, particularly dorsally and ventrally, of cycloid scales on caudal-fin base.

Dentition greatly reduced; a single row of tiny canine teeth on upper jaw, single row becoming smaller anteriorly on lower jaw, a few lateral teeth on

Fig. 2. Live specimen of *Serranus incisus*, approximately 24 mm SL, photographed in an aquarium. The white markings on the spinous dorsal fin and the two dark stripes on the body are visible. This specimen from 6 miles south of La Parguera, Puerto Rico subsequently disappeared.

lower jaw slightly enlarged. Palatine teeth villiform, uniserial; vomerine teeth in patch. Tip of tongue rounded and flattened.

Holotype gill rakers 26. Premaxillary moderately protrusible, with mouth closed, only upper margin of maxillary beneath lacrymal; no supramaxillary.

The pigment pattern of preserved specimens shown in Fig. 1. Dark markings of dorsal fin are apparent and dark spots on caudal-fin base faintly so. Live specimen shown in Fig. 2. Anterior part of dorsal fin has distinctive marking in life. Membrane near fin base between spines 1–4 dusky, distally at about midpoint of spine 2 there is faint white area between spines 2 and 4, black area more distally between spines 2 and 5. Fin margin between spine 3 and 8 edged in white.

Body with two brownish stripes narrower than width of pupil; the first running from upper margin of opercle to dorsal portion of caudal-fin base, ending in oval slightly darker than stripe itself; second running from midpoint of pectoral-fin base to ventral portion of caudal-fin base, ending as darker oval below similar marking of upper stripe. Third, narrower stripe running from temporal region to near anterior base of soft dorsal fin.

Upper and lowermost rays and membranes of caudal fin alternately banded brown and yellow; central portion of fin nearly colorless.

Distribution and habitat.—*Serranus incisus* is known from Puerto Rico (La Parguera and Mona Island) and Jamaica (Discovery Bay). I observed specimens I believed to be this species off Varsenbaai, Curacao in July 1971 but I collected none. In all instances I encountered *S. incisus* only on the steep slopes or vertical faces on the edge of island shelves at

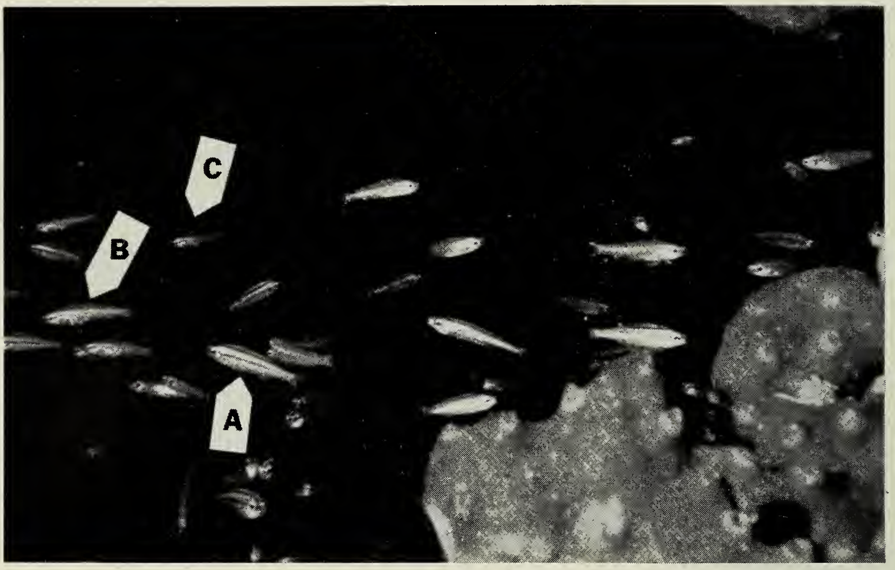

Fig. 3. Portion of a mixed school of small particulate plankton-feeding fishes photographed at 36 m depth, "Buoy Reef," Discovery Bay, Jamaica. Present are numerous juvenile *Haemulon striatum* (A), several *Schultzea beta* (B), and a few *Serranus incisus* (C). Due to the superficial similarities of *S. beta* and *S. incisus* it is impossible to positively identify to species individual fishes visible in the photograph.

depths of 30–60 m. Often the species occurred with other particulate plankton-feeding fishes, particularly *Schultzea beta* and juvenile *Haemulon striatum* (Fig. 3). In these mixed groups *S. incisus* often represented only a small percentage of the individuals present. While superficially similar to the other species in appearance, the distinctive markings on the spiny dorsal fin of *S. incisus* easily identify it.

In all cases these mixed zooplankton-feeding groups occurred above a large object on the bottom. In the case of the Jamaican specimens, these objects were isolated clumps of coral 1–3 m high on a sloping (20°) sandy plain. For the Puerto Rico specimens the objects were large barrel sponges (*Xestospongia muta*) on a narrow shelf protruding from a vertical wall (Mona Island) and on a steep (45°) rocky slope (La Parguera).

Etymology.—From the Latin *incisus* in reference to the deeply cleft dorsal fin.

Relationships.—The position of this species within the family Serranidae is uncertain, largely due to the confused nature of generic and higher classification within the group.

While superficially most similar to *Schultzea beta*, the new species is clearly not closely related to it. The two species share the deeply indented dorsal fin and basic morphology found in many particulate zooplankton feeders, yet differ in branchiostegal number, upper jaw morphology (see Robins and Starck, 1961: Fig. 8b) and other features.

The affinities of the new species are apparently closest to western Atlantic *Serranus* and is placed in this genus until such time as a reconsideration of serranid systematics determines otherwise. The generic characters put forward by Robins and Starck (1961:261) need only slight modification to include the new species. In their treatment of *Serranus* the spinous and soft portions of the dorsal fin are broadly united, but with a noticeable notch between them in some species. The notch depth is greater in S. *incisus* than in other Atlantic members *of Serranus* but not significantly more so when considering the range of this character in the other species. Robins and Starck (1961:261) reported members of *Serranus* to have small wedges of scales extending onto the basal portions of the dorsal and anal-fin membranes. These scales could not be found in S. *incisus*, and if present are exceedingly small. Whether S. *incisus* is hermaphroditic like other *Serranus* is unknown. Except for the above exceptions, S. *incisus* fits the 14 other characters cited by Robins and Starck (1961) for the genus *Serranus*.

Among western Atlantic members of *Serranus*, S. *incisus* seems most similar to S. *luciopercanus*. The two species share the upcurved middle opercular spine which no other western Atlantic *Serranus* possesses. In addition the upper spine is reduced in both. There is also a general similarity in color pattern with two longitudinal bands ending at the caudal-fin base.

Material examined.—All collections by P. L. Colin.

Holotype: ANSP 137657, 28.2 mm SL; Puerto Rico, Mona Island, Piedra de Carabinero, 33 m depth, 13 October 1974, collected with quinaldine-alcohol solution.

Paratypes: UMML 32963 (1, 23.4), Jamaica, Discovery Bay, "Buoy Reef," coral head on east side, 36 m depth, 7 August 1971, collected with quinaldine-alcohol solution; USNM 216596 (1, 18.9), Jamaica, Discovery Bay, "Buoy Reef," coral head (*Agaricia undata*) on west side, 33 m depth, 7 February 1973, multiprong spear; ANSP (1, 12.6), Jamaica, same locality as USNM 216596, 27 June 1972, Quinaldine-alcohol solution.

Another individual, shown in Fig. 2, from Puerto Rico, 6 miles south of La Parguera, on steep slope into deep water, 60 m depth, 13 August 1976 and retained alive for photography in aquarium, subsequently disappeared.

Acknowledgments

Thanks are due the staff of the Discovery Bay Marine Laboratory for making the Jamaican collections possible and for helping to "unbend" the author after the collection of one paratype. The Puerto Rican collections were made possible by NSF grant OCE76-02352, Oceanography

Section, to the author. The diving assistance of C. Arneson, J. Burnett-Herkes and J. B. Heiser is particularly appreciated. Specimens are deposited at the Academy of Natural Sciences, Philadelphia (ANSP), U.S. National Museum (USNM) and the University of Miami School of Marine and Atmospheric Sciences (UMML).

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A NEW SPECIES OF CARCINONEMERTES (NEMERTEA: CARCINONEMERTIDAE) WITH NOTES ON THE GENUS FROM THE PACIFIC COAST

Daniel E. Wickham

Abstract.—The carcinonemertean egg predator living on the host crab, *Cancer magister* Dana, 1852, is described and designated as the new species, *Carcinonemertes errans*. *C. errans* is compared with *C. epialti* Coe, 1902, the only previously described carcinonemertean from the Pacific coasts of North America. Both these species are compared with the described congeners from the Atlantic and Mediterranean regarding the location of Juvenile worms on the host's exoskeleton.

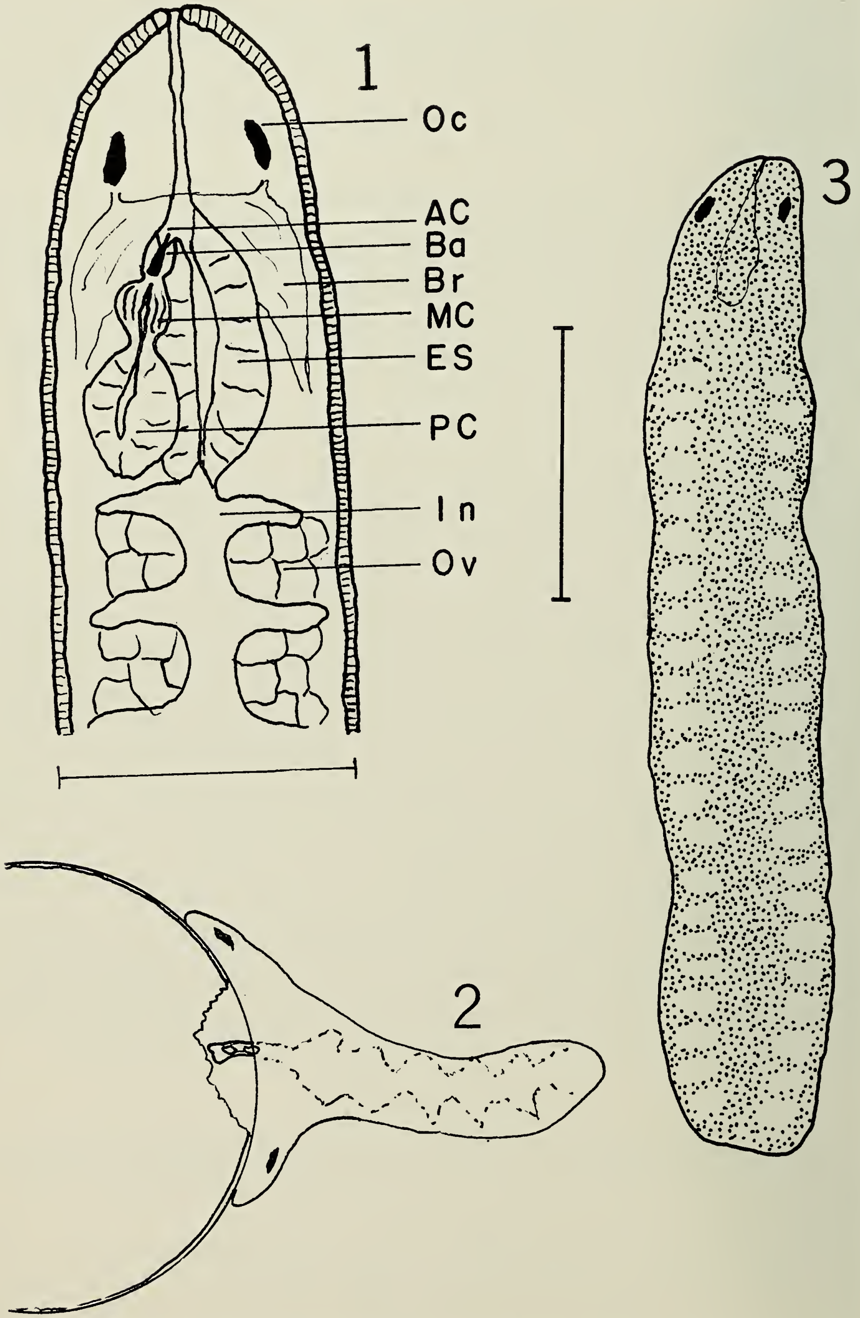
Members of the genus *Carcinonemertes* are nemerteans which live on the exoskeleton of brachyuran crabs and feed on their eggs (Humes, 1942). Only one species, *Carcinonemertes epialti* Coe, 1902, has been described from the Pacific coast of North America. This worm was described by Coe from the host crab *Pugettia* (= *Epialtus*) *producta* (Randall, 1839) from Monterey, California. Humes (1942) recorded *Euphylax dovii* Stimpson, 1860, from Peru as a host, and Kuris (1971) tentatively added *Hemigrapsus oregonensis* Dana, 1851, *Cancer productus* Randall, 1839, *Cancer antennarius* Stimpson, 1856, *Cancer gracilis* Dana, 1852, and *Cancer magister* Dana, 1852, from California as hosts and provided the first quantitative treatment of its effect on host reproduction. MacKay and Weymouth (1942) were the only other workers to note the presence of what were probably *Carcinonemertes* on *C. magister* but were unable to identify them.

During the course of studies of nemerteans on crabs from the San Francisco, California region, I observed several important differences between the nemertean on *C. magister* and that originally described as *Carcinonemertes epialti* by Coe. The differences were of such magnitude that it became clear that the sepcies under study was an undescribed member of the genus *Carcinonemertes*. The description of the species follows.

Carcinonemertidae

Humes' (1942) diagnosis of the family Carcinonemertidae has been modified to facilitate the inclusion of the new species. Modifications are in italics.

"Monostiliferan hoplonemerteans living as ectohabitants on the gills, *under the abdomen, in apodemes and axillae of the limbs*, and *in and on* the egg masses of crabs. One central stylet, no accessory stylet pouches or accessory stylets. Proboscis very short, reaching scarcely beyond the



Figs. 1–3. *Carcinonemertes errantia.* **1.** Anterior portion of body of living worm from dorsal surface. Oc, ocellus; Ac, anterior proboscis chamber; Ba, basis and stylet; Br,

posterior end of the muscular part of the esophagus. Anterior chamber of the proboscis extremely short and non-glandular. Lateral nerves lie internal to the massively developed submuscular glands. Cephalic glands well developed. No cerebral sense organs. Cephalic muscle fibers present. Excretory apparatus apparently absent. Dorsal blood vessel absent. Takakura's duct present in males. Internal fertilization and viviparity commonly occur. Extensive development of eggs and spermatozoa. *In most species,* mucous sheath secreted, attached to endopodite hairs of ovigerous crabs."

The family includes one genus, *Carcinonemertes,* with 5 species, *C. carcinophila carcinophila* Kolliker, 1845, *C. epialti* Coe, 1902, *C. carcinophila imminuta* Humes, 1942, *C. mitsukurii* Takakura, 1910, *C. coei* Humes, 1942, and *C. errantia* described as follows.

Carcinonemertes errans sp. nov.

Genus *Carcinonemertes*

Body short, round, sexually mature females 4–6 mm in length, .5 mm in width; males shorter; juveniles flattened, .90 ± .05 mm in length, .30 ± .01 mm wide; head not demarcated from body, without cerebral grooves.

Color pink to reddish orange; epidermis furrowed longitudinally; opaque due to numerous white spots becoming more transparent in sexually mature, large worms; head lighter color; preserved specimens opaque offwhite.

Single pair of ocelli near tip of head; irregular, 27×13 μm; bilobed brain on either side posterior to ocelli. Proboscis small, armed with single stylet; accessory stylets absent; posterior chamber with thickened, glandular walls; chamber elongated, approximately 100×50 μm; middle chamber round, thinner walled than posterior; approximately 40 μm in diameter; anterior chamber thin walled and narrow (Fig. 1).

Stylet surrounded by glandular cells; basis 35.1 ± .3 μm in length, slightly tapered from posterior to anterior, approximately 10 μm in diameter at posterior, 5 μm in diameter at anterior; stylet 11.0 ± .2 μm.

Esophagus large, everted during feeding (Fig. 2); intestine straight with several lateral pouches on both sides.

Mature females with 20–25 ovaries on each side of body between gut pouches. Sexual maturity first externally apparent when ovaries appear as single row of transparent spots on both sides of body (Fig. 3); gut

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←

brain; Mc, middle proboscis chamber; Es, esophagus; Pc, posterior proboscis chamber; In, intestine; Ov, ovary. Scale = .5 mm. 2. *C. errans* feeding on egg of *C. magister.* Esophagus used in sucking particles of egg yolk into intestine. 3. Dorsal view of live *C. errans.* Ovaries becoming visible as rows of transparent spots on both sides. Scale = 1.0 mm.

Table 1. Lengths (μm) of components of the proboscis armature from worms taken from the various Pacific coast host crabs. All except *P. producta* were from the Bodega Bay area. *P. producta* were collected from Santa Barbara and Monterey, California, since no carcinonemerteans are present on *P. producta* north of Monterey. *F* ratio is for pairwise ANOVA testing the significance of the differences between the mean measurements from *C. errans* with *C. epialti* from each host.

Worm	Host	*n* (worms)	Basis	Stylet	Total
C. errans	*Cancer magister*	62	35.22 ± .33	11.01 ± .16	46.23 ± .38
C. epialti	*Pugettia producta*	44	31.95 ± .43 ($F = 36.8$ $P < .001$)	10.20 ± .13 ($F = 13.2$ $P < .001$)	42.15 ± .44 ($F = 48.52$ $P < .001$)
	Hemigrapsus oregonensis	19	31.63 ± .50 ($F = 30.2$ $P < .001$)	10.58 ± .20 ($F = 1.89$ $P < .25$)	42.21 ± .50 ($F = 29.8$ $P < .001$)
	Cancer anthonyi	33	33.18 ± .41 ($F = 14.5$ $P < .001$)	10.70 ± .20 ($F = 1.42$ $P < .25$)	43.82 ± .44 ($F = 15.8$ $P < .001$)
	Cancer productus	31	31.9 ± .44 ($F = 36.0$ $P < .001$)	9.94 ± .20 ($F = 16.4$ $P < .001$)	41.84 ± .42 ($F = 35.5$ $P < .001$)
	Cancer antennarius	23	32.65 ± .51 ($F = 17.6$ $P < .001$)	10.57 ± .18 ($F = 2.27$ $P < .25$)	43.18 ± .61 ($F = 17.82$ $P < .001$)
	Cancer gracilis	29	31.97 ± .44 ($F = 31.5$ $P < .001$)	10.34 ± .18 ($F = 6.22$ $P < .025$)	42.24 ± .48 ($F = 39.16$ $P < .001$)

pouches and ovaries become visible when females fully mature, less obvious in males.

Found only on crab *Cancer magister*; juveniles on surface of exoskeleton within limb axillae and under abdomen; adult on and in host egg mass.

Type-locality.—Bodega Bay, Sonoma County, California (38°18′N, 123°2′W).

Range.—Continuous from Pacifica, Ca. (37°40′N, 122°30′W), to Auke Bay, Alaska (58°25′N, 134°30′W).

Type-material.—The following have been deposited at the National Museum of Natural History (Smithsonian Institution): Holotype: Mature female, 3 mm long, collected 27 December 1976, USNM 55171. Paratypes: 1 lot; 6 females, 2 males, 1 eggstring attached to eggs of host *C. magister*, collected 27 December 1976, USNM 55172. Additional specimens have been deposited at Bodega Marine Laboratory, Bodega Bay; the California Academy of Sciences, San Francisco; and at the British Museum (Natural History), London.

Etymology.—The specific name is derived from the Latin adjective *errans*, meaning wandering (things). This species moves freely about in the host egg mass since it lacks a mucous sheath.

Discussion.—*C. errans* differs from *C. epialti* by the presence of numerous small (1–2 μ) spots in the epidermis which results in an opacity that obscures the gut pouches in worms not fully mature. The gut pouches in *C. epialti* show clearly through its transparent epidermis resulting in a striped appearance. Drawings by Humes (1942) suggest a transparent epidermis in *C. carcinophila* although no specific mention of it is made.

The length of the proboscis armature in *C. errans* is significantly longer than that in *C. epialti* from its type host *Pugettia producta* as well as in worms from the other hosts. Work in progress suggests that worms from certain hosts other than *P. producta* may be distinct from *C. epialti* but they are not considered so for the present. Table 1 shows the length of the basis and stylet of worms from the various hosts.

Carcinonemerteans from the Pacific coast of North America differ from their Atlantic counterparts in one important feature. In the Atlantic and Mediterranean, worms on non-egg-bearing crabs are found encysted between the gill lamellae of their hosts. This feature prompted the first observers to consider them ectoparasites on the gills (Coe, 1902). *Carcinonemertes* on the Pacific coast, however, do not encyst themselves on the host gills. Kuris (in press) found them ensheathed in various sites on the exoskeleton of the host *H. oregonensis* but never on the gills. *C. errans* juveniles were never found specifically ensheathed anywhere. They cling to the host exoskeleton with the aid of copious mucous secretion. They can be found under the abdomen, surrounding the base of the limbs and mouthparts, in the eyesockets, in the limb joints, in the apodemal invaginations and in the entrance of the branchial chambers, but never on the gills.

Hopkins (1947) also noted that two types of worms could be found in the gills of *Callinectes sapidus* depending on whether or not the host had spawned during its life or not. Large, bright red worms were found along with small white worms. The larger worms were presumed to be worms which had already spent at least one reproductive period in the host egg mass and would, therefore, be iteroparous. Juvenile worms on non-egg-bearing hosts on the Pacific coast all appeared to be small and light pink in color. There was little size variation, and it is probable that these worms are semelparous.

The observations of actual worm feeding support Humes' (1942) and Kuris' (1971) contention that they are egg predators. Wickham and Fisher (1977) showed that on *C. magister* a high correlation existed between the number of worms present in an egg clutch and the number of dead eggs with some particularly dense samples exhibiting virtually complete mortality of the eggs.

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TWO NEW SPECIES OF *CALLOGOBIUS* FROM INDO-PACIFIC WATERS (TELEOSTEI: GOBIIDAE)

James F. McKinney and Ernest A. Lachner

Abstract.—Two new species of *Callogobius* are described: *C. hastatus* from the Palau Islands, Philippine Islands and the South China Sea, a species which is unique among the *Callogobius* complex in having no cephalic sensory pores; and *C. clitellus* from New Guinea, the Solomon Islands and the Philippine Islands, which differs greatly from all other nominal *Callogobius* species in its distinctive coloration. Twenty-nine nominal species and the two species described herein are currently considered by us as belonging to the *Callogobius* complex. Selected important characters for the 31 species of *Callogobius* are tabulated. The new species are compared and contrasted within this generic complex.

In our studies of the *Callogobius* complex, we encountered two new species that differ strikingly from all nominal forms; one species lacks all cephalic sensory pores, a unique character in the group, and the other has a distinctive bicoloration. We herein describe the two species.

In order to facilitate comparisons of the two new species with other members of the *Callogobius* complex, we include data in Table 1 taken from type and non-type specimens or published accounts of all nominal species that we currently recognize as belonging to this complex. All of the species listed in Table 1 are characterized in having fleshy papillose ridges on the head (see Figs. 2–4). We recognize that this assemblage may comprise more than one genus. A few of these nominal species ultimately may be placed in synonymy. Five nominal species originally described in *Callogobius* are not included in this generic complex because they lack the fleshy papillose head ridges, namely *C. atratus* Griffin, *C. liolepis* Koumans, *C. melanoptera* Visweswara Rao, *C. ocellatus* Herre and *C. seshaiyai* Jacob and Rangarajan. These five nominal species will be relegated to other genera in our subsequent studies.

Methods

The methods of taking and recording data are given in Lachner and McKinney (in press). Our references to the sensory pore and canal system follow Lachner and McKinney (1974). In Table 1 we give the number of scales in the lateral series often as a range for a single specimen, for example a holotype, because of the difficulty in duplicating the same count. Where the counts for the dorsal and anal fin rays were given in the original description as one number, for example 11 rays, we interpret

Table 1. Comparison of certain characters of the *Callogobius* complex. Data from holotypes (H), syntypes (S), paratypes (P), non-type specimens (N), or original and subsequent descriptions (D).

Nominal species	Source of data	Second dorsal fin rays	Anal fin rays	Scale type	Scales in lateral series	Scales on predorsal midline	Scale focus	Vertebrae	Temporal sensory canal
Callogobius andamanensis Menon and Chatterjee	P	I,11–I,12	I,10	cycloid	50–60	present	narrow	10 + 16	absent
Callogobius centrolepis Weber	H	I, 9	I, 7	ctenoid	23–25	present	broad	10 + 16	absent
Callogobius clitellus new species	H,P	I,10	I,8–I, 9	cycloid	46–48	present	narrow	10 + 16	absent
Callogobius hastatus new species	H,P	I,9–I,11	I,7–I, 9	cycloid	32–37	absent	narrow	10 + 16	absent
Callogobius mannarensis Rangarajan	P,N	I,9–I,11	I,7–I, 9	cycloid	33–35	absent	narrow	11 + 15	absent
Callogobius shunkan Takagi	H,N	I,10	I, 8	ctenoid	22–24	present	broad	10 + 16	present
Callogobius snelliusi Koumans	S	I, 9	I, 7	ctenoid	21–23	present	broad	10 + 16	present
Callogobius trifasciatus Menon and Chatterjee	P	I, 9	I, 8	ctenoid	28–30	present	variable	10 + 16	absent
Doryptena okinawae Snyder	H	I,11	I, 8	cycloid	46–48	absent	narrow	11 + 16	absent
Doryptena synderi Fowler	H	I,10	I, 8	cycloid	42–44	present	narrow	10 + 16	absent
Doryptena tanegasimae Snyder	H	I,14	I,12	cycloid	70–80	absent	narrow	12 + 18	absent
Drombus irrasus J. L. B. Smith	H,P	I, 9	I, 7	ctenoid	24–26	present	broad	10 + 16	present
Drombus maculipinnis Fowler	H,N	I, 9	I, 7	ctenoid	20–22	present	broad	10 + 16	present
Drombus tutuilae Jordan and Seale	H	I, 9	I, 7	ctenoid	27–29	present	variable	10 + 16	absent
Drombus plumatus J. L. B. Smith	H	I, 9	I, 7	ctenoid	22–24	present	broad	10 + 16	absent?
Eleotris hasseltii Bleeker	S	I,10	I, 8	ctenoid	41–43	present	variable	10 + 16	absent
Eleotris sclateri Steindachner	H	I, 9	I, 7	ctenoid	30–32	present	broad	10 + 16	absent
Galera producta Herre	N	I,12–I,13	I,10–I,11	cycloid	63–67	absent	narrow	11 + 17	absent
Gobiomorphus illotus Herre	D	I, 9	I, 8	ctenoid	ca. 30	present?	—	—	—
Gobius coelidotus Sauvage	H	I,10	I, 8	ctenoid	41–43	present	variable	10 + 16	absent
Gobius depressus Ramsey and Ogilby	H	I,11	I, 9	weakly ctenoid	35–37	present	variable	10 + 17	absent
Gobius mucosus Günther	H	I,11	I, 9	cycloid	39–41	present	broad	10 + 17	absent
Gunnamatta insolita Whitley	H	I,11	I, 9	weakly ctenoid	42–44	present	variable	10 + 17	absent
Intonsagobius kuderi Herre	H,P	I, 9	I, 7	ctenoid	25–27	present	broad	10 + 16	present

Table 1. Continued.

Nominal species	Source of data	Second dorsal fin rays	Anal fin rays	Scale type	Scales in lateral series	Scales on predorsal midline	Scale focus	Vertebrae	Temporal sensory canal
Intonsagobius vanclevei Herre	H	I, 9	I, 7	ctenoid	21–23	present	broad	10 + 16	present
Macgregorella badia Herre	H,P	I,10	I, 8	ctenoid	48–50	present	variable	10 + 16	absent
Macgregorella intonsa Herre	D	I,10	I, 8	cycloid	38–40	present?	—	—	absent?
Macgregorella moroana Seale	D	I,10	I, 8	cycloid	46–50	present	—	—	—
Macgregorella santa Herre	H	I,10	I, 9	cycloid	46–48	present	narrow	10 + 16	absent
Mucogobius bifasciatus J. L. B. Smith	H	I,10	I, 9	cycloid	35–38	present	—	10 + 16	—
Mucogobius flavobrunneus J. L. B. Smith	H,P	I, 9	I, 8	ctenoid	35–37	present	broad	10 + 16	absent

this count to be I,10. Obvious abnormal vertebral counts were not included in the column giving vertebral numbers.

In the descriptive accounts the values for meristic characters are followed by frequencies of counts in parentheses. The frequency that includes the value for the holotype is italicized.

Callogobius hastatus, new species

Figs. 1–4, Table 2

Holotype.—USNM 216811, male (28.2 mm SL), Palau Islands, 07°20′36″N; 134°28′13″E, W end Koror Island, S end of Arakabesan-Madalai causeway, Madalai District, collected by H. A. Fehlmann and company, GVF Reg. No. 511, 9 July 1955.

Paratypes.—South China Sea: CAS 38924, male (19.3), 12°11′33″N; 109°19.5′E, Viet Nam, Hon Lon Island at entrance to Nha Trang Bay, H. A. Fehlmann and company, GVF Reg. No. 2791, 1 February 1961.

Philippine Islands: USNM 99293, male (28.9), Mactan Island reef opposite Cebu, "*Albatross*" collection, 7 April 1908; USNM 99294, 5 males (18.7–27.7), 7 females (18.6–24.4), same data as USNM 99293; AMS I.19603-001, male (25.3), female (22.2), same data as USNM 99293; USNM 99570, female (18.8), Mindanao, Cascade River, Murcielagos Bay, "*Albatross*" collection, 20 August 1909; USNM 139323, female (20.5), Mactan Island, "*Albatross*" collection, 31 August 1909.

Palau Islands: CAS 38925, male (16.8), female (21.6), unsexed (14.7), same data as holotype; CAS 38926, 3 males (18.3–26.4), female (23.4), 07°20′22″N, 134°28′05″E, Koror Island, Madalai District, H. A. Fehlmann and company, GVF Reg. No. 509, 8 July 1955; CAS 38927, 3 males (15.2–19.9), female (17.9), 07°19′20″N, 134°30′13″E, Koror Island, Iwayama Bay, H. A. Fehlmann and company, GVF Reg. No. 532, 23 July 1955; CAS 38928, 3 males (21.8–24.1), 07°19′36″N, 134°29′06″E, SE tip of Koror Island, M. Brittan and company, GVF Reg. No. 814, 25 July 1956; CAS 38929, male (23.2), female (22.2), 07°18′58″N, 134°29′32″E, Iwayama Bay, H. A. Fehlmann and company, GVF Reg. No. 546, 28 July 1955; CAS 38930, 3 males (16.6–20.5), 07°20′13″N, 134°27′50″E, Auluptagel Island, H. A. Fehlmann and company, GVF Reg. No. 1414, 7 October 1957; CAS 38931, 15 males (17.0–21.5), 18 females (14.7–19.7), 2 unsexed (13.8–14.4), 07°23′28″N, 134°30′32″E, off Babelthaup Island, H. A. Fehlmann and company, GVF Reg. No. 1397, 22 September 1957; USNM 216812, 3 males (19.0–24.0), 3 females (15.7–17.9), same data as CAS 38931; CAS 38932, 2 males (18.4, 20.7), 07°20′55″N, 134°28′00″E, Arakabesan Island, collected by Sumang, GVF Reg. No. 1995, 1 November 1959.

Yap Islands: CAS 38933, male (16.0), 09°30′30″N, 138°07′49″E, Yap Island, Tomil Harbor, collected by Sumang and Bapilung, GVF Reg. No. 1903, 8 December 1959; CAS 38934, 3 males (21.6–27.1), 09°34′33″N,

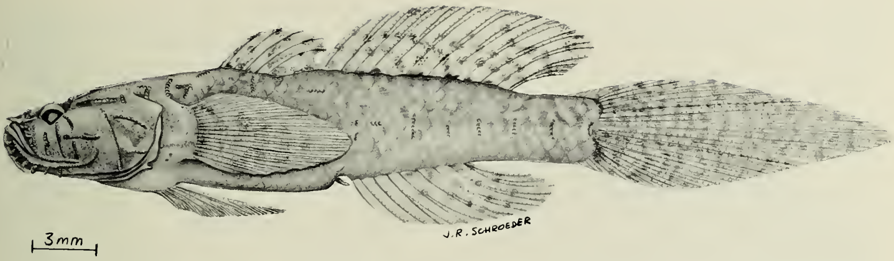

Fig. 1. *Callogobius hastatus*, USNM 99294, paratype, male, 26.4 mm SL, Philippine Islands.

138°09′24″E, W side of Map Island, collected by Bapilung and Manggur, GVF Reg. No. 1910, 16 December 1959; CAS 38935, male (17.0), female (19.3), 09°33′04″N, 138°06′30″E, Atelu district of W Yap Island, collected by Sumang and company, GVF Reg. No. 1927, 30 December 1959.

Diagnosis.—A species unique among *Callogobius* because it lacks cephalic sensory pores. Differs from most nominal *Callogobius* species in having

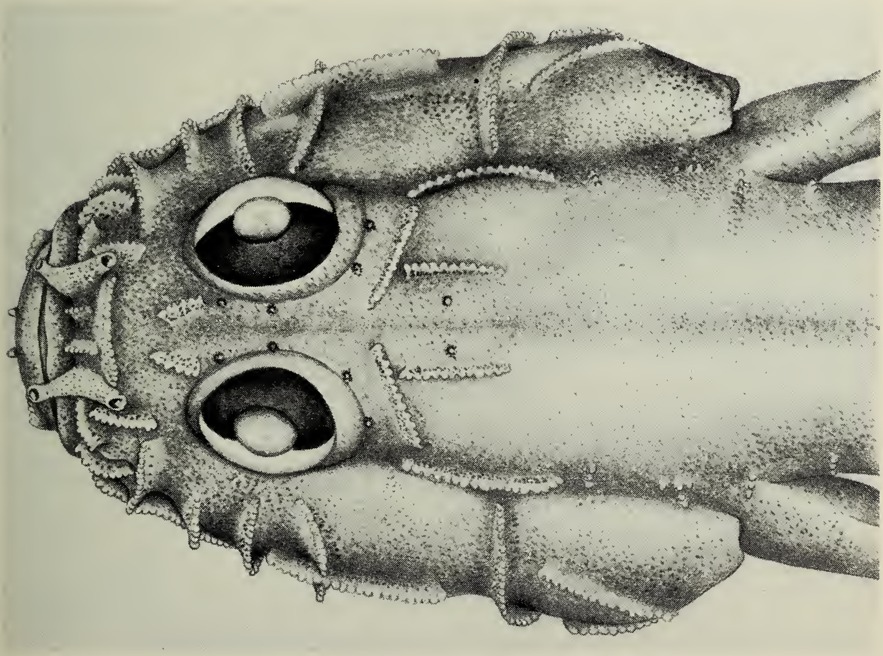

Fig. 2. Details of head of *Callogobius hastatus* showing papillose ridges; USNM 216811, holotype, male, 28.2 mm SL, Palau Islands.

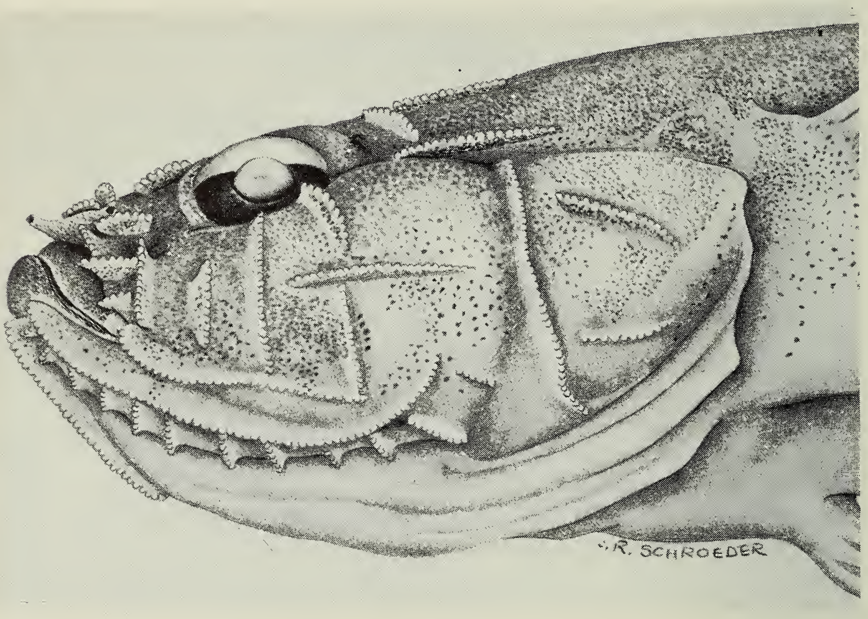

Fig. 3. *Callogobius hastatus,* data as in Fig. 2.

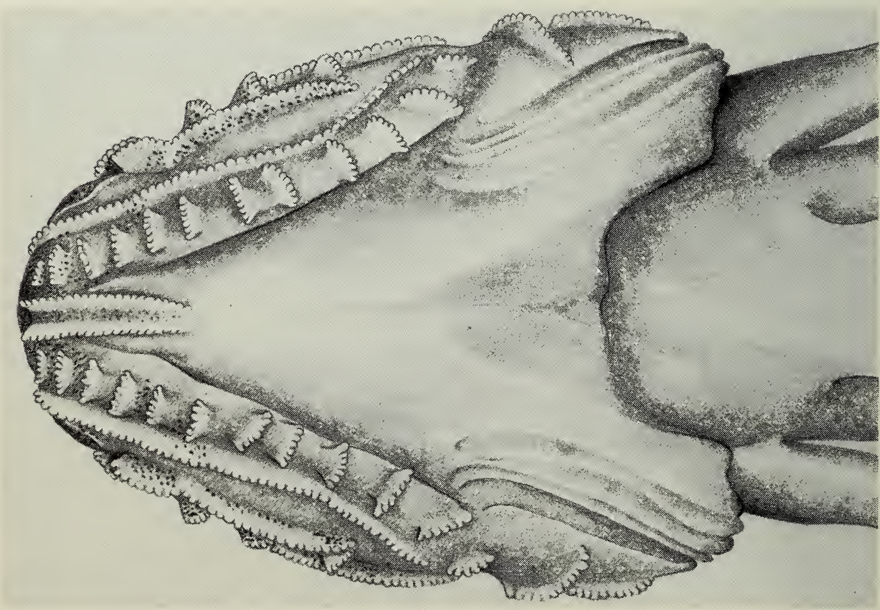

Fig. 4. *Callogobius hastatus,* data as in Fig. 2.

cycloid scales. Other distinctive features include absence of predorsal scales, an elongate caudal fin, a finely mottled and spotted color pattern, and intermediate size scales, numbering 32–37 in lateral series.

Four other nominal species of the *Callogobius* complex agree with *C. hastatus* in having only cycloid scales on the body and in lacking predorsal scales, *Callogobius mannarensis*, *Galera producta*, *Dorytptena tanegasimae* and *Doryptena okinawae*. Aside from the fact that these four species possess sensory pores, *C. mannarensis* differs mainly from *C. hastatus* in usually having 11 + 15 vertebrae rather than 10 + 16 and a distinctly barred color pattern; *G. producta* has very small scales, about 70 in lateral series, and high dorsal and anal fin counts, VI-I,13 and I,11 respectively; *D. tanegasimae* also has about 70–80 small scales in lateral series, has very high dorsal and anal fin ray counts, VI-I,14 and I,12 respectively, a high vertebral count of 12 + 18, and has distinct dark trunk saddles; and *D. okinawae* has a higher number of vertebrae, 11 + 16, smaller scales, 46–48, and a different color pattern.

Description.—Dorsal rays V-I,10(2), V-I,11(1), VI-I,9(5), VI-I,10(*36*), VI-I,11(1), VII-I,9(1); anal rays I,7(2), I,8(18), I,9(*26*); pectoral rays 15(8), 16(*56*), 17(6); pelvic rays I,5(15); segmented caudal rays 16(4), 17(*29*); branched caudal rays 14(1), 15(*23*), 16(6), 17(3); lateral scale rows 32–37(9); transverse scale rows 12–15(9); predorsal scales absent.

Scales cycloid, smaller anteriorly than posteriorly on trunk; scales eccentric, focal area narrow and oval-shaped; 15–21 primary radii and 1–3 secondary radii in large anterior field, 4–9 short primary radii and no secondary radii in small posterior field; radius of posterior field about one-sixth to one-seventh that of anterior field.

Vertebrae 10 + 15(1), 10 + 16(*39*), 10 + 17(1), 11 + 16(1); pterygiophore formula 3(22110) *30* specimens, 3(22100) 1, 3(20210) 1, 3(221101) 1.

Measurements for the holotype and five paratypes are given in Table 2.

A small species of *Callogobius*, males exceeding females in body length, largest male 28.9 mm, largest female 24.4 mm. Head moderately wide, somewhat depressed; trunk slender; interorbital narrow, less than one-half diameter of eye; lower jaw protruding, gape oblique (Fig. 3), jaw length short, not reaching vertical from anterior margin of eye; nares close together, anterior nares opening at tip of long tube, posterior nares opening at tip of short tube; tongue truncate; gill opening moderate, extending just below lower insertion of pectoral fin; first dorsal fin not as high as second dorsal fin and its posterior membrane weakly connected to base of spine of second dorsal fin; origin of second dorsal fin above anal opening; adpressed pectoral fin extends posteriorly to or slightly beyond vertical from origin of second dorsal fin; pectoral fin longer than deep, the posterior margin somewhat pointed; pelvic fin short, adpressed fin extends posteriorly just beyond midway from insertion of pelvic fin to origin of anal fin; pelvic frenum moderately developed, inner rays of pelvic fins joined nearly to their tips; anal fin almost as high as second dorsal fin; caudal fin elongate, spear-shaped, much longer than head length. Genital papilla in male tube-like, tapering, wider than deep; broad, bulbous and wider than deep in female.

Teeth of jaws small, pointed, canine-like, in a patch of three to four rows in each jaw, those of outer row slightly larger; no vomerine or palatine teeth.

The size, shape and distribution of the fleshy, papillose ridges dorsally, laterally and ventrally on the head are depicted in Figs. 2–4. Short, vertical rows of papillae present on mid-side of trunk, a few short horizontal rows dorso-laterally on anterior trunk and some short rows above pectoral base; three rows of fine papillae parallel lower margins of sixth and ninth caudal rays and upper margin of twelfth caudal ray.

There are no cephalic pores, but coarse, dark papillae (Fig. 2) are located between and behind the eyes in the areas occupied by the sensory canal system in other *Callogobius* species. There is also a coarse, dark papilla on each side of the midline, dorsally on the head.

Color in preservation.—Head and trunk mottled with small, brownish, irregular spots, as large as or larger than pupil. Head dorsally and laterally with irregular brown mottling; larger patches of brown coloration on preopercle and opercle; papillose ridges on head and cheek usually bicolored black and light but may be uniformly brownish (the typical mottled pattern is not shown in Fig. 2); lower portion of head uniformly pale. Trunk with numerous small, irregular brownish spots over a light to pale background (most specimens more darkly pigmented than shown on Fig. 1); breast and belly to origin of anal fin uniformly pale. Median fins with numerous small brown spots, which sometimes coalesce to form irregular bars or stripes. Spots on first dorsal fin darkest near bases of fourth and sixth spines, where they coalesce with spots dorsally on trunk that are about the size of eye (not developed on illustrated specimen). Three to four rows of small brownish spots on second dorsal fin, usually more heavily developed and larger at bases of third, fourth, sixth, seventh, eighth and ninth soft rays; usually these spots coalesce to form three saddle-like marks, similar to marks at base of first dorsal fin. Anal fin occasionally with three to four rows of small brown spots, usually on rays of posterior half; a few specimens with entire anal fin spotted; sometimes anal fin completely clear. Caudal fin profusely spotted with small brown marks arranged in about 8–11 irregular rows from its base to its tip; more diffuse in some specimens than others and entirely absent in some. Base of caudal fin with irregular bar, sometimes divided into upper, middle and lower basi-caudal spots. Pectoral fin with large brown spots or mottling on fleshy base and on proximal third of fin rays, the pigmentation sometimes more pronounced on base of upper rays; outer two-thirds of rays with about 4 light brownish irregular bars, obsolete in some specimens. Pelvic fin clear.

We observe differences in pigmentation between the Philippine and Palau populations, where our material is most abundant. Most Palau specimens have reduced pigmentation on the distal portions of the pectoral and caudal fins, and the anal fin is mostly clear compared to the Philippine specimens. Also, the mid-dorsal saddle-like blotches are larger and more pronounced on the Palau specimens compared to the Philippine specimens. Our material is too limited geographically to analyze the systematic significance of this variation.

Geographic distribution.—Taken at Viet Nam (South China Sea), Cebu and Mindanao Islands of the Philippine Islands, Palau Islands and Yap Islands.

Ecology.—The field data for 8 stations in the Palau Islands, 3 stations in the Yap Islands and 1 at Viet Nam are consistent in describing the ecology and nature of the habitat. The species was always taken in shallow water, up to about 3 m. Sand and broken coral, silt and patches of live coral, with some algae and eel grass was almost always listed as the predominate items on the bottom. Some of the patches of sand, silt, and broken coral reefs graded into shores of mangrove. Clay, mud and dead coral boulders were also described as occurring in one locality.

Etymology.—The specific epithet is taken from the Latin, *hastatus*, in reference to the spear shape of the caudal fin.

Remarks.—In the description above, we list three specimens with five and one specimen with seven spines in the first dorsal fin, an unusual variation in gobioid fishes. Correlated with these variations are the differences in the pterygiophore formula given in the description. The specimen with the 3(22100) formula lacks the sixth element of the first dorsal fin. The specimen with the 3(20210) formula lacks the third spine and pterygiophore and the fourth pterygiophore is inserted in the fifth interneural space rather than in the fourth. The third five-spined specimen lacks the last spine of the first dorsal fin, but the associated pterygiophore is present, resulting in a normal formula. The specimen that exhibits the pterygiophore formula of 3(221101) has an extra spine and pterygiophore at the end of the first dorsal fin, and it also has an extra pre-caudal vertebra.

Callogobius clitellus, new species

Fig. 5, Table 2

Holotype.—USNM 209249, male (30.2 mm), New Guinea, Madang Harbor, Bay in Krankett Island, collected by B. B. Collette, Sta. No. BBC-1495, 30 May 1970.

Paratypes.—USNM 99574, male (37.6), Philippine Islands, "*Albatross*" collection, no additional data; USNM 211935, one specimen (16.9), Banda Islands, 04°20′30″S; 129°54′20″E, SE coast of Naira Island, collected by V. G. Springer and M. F. Gomon, VGS Sta. 74-9, 8 March 1974; USNM

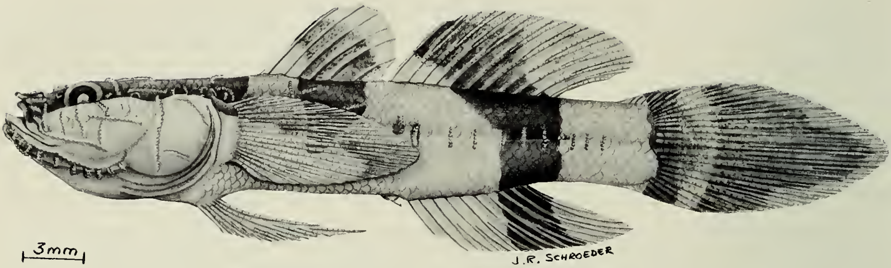

Fig. 5. *Callogobius clitellus*, USNM 209249, holotype, male, 30.2 mm SL, Madang Harbor, New Guinea.

209252, one specimen (17.8), Solomon Islands, Bougainville, Tautsina Island, E of Kieta Peninsula, collected by "*Te Vega*" Cr. 6, Sta. 247, 11 March 1965; BPBM 9591, male (27.8), Palau Islands, one-fourth mi SW of entrance to Malakal Pass, collected by J. E. Randall and company, 17 April 1970.

Diagnosis.—*C. clitellus* differs from most *Callogobius* species in having only cycloid scales on the body and trenchant bicoloration. In these characters, *C. clitellus* resembles *C. bifasciatus* (J. L. B. Smith), but differs mainly from the latter in having a distinct horizontal stripe through the eye, a prominent predorsal saddle, a cresent-shaped dark mark on the upper pectoral fin, and a prominent spear-shaped mark on the caudal fin. *C. bifasciatus* has dark oblique marks on the cheek and opercle that are lacking in *C. clitellus*. *C. bifasciatus* is a larger-scaled species, having about 35–38 in lateral series and 14–16 before the dorsal fin, while *C. clitellus* has 46–48 scales in lateral series and about 24 predorsal scales. Other species of the *Callogobius* complex that are entirely cycloid-scaled forms (Table 1) are variously mottled or lack outstanding bicoloration.

Description.—Dorsal rays VI-I,10(5), anal rays I,8(3), I,9(2); pectoral rays 17(9); pelvic rays I,5(5); segmented caudal rays 17(5); branched caudal rays 15(4), 16(1); lateral scale rows about 46–48(2); transverse scale rows about 24(2); predorsal scales about 24(2).

Scales cycloid, those on anterior trunk about one-half size of those on caudal peduncle, the scale highly eccentric, the focus narrow; anterior trunk scales with 10–12 radii, 0–2 secondary radii in large anterior field, no radii in posterior field; scales on caudal peduncle with 15–18 primary radii, no secondary radii in large anterior field, 0–4 short radii in small posterior field. Small scales present on nape to just behind eyes, on upper opercle, preopercle, on cheeks to level of vertical through anterior margin of eye, and on breast, belly and fleshy base of pectoral fin.

Vertebrae 10 + 16(5); pterygiophore formula 3(22110) in 4.

Table 2. Selected measurements, expressed as thousandths of SL, of type specimens of two new species of *Callogobius*.

	hastatus			*clitellus*	
		paratypes			paratypes
Character	holotype	males $N = 2$	females $N = 3$	holotype	males $N = 2$
Standard length (mm)	28.2	24.1–28.9	21.6–24.4	30.2	27.8–37.6
Head length	259	257–266	282–292	331	293–327
Snout length	64	62–66	59–65	83	74–86
Bony interorbital width	18	14–15	13–19	17	16–18
Greatest diameter of orbit	50	50–55	57–60	70	64–72
Upper jaw length	74	71–83	74–82	89	82–94
Predorsal length	362	357–367	378–402	404	372–381
Greatest depth of body	167	170–173	181–213	162	173
Pectoral fin length	344	311–325	295–338	325	282–331
Pelvic fin length	223	225–228	213–242	242	213–263
Caudal fin length	500	477–484	447–458	454	421
Pelvic fin insertion to anal fin origin	340	315–336	328–361	328	311–360

Measurements for the holotype and two male paratypes are given in Table 2.

A moderately stout species of *Callogobius*; head depressed; snout pointy; trunk moderately deep and somewhat compressed; interorbital narrow, about one-fourth diameter of eye; lower jaw protrudes, the gape oblique (Fig. 5), its length short, not reaching vertical from anterior margin of eye; nares close together in bulbous area, the anterior nares at tip of long tube, posterior nares at tip of short tube; tongue truncate to slightly rounded; gill opening moderate, extending below and anteriorly to pectoral base, reaching vertical below preopercle; first dorsal fin as high as second dorsal or anal fins; first dorsal fin free from second dorsal fin; origin of second dorsal fin above anal opening; adpressed pectoral fin extends posteriorly to or slightly beyond vertical through origin of anal fin; pectoral fin longer than deep, the posterior margin somewhat pointed; adpressed pelvic fin extends posteriorly about three-fourths distance from pelvic fin insertion to anal fin origin; pelvic frenum weak, the inner pelvic rays connected only at base; caudal fin elongate, longer than head length, the posterior margin moderately pointed. Genital papilla in male short, tapering to a point.

The dentition of the jaws small, pointed, canine-like teeth, in a patch of three to four rows in each jaw, those of outer row of both jaws largest; vomerine and palatine teeth absent.

The size, shape and distribution of the prominent fleshy papillose ridges are the same as those illustrated for *C. hastatus*. Short vertical rows of papillae are present on the mid-side of the trunk and a few short, irregular rows are above pectoral base; three rows of fine papillae parallel to the lower margins of the sixth and ninth caudal fin rays and the upper margin of the twelfth caudal ray.

The cephalic sensory pore and canal system includes the following pores: paired nasals, a single anterior interorbital (absent on 17.8 mm specimen), a single posterior interorbital, paired supraotics, paired anterior otics, paired posterior otics and paired intertemporals. The holotype has three preopercular pores on left side and two on right side. The preopercular area is damaged on the paratypes and the exact number of pores could not be determined.

Color in preservation.—Head and trunk sharply bicolored with dark saddles and bars on head, trunk and fins over a light body. Head with broad, dark brown stripe, equal in width to pupil or wider, extending from tip of snout and upturned lower jaw through middle of eye and dorsolaterally posteriorly to end of upper opercle. The head stripes on both sides join a broad, dark brown saddle that traverses the predorsal region to upper base of pectoral fins. Head stripe and predorsal saddle contiguous with upper pectoral fin base. Upper pectoral base and upper eight fin rays darkened to their extremities, as well as tips of longest pectoral rays, forming a crescent-shaped mark. Lower portion of pectoral fin and pelvic fin clear. Middle of head, cheeks and opercle with scattered dusky pigment in adults; these areas light colored in smaller specimens. The small specimens have a distinct dark spot, smaller than or equal to pupil, present near lower margin of opercle, indistinct in adults. Trunk with broad, dark brown saddle through first dorsal fin, commencing at base of third spine, passing through middle of fin and extending to lower portion of trunk as dark v-shaped mark; lower anterior portion and outer third of first dorsal fin clear. A broad, irregular band passes through upper anterior portion of second dorsal fin, encompassing bases of fourth to last rays, extending over trunk to anterior portion of caudal peduncle and posterior base of anal fin where it covers bases of seventh to last anal fin rays. The band extends out on anal fin to tips of fourth and fifth rays. Anterior lower portion of second dorsal fin clear; outer posterior portion of fin weakly pigmented in adults, clear in young. Anterior half and outer posterior portion of anal fin clear. A dark, wide bar at base of caudal fin, weakly joined in center with prominent, dark spear-shaped mark that covers most of caudal fin. Wide clear band, widest on upper and lower portions, nearly separates caudal bar and spear-shaped mark. Posterior margin of caudal fin clear. Development of spear-shaped mark appears to be ontogenetic. Smaller specimens have caudal bar well developed but remainder of fin lacks spear-shaped mark. The Palau specimen (27.8 mm SL) has a spear-shaped mark about one-half the size of that of holotype. The Philippine specimen (37.6 mm SL) has an intense dark streak on upper margin of caudal bar at procurrent rays. Another intensely dark streak occurs on spear-shaped mark at the fourth branched caudal ray of this specimen, and the Solomon Island specimen (17.8 mm) has a small brown spot in the same area. The middle areas of the light trunk interspaces have weak brown chromatophores, reduced or absent in smaller specimens. Papillose ridges on head and papillae rows on trunk are variously darkened.

Geographic distribution.—Taken in the Philippines, Banda Islands, New Guinea, Solomon Islands and the Palau Islands.

Ecology.—The holotype was captured in a bay at a depth between 1½ and about 6 m. The Palau paratype was taken over a bottom of white sand in a cave on a steep coral-rubble slope at about 20 m. The Banda Island paratype was taken in a dead and live coralline area at a depth of about 3–10 m.

Etymology.—The specific name is taken from the Latin, *clitella*, in reference to the dark body saddles.

Acknowledgments

We acknowledge the curators and staffs responsible for the fish collections at the Bernice P. Bishop Museum (BPBM), Honolulu, and the California Academy of Sciences (CAS), San Francisco, for loan and exchange of study materials and data. We are indebted to numerous individuals at many museums throughout the world for loan and exchanges of type-material and other collections for use in our continuing revisionary study of *Callogobius*. The illustrations were made by J. R. Schroeder.

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NEW GENUS AND SPECIES OF AHERMATYPIC CORAL (ANTHOZOA: SCLERACTINIA) FROM THE WESTERN ATLANTIC

Stephen D. Cairns

Abstract.—A new genus and species are described in the subfamily Parasmiliinae. *Bathycyathus maculatus* Pourtalès, 1874 is transferred to the new genus. Both species are characterized by having paliform lobes before the penultimate cycle of septa and an identical method of basal reinforcement. [Scleractinia; *Rhizosmilia*; Parasmiliinae.]

Numerous species have been uncritically placed in the genera *Bathycyathus* and *Coenocyathus*. One of these is *Bathycyathus maculatus* Pourtalès, 1874 (= *Caryophyllia maculata*, Pourtalès, 1880; Wells, 1972; Cairns, 1977; *Coenocyathus bartschi* Wells, 1947). A re-examination of *B. maculatus* indicates that it has endothecal dissepiments (Plate 1, Fig. 8), which would transfer it from the Caryophylliinae to the Parasmiliinae. It is necessary to describe a new parasmilid genus to contain both *B. maculatus* and another undescribed species.

Some of the specimens used in this study were collected by the R/V *Gerda* in the Deep-Sea Biology Program sponsored by the National Geographic Society. Ship time was supported by a National Science Foundation grant. This is a contribution from the Rosenstiel School of Marine and Atmospheric Science, University of Miami.

I would like to thank Dr. Gilbert L. Voss, Rosenstiel School of Marine and Atmospheric Science, for access to the University of Miami collections, and Dr. Frederick M. Bayer, National Museum of Natural History, for the opportunity to study the Smithsonian specimens. I am grateful to Dr. John W. Wells, Cornell University, for reviewing the manuscript.

All of the specimens listed in this paper are deposited at the National Museum of Natural History (USNM).

Suborder Caryophylliina Vaughan and Wells, 1943
Family Caryophylliidae Gray, 1847
Subfamily Parasmiliinae Vaughan and Wells, 1943
Rhizosmilia, new genus

Diagnosis.—Small phaceloid clumped colonies formed by extratentacular budding. Corallite bases increase in diameter by adding exothecal dissepiments over raised costae producing concentric rings of partitioned chambers. Paliform lobes present before penultimate cycle. Columella prominent, varying from spongy to fascicular (a line of pillars) to lamellar. Endothecal dissepiments present.

Type-species.—Rhizosmilia gerdae, n. sp., here designated.

Discussion.—Rhizosmilia is easily distinguished from the other genera in the subfamily Parasmiliinae by a combination of three easily observed characters: it is colonial (clumped phaceloid), has a prominent columella, and has large paliform lobes.

The position of the paliform lobes before the penultimate cycle of septa requires explanation. The first paliform lobes to form are the 12 that border the S_3 at the 48-septa stage (Fig. 1a). When a pair of S_5 appears within a half-system, one of two things occurs to maintain the paliform lobes before the penultimate cycle: 1) the original P_3 may remain stationary before the S_3 while an independent lobe forms on the accelerated S_4 (Fig. 1b), or 2) the original P_3 may gradually begin to align with the accelerated S_4, maintaining trabecular connections with both S_3 and S_4 simultaneously (Fig. 1c). With greater development, this transitional paliform lobe becomes completely aligned and attached to the S_4 (Figs. 1d, e). (For example, every transitional P_4 merges with a P_3 lower in the fossa.) When the second pair of S_5 occurs in the half-system, if the P_3 is still present (case 1), it becomes a transitional lobe and forms the P_4. If the P_3 has already aligned with the other S_4 (case 2), then an independent lobe is formed of equal size on the second S_4. In both cases, the final condition is two equal paliform lobes bordering the S_4 (penultimate cycle) and no lobe visible before the S_3 (Fig. 1f).

Both species in this genus also have a peculiar method of basal reinforcement. As the corallite increases in size, the edge zone secretes thin costae, up to 2 mm high and 10 mm long, perpendicular to the corallum wall around the base (Plate 1, Fig. 2). Next, exothecal dissepiments form over the costae, producing a series of chambers around the base. This process may occur several times, producing 4–5 concentric rings of hollow compartments that substantially increase the basal diameter of the corallite and therefore its stability. If a transverse section is made through the base (Plate 1, Fig. 7), these concentric rings appear identical to Durham's (1949) thecal rings of polycyclic development. The rings described here are, however, structurally and ontogenetically different, since they are formed much later in development by raised costae and exothecal dissepiments, whereas polycyclic thecal rings are an early developmental feature involving overlapping of primitive thecal walls. Furthermore, there is no extension of the polyp into the compartments of the costal roots, whereas in polycyclic development, the polyp occupies the area created by the last thecal ring. The identical mode of basal reinforcement also occurs in *Phyllangia* and *Oxysmilia.*

Etymology.—The prefix is derived from the Greek *rhiza,* meaning root, and pertains to the concentric rings of root-like costal chambers around the base. Gender: feminine.

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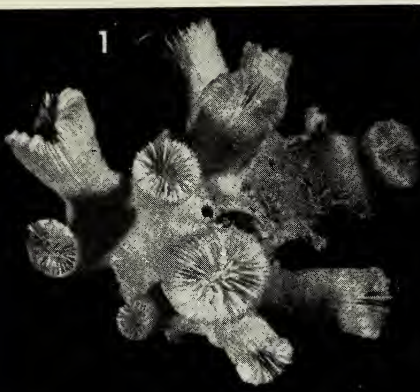

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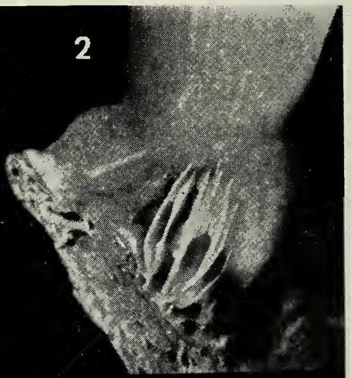

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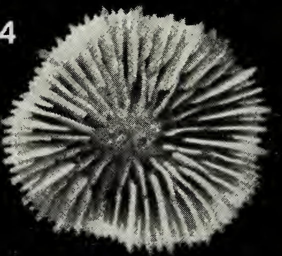

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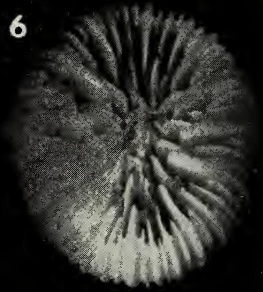

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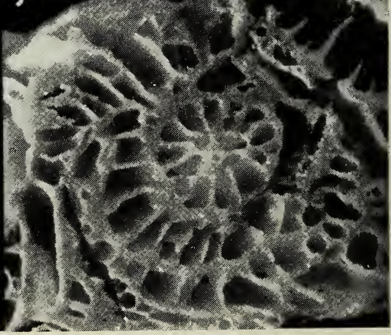

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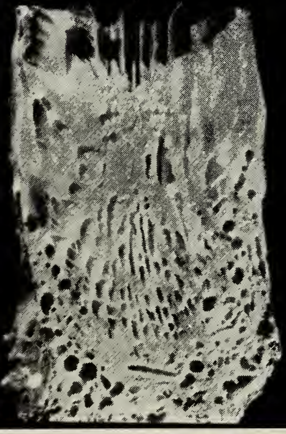

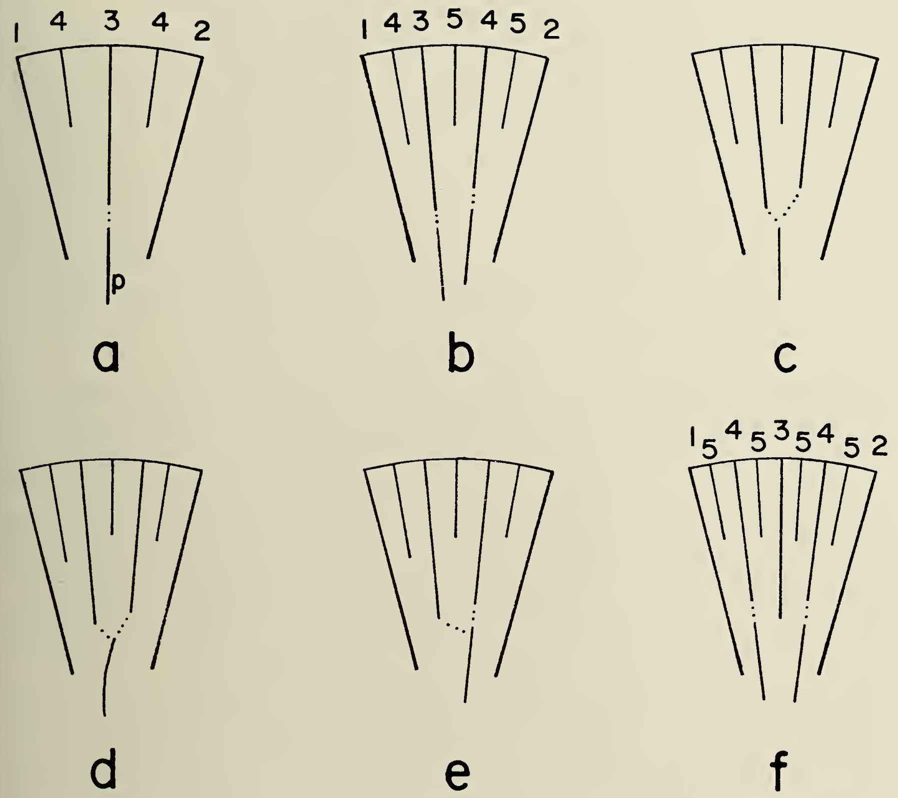

Fig. 1. Diagrams illustrating the maintenance of paliform lobes (p) before penultimate cycle of septa (see text). Only one half-system is illustrated; numbers 1–5 correspond to respective septal cycles. Dotted line represents trabecular connection of paliform lobe to adjacent septa.

Rhizosmilia gerdae, new species
Plate 1, Figs. 1–7

Material examined.—Types: USNM 46812, holotypic colony (13 corallites), USNM 46813, paratypes 36+ corallites), all from *Gerda*-725, 26°01′N,

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Plate 1. 1. *Rhizosmilia gerdae* (holotypic colony): *Gerda*-725, ×0.95, USNM 46812; 2. *R. gerdae* (paratype): *Gerda*-725, ×3.0, USNM 46813; 3. *R. gerdae* (paratype): *Gerda*-725, ×3.9, showing dissepiments, USNM 46813; 4–6. *R. gerdae* (calices of holotypic colony), ×3.0, USNM 46812; 7. *R. gerdae* (paratype): *Gerda*-725, ×3.8, cross-section through base, USNM 46813; 8. *Rhizosmilia maculata*: off Cozumel, Yucatan, 6.5 m, ×1.5, showing dissepiments, USNM 46811.

79°10′W, 143–210 m, 3 August 1965; USNM 46814, paratype (1), *Gerda*-698, 26°28′N, 78°42′W, 165–329 m, 22 July 1965; USNM 46815, paratype (1), *Gerda*-701, 26°29′N, 78°40′W, 275–311 m, 22 July 1965; USNM 46816, paratypes (6 corallites), *Gerda*-702, 26°29′N, 78°40′W, 73–220 m, 22 July 1965; USNM 16138, paratypes (7 corallites), *Albatross*-2332, 23°10′38″N, 82°20′06″W, 285 m, 19 Jan. 1885; USNM 36364, paratypes (10 corallites), *Albatross*-2334, 23°10′42″N, 82°18′24″W, 123 m, 19 Jan. 1885; USNM 10210, paratype (1), *Albatross*-2336, 23°10′48″N, 82°18′52″W, 287 m, 19 Jan. 1885; USNM 36418, paratypes (14+ corallites), *Albatross* station unknown (off Havana, Cuba), 1885.—Other material: USNM 46817, 1 colony (4 corallites), *Albatross* station unknown (off Havana, Cuba), 1885; USNM 46818, 4 corallites, Caribbean Sea (no additional data).

Description.—The colony forms phaceloid clumps by extratentacular budding from a common basal coenosteum. Corallites are cylindrical or slightly tapered at the base. The base of a corallite increases in diameter by adding exothecal dissepiments over raised costae as previously described for the genus. A typical corallite measures 12 × 10 mm in calicular diameter and 21 mm tall, although adult corallites vary from 7–17 mm in greater calicular diameter and may be up to 45 mm tall. Costae are usually well-defined only in the upper half of the corallum where they are equal, low, rounded ridges separated by equally shallow grooves. Very small granules cover the costae.

Septa are arranged in 6 systems and 4–5 cycles. A corallite of 8–11 mm calicular diameter usually has a complete fourth cycle (48 septa), whereas, above 11 mm, pairs of S_5 are common, but a complete fifth cycle is rare. S_1 are usually slightly larger than S_2, exsert, and have straight, vertical inner edges that do not reach the columella. The remaining cycles are progressively smaller and less exsert; S_5 are rudimentary with dentate inner edges. Low, blunt granules cover the septal faces.

A large paliform lobe, compressed in the plane of the septum, occurs before each septum of the penultimate cycle and maintains its position there as described in the generic discussion. Each paliform lobe is separated from its respective septum by a deep, narrow notch and together they form a crown deeply set in the fossa.

The columella is prominent and quite variable. It may be an elliptical, spongy mass, or linear, individualized pillars, or a single lamella. Endothecal dissepiments are abundant.

Discussion.—*R. gerdae* is very similar to *Rhizosmilia maculata* (Pourtalès, 1874) n. comb., particularly in its growth form and aspects of its paliform lobes, dissepiments (Plate 1, Fig. 8), costal roots, and columella. It may be distinguished by the smaller size of its corallites (none known to exceed 15 mm in greater diameter), complete absence of S_6, absence of brown speckled pigmentation, and shallower fossa. Although they have overlapping depth ranges, *R. gerdae* is more typical of the deeper shelf, whereas *R. maculata* is found in shallower waters (3–161 m). *R. maculata* is described and illustrated in Cairns (1977) as *Caryophyllia maculata.*

Etymology.—The specific name *gerdae* is given in honor of the University of Miami's R/V *Gerda*, aboard which many of the type-specimens were collected.

Type-locality.—Off Bimini, Straits of Florida: 26°01′N, 79°10′W, 143–210 m.

Geographic distribution.—Insular side of Straits of Florida.

Bathymetric range.—123–287 m (confirmed).

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TWO NEW SPECIES OF THE GENUS *PSEUDANTHURA* RICHARDSON (CRUSTACEA: ISOPODA: ANTHURIDEA)

Brian Kensley

Examination of the isopod material collected during the South African Museum's 1975–77 *Meiring Naude* cruises revealed specimens of a very slender anthurid displaying the reduced uropodal exopod of *Pseudanthura* Richardson. While working through the Smithsonian collection of anthurid material, two specimens of a very large species collected by the R/V *Albatross* in 1909 were also found to show this feature. As *Pseudanthura lateralis* has never been fully described and figured, it was decided to deal with all three species together for completeness and ease of comparison.

Pseudanthura Richardson, 1911

Diagnosis.—Mouthparts adapted for piercing and sucking. Eyes lacking. Pereonites with dorsolateral grooves. Pereonite 7 considerably shorter than preceding pereonites. Pleonites and telson fused, anterior 5 pleonites indicated by shallow grooves, pleonite 6 indistinguishable from telson. Telson lacking statocyst. Flagellum of antennule multiarticulate in male and female, brush-like in male. Distal segment of mandibular palp armed with row of distal spines. Maxilliped 4-segmented, second segment produced into lobe at distomedial corner. Pereopod 1, unguis of dactylus very short, palm of propodus armed with row of short spines. Pereopods 4–7 with cylindrical carpus not underriding propodus. Pereopod 7 distinctly shorter than preceding pereopods. Exopod of pleopod 1 indurate, operculate, endopod reduced. Pleopod 2 in male, stylet of endopod slender, considerably longer than rami, apically hooked. Uropods with exopod reduced to short triangular structure, endopod and basis tending towards fusion. Brood pouch formed by 4 pairs of oostegites.

Type-species.—*Pseudanthura lateralis* Richardson

Gender.—Feminine.

Pseudanthura tenuis, sp. nov.

Figs. 1, 2

Description.—♀. Integument indurated, brittle, bearing tiny evenly spaced ovoid scales. Cephalon half length of pereonite 1; anterolateral corners extending slightly beyond rostrum. Pereonites with well marked dorsolateral

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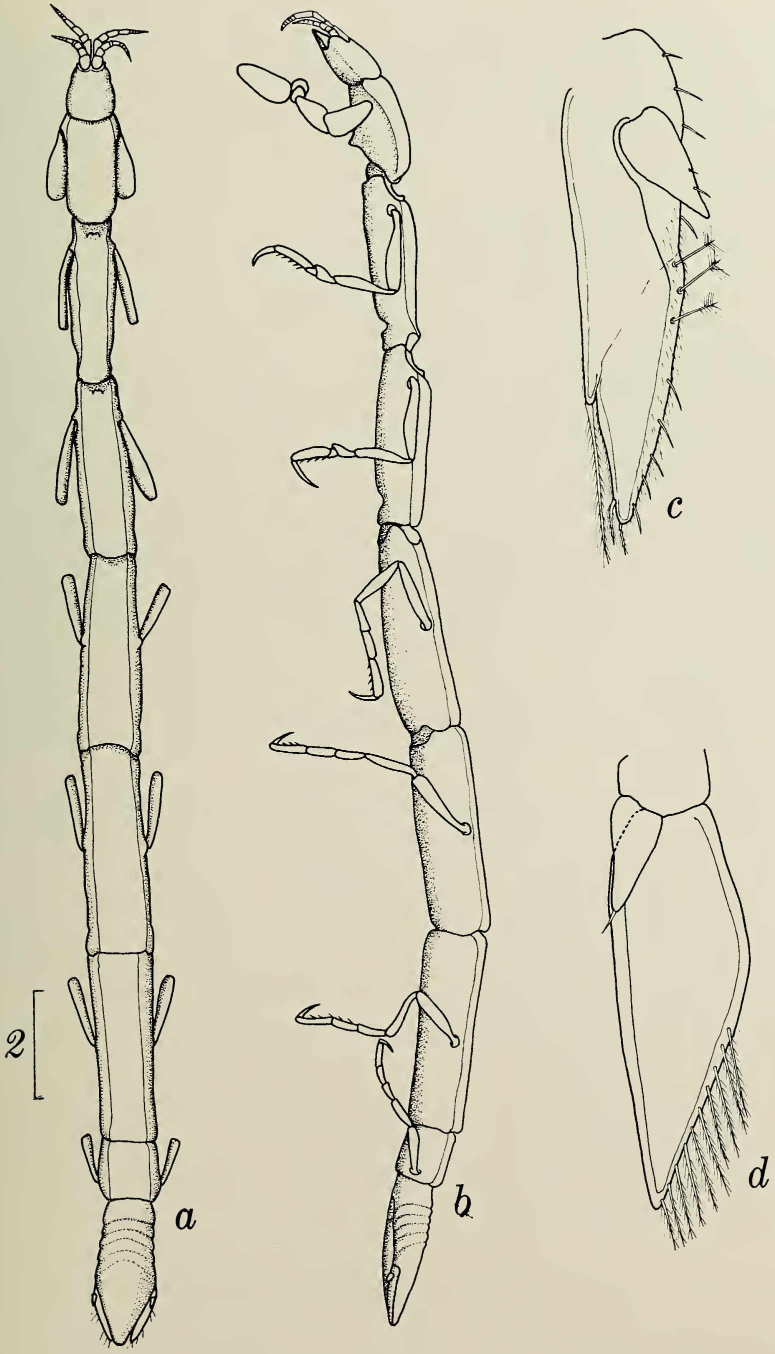
Fig. 1. *Pseudanthura tenuis*: a, Holotype in dorsal view; b, Holotype in lateral view; c, Uropod; d, Pleopod 1.


a
b
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grooves. Pereonite 1 two-thirds length of pereonite 2, with strong medioventral crest bearing tooth-like triangular process. Pereonite 2 bearing 2 low rounded semi-coalesced tubercles dorsally, close to articulation with pereonite 1; pereonite 3 with similar pair of tubercles. Pereonites 2 and 3 subequal in length, 4–6 subequal but longer than anterior pereonites; pereonite 7 slightly less than one-third length of pereonite 6. Pleon twice length of pereonite 7; pleonite 1 twice length of pleonite 2; pleonites 3–5 subequal in length. Telson triangular, tapering to acutely rounded apex.

Antennule with 4-segmented peduncle, basal segment longest, fourth segment very short; flagellum of 8 or 9 articles. Antenna with 5-segmented peduncle, fifth segment longest; flagellum of 9 articles.

Mandible distally narrowly triangular, acute; palp 3-segmented, basal segment short, two distal segments subequal, distal segment bearing row of 14–15 spines. Upper lip distally narrowed, apex narrowly rounded, serrate. Maxilla lancet-like with 10–12 serrations. Maxilliped 4-segmented, second segment produced at mediodistal angle into lobe tipped with single seta; third segment shorter than fourth; latter armed with several setae.

Pereopod 1 far more robust than following pereopods; propodus proximally broad, carpus small, triangular; propodus and carpus with several short serrate spines on posterior margin. Pereopod 2 with all segments slender; propodus with row of 9 serrate spines on posterior margin; carpus very short, triangular.

Pereopods 4–7 very slender, carpus two-thirds length of propodus; latter with 3 serrate spines on posterior margin; carpus with 2 serrate spines on posterior margin.

Pleopod 1 exopod operculate, indurate, completely closing off the branchial chamber, bearing plumose setae on distolateral margin; endopod reduced to small triangular process bearing single distal seta.

Uropod with basis and endopod fused into single structure, but with suture line faintly indicated, and with short lobe on median margin bearing single elongate plumose seta marking area of fusion; exopod reduced to short triangular lobe folding into hollow of fused exopod/basis.

Etymology.—The specific name of *P. tenuis* is derived from the very slender form of the body.

Material.—*Meiring Naude* st 103, 28°31′S, 32°34′E, 680 metres (off east coast of South Africa). Holotype SAM-A15644 ♀ TL 25.3 mm. Paratypes SAM-A15644 ♀♀ TL 23.4 mm, 17.1 mm, 6.0 mm; USNM 170272 ♀♀ TL 18.9 mm, 6.0 mm. *Meiring Naude* st 53, 26°51′S, 33°12′E, 720 metres (off east coast of South Africa) SAM-A15645 ♀ TL 9.9 mm.

Pseudanthura albatrossae, sp. nov.

Figs. 3, 4

Description.—♂. Body anteriorly narrow, widening posteriorly, widest at pereonite 5. Cephalon narrower and about half length of pereonite 1.

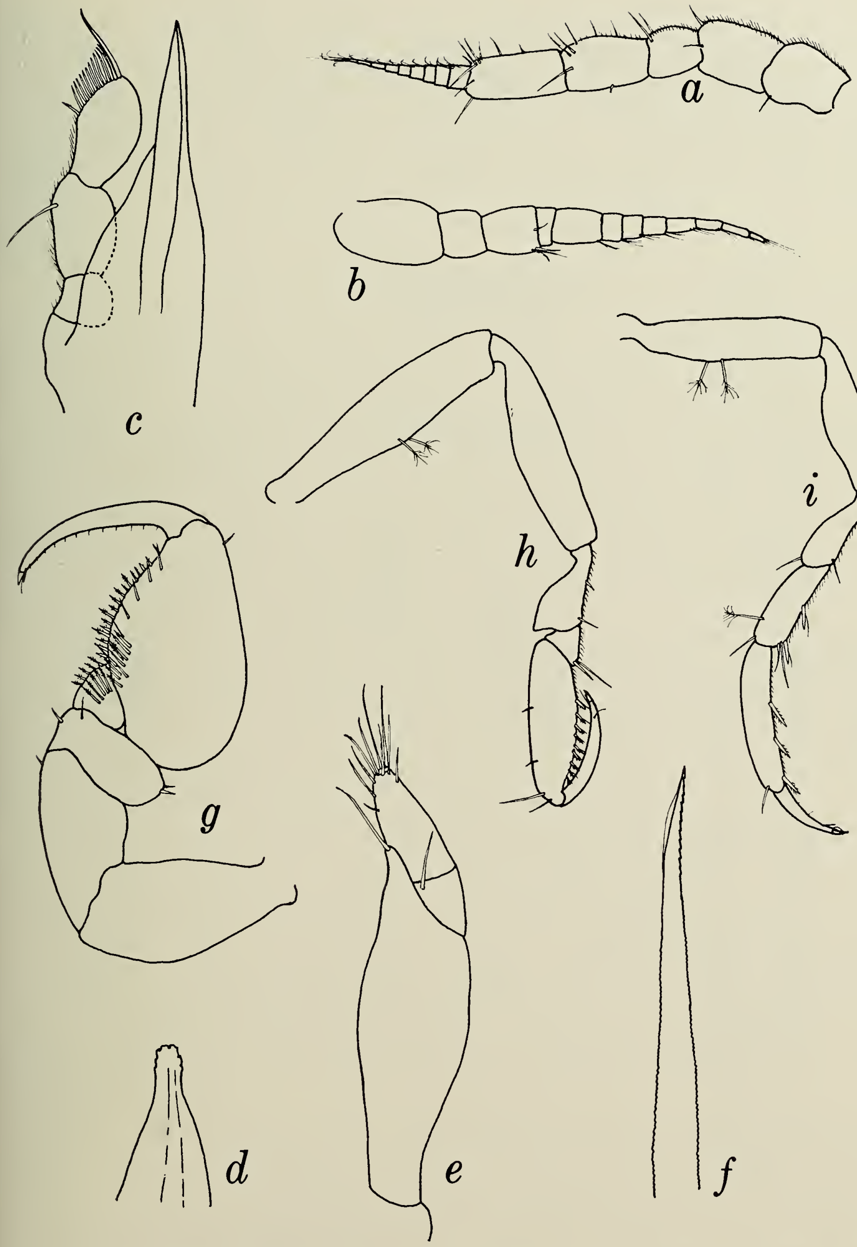

Fig. 2. *Pseudanthura tenuis*: a, Antenna; b, Antennule; c, Mandible; d, Upper lip; e, Maxilliped; f, Maxilla; g, Pereopod 1; h, Pereopod 2; i, Pereopod 6.

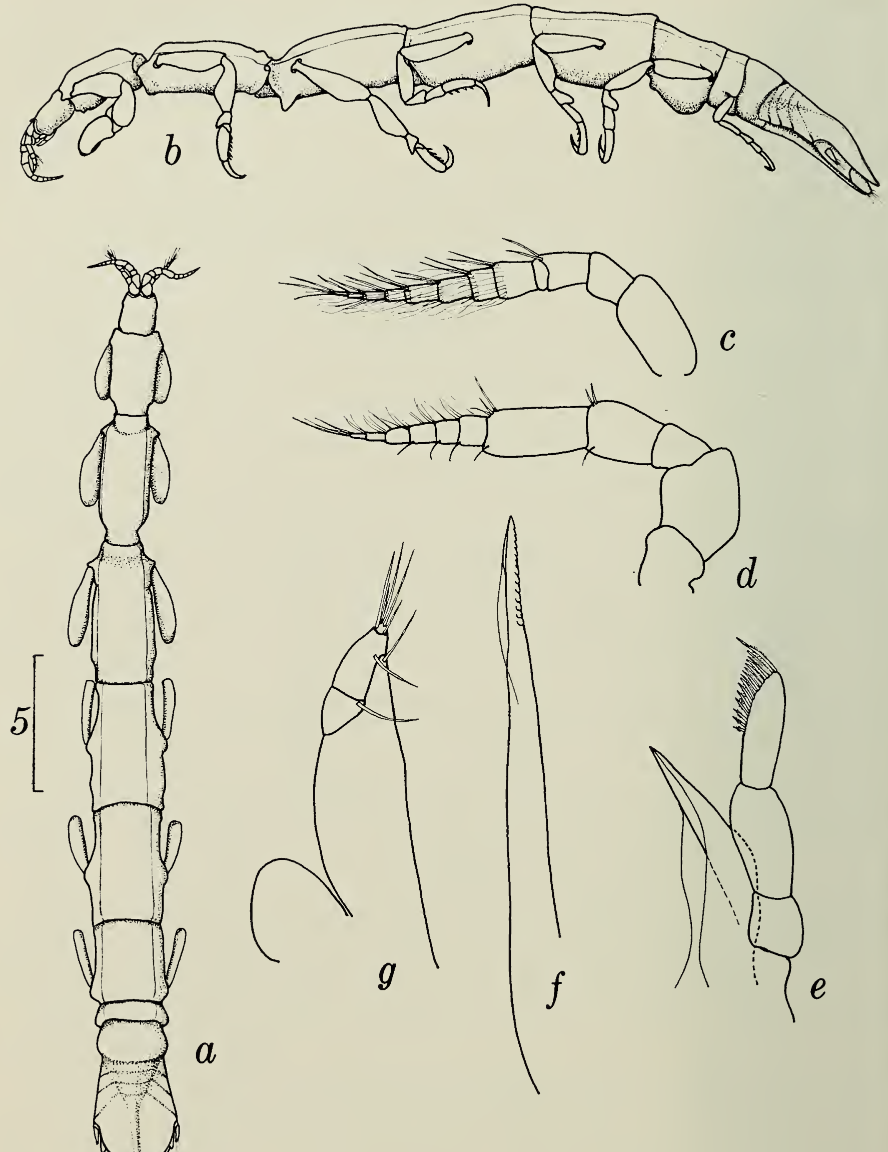

Fig. 3. *Pseudanthura albatrossae*: a, Holotype in dorsal view; b, Holotype in lateral view; c, Antennule; d, Antenna; e, Mandible; f, Maxilla; g, Maxilliped.

Latter two-thirds length of pereonite 2. Pereonite 3 with pair of triangular anteroventral processes below articulation of pereopod. Pereonites 2–5 of similar length; sixth two-thirds length of fifth, ventrally bulbous; seventh very short, one-quarter length of sixth. Dorsolateral pereonal grooves present. Pleonite 1 broad and equal in length to fused pleonites 2–5; pleonite 6 indistinguishable from telson. Telson indurated, triangular, margins gently sinuous, tapering to narrowly-rounded apex; strong middorsal rounded ridge present as extension of raised triangular pleonal area. No statocyst visible.

Antennular peduncle 4-segmented, basal segment longest and broadest, fourth segment short, about one-third length of third; flagellum of 8 articles, carrying filiform aesthtascs. Antennal peduncle 5-segmented, second segment broadest, fifth segment longest; flagellum of 6 articles.

Mandible apically acute; palp 3-segmented, basal segment half length of middle segment; latter broader than, but equal in length to terminal segment; latter armed with 14 or 15 serrate spines. Maxilla lanceolate, slender, with about 14 serrations distally, proximal serrations becoming rounded. Maxilliped 4- (possibly 5-) segmented, second segment elongate, produced at mediodistal corner into narrowly triangular lobe; suture of tiny terminal setiferous segment hardly discernible.

Pereopod 1 robust, dactylus strongly curved, row of fine evenly-spaced setules on inner margin; palm of propodus with few short distal setae plus cluster of more elongate setae proximally; carpus triangular, with 6–8 setae on posterior margin; posterior surface of carpus, merus, and ischium with dense very short setules. Pereopod 2 propodus with 6 spines plus very fine setules on posterior margin; carpus small, triangular.

Pereopods 3–6 increasing in length; carpus becoming elongate, armed with 3 posterior spines. Pereopod 7 about half length of sixth, with 3 spines on posterior propodal margin; no spines on carpus.

Pleopod 1, basis with 6 retinaculae; exopod strongly indurated, with several plumose setae on distolateral margin; endopod three-quarters length of exopod, about one-quarter width, almost entire margin bearing plumose setae. Pleopod 2 endopod three-quarters length of exopod, with 5 distal plumose setae; stylet about twice length of endopod, distally curved, with small terminal barb.

Uropod with narrow exopod somewhat reduced, about three-quarters length of basis, bearing several setae distally; endopod distally narrowly rounded with plumose setae on median margin, simple setae on distolateral margin; suture between endopod and basis clearly visible, but ramus apparently not freely articulating.

Etymology.—The species is named for the R/V *Albatross.*

Material.—Albatross st 5660, 5°36′30″S, 120°49′00″E, 1,380 metres (Flores

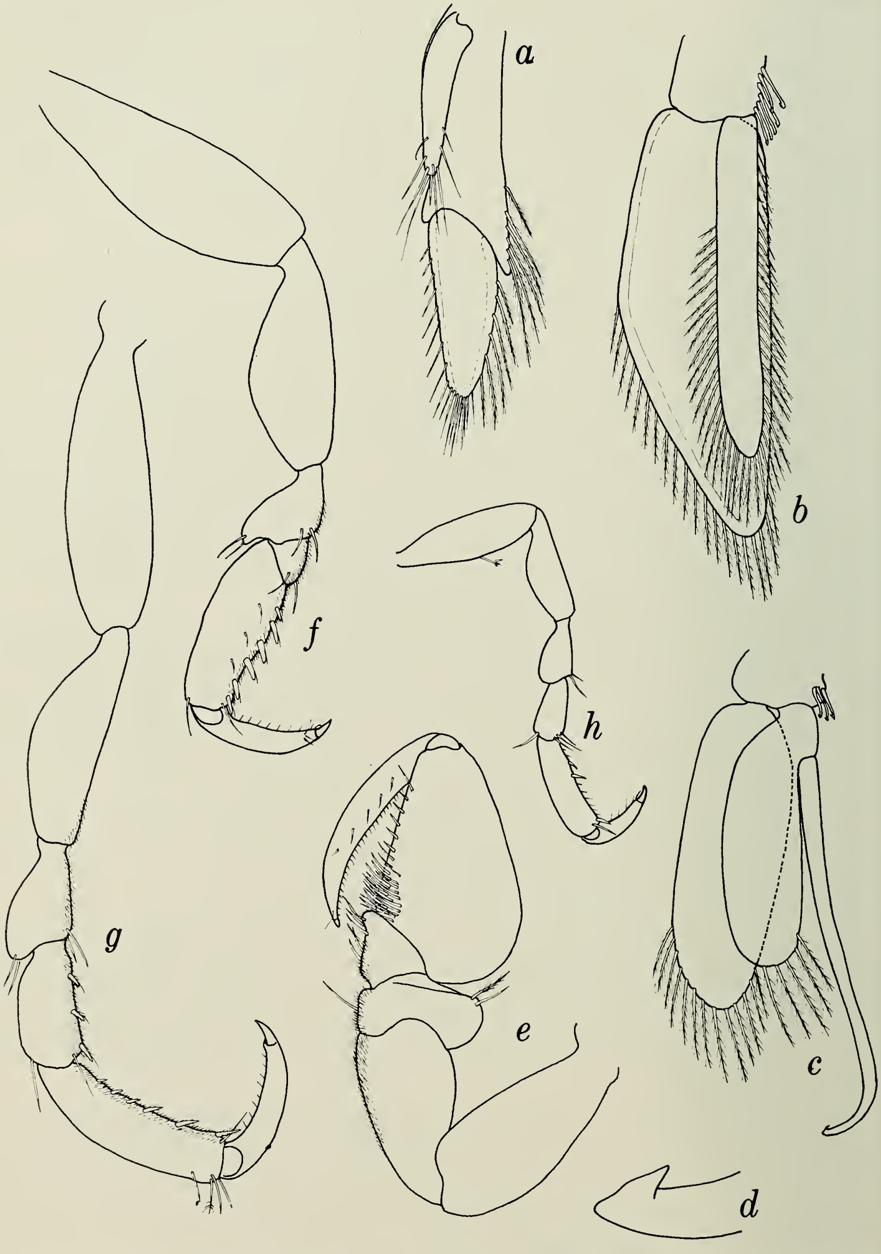

Fig. 4. *Pseudanthura albatrossae*: a, Uropod; b, Pleopod 1; c, Pleopod 2; d, Apex of stylet; e, Pereopod 1; f, Pereopod 2; g, Pereopod 6; h, Pereopod 7.

Sea south of Celebes). Holotype USNM 170273 ♂ TL 39.9 mm; paratype USNM 170276 ♂ TL 23.9 mm.

Pseudanthura lateralis Richardson
Figs. 5, 6

Pseudanthura lateralis Richardson, 1911:7.—Barnard, 1920:343, pl. 15 (figs. 13–16); 1925:157, figs. 1s, 3e, 5d; 1940:497.—Nierstrasz, 1941:252.—Menzies, 1962:191, fig. 70.

Description.—♀. Integument only slightly indurated, bearing tiny evenly spaced ovoid scales. Cephalon less than half length of pereonite 1, lateral margins sinuous. Dorsolateral grooves present on all pereonites. Pereonite 1 two-thirds length of pereonite 2, with strong medioventral crest bearing tooth-like triangular process. Pereonites 2 and 3 each with anterodorsal pair of conical tubercles. Pereonites 2 and 5 subequal in length, 3 and 4 slightly longer, 6 slightly shorter, 7 one-third length of sixth. Telson triangular, apex narrowly rounded.

Antennular peduncle 4-segmented, basal segment longest and broadest, fourth segment very short; flagellum of 6 articles. Antennal peduncle 5-segmented; flagellum of 6 articles.

Mandible acutely triangular; palp 3-segmented, terminal segment tapering distally with row of 9 or 10 spines, middle segment with single distal seta. Maxilla lanceolate, with 13 or 14 distal serrations. Maxilliped 4-segmented, second segment produced into lobe at mediodistal angle; terminal segment bearing several setae.

Pereopod 1, propodus with palm gently convex, armed with row of spines; carpus with 5 or 6 spines on posterior margin. Pereopod 2 propodus with 8 spines on posterior margin; carpus small, triangular.

Pereopods 5–7 with carpus becoming elongate/cylindrical. Pereopod 6 propodus with 5 spines on posterior margin, carpus with 4 spines on posterior margin. Pereopod 7 shorter than preceding pereopods, propodus armed with 4 spines on posterior margin.

Exopod of pleopod 1 indurated, operculate, with plumose setae on distolateral margin, apically acutely rounded; endopod one-third length of exopod, tapering distally, with 2 apical setae.

Uropodal exopod very small, triangular; endopod and basis fused, distolateral margin faintly serrate, with short setae; tiny lobe bearing single plumose seta on mediodistal margin.

♂ Antennular peduncle and flagellum not clearly demarked, filiform aesthetascs on 8 distal segments.

Pleopod 2 stylet twice length of endopod, slender, distally curved, with apical barb; endopod only slightly shorter than exopod.

Previous records.—Coast of West Africa, between Dakar and Praya, 930–

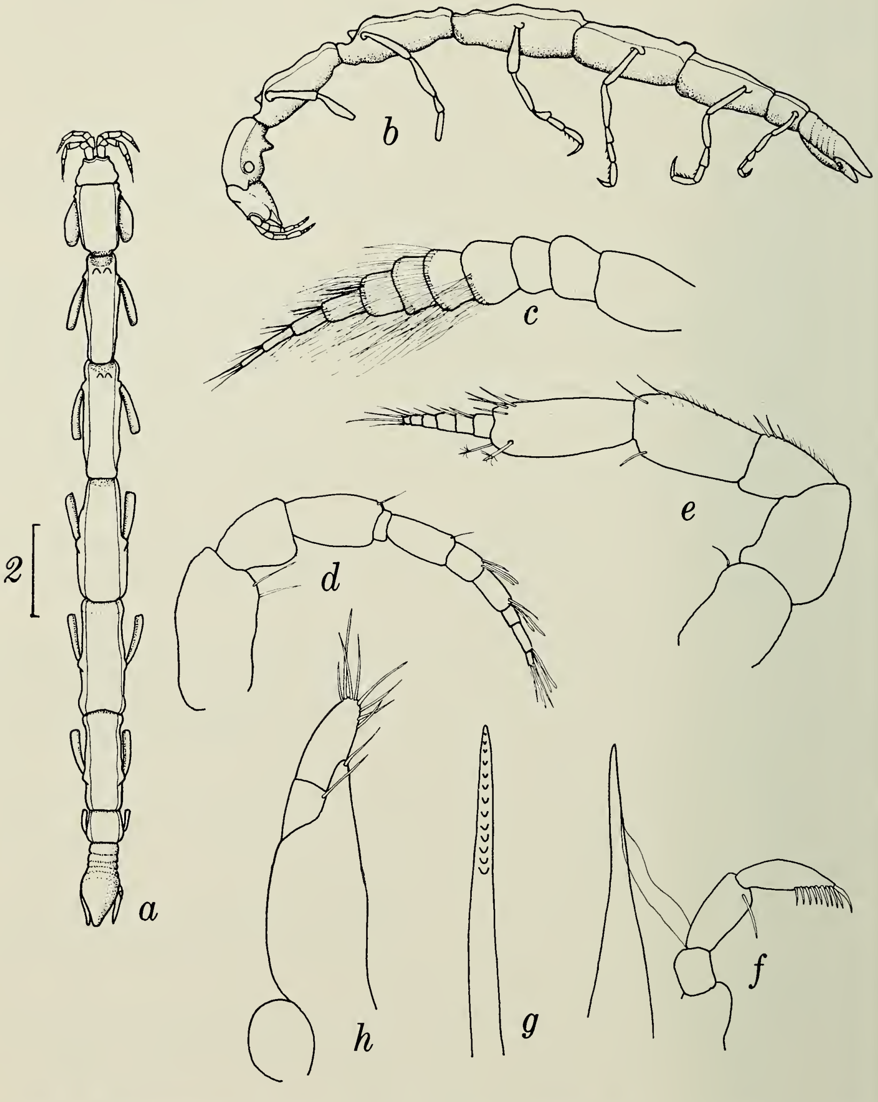

Fig. 5. *Pseudanthura lateralis*: a, Paratype in dorsal view; b, Paratype in lateral view; c, Antennule ♂; d, Antennule ♀; e, Antenna; f, Mandible; g, Maxilla; h, Maxilliped.

3,200 metres (Richardson). Off Cape Point, South Africa, 1,620–1,816 metres (Barnard; Menzies).

Material examined.—Paratype USNM 42171 ♀ West Africa TL 17.5 mm. SAM-A3832 ♂ Cape Point TL 15.5 mm, ♀ 15.6 mm, ovigerous ♀ damaged.

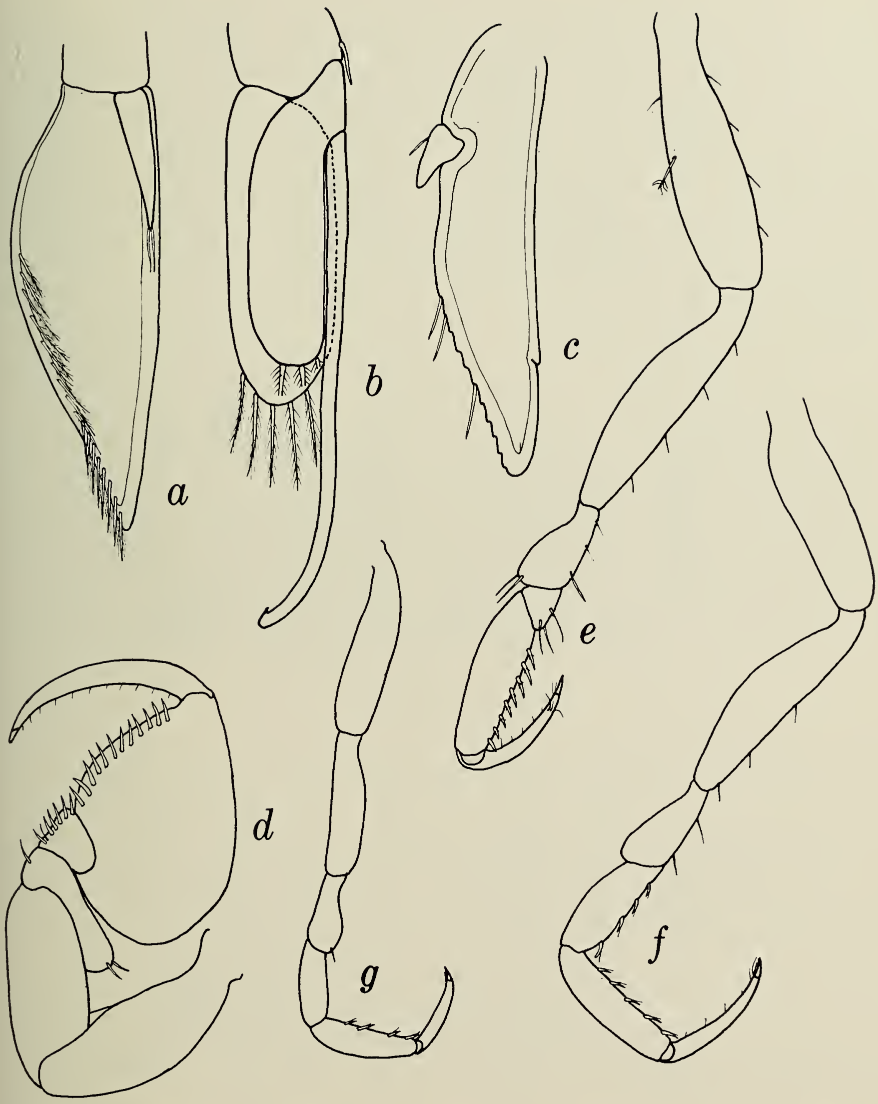

Fig. 6. *Pseudanthura lateralis*: a, Pleopod 1; b, Pleopod 2 ♂; c, Uropod; d, Pereopod 1; e, Pereopod 2; f, Pereopod 6; g, Pereopod 7.

Discussion.—Richardson (1911) established the genus *Pseudanthura* for three specimens from deep water off West Africa, collected by the R/V *Talisman*, and noted that this genus differed from all others in the family in the reduced uropodal exopod. The formerly monotypic genus now contains three species, each displaying such important diagnostic features

Table 1.

	P. tenuis	*P. albatrossae*	*P. lateralis*
Body Width/Length	1/18	1/14	1/11
Integument	Strongly indurated, with tiny scales	Slightly indurated, lacking tiny scales	Slightly indurated, with tiny scales
Pereonite 1	Strong medioventral crest with tooth-like process	Strong medioventral crest tooth lacking	Strong medioventral crest with tooth-like process
Pereonite 3	Anterolateral corners rounded	Anterodorsal corners produced	Anterolateral corners rounded
Pereonites 7/6	3/10	1/4	1/3
Pleopod 1	Endopod ¼ exopod length, triangular	Endopod ⅘ exopod length parallel-sided, elongate	Endopod ⅓ exopod length triangular
Uropod	Articulation faintly indicated between basis and endopod Exopod short, triangular	Articulation visible between basis and endopod Exopod elongate, triangular	No articulation visible Exopod short, triangular
Telson	Triangular, lateral margin straight Dorsally smoothly convex	Triangular, lateral margin sinuous Strong mediodorsal ridge	Triangular, lateral margin slightly sinuous Dorsally smoothly convex

as the reduction of the uropodal exopod and the endopod of pleopod 1, and the tendency towards fusion of the uropodal basis and endopod into a rigid structure which closes the branchial chamber laterally. The three species may be separated on several features, the more obvious of which are given in Table 1. The species from the Flores Sea may be regarded as the least specialized of the three, showing as it does, the relatively elongate endopod of pleopod 1, the relatively elongate uropodal exopod (when compared with *P. lateralis* and *P. tenuis*) and the suture between uropodal basis and endopod. *P. tenuis* is perhaps intermediate between *P. albatrossae* and *P. lateralis* as there are still traces of the fusion line between uropodal basis and endopod, although this structure is completely rigid. The uropodal exopod is relatively longer than in *P. lateralis* but shorter than in *P. albatrossae.*

Barnard (1925:127) regarded *Pseudanthura* as a representative of the 'limicolous' group of anthurids i.e. living on fine muddy substrates. The Natal species was taken in a light biological dredge, from hard fine mud overlain with pteropod, heteropod, and foraminiferan shells, coral fragments, and sponge spicules. The fauna of this conglomerate was rich, containing numerous crustacea, small molluscs, and echinoderms. Compared to the Atlantic and Flores species, the much harder integument of this species may be related to this fairly coarse substrate.

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THE TAXONOMIC POSITION OF THE MODERN SEA-STAR *CISTINA* GRAY, 1840

Daniel B. Blake

Abstract.—The taxonomic position of the sea-star *Cistina columbiae* Gray, 1840, has been uncertain because it possesses characters which allow its referral to two different families, as presently conceived. A reevaluation, stressing skeletal morphology, strongly indicates ophidiasterid affinities, as originally suggested by Gray.

Introduction

Gray (1840) included his new genus and species *Cistina columbiae* with genera now assigned to the Ophidiasteridae. Because *C. columbiae* bears a small spine on the primary abactinal and marginal ossicles, a feature otherwise unknown among ophidiasterid genera, its taxonomic position has been questioned (H. L. Clark, 1921) and the genus recently has been included in the family Echinasteridae (A. M. Clark and Rowe, 1971). Assignment has remained difficult because the genus has been only rarely encountered, hence adequate material for comparative study has not been available.

Miss A. M. Clark [British Museum (Natural History)] brought this taxonomic problem to the attention of the writer, and very kindly made a specimen of *C. columbiae* available for dissection and study.

In evaluating the ossicle morphology of the ambulacral column, I became convinced that Gray was correct in his assessment of affinities and that *Cistina* indeed is an ophidiasterid. Further studies at the U.S. National Museum of Natural History revealed that *Cistina* is very close to *Leiaster*, a fact suggested by the close placement of the two genera in H. L. Clark's key (1921:37).

It is therefore recommended here that *Cistina* be returned to the Ophidiasteridae and assigned a position near *Leiaster*. The two genera are here compared with each other and with *Echinaster*, and a diagnosis of *Cistina columbiae* is provided.

Materials and Methods

Specimens studied included the following:

Cistina columbiae Gray, 1840, BM(NH) 86.12.29.4; Mauritius; *R* range = 48–85 mm, *r* = 9 mm.

Leiaster teres Verrill, 1871, USNM 39991; Gulf of California; *R* = 90 mm, *r* = 13 mm.

Echinaster modestus Perrier, 1881, University of Illinois, Department of Geology; west coast of Florida; 10 specimens, ossicles from specimen $R = 60$ mm, $r = 12$ mm.

Arm fragments were manually broken from the specimens; disc fragments were removed using a high speed rotary hand tool with a cutting disc. Such a tool permits removal of fragments with very little vibration and specimen distortion, hence minimizing the chances for ossicle breakage. In spite of this procedure, ossicles commonly are found to be broken once the flesh has been cleared (e.g., Fig. 2 row C, middle). Study of untreated, dried specimens frequently reveals ossicles already broken; tissue shrinkage associated with drying apparently can pull ossicles apart, especially where these structures are relatively fragile and the tissues thick.

Ossicles were isolated through treatment in sodium hypochlorite (common household bleach). Drawings were prepared through the use of photographic negatives and an enlarger; shading was based on prints from the negatives. In preparation for photography, ossicles and the arm of *Echinaster* were first painted with dark ink, dried, then coated with ammonium chloride. Arm fragments of *Leiaster* and *Cistina* were not ink-painted because the thick skin layer does not absorb ink, resulting in an irregular coloring and poor photographs.

Comparative Morphology of *C. columbiae* (C.), *L. teres* (L.), and *E. modestus* (E.)

1. Arrangement of abactinal ossicles, marginals
   - L. all in regularly defined longitudinal rows, overlapping in proximal direction
   - C. rows more or less regularly defined, otherwise as L.
   - E. abactinals in more or less irregular, longitudinal rows; marginals in regular rows; all series overlapping in the distal direction
2. Morphology of primary abactinals (see Fig. 2, row a)
   - L., C. flattened, cross-shaped
   - E. weakly inflated, bearing small articulation facets
3. Encrusting ossicles on primary abactinals
   - L. absent
   - C.,E., short spines
4. Secondary abactinals and papulae distribution
   - L., C. secondaries in well-defined rows, separating well-defined rows of papulae
   - E. secondaries scattered, papulae irregular in distribution
5. Intermarginals[1]
   - L. on arms, single row of rod-like ossicles reaching or nearly reaching arm tip; few extra ossicles probably present interbrachially

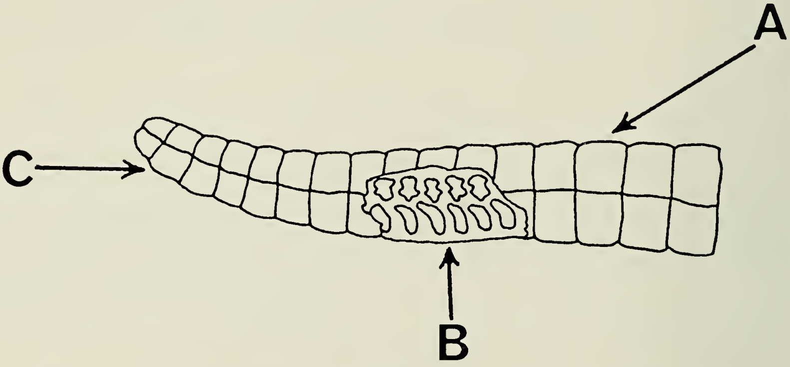

Fig. 1. Stylized lateral view of sea-star arm showing orientation of drawings of ambulacrals and adambulacrals in Figs. 2, 3. Marginals have been removed medially to show positions and orientation of ambulacrals (above) and adambulacrals (below).

C. arm development as in L.; interbrachial region not clearly observed, but space available for few added intermarginals

E. single irregular row originating about ¼ distance from arm tip, increasing to numerous somewhat irregularly arranged interbrachial series, these ossicles largely actinal in position on disc

6. Interactinals[1]

L., C. two rows, abactinal row similar to secondary abactinals; actinal row ossicles flat, overlapping

E. lacking, or few ossicles present immediately radial to oral ossicles

7. Adambulacral form (see Fig. 3)

L., C. adradial ossicle tip directed distally as flange (Fig. 3:1); furrow armature longitudinally arranged

E. adradial ossicle tip directed into furrow (Fig. 3:1); furrow armature radially arranged

8. Adambulacral articulation (Fig. 3)

a. L., C. inter-adambulacral muscle depression on proximal face high, triangular (Fig. 3:2)

E. inter-adambulacral muscle depression on proximal face low, elliptical (Fig. 3:2)

b. L., C. interadambulacral contact structures developed as distinct adradial process and a low transverse ridge rather sharply set off from adambulacral-ambulacral articulation structures (Fig. 3:3)

E. interadambulacral contact structures developed as a transverse ridge, forming the base of a broad, V-shaped ridge continuous with adambulacral-ambulacral articulation structures (Fig. 3:3)

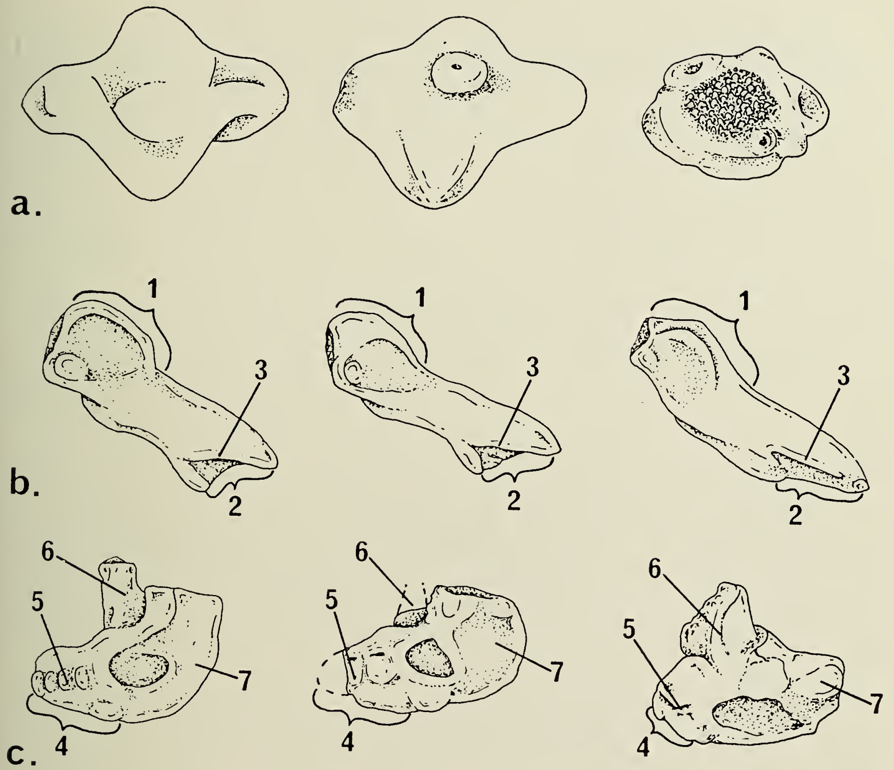

Fig. 2. Ossicle morphology of *L. teres* (left column), *C. columbiae* (middle column) and *E. modestus* (right column). Row a, abactinals in oblique abactinal view; spine bases present on *columbiae*, *modestus*, glassy granules on *modestus*. Row b, ambulacrals in proximal view (C in Fig. 1), furrow left. 1. Adradial articulation flanges; 2. Ambulacral-adambulacral articulation structures; 3. Muscle wings. Row c, oral ossicles in furrow view, mouth to left, actinal down; 4. Proximal tip; 5. Spine base row; 6. First ambulacral articulation flange; 7. Distal flange. Dotted lines on *Cistina* are reconstructions based on fracture surfaces visible on ossicles.

c. L., C. adambulacral-ambulacral contact structures developed as two distinct, prominent, subcircular processes (Fig. 3:4)
E. adambulacral-ambulacral contact structures developed as the vertical arms of a broad U-shaped ridge (Fig. 3:4)

9. Ambulacral morphology (see Fig. 2, row b)
   a. L., C. adradial articulation structures on a prominent flange, sharply set off from remainder of ossicle; flanges strongly overlap next proximal ambulacral (Fig. 2:1)
   E. adradial articulation structures on a low flange, gradational with remainder of ossicle; flanges weakly overlap next proximal ambulacral (Fig. 2:1)

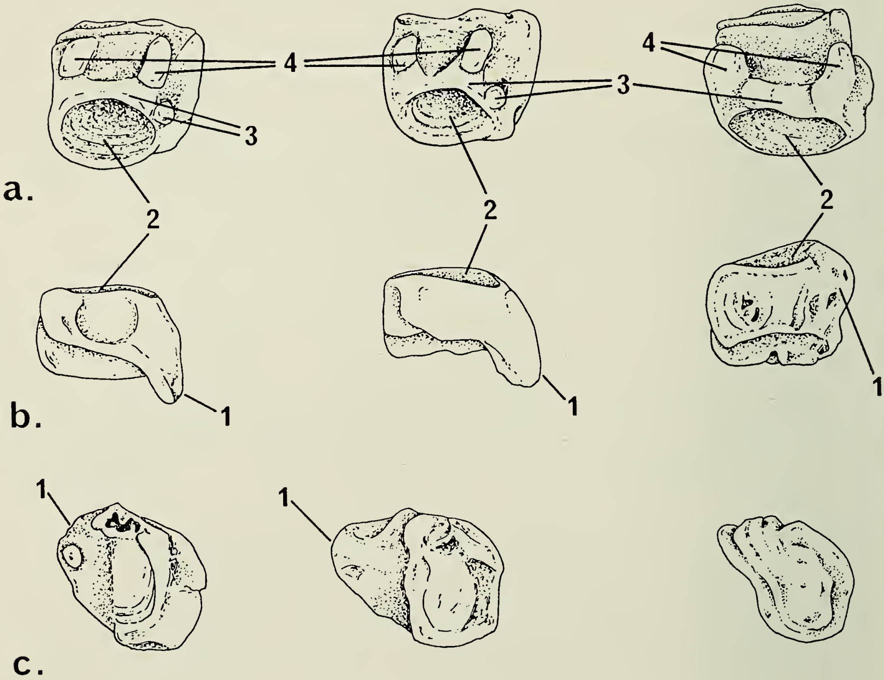

Fig. 3. Ossicle morphology of *L. teres* (left column), *C. columbiae* (middle column) and *E. modestus* (right column). Adambulacrals from left side of arm, row a, oblique proximal view (A, Fig. 1); row b, actinal view (B, Fig. 1); row c, abradial view (normal to Fig. 1); furrow right in a, b; down in c. Key: 1. Adradial flange, distally directed; 2. Interadambulacral muscle depression; 3. Interadambulacral articulation facets; 4. Adambulacral-ambulacral articulation facets.

b. L., C. ambulacral-adambulacral articulation structures developed as narrow, high surface, the actinal margin of the surface and the articulation wings more or less steeply inclined to the ossicle axis (Fig. 2:2, 3)

E. ambulacral-adambulacral articulation structures developed as broad, low surface, the actinal margin of the surface and the articulation wings oriented subparallel to the ossicle axis (Fig. 2:2, 3)

10. Orals[2] (see Fig. 2, row c)

a. L., C. proximal ossicle tip triangular, attenuated; bearing prominent spine base row (Fig. 2:4, 5)

E. proximal ossicle tip short, broadly triangular; spine base row not prominent (Fig. 2:4, 5)

b. L., C. first ambulacral articulation bar approximately medially placed (Fig. 2:6)

E. first ambulacral articulation bar placed proximal of medial (Fig. 2:6)

c. L. distal portion of ossicle developed as a high, prominent flange (Fig. 2:7)

C. distal portion of ossicle developed as moderately high flange (Fig. 2:7)

E. distal portion of ossicle developed as a low flange (Fig. 2:7)

Family OPHIDIASTERIDAE Verrill, 1867
Genus CISTINA Gray, 1840
Cistina columbiae Gray, 1840
Plate 1, figs. 1a–1d; Figs. 2, 3, middle columns

Echinaster sladeni de Loriol, 1893

Rays cylindrical, 5 in number, somewhat stout for family, of varied lengths, tips blunt; disc relatively small. Body covered by fairly thick skin which can be reddish brown when dried. Papulae arranged in longitudinal rows between secondary abactinals, intermarginals, and abactinal row of interactinals. Marginals and primary abactinals morphologically similar, arranged in 7 fairly well-defined longitudinal rows (3 abactinal, 4 marginal); individual ossicles flat, generally bearing 4 flanges that overlap adjacent secondary ossicles and next proximal ossicle of primary series. Generally 1, occasionally more short stout spines borne medially on ossicle; spine base circular, inflated; remainder of surface without encrusting ossicles. Secondary ossicles flattened, transversely elongate, separated from one another by gaps for papulae; secondaries link and are overlapped by primary series. Interactinals in 2 series; row below inframarginals similar to secondary abactinals; row adjacent to adambulacrals simple flat discs, overlapping proximally. Secondary abactinals, interactinals lack encrusting ossicles. Adambulacral ossicle actinal surfaces rectangular in outline, closely spaced along arm. Furrow spines short, tapered, columnar, not grooved, arranged in single longitudinal row on arm, 2 spines on each adambulacral. Sub-ambulacral spines longer, tapered, columnar, arranged in single longitudinal row, 1 on each adambulacral proximally, gradually reduced to 1 on alternate adambulacrals distally. Individual adambulacrals rectangular in side face outline, bearing prominent distally deflected furrow flange. Ambulacral ossicles bearing prominent adradial, proximally directed muscle flange for articulation with next proximal ambulacral. Oral ossicles bear attenuated, triangular proximal tip; prominent spine bases; approximately medially placed first adambulacral articulation bar.

Remarks.—Gray (1840:283) reports the type-material of *Cistina columbiae* from the west coast of Colombia; unfortunately, the location of the types is unknown (Clark, 1921:71; Clark & Rowe, 1971:72). Clark and Rowe

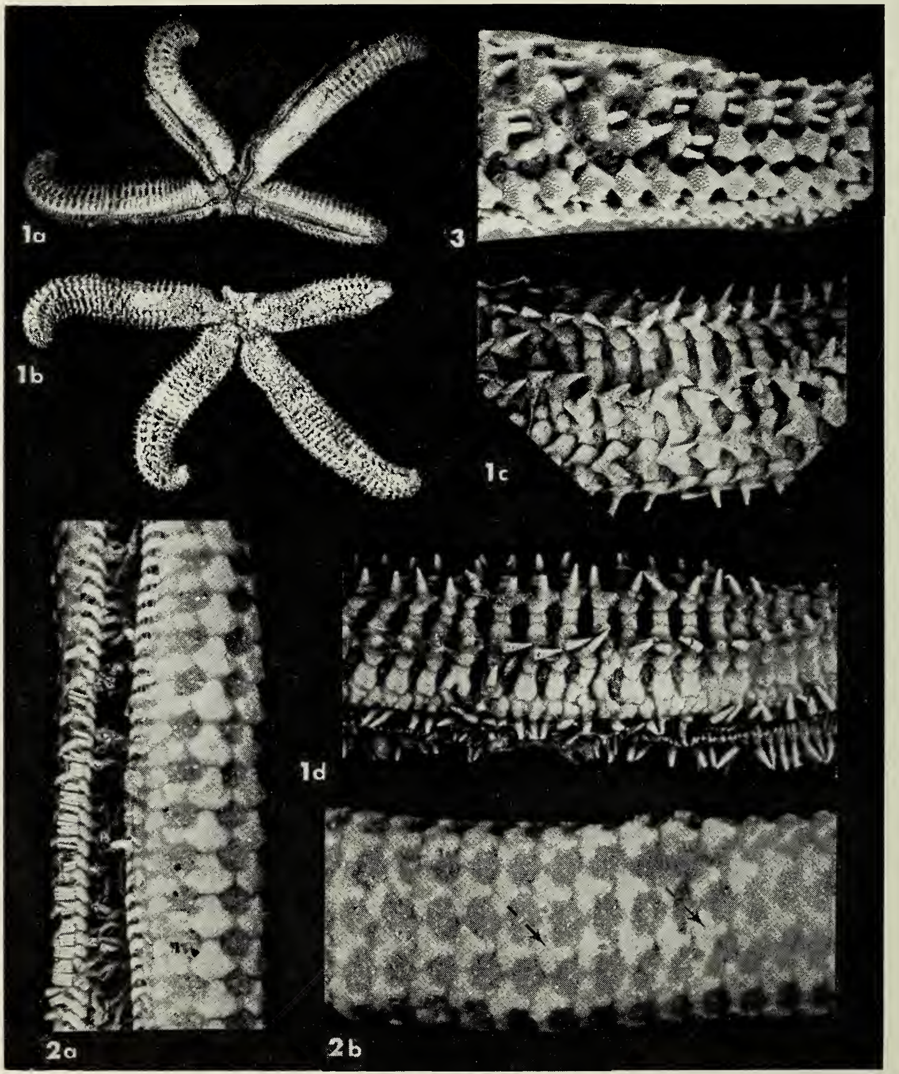

Plate 1. 1. *C. columbiae.* a, b, Abactinal, actinal views, overall form of species, ×4; c, Lateral view of arm, marginals below, lateral row of abactinals, carinals, secondary abactinals above, ×2; d, Ventrolateral view, marginals, interactinals, furrow area, ×2½. 2. *L. teres.* a, Ventrolateral view, marginals, interactinals, furrow area, ×2; b, Abactinal view, carinals (arrow), laterals, supramarginals, ×2. 3. *E. modestus*, lateral view, double row of marginals below, irregular distribution of abactinals, ×3.

(1971), in comparing Gray's and de Loriol's descriptions to the specimen studied here, place *E. sladeni*, the types of which are from Mauritius, in synonymy with *C. columbiae.* They further argue that the *Cistina* type-material probably also was from Mauritius, source of much of Gray's material. The available specimen does closely fit Gray's description, including the presence of 7 rows of spines on the arms, a critical feature leading to the taxonomic difficulties considered here.

Acknowledgments

I am indebted to Miss Ailsa M. Clark for bringing the problem to my attention and for making a specimen of *C. columbiae* available; to Ms. Maureen E. Downey for reviewing the manuscript and making available a specimen of *Leiaster teres* Verrill; to Mr. Edward Snyder (University of Illinois) for preparation of drawings, and to Ms. Danita Brandt (University of Illinois) for other technical assistance. Research was supported in part through NSF BMS 75-19427.

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Footnotes

[1] Identification of marginals, and hence recognition of intermarginal and interactinal series can be difficult in those sea stars, such as the three under discussion here, that lack marginals clearly differentiated in either size or morphology. It is my opinion, however, that almost invariably in the sea-stars a double series of ossicles arises near the actinal lateral margin of each side of the terminal, and that this series can be traced along the arm, recognizable through position and alignment, size, or morphology, or some combination of these criteria. I believe marginals can be recognized in the taxa under consideration, and hypothesize that the marginal series are homologous as a differentiated arm framework (a hypothesis presumably testable by ontogenetic studies) and the intermarginal and interactinal series evaluations were based on these conclusions.

[2] Both the first ambulacral articulation bar and the proximal ossicle tip are missing in the available orals of *Cistina* on which the drawings are based; see remarks under Materials and Methods.

Note added in proof.—Tortonese and Downey (1977) have revived the generic name *Othilia* Gray for those species previously assigned to *Echinaster* that bear glassy tubercles on the primary ossicles of the surface (e.g., abactinals, marginals). *O. modestus*, discussed here under *Echinaster*, is included in this group.

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A NEW CYCLOPOID COPEPOD, *PSEUDANTHESSIUS LIMATUS*, ASSOCIATED WITH AN OPHIUROID IN PANAMA (ATLANTIC SIDE)

Arthur G. Humes

Abstract.—The poecilostome copepod *Pseudanthessius limatus*, new species, occurs on the disk rather than the arms of the ophiuroid *Ophiopsila* sp. in Panama. The host is buried in sand, completely so during the day, but with three arms extended during the night.

Copepods of the genus *Pseudanthessius* Claus, 1889, are infrequently associated with brittle stars (Ophiuroidea). The only known association is that of *Pseudanthessius deficiens* Stock, Humes, and Gooding, 1963, on *Ophioderma cinereum* Müller and Troschel in the West Indies (Curaçao, St. Martin, Puerto Rico). In Panama a second species of *Pseudanthessius* has been found on an ophiuroid, in this case *Ophiopsila* sp.

I am greatly indebted to Dr. Gordon Hendler, Smithsonian Tropical Research Institute, Balboa, Canal Zone, for sending me the specimens of the new species and for supplying observations on living copepods and the host.

The study of the copepods has been aided by two grants from the National Science Foundation, BMS 74-17652 and DEB 77-11879.

The observations and measurements were made on specimens cleared in lactic acid. All figures were 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, MXPD = maxilliped, and P_1 = leg 1.

Pseudanthessiidae Humes and Stock, 1972

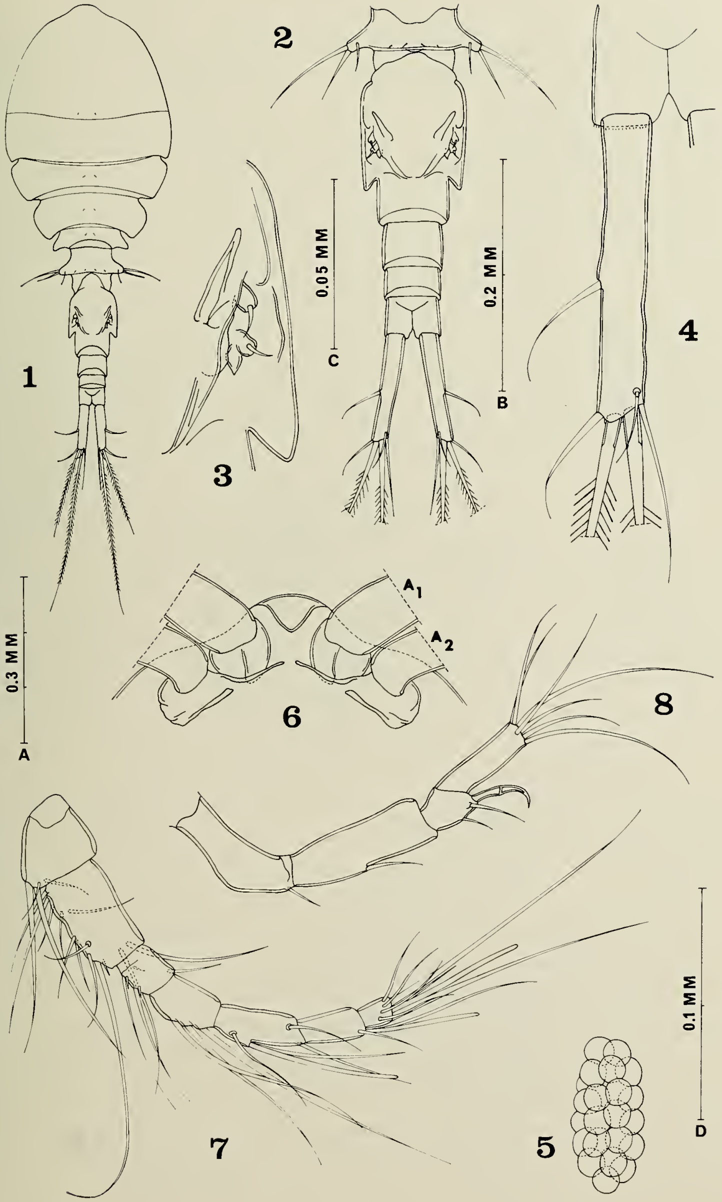
Pseudanthessius Claus, 1889

Pseudanthessius limatus, new species

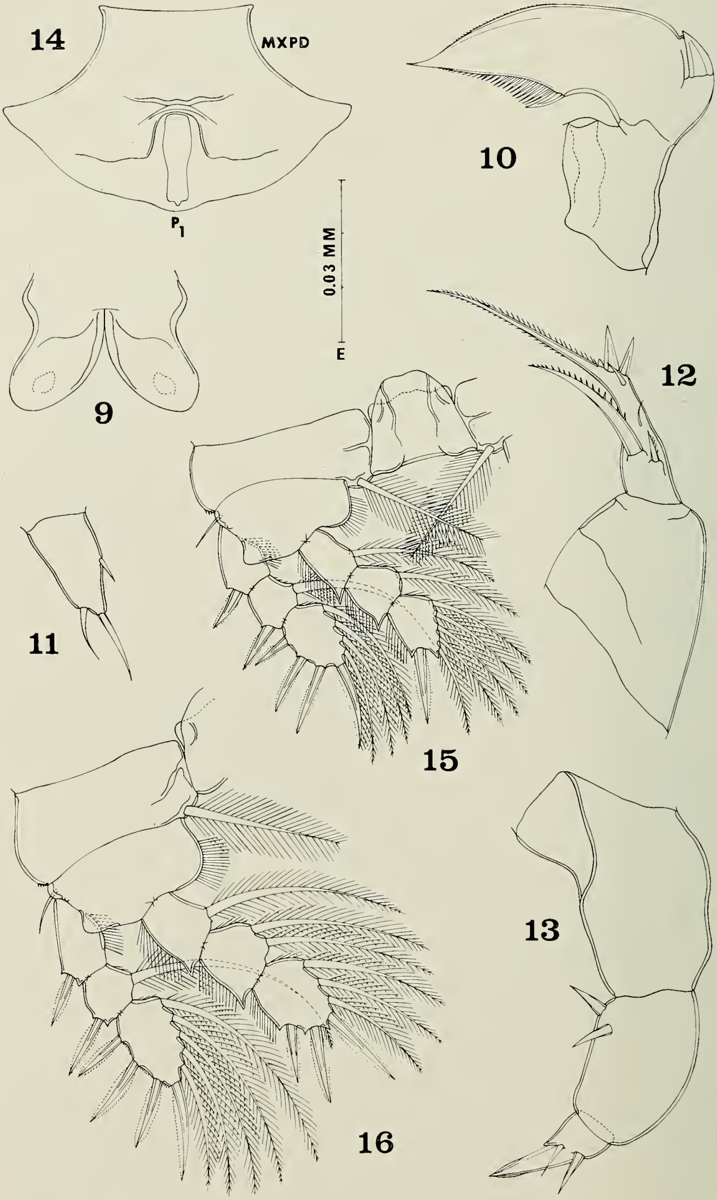
Figs. 1–25

Type-material.—8♀♀, 4♂♂ from the disk of the ophiuroid *Ophiopsila* sp., in a depth of 6–9 m, Korbiski Reef, San Blas Islands, Panama (Atlantic side), 5 November 1976. Collected by G. Hendler. Holotype ♀ (USNM 170306), allotype (USNM 170307), and 6 paratypes (5♀♀, 1♂, USNM 170308) deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.; the remaining paratypes (dissected) in the collection of the author.

Female.—Body (Fig. 1) with moderately broad prosome. Length (not including setae on caudal rami) 0.80 mm (0.73–0.86 mm) and greatest



Figs. 1–8. *Pseudanthessius limatus*, female: 1. Dorsal (A); 2. Urosome, dorsal (B); 3. Genital area, dorsal (C); 4. Caudal ramus, dorsal (C); 5. Egg sac, lateral (A); 6. Rostrum, ventral (D); 7. First antenna, dorsal (D); 8. Second antenna, posterior (D).



Figs. 9–16. *Pseudanthessius limatus,* female: 9. Labrum, with positions of paragnaths indicated by broken lines, ventral (C); 10. Mandible, anterior (E); 11. First maxilla, posterior (E); 12. Second maxilla, posterior (E); 13. Maxilliped, inner (E); 14. Area between maxillipeds and first pair of legs, ventral (D); 15. Leg 1 and intercoxal plate, anterior (D); 16, Leg 2, anterior (D).

width 0.24 mm (0.23–0.25 mm), based on 4 specimens in lactic acid. Ratio of length to width of prosome 1.47:1. Ratio of length of prosome to that of urosome 1.21:1. Segment of leg 1 separated from head by a weak dorsal transverse furrow.

Segment of leg 5 (Fig. 2) 52 × 104 μm. Genital segment in dorsal view 122 μm long. Anterior two-thirds 86 μm wide with parallel lateral margins, posterior corners acuminate. Posterior third narrower, 59 μm wide. Genital areas located dorsolaterally near middle of segment. Each genital area (Fig. 3) bearing 2 small naked setae and a spiniform process. Three postgenital segments from anterior to posterior 39 × 50, 26 × 44, and 31 × 44 μm. Posteroventral margin of anal segment with minute spinules.

Caudal ramus (Fig. 4) elongate, 86 × 13 μm, ratio of length to width 6.6:1. Outer lateral seta 36 μm, dorsal seta 22 μm, outermost terminal seta 35 μm, innermost terminal seta 52 μm; all these setae naked. Two long median terminal setae 164 μm (outer) and 300 μm (inner), both with delicate lateral spinules.

Body surface with very few hairs (sensilla).

Egg sac (Fig. 5) elongate oval, 278 × 120 μm, reaching to end of caudal ramus, containing approximately 27 eggs each about 51 μm in average diameter.

Rostrum (Fig. 6) small with acutely rounded posteroventral margin.

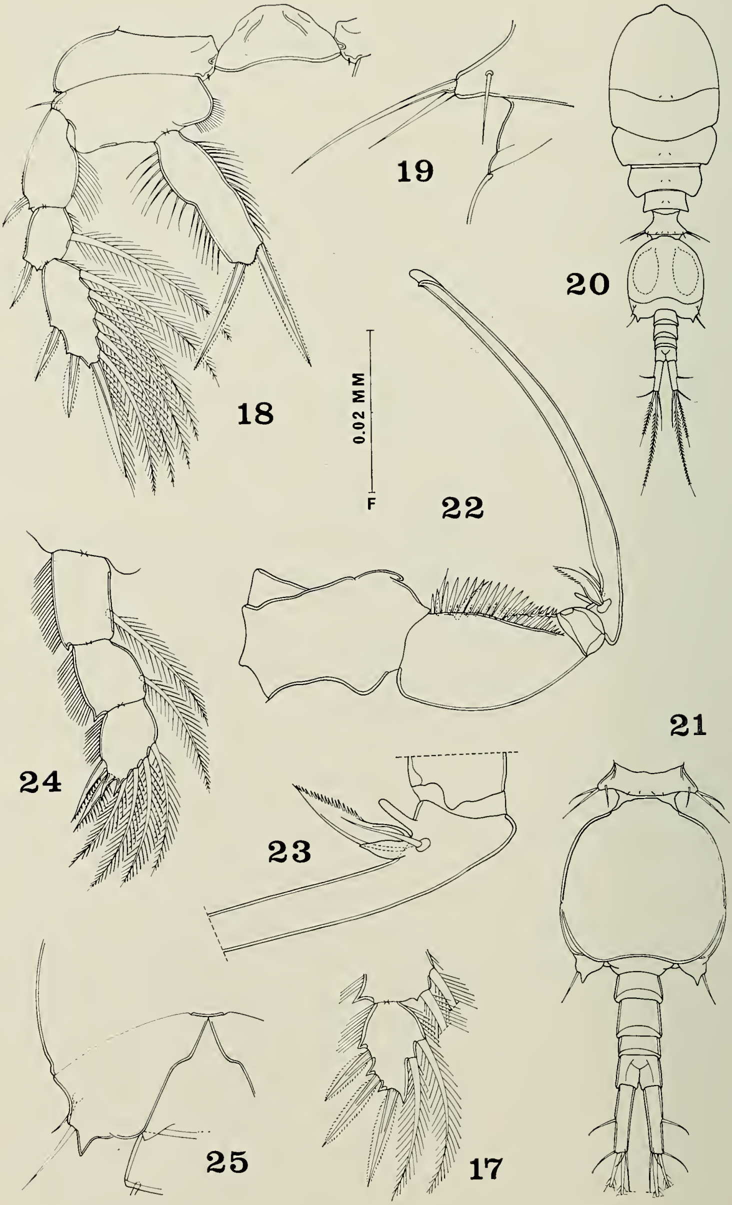
First antenna (Fig. 7) 181 μm long. Lengths of 7 segments (measured along their posterior nonsetiferous margins): 26 (32 μm along anterior margin), 42, 17, 24, 30, 23, and 13 μm respectively. Formula for armature: 4, 13, 6, 3, 4 + 1 aesthete, 2 + 1 aesthete, and 7 + 1 aesthete.

Second antenna (Fig. 8) 146 μm long. Formula: 1, 1, 2 + 1 claw, and 7. Fourth segment 41 μm along outer edge, 33 μm along inner edge, and 12 μm wide. Distinct claw on third segment, but none of terminal elements on fourth segment clawlike. All setae smooth.

Labrum (Fig. 9) with 2 slender posteroventral lobes. Mandible (Fig. 10) with convex margin bearing a toothlike scale and minute distal spinules; concave margin with a stout spine followed by slender spinules. Paragnath a small lobe. First maxilla (Fig. 11) with 3 setae. Second maxilla (Fig. 12) with first segment unarmed; second segment bearing on its posterior surface a large spine and a small spine, both with spinules along one side, and a slender setule. Second segment produced to form a barbed lash having near its base 2 prominent spines, a small seta, and a small spine. Maxilliped (Fig. 13) with first segment unarmed; second segment with 2 smooth setae; third segment with 2 smooth setae and produced to form an acuminate tip with narrow lamellae.

Ventral area between maxillipeds and first pair of legs (Fig. 14) slightly protuberant.

Legs 1–4 (Figs. 15, 16, 17, 18) segmented as in other species of *Pseudan-*



Figs. 17–19. *Pseudanthessius limatus*, female: 17. Third segment of endopod of leg 3, anterior (D); 18. Leg 4 and intercoxal plate, anterior (D); 19. Leg 5, dorsal (D).

Figs. 20–25. *Pseudanthessius limatus*, male: 20. Dorsal (A); 21. Urosome, dorsal (B); 22. Maxilliped, posterior (C); 23. Detail of base of claw of maxilliped, anterior (F); 24. Endopod of leg 1, anterior (C); 25. Leg 6, ventral (D).

thessius. Formula for armature as follows (Roman numerals representing spines, Arabic numerals setae):

P_1	coxa	0-1	basis	1-0	exp	I-1;	I-1;	III,I,4
					enp	0-1;	0-1;	I,5
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	II		

Inner margin of basis with hairs in all 4 legs. Inner coxal seta in legs 1–3 long and plumose, but in leg 4 minute, 3 μm. Leg 4 with exopod 102 μm long. Endopod 62 × 20 μm, its 2 terminal fringed spines 47 μm (outer) and 53 μm (inner); bearing well developed setules along both inner and outer margins.

Leg 5 (Fig. 19) with 2 smooth setae 86 μm and 44 μm and an adjacent smooth dorsal seta 29 μm.

Leg 6 probably represented by 2 setae on genital area (Fig. 3).

Living specimens in reflected light transparent, egg sacs white.

Male.—Body (Fig. 20) with prosome more slender than in female. Length (excluding setae on caudal rami) 0.69 mm (0.66–0.72 mm) and greatest width 0.19 mm (0.17–0.20 mm), based on 4 specimens in lactic acid. Ratio of length to width of prosome 1.91:1. Ratio of length of prosome to that of urosome 1.17:1.

Segment of leg 5 (Fig. 21) 41 × 71 μm. Genital segment 133 × 133 μm (length including leg 6). Four postgenital segments from anterior to posterior 23 × 42, 29 × 38, 18 × 34, and 26 × 36 μm.

Caudal ramus (Fig. 21) 60 × 13 μm, ratio 4.62:1, relatively shorter than in female.

Body surface with very few hairs, as in female.

Rostrum, first antenna, second antenna, labrum, mandible, paragnath, first maxilla, and second maxilla as in female. Maxilliped (Fig. 22) with unornamented first segment. Second segment with 2 smooth setae and 2 rows of spines. Small third segment unarmed. Claw 120 μm including terminal lamella, bearing proximally 2 unequal setae, one stout with distal barbed fringe, other slender and smooth. Near insertions of these 2 setae 2 processes (Fig. 23), one digitiform, other lamelliform.

Ventral area between maxillipeds and first pair of legs as in female.

Legs 1–4 similar to those of female except endopod of leg 1 (Fig. 24) where formula is 0-1; 0-1; I,I,4.

Leg 5 like that of female.

Leg 6 (Fig. 25) a posteroventral flap on genital segment, bearing 2 slender smooth setae 36 μm and 18 μm.

Fully developed spermatophores not seen.

Living specimens colored as in female.

Etymology.—The specific name *limatus*, Latin = polished or refined, alludes to the smooth nature of the body in this species.

Comparison with other species of Pseudanthessius.—In 27 of the 34 species presently attributed to the genus *Pseudanthessius* the caudal rami in the female have a length to width ratio of only 5:1 or less, distinctly shorter than in *Pseudanthessius limatus.* In three species, *Pseudanthessius concinnus* Thompson and A. Scott, 1903, *Pseudanthessius dubius* Sars, 1918, and *Pseudanthessius thorelli* (Brady, 1880), the caudal ramus is much longer (at least 9:1) than in *P. limatus.* The remaining four species, in which the length of the caudal ramus approaches that of *P. limatus*, may be distinguished from the new species by the form of the genital segment in the female, the genital segment in these having neither parallel sides nor acuminate points. Each of the four species may be distinguished from *P. limatus* on the other grounds also. In *Pseudanthessius gracilis* Claus, 1889, several elements on the fourth segment of the second antenna are clawlike. In *Pseudanthessius graciloides* Sewell, 1949, the long setae on the caudal rami are flattened and spinelike. In *Pseudanthessius aestheticus* Stock, Humes, and Gooding, 1963, none of the elements on the third segment of the second antenna is a well-formed claw but instead all are setiform. In *Pseudanthessius deficiens* Stock, Humes, and Gooding, 1963, one of the terminal elements on the fourth segment of the second antenna is a stout claw.

Observations on living copepods and their host.—One to several *Pseudanthessius limatus* occur on both dorsal and ventral surfaces of the disk, rather than on the arms of the ophiuroids. The copepods are motile and perch on the disk with their bodies arched between the prosome and urosome. An unidentified heterotrich is common on these *Ophiopsila*, but on the spines rather than on the disk.

Ophiopsila sp. lives in 1.5–12 m, buried usually in medium grain calcareous sand, with generally three arms extended almost straight out of the sand. These ophiuroids are seen only at night, when they extend their arms at dusk but withdraw into the sand by the first light of dawn.

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A REVISION OF THE NEARCTIC SPECIES OF *LIMNELLIA* MALLOCH (DIPTERA: EPHYDRIDAE)

Wayne N. Mathis

Abstract.—Nearctic species of *Limnellia* Malloch are revised. Of the 10 species considered, the following seven are newly described, with type-localities listed in parentheses: *L. andersoni* (3 mi SE Auburn, Calif.); *L. balioptera* (23.2 mi S South Bend, Wash.); *L. huachuca* (Ramsey Canyon, Ariz.); *L. lactea* (Rustler Park, Ariz.); *L. lecocercus* (Robson, British Columbia); *L. sticta* (Knowlton Ldg., Quebec); *L. turneri* (Mt. Rainier, Berkeley Park, Wash.). *L. oscitans* (Walker) is synonymized under *L. stenhammari.* All Nearctic species except *L. stenhammari* are endemic, the latter is the only species known to occur in both western and eastern North America; and *L. quadrata* (Fallén) has not been found in North America. Male genitalia are used extensively to distinguish species, these are illustrated for most species. A key, wing photos, and distribution maps are also provided.

Introduction and Review

Many Diptera, particularly those inhabiting boreal zones at northern latitudes, have Holarctic distributions (Vockeroth, in preparation). Species thus distributed have often been described more than once, each without considering the adjoining but sometimes disjunct fauna. Sometimes a disjunct distribution has itself been interpreted as sufficient evidence for a second description. The opposite also occurred. Older names of well known European species have frequently been used for similar appearing, but distinct Nearctic species, the identities of which were discovered later. Both situations are apparent with species of the shore fly genus *Limnellia* Malloch. The resulting confusion has prompted the present endeavor.

Solving many of these problems is due in large measure to Andersson's (1971) revision of the European *Limnellia.* In this thorough work, adequate descriptions and illustrations were made available for European species. Andersson also examined type specimens, usually syntype series, and where necessary designated lectotypes. With reliable information on the European species, much of the confusion noted above could be clarified.

The shore fly genus *Limnellia* presently numbers 16 species, seven of which are described below. Prior to the present revision, the only treatments of the Nearctic species other than isolated species descriptions and catalogue entries were those of Cresson (1935) and Sturtevant and Wheeler

(1954). Cresson's review considered the world fauna, whereas Sturtevant and Wheeler's synopsis treated Nearctic species only. Sturtevant and Wheeler considered *Limnellia* to be a subgenus of *Scatella* Robineau-Desvoidy, although they felt that ". . . *Limnellia* is the one of the subgenera here recognized that is most nearly deserving of generic standing."

Wirth and Stone (1956) and Deonier (1964) published studies on the shore fly faunas of California and Iowa respectively. Both studies include keys to the *Limnellia* species occurring within each state.

Characters of the male postabdomen of *Limnellia* were illustrated and described first by Wirth (1948) who studied males of *L. sejuncta* (Loew). Andersson (1971) figured and described these structures for each species in his revision of the European fauna and demonstrated their usefulness as characters for species identification. In the present study, I found characters of the male postabdomen to be reliable and in several cases have utilized them for recognizing species.

Methods and Materials

The present revision is based on study of nearly 500 specimens from the collections listed below. Included with the listings are the curators responsible for loaning the specimens, acronyms to identify the collection in which the specimens are housed, and asterisks to indicate institutions from which holotypes were borrowed.

Academy of Natural Sciences of Philadelphia (ANSP)—Dr. Wayne W. Moss.
American Museum of Natural History (AMNH)—Dr. Pedro W. Wygodzinsky.
*British Museum (Natural History) (BMNH)—Dr. Brian H. Cogan.
California Academy of Sciences (CAS)—Dr. Paul H. Arnaud, Jr.
Canadian National Collection (CNC)—Dr. J. Richard Vockeroth.
*Museum of Comparative Zoology (MCZ)—Ms. Margaret Thayer.
National Museum of Natural History (USNM).
University of Kansas (KU)—Dr. George W. Byers.
University of Minnesota (UMI)—Dr. Philip J. Clausen.
Washington State University (WSU)—Dr. William J. Turner and Mr. Richard Zack.
Wayne N. Mathis (WNM)—personal collection.

Label data and depositories for all specimens of the type series I examined are cited in full. Label data for other specimens examined have been condensed (locality, habitat data, sex, depository) and arranged alphabetically.

Descriptive ratios are explained elsewhere (Mathis, 1977); each is an average of measurements taken from four specimens when available. Specimens to be measured were selected as follows: the largest, the smallest, and two others picked randomly.

The illustrations were inked on drafting film from drawings made using a Wild M20 compound microscope equipped with a drawing tube. The scale of each illustration is indicated by a line, which equals 0.1 mm. I have endeavored to portray the same aspect when drawing homologous structures. The epandrium of male specimens has randomly scattered, hairlike setae in addition to the larger bristles. Rather than draw each of these, I have included only a small patch in most of the drawings to indicate their size and arrangement. Structures to be illustrated were mounted on temporary slides using a glycerin-jelly mounting medium. Wing photographs were taken from permanently slide-mounted preparations.

Limnellia Malloch

Limnellia Malloch, 1925:331. Type-species: *Limnellia maculipennis* Malloch, by original designation and monotypy.

Eustigoptera Cresson, 1930:126. Type-species: *Notiphila quadrata* Fallén, by original designation. Synonymy by Cresson, 1935:362.

Stictoscatella Collin, 1930:133. Type-series: *Notiphila quadrata* Fallén, by original designation. Synonymy by Cresson, 1935:362.

Stranditella Duda, 1942:30 (as subgenus of *Scatella*). Type-species: *Notiphila quadrata* (Fallén), by original designation. Synonymy by Dahl, 1959:126.

Diagnosis.—Specimens of *Limnellia* are distinguished from those of other genera of the tribe Scatellini as follows: 1 pair of well-developed, lateroclinate, fronto-orbital bristles; gena narrow; thorax mostly brownish black to black, but with cinereous vittate and guttate markings; acrostichal setae arranged in 2 rows, each extending to base of scutellum; dorsocentral bristles 2 (0 + 2); wing maculate, mostly dark brown, with white, generally guttate markings; abdominal terga black, becoming polished, smooth, and shiny posteriorly; surstyli well developed as unfused processes at ventral margin of epandrium; aedeagal apodeme rudimentary.

Description.—Small to moderately-small shore flies, length 1.24–2.47 mm; mostly dark brown to black, pollinose to shiny, frequently with cinereous, guttate and vittate markings; wings maculate.

Head.—Wider than high from cephalic view; frons wider than long, vestiture more or less uniform, pollinose, dull, coloration varying, brown to charcoal brown, frequently with cinereous areas; mesofrons broadly triangular, narrowing anteriorly, forming an obtuse, rounded angle, not differentiated from parafrons except by differences in conformational relief; parafrons generally similar to mesofrons, occasionally slightly darker, more charcoal colored, narrowing posteriorly, forming an acute angle between convergence of fronto-orbital plate and mesofrons; fronto-orbital plate distinct only by differences in conformational relief, paralleling dorsal margin of eye. Ocelli arranged in equilateral triangle, on suboval plate which is slightly raised in relief. Two pairs of fronto-orbital bristles, anterior pair much smaller, proclinate; posterior pair of fronto-orbitals lateroclinate; 1 pair each of inner and outer vertical bristles, distance between them less than between inner vertical and posteromost fronto-orbital; 1 pair of large, proclinate, divergent ocellar bristles, insertions aligned with median margin of posterior ocelli; 1 or 2 pairs of much smaller postocellar setae. Antennae generally dark, black, occasionally with pale areas; third segment macropubescent to tomentose, longer than combined length of first and second segments, broadly rounded apically; arista inserted dorsally near posterodorsal corner of third segment, thickened basally, tapering gradually to stylelike tip, with short, micropectinate branching above. Face generally pollinose to tomentose; antennal fovea shallowly impressed; interfoveal carina not projecting as in other Scatellini; portion of face below antennal fovea setulose, with 2–3 pairs of posterolateroclinate, larger setae dorsally and several ventroclinate setae along oral margin, these becoming larger toward lateral margins; 2–3 indistinct, small, parafacial setae. Eye nearly round, oriented at slight oblique angle to plane of epistoma, bare; gena very narrow, postgena widening, setulose, with 1 large pair of bristles. Mouthparts generally retracted into oral opening, clypeus not exposed; maxillary palp dark colored; prementum longer than wide; pollinose to tomentose.

Thorax.—Generally pollinose, dull, dark brown with cinereous guttate or vittate markings. Mesonotum dull to slightly subshiny, generally pollinose, anterior portion duller, more densely pollinose, usually with paired, guttate to vittate, cinereous areas just laterad of acrostichal tract, cinereous color weakening abruptly to form a faintly, lighter colored vitta which gradually blends with surrounding color posteriorly; color of acrostichal tract generally brown with distinct cinereous vitta developing posteriorly between setae, evident for about posterior two-thirds of mesonotal length, becoming stronger posteriorly; humeral callus cinereous dorsally 1 or 2 pairs of additional cinereous guttate to vittate areas lateral and paralleling dorsocentral tract; scutellum generally flat, subshiny. Chaetotaxy of thorax as follows: acrostichal setae arranged in 2 rows which extend to base of scutellum, none prominently larger than others, 2 pairs of larger dorsocentral bristles (0 + 2) and 3–4 setae, especially anteriorly; posteromost dorsocentral slightly displaced laterally; 1 pair of presutural bristles; 2 pairs of notopleural bristles, both near ventral margin of notopleuron; 1 pair of posterior supra-alar bristles; 2 pairs of lateral scutellar bristles, anterior pair less than one-third length of posterior pair; 1 pair of large mesopleural bristles near posterior margin at middle; 1 pair of sternopleural bristles; mesopleuron and sternopleuron usually more pollinose, cinereous for the most part. Legs generally dark, tending to be subshiny to shiny; femora and tibiae dark, brownish black to black; color of tarsi variable, apical tarsomeres generally dark regardless of color of basitarsi; fore femur with row of setae along posteroventral margin; mid femur with row of setae along anterior surface, becoming stronger apically. Prosternum bare. Wing maculate, mostly dark brown with white or hyaline markings, these mainly guttate; maculation pattern variable but generally recognizable for each species. Halter color variable, yellowish to dark brown.

Abdomen.—Generally black, anterior terga with pollinose, brownish-black vestiture, posterior segments becoming polished, shiny; both sexes with 5 terga exposed, occasionally females with posterior portion of sixth exposed; fifth tergum generally truncate posteriorly. Male genitalia as follows: symmetrical; surstyli well developed as unfused processes at ventral margin of epandrium, shape of epandrium and surstyli diagnostic at species level; aedeagal apodeme generally reduced, broadly Y-shaped, with each arm attached to posterodorsal corners of aedeagus; gonite with larger process oriented ventrally and with second, smaller, thin process more or less fused apically with similar process from opposite side, forming an irregularly-shaped loop through which the aedeagus projects; aedeagus with sclerotized and membraneous areas, usually longer than high, frequently with V-shaped notch dorsally.

Geographic distribution.—In general, the paucity of locality data for several species precludes a meaningful synthesis at this time. For the Nearctic Region; two species are known from their type-localities only, two others from three or fewer localities. Consequently my comments below are primarily descriptive and lack satisfactory explanations.

Limnellia is worldwide in distribution, with members occurring in all major faunal realms. More species are presently known from the Northern Hemisphere, which may or may not be reflective of their actual diversity. Vast areas of the Southern Hemisphere have simply not been collected. The only species known from the Afrotropics, for example, were described within the last decade (Canzoneri and Meneghini, 1969).

Of the Nearctic species of the genus, only *L. stenhammari* is known to occur also in the Palearctic Region; apparently the remaining Nearctic species are endemics. *Limnellia turneri*, n. sp., has been misidentified for over a century as *L. quadrata* (Fallén) (European), and as such it was thought to be Holarctic. Not until Andersson's recent revision of the European species (1971) was the true identity and narrower distribution of the latter made known.

Eight of the 10 known Nearctic species occur in western North America, mostly from the Rocky Mountains westward. These western species, comprising one-half of the world's known species are endemics for the most part. Only *L. stenhammari* is widespread, occurring in both the east and west. Some species are associated with fairly specific or identifiable geographic features. *Limnellia sejuncta* appears to be closely linked with the Pacific Coast; *L. huachuca* with the semi-isolated mountain ranges along the common border of the United States and Mexico. Other species are widespread, notably *L. stenhammari* and to a lesser extent *L. turneri.* The reason(s) for either type of distribution has not been discovered.

The distribution of each Nearctic species overlaps to some degree that of at least one other species of the genus. Where species occur in sympatry, species identifications can usually be made accurately without reference to structures of the male genitalia. Examination of these structures is sometimes necessary for identification of allopatric populations.

Natural history.—Virtually nothing is known of the immature stages, behavior, or habitat preferences of *Limnellia* species. In Scandinavia, Dahl (1959) reported that specimens of *L. stenhammari* exhibit weak xerophilous tendencies, preferring drier meadow and dune heath habitats. Adults of other species are collected more often by sweeping through emergent vegetation from wet meadow habitats and similar situations along lotic and lentic aquatic systems. Sturtevant and Wheeler (1954) noted that *Limnellia* specimens have also been collected from tree trunks and flowers.

Variation.—Characters of the wing maculation pattern have been used extensively for identifying species of *Limnellia.* The pattern of white spots against a dark background is conspicuous and fairly constant. However, caution should be exercised in giving undue emphasis to these characters alone, as they are known to vary. Furthermore, the patterns of some species are almost identical and the intra- and interspecific variations broadly overlap. Where intraspecific variations appear more commonly, I have included wing photos of them as an aid to species identification.

Caution should also be exercised in relying on the color of halteres and basitarsi without supporting characters to determine a species identity. Although the color of these structures generally holds as described, I have examined occasional specimens that differ. This is especially evident with teneral specimens, where typically black colored structures are frequently reddish or yellowish red. Facial color also varies, and I have used it to characterize a species only when it complements other characters and when the facial color pattern is relatively constant. Too frequently, a "rubbed" specimen, or one that is greasy, makes use of these characters for species recognition futile.

Discussion.—I follow Wirth (1965) in placing *Limnellia* in the subfamily Ephydrinae, tribe Scatellini. Characters evidencing these relationships and by which the subfamily and tribe are recognized are: face slightly arched transversely, setulose, particularly along the ventral margin; tarsal claws short and curved; and pulvilli normally developed. Within Scatellini, however, the relationship of *Limnellia* to other taxa has not been specified other than unannotated classifications or vaguely worded statements allying it with *Scatella*. *Limnellia* has been treated as a subgenus of the latter by some authors.

The sister-group of *Limnellia* is *Scatophila* Becker. This relationship is confirmed by the following apotypic character states:

1. Number of fronto-orbital bristles.—The common number throughout the subfamily is two pairs of lateroclinate, fronto-orbitals. Specimens of *Limnellia* and *Scatophila* have only one pair.
2. Thoracic coloration and vestiture.—The plesiotypic condition is for a more or less unicolorous thorax or one with gradually-blending color changes. The thorax in *Scatophila* and *Limnellia* specimens is bi- or tricolored, with each color being sharply demarcated from the other(s). Frequently the contrasting marks are cinereous, either as guttate or vittate markings and are particularly evident on the dorsum.
3. Aedeagal apodeme.—The shape of this structure appears to form a multidirectional morphocline. In males of *Scatophila* and *Limnellia*, the aedeagal apodeme is rudimentary, as a connecting, rod-like structure between the base of the aedeagus and the hypandrium or fused apices of the ventral gonal process. Basally, the apodeme is frequently bifurcate, as in *Limnellia* males, forming a Y-shaped structure.

Apotypic character states distinguishing *Scatophila* are:

4. Extension of costal vein.—The costa extends to vein R_{4+5} (3rd vein) in *Scatophila* wings, which is the apotypic state. Throughout the remainder of the subfamily, the costa reaches vein M_{1+2} (4th vein).
5. Surstyli.—Paired surstyli are lacking or have been fused indistinguishably with the ventral margin of the epandrium in males of *Scatophila*. In males of *Limnellia*, as well as the subfamily in general, the surstyli are conspicuous, usually as setulose processes. The surstyli are frequently of diagnostic importance for distinguishing taxa at various levels in the subfamily.

Apotypic character states distinguishing *Limnellia* are:

6. Wing maculation pattern.—The wing maculation pattern appears to be a simple morphocline in which the plesiotypic state is a hyaline wing, characteristic of most members of Ephydrinae. At

the next level, the wing is lightly infuscated, grayish to tan, with a pattern of white areas arranged as follows: cell R_1 with one white spot, sometimes subquadrate, more or less aligned or slightly apicad of posterior crossvein; cell R_3 with two white spots on either side of posterior crossvein; discal cell with one white spot, often subdivided, near the apical end; cell M_2 with one basal white area, frequently large and irregular in shape and/or subdivided; cell M_4 with one to two white areas, usually in apical one-half. Some inter- and intraspecific variation occurs, usually by the addition of white spots. In *Limnellia* wings, the addition of several more white spots becomes consistent and the wing membrane around the spots becomes darker, brownish black.

7. Aedeagus.—The aedeagus of *Limnellia* males has an anteroventral, median, slightly-curved prong which to my knowledge is unique within the subfamily.

Because the present study is not a world revision, I have not attempted a detailed account of the species relationships of Nearctic *Limnellia*. However, certain tendencies are evident and will provide a basis for future studies. These are outlined in Fig. 1 plus the accompanying list of character evidence.

8. Size of surstyli.—The common condition in the species I have examined is for the surstyli to be longer than wide. The apotypic state is for each surstylus to be wider than long.
9. Shape of aedeagus.—This character is multidirectional. I interpret the plesiotypic state to be the common condition as in *L. stenhammari*, for example, where the aedeagus is longer than wide and has a distinct V-shaped notch dorsally. The lineages indicated with this number represent derived conditions from the common state described. The specific state is best shown in the illustrations accompanying the taxa whose lineage is being characterized.
10. Wing maculation pattern.—Although several patterns are evident, that exhibited by *L. turneri* is most common, especially the two darker brown spots in cell R_5 along the posterior margin of vein R_{4+5}. Variations from that pattern are apotypic and like number 9 above, are best seen by examining the appropriate wing photos.
11. Size of epandrium.—The epandrium is most often quite small as compared with overall length of the specimen. But in males of *L. sejuncta* and *L. balioptera*, the epandrium is considerably larger, a condition I interpret as apotypic.
12. Shape of ventral margin of epandrium.—Typically the epandrium terminates ventrally rather abruptly; frequently it is truncated. In males of *L. anna*, *L. lecocercus*, and *L. anderssoni*, however, the

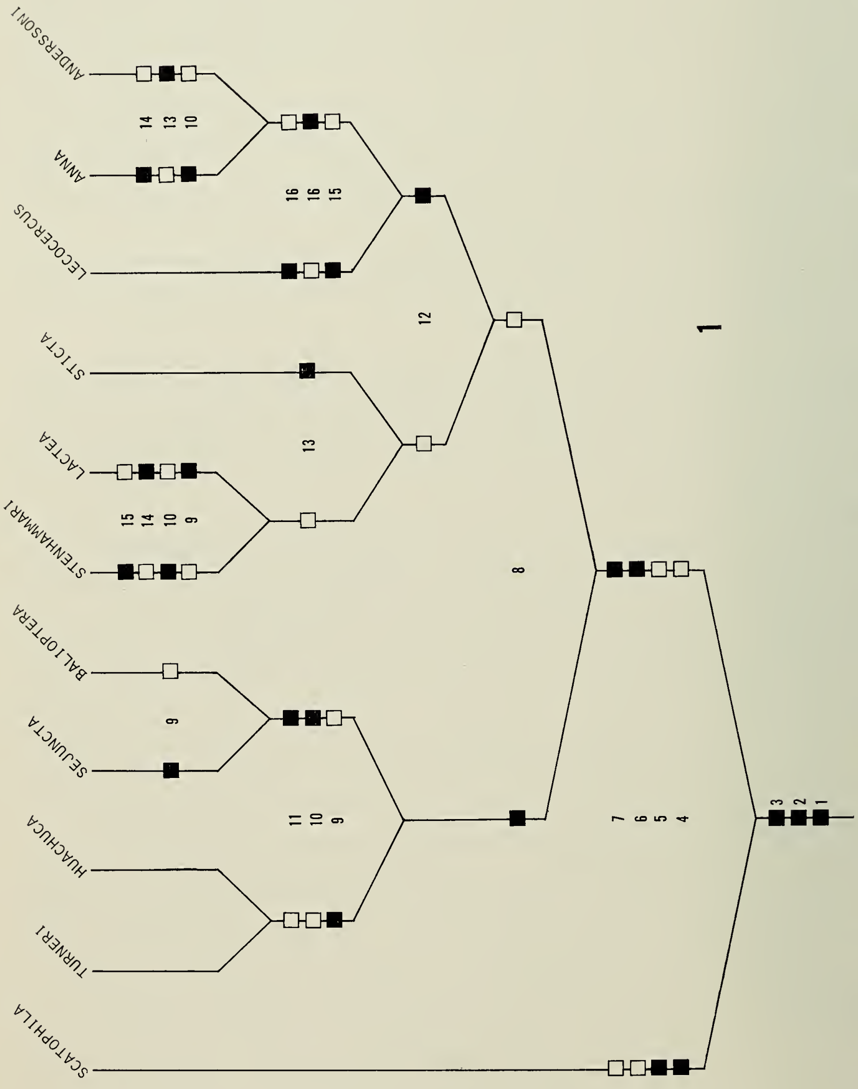


Fig. 1. Argumentation scheme for the hypothetical phylogeny of the Nearctic species of *Limnellia.* Filled square = apotypic state, open square = plesiotypic state.

ventral margin narrows, forming a parallel-sided projection to which the surstyli are attached. The latter condition is apotypic.

13. Color of halteres.—The most common color for the halteres is brownish yellow to brown. Pale yellow halteres, as in *L. sticta* and *L. anderssoni* are apotypic.
14. Facial color.—I interpret this character to be at least a duo morphocline. The most frequent color is grayish brown to yellowish brown, sometimes with faint indications of a darker, transverse band. The milky-white face of *L. lactea* and the distinctly banded face of *L. anna* are apotypic.
15. Color of basitarsi.—Throughout the subfamily Ephydrinae, the most common color is pale yellow. Accordingly, I consider the black basitarsi, as in *L. stenhammari*, to be apotypic.
16. Shape of surstyli.—I believe the plesiotypic condition is subrectangular surstyli, as in males of *L. stenhammari.* Marked deviations from that basic form are apotypic. Certainly the shape of these structures in *L. lecocercus*, *L. anna*, and *L. anderssoni* are unique.

Checklist of *Limnellia* species

1. *L. anderssoni*, new species. Nearctic.
2. *L. anna* Cresson, 1935:363. Nearctic.
3. *L. balioptera*, new species. Nearctic.
4. *L. fallax* (Czerny), 1903:239. Palearctic.
   L. pauciguttata (Strobl), 1910:208. Palearctic.
5. *L. huachuca*, new species. Nearctic.
6. *L. lactea*, new species. Nearctic.
7. *L. lecocercus*, new species. Nearctic.
8. *L. maculipennis* Malloch, 1925:331. Australian.
9. *L. minima* Canzoneri and Meneghini, 1969:105. Afrotropical.
10. *L. picta* Canzoneri and Meneghini, 1969:106. Afrotropical.
11. *L. quadrata* (Fallén), 1813:255. Palearctic.
    L. gramium (Haliday), 1833:176. Palearctic.
12. *L. sejuncta* (Loew), 1863:326. Nearctic.
13. *L. stenhammari* (Zetterstedt), 1846:1842. Holarctic.
    L. oscitans (Walker), 1849:1106. Nearctic.
14. *L. sticta*, new species. Nearctic.
15. *L. surturi* Andersson, 1971:56. Palearctic.
16. *L. turneri*, new species. Nearctic.

Key to Nearctic Species of *Limnellia*

1. Lower portion of face transversely banded, ventral margin cinereous, contrasting distinctly with dorsally bordering brown band;

antennal fovea shallow, little evident; costal vein index averaging 1:0.35 *L. anna* Cresson
- Ventral portion of face unicolorous; antennal fovea more deeply impressed; costal vein index averaging 1:0.25 or less 2

2. Legs, including tarsi, generally unicolorous, black 3
- Tarsi mostly pale, yellowish, contrasting with black tibiae 5

3. Wing cell R_5 with 3 darker spots closely appressed to vein R_{4+5} *L. stenhammari* (Zetterstedt)
- Wing cell R_5 with 2 darker brown spots closely appressed to vein R_{4+5} 4

4. Surstyli fused basomedially, together forming a broad, semicircular plate; epandrium distinctly narrowing ventrally *L. lecocercus*, new species
- Surstyli not fused medially, each subrectangular; epandrium uniformly wide *L. turneri*, new species

5. Wing cell R_5 with 1 or 2 darker spots wholly separated from vein R_{4+5} by hyaline area 6
- Wing cell R_5 with darker spots touching vein R_{4+5} 7

6. Halter distinctly pale, yellowish; large species, wing length averaging 2.75 mm *L. balioptera*, new species
- Halter darker, brownish yellow to black; smaller species, wing length averaging less than 2.30 mm *L. sejuncta* (Loew)

7. Halter distinctly pale, yellowish 8
- Halter darker, brownish yellow to black 9

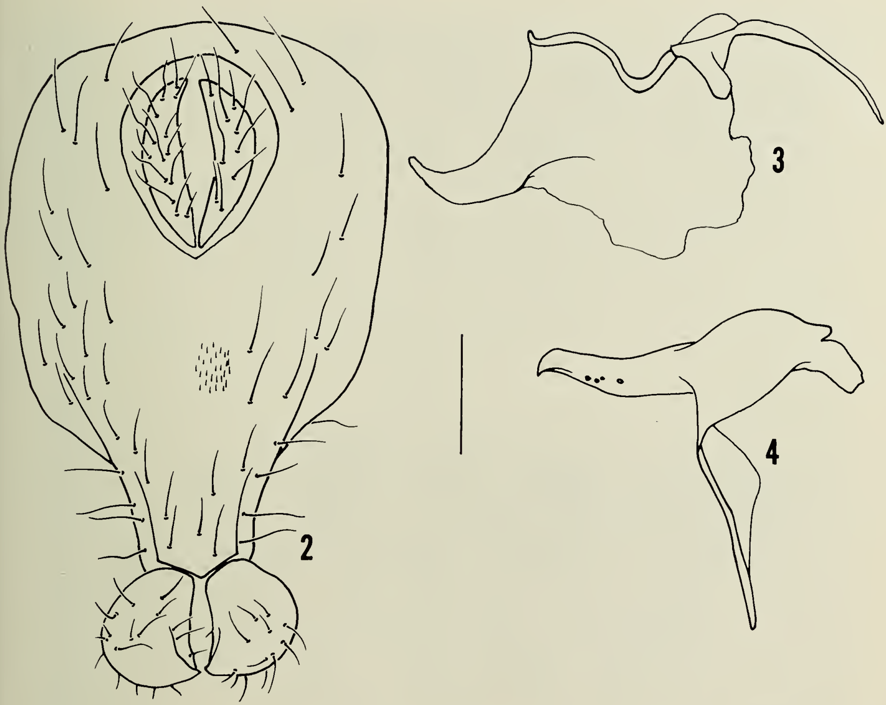
8. Epandrium narrowing ventrally more abruptly; surstyli only slightly longer than wide (California) *L. anderssoni*, new species
- Epandrium gradually narrowing ventrally; surstyli nearly 3 times longer than middle width (Quebec) *L. sticta*, new species

9. Face generally lacteus; surstyli about twice as long as middle width *L. lactea*, new species
- Face with lower portion mostly brownish; surstyli wider than long 10

10. Surstyli longer laterally than medially, ventrolateral edge angulate *L. huachuca*, new species
- Surstyli wider medially than laterally, ventrolateral edge broadly rounded *L. turneri*, new species

Limnellia anderssoni, new species
Figs. 2–5

Diagnosis.—Specimens of *L. anderssoni* are distinguished from those of congeners by the following characters: setulose portion of face mostly unicolorous, grayish brown; antennal fovea shallowly but distinctly im-



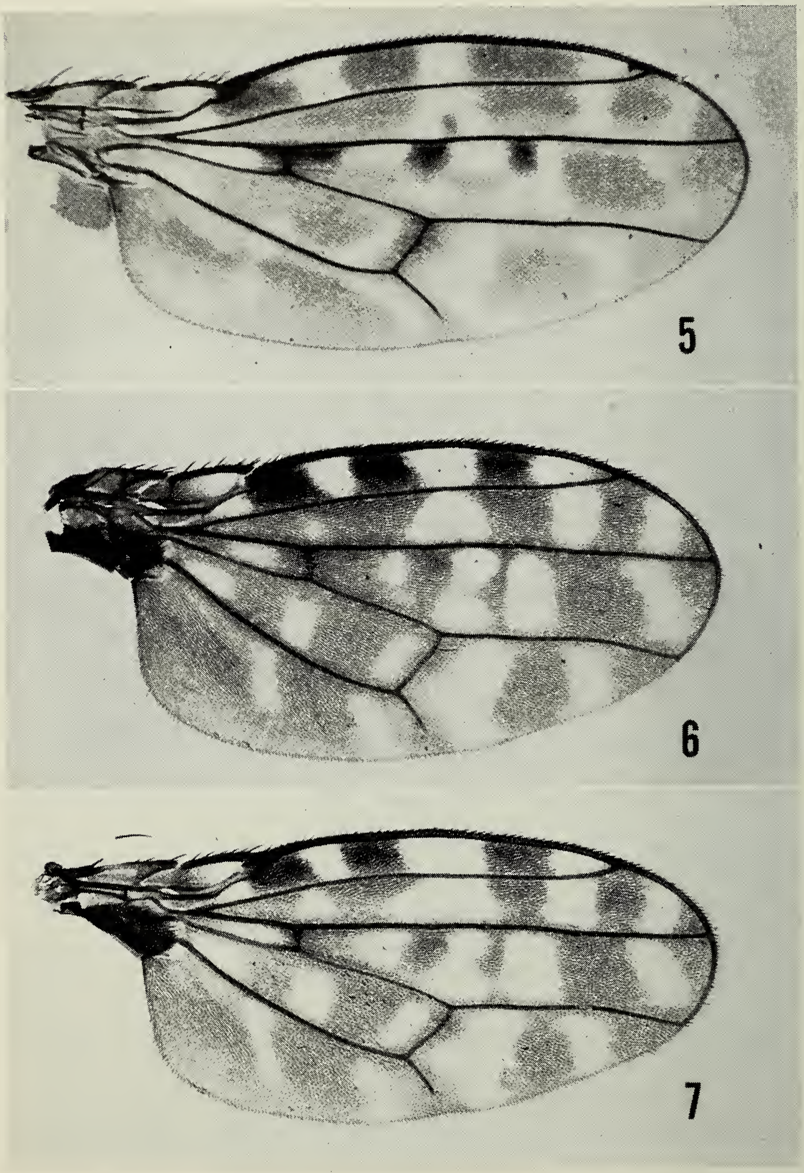
Figs. 2–4. *Limnellia anderssoni*: 2. Epandrium and surstyli, caudal view; 3. Aedeagus, lateral view; 4. Gonite, lateral view.

pressed; wing maculation pattern as in Fig. 5; basitarsi and halter pale, yellowish; male genitalia as in Figs. 2–4.

Description.—Small shore flies, length 1.86 mm (holotype).

Head: Head width-to-height ratio 1:0.59. Frons mostly brown, becoming darker, more charcoal colored laterally; mesofrons unicolorous; parafrons with anterior margin cinereous to grayish green, otherwise brown, concolorous with mesofrons. Face slightly arched transversely; interfoveal carina indistinct; antennal fovea shallowly impressed but distinct; lower portion of face grayish brown, becoming slightly darker near insertions of dorsomost setae; antennal fovea brown to cinereous, becoming more cinereous dorsally and laterally. Eye height-to-width ratio 1:0.86; eye-to-cheek ratio 1:0.15.

Thorax: Basitarsi and usually second and third tarsomeres of each leg pale, yellowish, contrasting distinctly with black tibiae. Wing maculation pattern (Fig. 5) as follows: cell R_1 with 3–4 white spots, basal one weakly developed, thin, brown areas subrectangular, becoming larger apically; cell R_3 with 2–3 white areas, white area aligned with posterior



Figs. 5–7. Wings. 5. *Limnellia anderssoni*; 6. *L. anna* (Great Smokey National Park, North Carolina); 7. *L. anna* (La Fayette, North Dakota).

crossvein with small brown spot within and close to vein R_{4+5}, apical spot larger and with larger brown spot within, the latter nearly equalling width of cell; cell R_5 with 2 darker brown spots, each closely appressed against vein R_{4+5}, with 2–3 white areas; discal cell with 2 white areas closer to posterior margin of cell, apical one transversely linear; cell M_2 with 2 white areas, basal one much larger, irregular in shape; cell M_4 with 2–4 white areas, sometimes subdivided. Wing length-to-width ratio 1:0.47; costal vein index 1:0.27; M_{1+2} index 1:0.54. Halter pale, yellowish.

Abdomen: Male genitalia (Figs. 2–4) as follows: epandrium (Fig. 2) in caudal view rounded dorsally, ventral margin narrowed distinctly; surstyli broadly semicircular in shape, symmetrical, setulose, slightly longer than wide; aedeagal apodeme closely attached with posterior portion of aedeagus; aedeagus with V-shaped notch dorsally and anteroventral, median prong.

Type-material.—Holotype male, labelled: "3 mi. SE. Auburn in El Dorado Co. Calif V-9-1965/ M. R. Gardner Collector." The holotype is in the National Museum of Natural History, Smithsonian Institution, type number 75473. The right wing has been removed and slide mounted; the postabdomen has been removed, dissected, and the parts placed in an attached microvial.

Geographic distribution.—This species is known only from the type-locality.

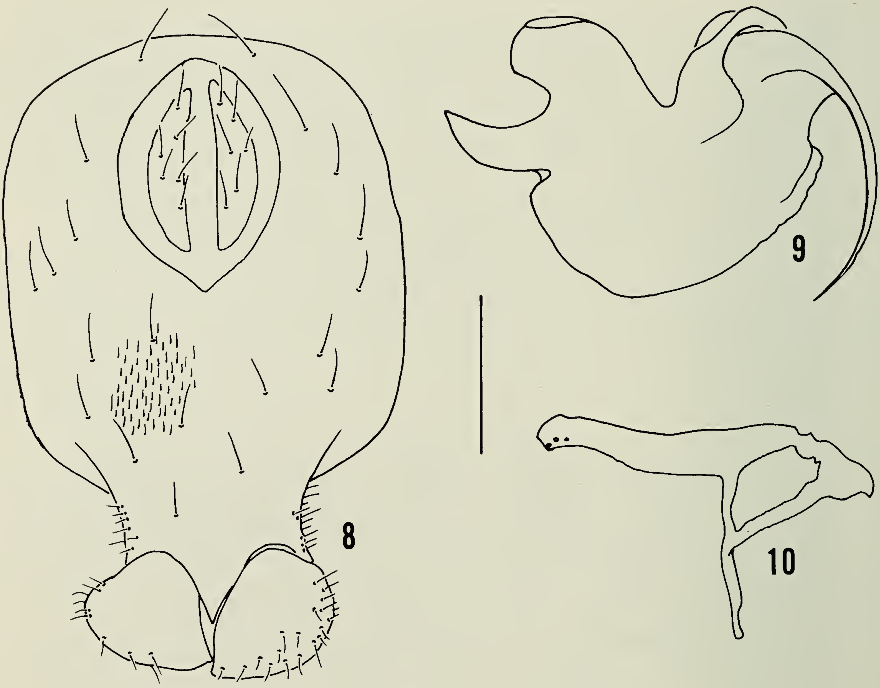
Relationship.—*Limnellia anderssoni* is closely related to *L. anna* as demonstrated by similarities of the male genitalia. The epandrium in males of both species is abruptly narrowed ventrally, forming a parallel-sided process to which the surstyli are attached. Each surstylus is broadly crescent shaped to semicircular.

Etymology.—*Anderssoni* is a genitive patronym honoring Dr. Hugo Andersson, Zoological Institute, Lund, Sweden, for his outstanding contribution to the systematics of *Limnellia.*

Limnellia anna Cresson
Figs. 6–11

Limnellia anna Cresson, 1935:363 (review). Wirth, 1965:758 (catalogue).
Scatella (*Limnellia*) *anna*, Sturtevant and Wheeler, 1954:177 (review).

Diagnosis.—Specimens of *L. anna* are distinguished from those of congeners by the following characters: setulose portion of face with ventral margin pollinose, cinereous, bordered dorsally by a distinctly contrasting, dark brown band; antennal fovea shallowly impressed; costal vein index averaging 1:0.35; wing maculation pattern as in Figs. 6–7; tarsi of fore leg concolorous with tibia, those of mid and hind legs pale, yellowish; halter brownish yellow to blackish brown; male genitalia as in Figs. 8–10.



Figs. 8–10. *Limnellia anna*: 8. Epandrium and surstyli, caudal view; 9. Aedeagus, lateral view; 10. Gonite, lateral view.

Description.—Small shore flies, length 1.38–1.89 mm.

Head: Head width-to-height ratio averaging 1:0.62. Frons mostly brown to charcoal brown; anterior margin, wedge shaped area of parafrons, and spot anterolaterad of inner vertical bristle cinereous, contrasting distinctly with overall color of frons; small generally guttate areas laterad of ocellar triangle slightly lighter brown, sometimes with similar spot anterior of triangle. Face shallowly arched; interfoveal carina little evident; antennal fovea shallowly impressed; ventral margin of face cinereous, bordered dorsally with brown, transverse band which extends dorsally to dorsalmost facial setae; dorsad of brown band cinereous except for a brown area between and below antennae which is shaped like an inverted T. Eye height-to-width ratio averaging 1:0.91; eye-to-cheek ratio averaging 1:0.13.

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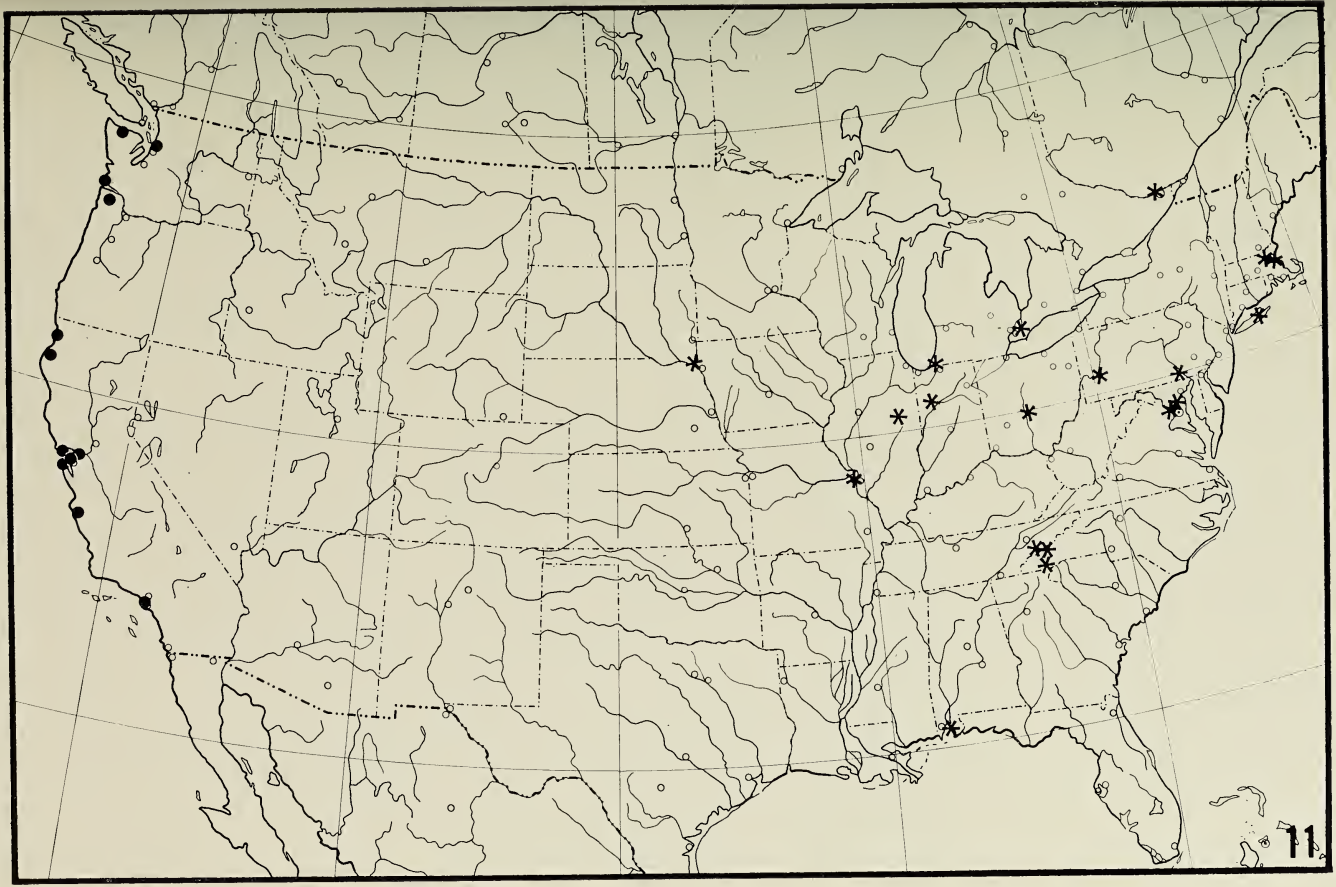
Fig. 11. Distribution map. *Limnellia anna,* asterisk; *L. sejuncta,* dot.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Thorax: Fore basitarsus black, concolorous with fore tibiae; basitarsi of mid and hind legs pale, yellowish, contrasting with black tibiae. Maculation pattern of wing (Figs. 6–7) as follows: cell R_1 with 4 white spots; cell R_3 with 3–5 white spots, frequently basal spot is weak, sometimes second basal spot partially divided; cell R_5 with 4–5 white spots, second basal spot frequently partially or wholly divided; discal cell with 3 white spots, cell M_2 with 2 white spots, cell M_4 with 2 white spots. Wing length-to-width ratio averaging 1:0.52; costal vein index averaging 1:0.35; M_{1+2} vein index averaging 1:0.67. Halter brownish yellow to brownish black.

Abdomen: Male genitalia (Figs. 8–10) as follows: epandrium (Fig. 8) in caudal view rectangular-oval, ventral margin produced ventrally, forming narrower projection to which the surstyli are attached; surstyli symmetrical, frequently one or the other curved, appearing asymmetrical, broadly oval in conformation, setulose; aedeagus with anterior projection, V-shaped notch dorsally, broadly rounded ventrally; aedeagal apodeme distinguished from aedeagus as Y-shaped posterior process with each arm attached to posterior end of aedeagus.

Type-material.—Holotype male, labelled: "Boston XI. 6. 24. Mass/ Greenhouses Bussey Inst. Forest Hills Kellogg/ M.C.Z. Type 25376 (red)/ TYPE No. Limnellia ANNA ♂ E T Cresson, Jr." The holotype and 2 female paratypes are in the Museum of Comparative Zoology, Harvard University, type number 25376. One male paratype is in the Academy of Natural Sciences of Philadelphia.

Specimens examined.—Forty-one specimens (6♂♂, 35♀♀). CANADA: Ontario: Chatham (1♀, CNC). Quebec: Old Chelsea (2♀♀, CNC), Summit King Mt., 1,150′ (1♂, CNC): Wakefield (1♀, CNC). UNITED STATES: Alabama: Mobile Co., Kushla (1♀, USNM). Illinois: (1♀, ANSP); Champaign Co., Champaign (1♀, CNC), Urbana (2♀♀, ANSP). Indiana: Tippecanoe Co., Lafayette (1♀, USNM). Maryland: Montgomery Co., Colesville, malaise trap (1♂, 2♀♀, USNM). Massachusetts: Middlesex Co., Framingham (2♀♀, USNM); Suffolk Co., Boston (2♂♂, 4♀♀, ANSP, MCZ, USNM). Michigan: Berrien Co., Stevensville (1♀, USNM). Missouri: Saint Louis Co., St. Louis, 2 mi W (1♀, USNM). New York: Nassau Co., Long Island, Wantagh, lilium plant (8♀♀, USNM). North Carolina: Great Smoky Mountains National Park, New Foundland Ridge (2♀♀, USNM); Macon Co., Wayah Bald, 5,400′ (1♂, CNC). Ohio: Franklin Co., Columbus (1♂, ANSP). Pennsylvania: Allegheny Co., Pittsburg (1♀, USNM); York Co., York, 13 mi W Conewago Creek (1♀, USNM). South Dakota: Union Co., Elk Point (1♀, USNM). Tennessee: Sevier Co., Great Smoky Mountains National Park, Gatlinburg, 4,900′—3D Heath Bald (1♀, USNM). Virginia: Fairfax Co., Dead Run (1♀, USNM).

Geographic distribution (Fig. 11).—The distribution of *L. anna* ranges over much of eastern North America, from Elk Point, South Dakota

(42°40′N, 96°40′W) in the northwest to Wakefield, Quebec (45°38′N, 75°96′W) in the northeast, and southward to St. Louis, Missouri (38°40′N, 90°15′W) in the southwest to Kushla, Alabama (30°80′N, 88°18′W) in the south, and to Wayah Bald, North Carolina (35°22′N, 83°70′W) in the southeast.

Natural history.—The type-series was collected in a greenhouse and other specimens have been taken from windows. Most specimens, however, were collected out-of-doors.

Relationship.—My comments under *L. anderssoni* apply here also.

Limnellia balioptera, new species
Figs. 12–17

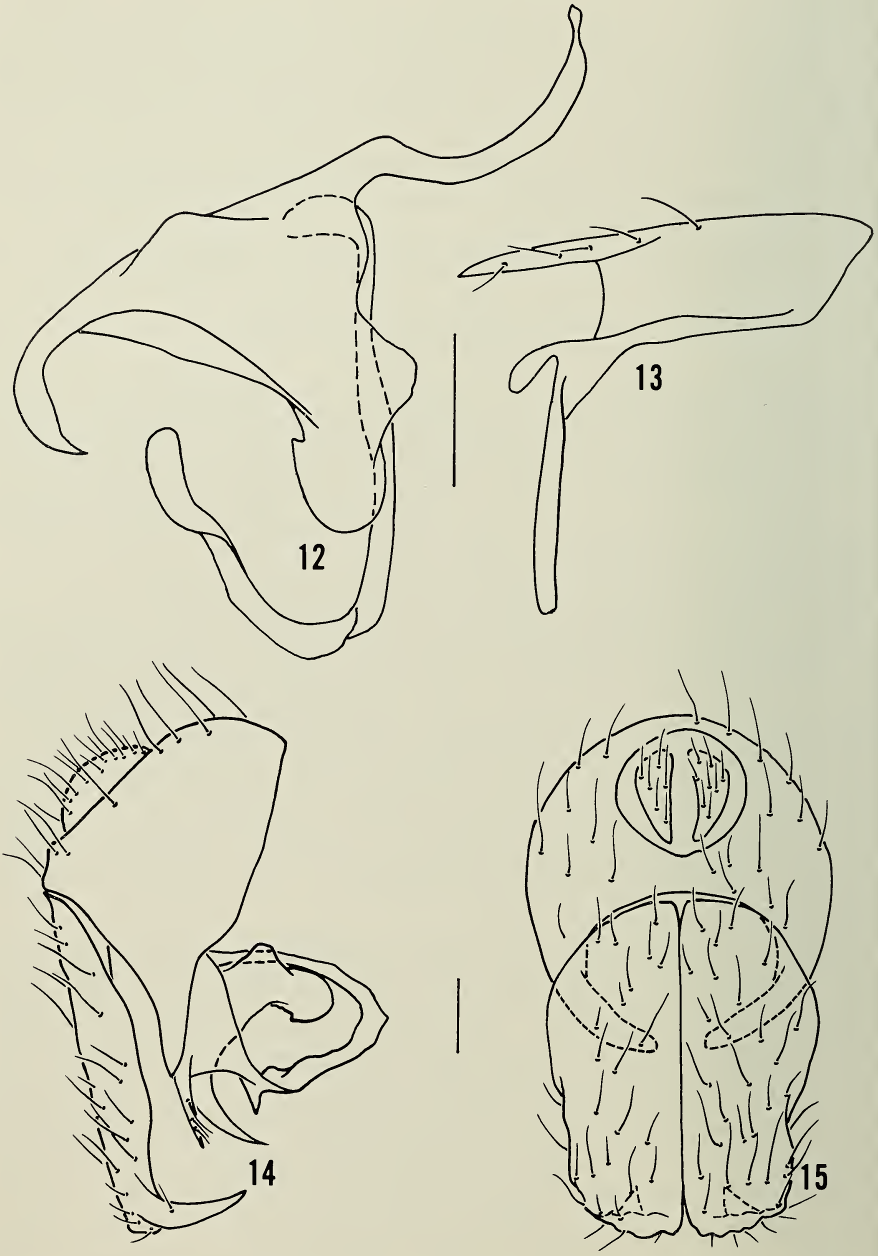
Diagnosis.—Specimens of *L. balioptera* are distinguished from those of congeners by the following characters: large species, length averaging 2.28 mm; setulose portion of face mostly unicolorous, grayish brown; antennal fovea shallowly but distinctly impressed; wing maculation pattern as in Figs. 16, 17; basitarsi of all legs and halteres concolorous, pale, yellowish; male genitalia as in Figs. 12–15.

Description.—Moderately-small shore flies, length 2.15–2.46 mm.

Head: Head width-to-height ratio averaging 1:0.58. Frons mostly brown to charcoal brown; mesofrons with faintly evident, vertical, yellowish-gray strip anteriorly, with lighter brown areas laterad of ocellar triangle; parafrons with anterior margins and thin strip near vertex cinereous, otherwise concolorous with mesofrons. Face mostly unicolorous, grayish brown; antennal fovea and area laterad becoming more grayish; shape of face nearly flat, very slightly arched transversely; interfoveal carina evident but not protruding distinctly; antennal fovea distinctly impressed although shallow. Eye height-to-width ratio averaging 1:1; eye-to-cheek ratio averaging 1:0.15.

Thorax: Basitarsi and usually second and third tarsomeres pale, yellowish, contrasting with black tibiae of each leg. Maculation pattern of wing (Figs. 16, 17) as follows: cell R_1 with 5–7 white spots, each clearly defined; cell R_3 with 4 white spots, spot at each end smaller and lacking clear definition, middle 2 white spots with brown spots completely surrounded by white coloration; cell R_5 with 4–5 white areas, middle white areas with darker brown spots, each surrounded by white; discal cell with 2–3 white areas, these better developed along posterior margin of cell; cell M_2 with 2 white areas, basal one larger and irregular in shape, sometimes subdivided; cell M_4 with 2–3 white areas, generally guttate. Wing length-to-width ratio averaging 1:0.47; costal vein index averaging 1:0.22; M_{1+2} vein index averaging 1:0.51. Halter yellowish.

Abdomen: Male genitalia (Figs. 12–15) as follows: epandrium (Figs. 14, 15) short, rounded dorsally, wider than long in caudal view, anteroventral



Figs. 12–15. *Limnellia balioptera*: 12. Aedeagus, lateral view; 13. Gonite, lateral view; 14. Male genitalia, lateral view; 15. Epandrium and surstyli, caudal view.

Figs. 16–18. Wings. 16. *Limnellia balioptera* (23.2 mi S South Bend, Washington); 17. *L. balioptera* (Fields Springs State Park, Washington); 18. *L. huachuca.*

portions of each side drawn out, forming narrow processes enlarged, robust, each much longer than wide, apex curved posteriorly at right angle, becoming subulate (best seen in lateral view), setulose; aedeagus considerably modified, with curved, anterodorsal, acutely-pointed process and narrowly-rounded, ventral process, posterodorsal portion extends dorsally, attaching to anterior surface of surstyli; aedeagal apodeme as two linear processes which remain unfused until merger with apices of ventral gonal processes, beyond mergence as a single, slightly curved, bluntly-rounded process; gonite complicated (Fig. 13).

Type-material.—Holotype male, labelled: "WASH: Pierce Co. Mt. Rainier N. P., Van Trump Ck., 21 mi Above Christine Falls. VIII-13-1977 R. S. Zack Collr. (handwritten on black bordered label)." Allotype female and six male paratypes: with same locality data as holotype. Other paratypes as follows: Washington: 23.2 mi S South Bend, 9. X. 68, Mal(aise) Tr(ap) D. D. Munroe (1♀, CNC); Okanagan Co., 5 mi E Wauconda Rt. 30. VII. 7. 1972, W. J. Turner (1♀, WSU); Ilwaco, VI. 6. 18, A. Spuler (1♀, WSU). The holotype and allotype are in the James Entomological Collection, Washington State University, Pullman, type number 356; the male paratype from the type-locality is in the National Museum of Natural History, Smithsonian Institution.

Geographic distribution.—The distribution of *L. balioptera* is based on the six specimens listed above, all from the state of Washington.

Natural history.—Richard Zack, collector of the specimens from the type-locality, described the habitat as a wet, rocky area that was strewn with forest debris and through which water trickled. The rocks averaged about one foot in diameter and there was no apparent standing water.

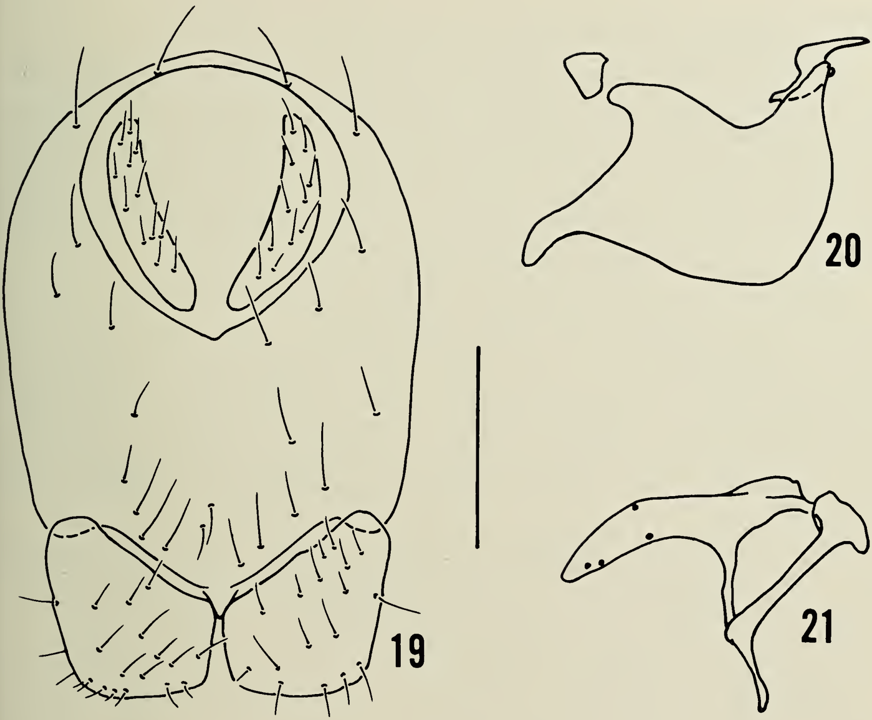
Relationship.—This species is difficult to associate using characters of the male genitalia because they are substantially modified. Accordingly, I have depended more on the wing maculation pattern which resembles that of *L. sejuncta* specimens, to which I believe it is closely allied.

Etymology.—*Balioptera* is of Greek derivation and is a combination of the adjective *balios*, meaning "spotted" and the noun *pterum* (Gr. *pteron*), meaning "wing," in allusion to the spotted wings of this species. It is a compound adjective.

Limnellia huachuca, new species
Figs. 18–21

Diagnosis.—Specimens of *L. huachuca* are distinguished from those of congeners by the following characters: setulose portion of face mostly unicolorous, grayish brown; antennal fovea shallowly impressed; wing maculation and venation as in Fig. 18; basitarsi of all legs pale, yellowish; halteres brownish yellow; male genitalia as in Figs. 19–21.

Description.—Small shore flies, length 1.24–1.93 mm.



Figs. 19–21. *Limnellia huachuca*: 19. Epandrium and surstyli, caudal view; 20. Aedeagus, lateral view; 21. Gonite, lateral view.

Head: Head width-to-height ratio averaging 1:0.62. Frons generally brown to charcoal brown; mesofrons with faintly evident, vertical, cinereous vitta; parafrons with anterior margin cinereous, becoming more brownish in color posteriorly. Face in profile nearly flat, very slightly arched; interfoveal carina not evident; antennal fovea evident but shallowly impressed; ventral margin of face slightly cinereous, remaining area brownish gray, becoming more cinereous dorsally, lacking distinct banding sequence. Eye height-to-width ratio averaging 1:0.83; eye-to-cheek ratio averaging 1:0.11.

Thorax: Basitarsi plus second and third tarsomeres of each leg pale, yellowish, contrasting distinctly with black tibiae. Maculation pattern of wing (Fig. 18) as follows: cell R_1 with 6–7 white spots; cell R_3 with 4–5 white spots, frequently basal spot weakly developed; cell R_5 with 4 white spots, second basal white spot largest, with brown spot in center; discal cell with 3 white spots; cell M_2 with 2 white spots; cell M_4 with 2 spots, one or the other frequently weakly developed. Wing length-to-width ratio averaging 1:0.46; costal vein index averaging 1:0.25; M_{1+2} vein index averaging 1:0.53. Halter brownish yellow.

Abdomen: Male genitalia (Figs. 19–21) as follows: epandrium (Fig. 19) in caudal view oval dorsally, becoming subtruncate ventrally, forming a broadly based triangular process between attachments of surstyli; surstylus truncate ventrally, quadrate except for lateral margin which extends dorsally further than median margin, setulose; aedeagus (Fig. 20) generally subquadrate but with extending anterior and posterior processes; aedeagal apodeme indistinguishable from aedeagus.

Type-material.—Holotype male, labelled: "Ramsey Cyn. 6000′ 15 mi. S. Sierra Vista Huachuca Mts. ARIZ. Sternitsky 18. V. 67." Allotype female and 18 paratypes (9♂♂, 9♀♀, CNC, USNM): with same label data as holotype except for dates which are from 13 April to 13 August, 1967. Other paratypes as follows: Arizona: Cochise Co., Chiricahua Mts. (1♂, 2♀♀, USNM). The holotype, allotype, and most of the paratypes from the type-locality are in the Canadian National Collection, Ottawa, type number 15433.

Other specimens examined.—UNITED STATES: Arizona: Cochise Co., Herb Matyr Park (1♂, WNM); Portal-Southwest Research Station, malaise trap (1♀, USNM). Pima Co., Greaterville (1, CAS).

Geographic distribution.—This species is known only from Cochise and Pima counties in southern Arizona.

Relationship.—Apparently *L. huachuca* is closely allied with *L. turneri*. The surstyli of males of both species are wider than long, the aedeagal conformations are similar, and the whole genital complex of each is relatively smaller.

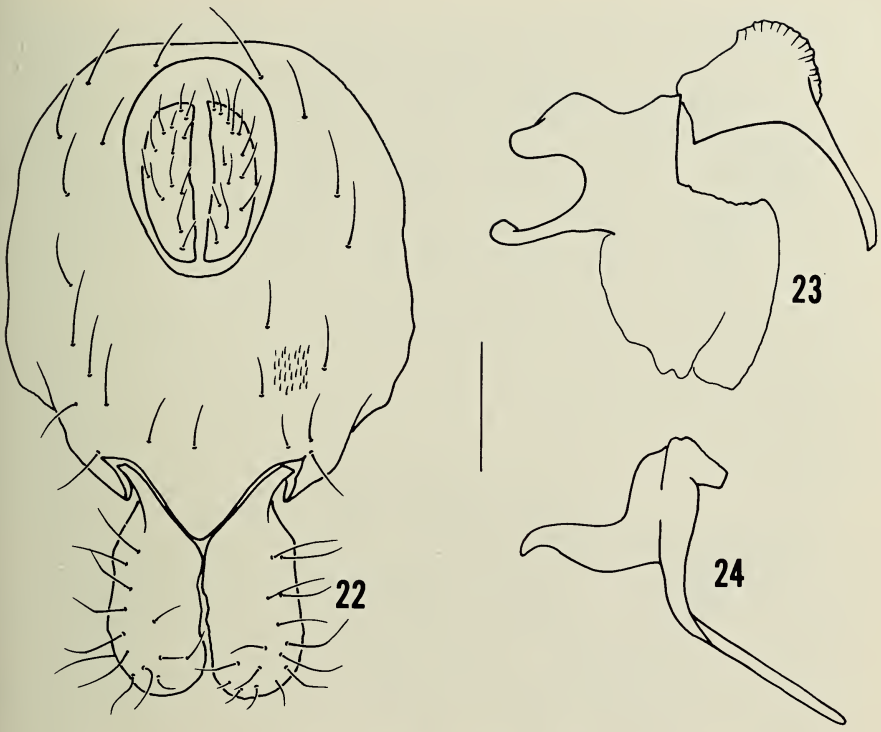
Etymology.—According to Barns (1960) *huachuca* was apparently used first for a Pima Indian village located in what is now Cochise County, Arizona. The name was later applied to a historic U.S. Army post and to a range of mountains in southern Arizona, where the type series was collected. As a species name it is a noun in apposition.

Limnellia lactea, new species
Figs. 22–25

Diagnosis.—Specimens of *L. lactea* are distinguished from those of congeners by the following characters: setulose portion of face mostly unicolorous, lacteus but with small median and lateral areas slightly darker, lacteus brown; antennal fovea very shallowly impressed; wing maculation pattern as in Fig. 25; basitarsi of all legs pale, yellowish, contrasting with black tibial coloration; halter brownish yellow to brown; male genitalia as in Figs. 22–24.

Description.—Small shore flies, length 1.55–1.94 mm.

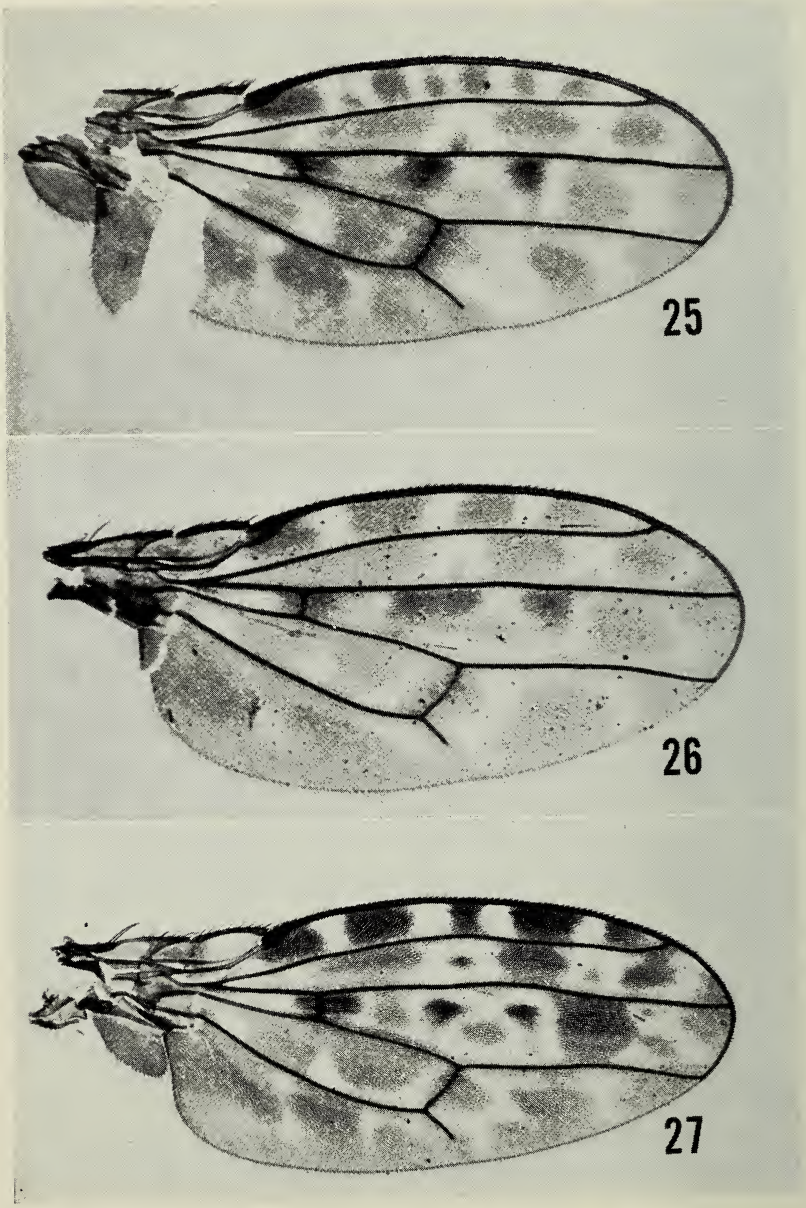
Head: Head width-to-height ratio averaging 1:0.62. Frons color vary-



Figs. 22–24. *Limnellia lactea*: 22. Epandrium and surstyli, caudal view; 23. Aedeagus, lateral view; 24. Gonite, lateral view.

ing from light grayish green to charcoal brown, lateral margins generally darker; mesofrons generally brown but with anteromedian, light grayish-green areas and 2 lighter brown spots laterad of ocellar triangle; parafrons mostly unicolorous, charcoal brown; fronto-orbital plates not generally discernable. Face weakly arched transversely; interfoveal carina evident but weakly developed; antennal fovea very shallowly impressed; facial color nearly unicolorous, mostly lacteus, especially antennal fovea and laterad, setulose portion with some darker, more brownish areas. Eye height-to-width ratio averaging 1:0.88; eye-to-cheek ratio averaging 1:0.12.

Thorax: Basitarsi and generally second and third tarsomeres of each leg pale, yellowish, contrasting with black tibiae. Wing maculation pattern (Fig. 25) as follows: cell R_1 with 6 white spots, those at each end tending to be smaller and less definite; cell R_3 with 2 white areas apicad of alignment of posterior crossvein, apical one with brown spot which is closely appressed to apex of vein R_{2+3}; cell R_5 with 2–3 white areas, frequently basal one partially subdivided, with 2 darker brown spots, each closely



Figs. 25–27. Wings. 25. *Limnellia lactea*; 26. *L. lecocercus*; 27. *L. sejuncta.*

appressed to vein R_{4+5}; discal cell with 2–3 white areas, more closely associated with vein M_{3+4}; cell M_2 with 2 white spots, basal one much larger and tending to be irregular; cell M_4 with 2–4 white areas, median ones sometimes subdivided. Wing length-to-width ratio averaging 1:0.48; costal vein index averaging 1:0.24; M_{1+2} vein index averaging 1:0.56. Halter yellowish brown to brown.

Abdomen: Male genitalia (Figs. 22–24) as follows: epandrium (Fig. 22) in caudal view slightly longer than wide, rounded dorsally, obtusely angulate ventrally; surstyli nearly twice as long as wide, bluntly rounded apically, attached but not indistinguishably with ventral margin of epandrium at lateral margins of ventromedian, epandrial process, setulose; aedeagus deeply emarginate anteriorly in profile, ventral prong slightly longer than dorsal one; venter becoming less sclerotized, membraneous, irregular but generally rounded; aedeagal apodeme attached laterally with posterior portion of aedeagus, posterodorsal margin forming slightly crenulate ridge, ventrally extending process attached ventrally with gonal process from each side.

Type-material.—Holotype male, labelled: "Rustler Park Ariz. 6-11-51 (handwritten)/A. H. Sturtevant Collection, 1970." Allotype female and 2 paratypes (1♂, 1♀), labelled: "ARIZ. Graham Co. Hospital Flat Pinaleno Mts. Alt. 8950′ 2.VIII.1965 Hugh B. Leech." The holotype is in the National Museum of Natural History, Smithsonian Institution, type number 75474. The allotype and other paratypes are in the California Academy of Sciences, San Francisco. The postabdomen of the holotype has been removed, dissected, and placed in an attached microvial; the left wing of the female paratype was removed and slide mounted.

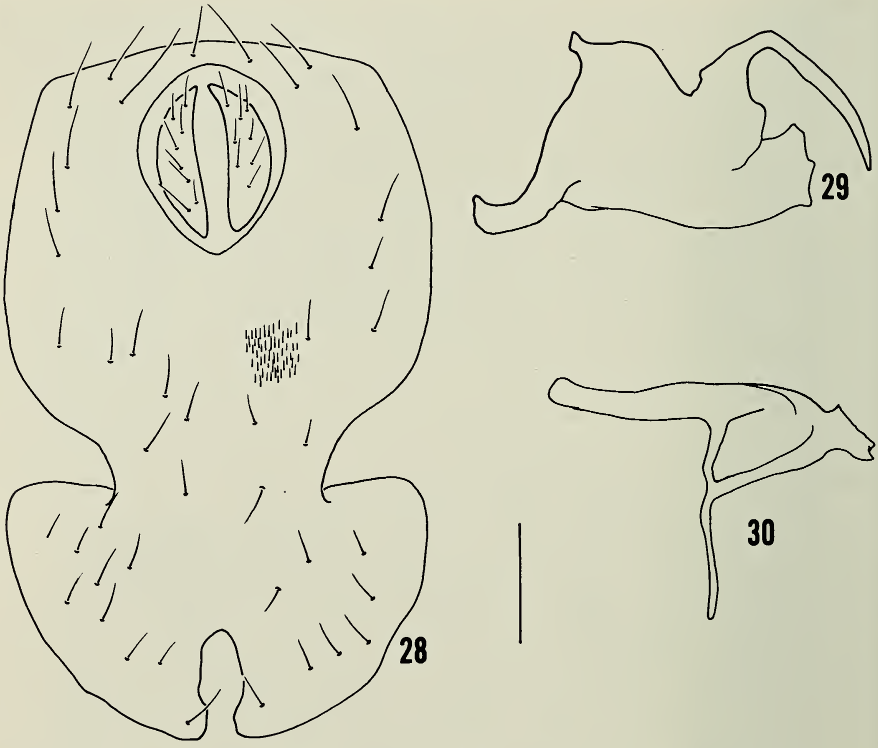
Geographic distribution.—The known distribution of *L. lactea* is limited to southwestern Arizona.

Relationship.—I have placed this species near *L. stenhammari*, although there is little confirming evidence. The epandrium and surstyli of both species are similar, but whether these character states are synapotypic has not been determined.

Etymology.—*Lactea* is a Latin adjective meaning "milky," in allusion to the milky-colored face of specimens of this species.

Limnellia lecocercus, new species
Figs. 26, 28–30

Diagnosis.—Specimens of *L. lecocercus* are distinguished from those of congeners by the following characters: setulose portion of face unicolorous, golden brown to grayish brown; antennal fovea shallowly impressed; wing maculation pattern as in Fig. 26; basitarsi of all legs concolorous with tibiae; halter brownish yellow; male genitalia as in Figs. 28–30.



Figs. 28–30. *Limnellia lecocercus*: 28. Epandrium and surstyli, caudal view; 29. Aedeagus, lateral view; 30. Gonite, lateral view.

Description.—Small shore flies, length 1.73–1.86 mm.

Head: Head width-to-height ratio averaging 1:0.51. Frons mostly unicolorous, brown to charcoal brown, becoming darker laterally, anterior margin of parafrons bordered with cinereous color. Face weakly arched; interfoveal carina weakly developed but evident; antennal fovea distinct but shallowly impressed; color generally brown to grayish brown, becoming lighter and grayer dorsally, this especially evident laterad of antennal fovea. Eye height-to-width ratio averaging 1:0.97; eye-to-cheek ratio averaging 1:0.17.

Thorax: Legs unicolorous, entirely black, occasionally with some surfaces more pollinose, slightly cinereous. Wing maculation pattern (Fig. 26) as follows: cell R_1 with 4–5 white spots, frequently spots at either end of cell weakly developed; cell R_3 with 3–4 white spots, if fourth present, weakly developed; cell R_5 with 4 white spots and with 2 darker brown spots along anterior margin of cell, each closely appressed to vein R_{4+5}; discal cell with 2 white spots; cell M_2 with 2 white spots; cell M_4 with 2 white spots. Wing length-to-width ratio averaging 1:0.5; costal vein index averaging 1:0.27; M_{1+2} vein index averaging 1:0.65. Halter brown to brownish black.

Abdomen: Male genitalia (Figs. 28–30) as follows: epandrium (Fig. 28) in caudal view angulate dorsally, deeply incised just below what appears to be the middle of genital plate (combined epandrium and surstyli); surstyli broadly produced laterally, explanate, fused dorsally together and with ventral margin of epandrium, both surstyli together forming semicircular plate which is deeply notched medially at ventral margin; aedeagus in profile (Fig. 29) longer than wide, with V-shaped notch along dorsum; aedeagal apodeme attached to posterior portion of aedeagus and extending ventrally.

Type-material.—Holotype male, labelled: "Robson, B. C. 3-IX-1949 H. R. Foxlee." Allotype female: with same label data as holotype except for the date which is "31. VIII. 1948." One female paratype as follows: Alaska, Anchorage, June, 1964, K. M. Sommerman. The holotype and allotype are in the Canadian National Collection, Ottawa, type number 15434; the paratype is in the National Museum of Natural History, Smithsonian Institution. The left wing of the holotype has been removed and slide mounted; the postabdomen has been dissected, the parts are in an attached microvial.

Geographic distribution.—The known range of *L. lecocercus* lies between 49° and 61° north latitude along the West Coast of North America and the mountains just inland.

Relationship.—*Limnellia lecocercus* is probably the sister species of *L. anna* and *L. anderssoni.* Males of these three species have a constricted ventral margin of the epandrium; but the surstyli of the former are substantially and uniquely modified as described above.

Etymology.—*Lecocercus* is formed from the Greek nouns *lekos* (Latin transcription *lecos*), meaning "plate," and *kerkos* (Latin transcription *cercus*), meaning "tail," in allusion to the platelike surstyli of the male postabdomen of specimens of this species. The specific epithet stands as a noun in apposition to the generic name.

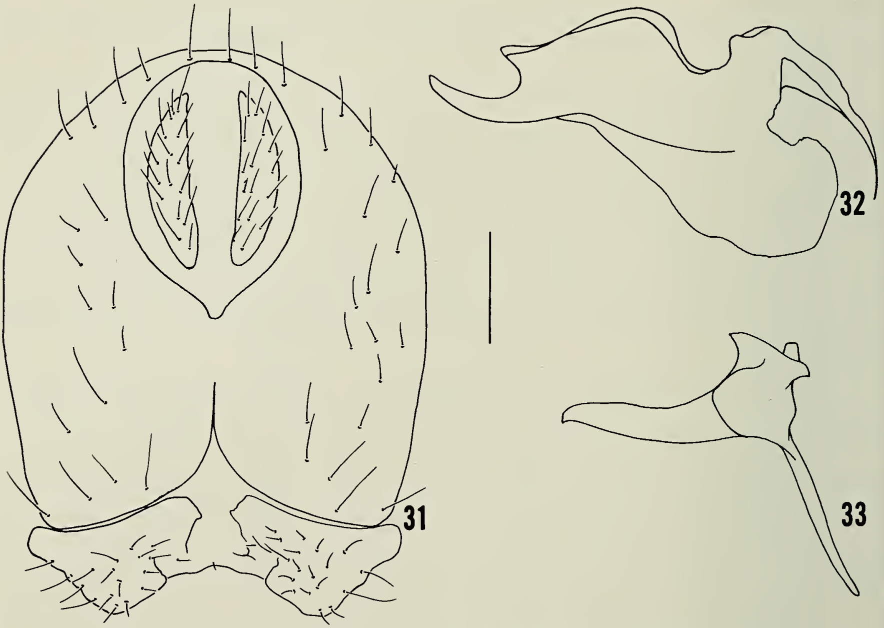
Limnellia sejuncta (Loew)
Figs. 11, 27, 31–33

Scatella sejuncta Loew, 1863:326. Osten Sacken, 1878:204 (catalogue).—Aldrich, 1905:631 (catalogue).

Limnellia sejuncta, Cresson, 1935:364 (review). Wirth and Stone, 1956: 474 (review).—Wirth, 1965:758 (catalogue).

Scatella (*Limnellia*) *sejuncta*, Sturtevant and Wheeler, 1954:177 (review).

Diagnosis.—Specimens of *L. sejuncta* are distinguished from those of congeners by the following characters: setulose portion of face unicolorous,



Figs. 31–33. *Limnellia sejuncta*: 31. Epandrium and surstyli, caudal view; 32. Aedeagus, lateral view; 33. Gonite, lateral view.

golden brown to grayish brown; antennal fovea shallowly impressed, but more deeply so than in *L. ana*; wing maculation pattern as in Fig. 27; basitarsi of all legs pale, yellowish; halter brownish yellow to brown; male genitalia as in Figs. 31–33.

Description.—Small to moderately-small shore flies, length 1.46–2.19 mm.

Head: Head width-to-height ratio averaging 1:0.47. Frons generally unicolorous, brown to charcoal brown except for small cinereous areas along anterior margin of parafrons, color generally darker toward lateral margins. Third antennal segment with posteroventral portion tending to be paler, yellowish, especially as viewed from some angles. Face weakly arched transversely; interfoveal carina feebly developed but evident; antennal carina distinct but weakly impressed; facial color brown or grayish brown ventrally, becoming more cinereous dorsally, particularly antennal fovea and laterad. Eye height-to-width ratio averaging 1:0.94; eye-to-cheek ratio averaging 1:0.14.

Thorax: Basitarsi and frequently second tarsomeres pale, yellowish, contrasting distinctly with black tibiae of each leg. Wing maculation pattern (Fig. 27) as follows: cell R_1 with 4–5 white spots, basal spot generally weakly developed; cell R_3 with 2–3 white spots, both larger spots with distinct brown spot in middle, surrounded by white color; cell R_5 with 3–4 white spots, frequently 1 or 2 spots indistinct or tending to be fused together, 2 darker brown spots within white spots and not touching any veins; discal cell with 2–3 spots, none distinctly developed; cell M_2 with 2 white areas, basal one usually Z-shaped; cell M_4 with 2 white spots, basal one sometimes constricted medially, appearing as 2 spots. Wing length-to-width ratio averaging 1:0.45; costal vein index averaging 1:0.19; M_{1+2} vein index averaging 1:0.56. Halter brownish yellow to brown.

Abdomen: Male genitalia (Figs. 31–33) as follows: epandrium (Fig. 31) in caudal view nearly as wide as long, rounded dorsally, emarginate ventrally; surstyli weakly fused medially, each wider than long, projecting as broadly angulate, shallow process; aedeagus large, longer than wide in profile, anterior tip curved, emarginate dorsally; aedeagal apodeme evident as slender process at posterior end of aedeagus.

Type-material.—Loew's original description (1863) states that the holotype is a female specimen collected from Sitka (Alaska) by Sahlberg. I have not located this specimen despite several inquiries and two visits to the Museum of Comparative Zoology, Harvard University, where Loew's types of New World Diptera are deposited. Apparently Cresson (1935) was likewise unsuccessful in finding the type, as his concept of this species was based on California specimens only. Perhaps it is significant, moreover, that Clausen and Cook (1971) did not find the type(s) of a second ephydrid species, *Parydra varia*, which Loew described in the same paper.

Specimens examined.—Fifty-one specimens (24♂♂, 27♀♀). UNITED STATES: California: Strawberry Canyon (1♂, CNC). Alameda Co., Alameda (1♀, CAS), Berkeley (7♂♂, 7♀♀, USNM), Berkeley Hills (4♂♂, 3♀♀, ANSP), Berkeley Hills-Tilden Park (1♂, CAS). Contra Costa Co., Antioch (1♀, CAS), Lafayette (1♂, CNC). Humboldt Co., Dyerville (1♀, USNM), Orick (1♂, USNM). Los Angeles Co., Whittier (1♂, USNM). Marin Co., Black Point (1♀, USNM), Inverness (1♂, CNC), Lily Pond, Alpine Lake, 1,500′ (1♂, 1♀, CNC), Mill Valley (2♂♂, CAS), Muir Woods (1♂, 3♀♀, USNM), Redwood Canyon (1♀, ANSP). Monterey Co., Lucia (1♂, 1♀, USNM). San Francisco Co., San Francisco (4♀♀, CAS, USNM). Oregon: Wahkenna Falls (1♀, USNM). Clatsop Co., Astoria (1♀, WNM). Washington: Clallam Co., Kalaloch-Olympic National Park (1♀, USNM). Pacific Co., Ilwaco (1♂, USNM). Snohomish Co., Everett (1♂, USNM).

Geographic distribution (Fig. 11).—The known distribution of *L. sejuncta* ranges throughout the coastal region of western North America between 34° (Whittier, California) and 57° (Sitka, Alaska) north latitude.

Relationship.—My comments under *L. balioptera* apply here also.

Remarks.—I have accepted Cresson's (1935) concept of this species, realizing that I could be perpetuating an error. Specimens Cresson determined as this species match Loew's description well.

Limnellia stenhammari (Zetterstedt)

Figs. 34–40

Ephydra stenhammari Zetterstedt, 1846:1842.

Ephydra oscitans Walker, 1849:1106. Osten Sacken, 1858:84 (catalogue) NEW SYNONYMY.

Scatella stenhammari, Loew, 1860:40. Osten Sacken, 1878:204 (catalogue).—Aldrich, 1905:631 (catalogue).

Scatella oscitans, Osten Sacken, 1878:204 (catalogue). Aldrich, 1905:630 (catalogue).

Eustigoptera stenhammari, Cresson, 1930:128 (review).

Limnellia stenhammari, Cresson, 1935:363. Wirth, 1965:758 (catalogue).

Stranditella stenhammari, Duda, 1942:30 (review).

Scatella (*Limnellia*) *stenhammari*, Sturtevant and Wheeler, 1954:177 (review).

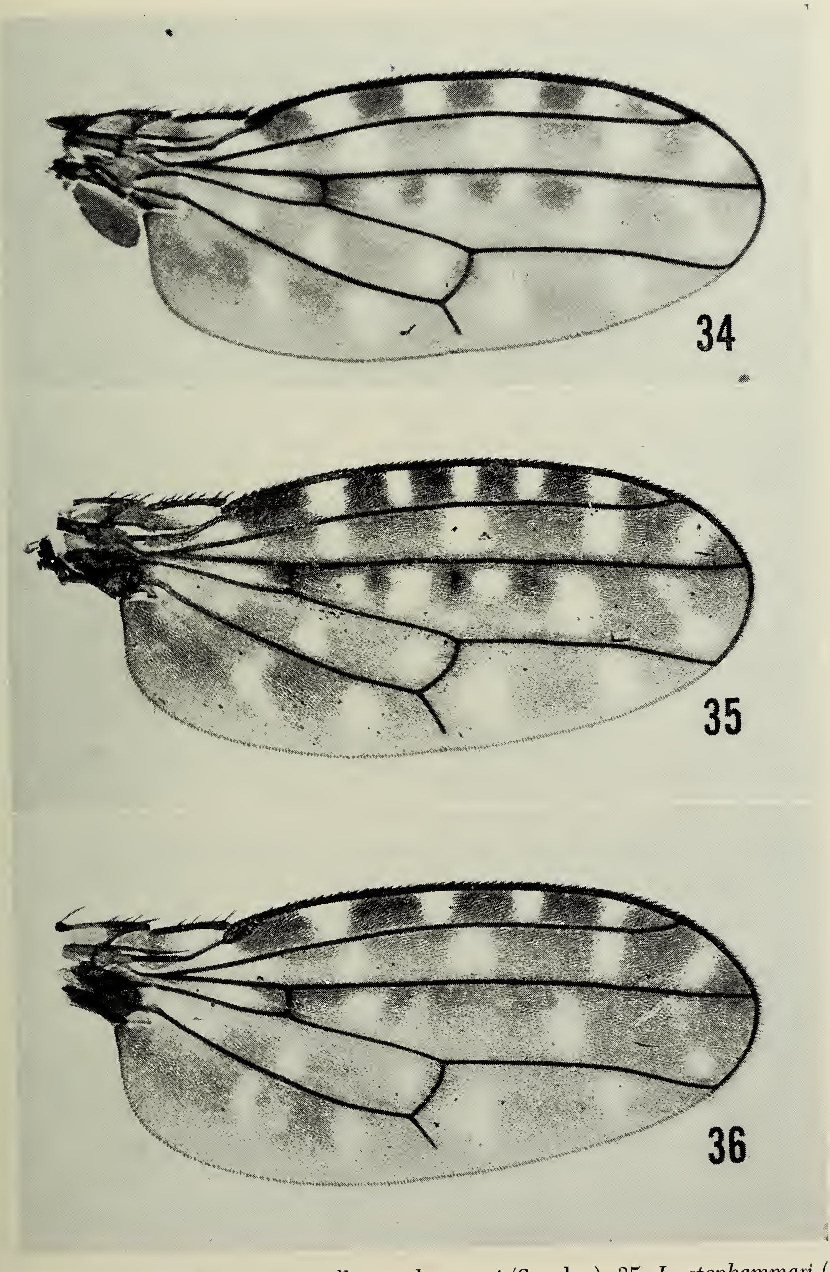
Limnellia oscitans, Wirth, 1965:758 (catalogue).

Diagnosis.—Specimens of *L. stenhammari* are distinguished from those of congeners by the following characters: setulose portion of face mostly unicolorous, brown to grayish brown, occasionally with faintly colored, cinereous band along ventral margin; antennal fovea shallowly impressed, but more so than in *L. anna*; wing maculation pattern as in Figs. 34–36; basitarsi of all legs concolorous with tibiae, black; halter brownish yellow to black; male genitalia as in Figs. 37–39.

Description.—Small to moderately-small shore flies, length 1.57–2.23 mm.

Head: Head width-to-height ratio averaging 1:0.58. Frons generally brown, becoming darker, more charcoal colored laterally; parafrons with anterior margin and linear strip near vertex cinereous. Face weakly arched transversely; interfoveal carina evident but weakly developed; antennal fovea distinct but weakly impressed; facial color with extreme ventral margin slightly cinereous along with antennal fovea, otherwise brown to golden brown, brown color slightly more lustrous than that of frons. Eye height-to-width ratio averaging 1:0.91; eye-to-cheek ratio averaging 1:0.12.

Thorax: Legs generally unicolorous, brownish black to black. Wing maculation pattern (Figs. 34–36) as follows: cell R_1 with 4–5 white spots, each more or less clearly defined; cell R_3 with 4–5 white spots, those at either end tending to be weaker; cell R_5 with 4–6 white spots, apical one sometimes divided medially, generally with 3, occasionally with 2 darker brown spots, each closely appressed against vein R_{4+5}; discal cell with 3 white spots; cell M_2 with 2 spots, basal one elongate, sometimes subdivided; cell M_4 with 2 white spots. Wing length-to-width ratio averaging 1:0.44; costal vein index averaging 1:0.21; M_{1+2} vein index averaging 1:0.67. Halter brownish yellow to brownish black.



Figs. 34–36. Wings. 34. *Limnellia stenhammari* (Sweden); 35. *L. stenhammari* (Belfontain, Ontario); 36. *L. stenhammari* (Dune Park, Indiana).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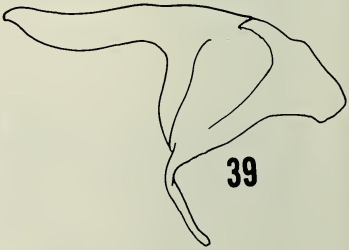
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Figs. 37–39. *Limnellia stenhammari*: 37. Epandrium and surstyli, caudal view; 38. Aedeagus, lateral view; 39. Gonite, lateral view.

Abdomen: Male genitalia (Figs. 37–39) as follows: epandrium (Fig. 37) in caudal view longer than wide, rounded dorsally, truncate ventrally; surstyli large, generally subrectangular, posterolateral margin rounded, setulose, not fused indistinguishably with ventral margin of epandrium; aedeagus longer than wide, with a V-shaped notch dorsally; aedeagal apodeme as a slender process attached to posterior end of epandrium.

Type-material.—Lectotype female, designated by Andersson (1971); Sweden, Skåne, Mellby, Esperöd. The lectotype is in Zetterstedt's Diptera Scandinaviae collection at the Zoological Institute, Lund University, Sweden. Junior synonym, sex unknown, labelled: "Type (green bordered circle)/ Ephydra oscitans Walk (handwritten)/ Hudson's Bay St. Martin's Falls. George Barnston, B. M. 1844 — 17 (handwritten)." The specimen is double mounted on a celluloid square; the abdomen, one-half to two-thirds of each wing, and both third antennal segments are missing.

→

Fig. 40. Distribution map. *Limnellia stenhammari*.


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Specimens examined.—Ninety-five specimens (39♂♂, 56♀♀). CANADA: Alberta: Edmonton (1♂, USNM). British Columbia: Prince Rupert (1♀, CNC). Manitoba: Aweme (1♀, CNC); Churchill (1♂, 3♀♀, CAS, CNC, USNM); Treesbank (1♂, 5♀♀, CNC, USNM). Newfoundland: Colinet (2♀♀, CNC). Northwest Territories: Aklavik (5♂♂, 9♀♀, CAS, CNS, USNM); Hyndman Lake—68°15′N, 131°03′W (1♂, CNC); Reindeer Depot—Mackenzie Delta (1♂, CNC). Ontario: Belfountain (1♀, USNM): Midland (1♂, 1♀, CNC); Ottawa (1♂, 1♀, CNC); Simcoe (1♀, CNC); Stittsville (1♀, CNC); Toronto (1♀, USNM); Waubamic—Parry Sound (1♂, 2♀♀, ANSP, USNM). Quebec: Breckenridge (1♂, CNC); Harrington Lake—Gatineau Park (1♂, CNC); Mistassini (1♀, CNC); Montreal (1♀, AMNH); Old Chelsea—Summit King Mountain (1♀, CNC); Rigaud (1♂, MCZ). Saskatchewan: Saskatoon (1♂, CNC). UNITED STATES: Alaska: Lower Tonsina (1♀, WNM); Matanuska (4♂♂, 3♀♀, USNM); Savonoski—Naknek Lake (1♂, CAS); Unalakleet (1♀, CNC). Connecticut: Fairfield Co., Redding (1♀, USNM). Idaho: Latah Co., Bovill (1♀, USNM); Moscow Mountain (2♂♂, ANSP, USNM); Potlatch (1♂, USNM). Nez Perce Co., Waha (1♀, USNM). Illinois: Union Co., Dongola (1♀, ANSP). Indiana: Dune Park (1♂, USNM). Tippecanoe Co., Lafayette (1♂, 1♀, USNM). Maryland: Montgomery Co., Cabin John (2♂♂, USNM); Plummer Island (1♂, USNM). Massachusetts: Essex Co., Beverly (1♂, USNM). Suffolk Co., Boston (1♂, USNM). Minnesota: Houston Co., (1♀, UMI). Kittson Co., (1♀, UMI). Montana: Glacier Co., Glacier National Park—Avalvanche Lake (1♀, USNM). New Hampshire: Coos Co., Mt. Washington—cow pasture, 5,700′ (1♂, CNC). New Jersey: Camden Co., Clementon (1♀, MCZ). Essex Co., Newark (1♂, MCZ). New York: New York (1♀, USNM). North Carolina: Summit of Black Mountains (1♂, AMNH). Oregon: Umatilla Co., Fly Creek Valley—on snow (1♀, WNM). Pennsylvania: Delaware Co., Swarthmore (2♂♂, ANSP). Philadelphia Co., Germantown (1♂, ANSP). South Carolina: Greenville Co., Greenville (1♀, USNM). South Dakota: Union Co., Elk Point (1♀, USNM). Virginia: Fairfax Co., Falls Church (1♂, MCZ). Washington: San Juan Co., Mt. Constitution (2♂♂, ANSP, USNM). Spokane Co., Deer Park (1♂, 1♀, USNM, WNM). Stevens Co., 3 mi NE Deer Lake (1♀, WNM). Whitman Co., Pullman (1♂, 3♀♀, ANSP, USNM). Valley Ford (1♂, USNM).

Geographic distribution (Fig. 40).—The distribution of *L. stenhammari* ranges throughout the Holarctic Region (Andersson, 1971; Miyagi, 1977; Wirth, 1965). In North America, it is widespread, occurring throughout Canada and Alaska and southward into the northern portions of continental United States. I have not examined any specimens south of South Carolina in the East, Indiana in the Midwest, or Oregon in the West.

Relationship.—See my comments under *L. lactea.*

Remarks.—I did not examine the lectotype of this species but feel confident that the name has been applied correctly. Careful comparison was made with figures of the male genitalia and of the wing maculation pattern, illustrated by Andersson (1971), who designated the lectotype.

The only clues to the identity of the holotype of the junior synonym are the dark tarsomeres which are generally black dorsally, and the type-locality, which is well within the range of *L. stenhammari.* Because the holotype is badly damaged and because there is only one species known from the type-locality with dark tarsomeres, I have elected to recognize the type as conspecific with *L. stenhammari.*

Limnellia sticta, new species
Figs. 41–44

Diagnosis.—Specimens of *L. sticta* are distinguished from those of congeners by the following characters: setulose portion of face mostly grayish brown; antennal fovea shallowly impressed, but more so than in *L. anna*; wing maculation pattern as in Fig. 44; basitarsi of all legs and halteres pale, yellowish; male genitalia as in Figs. 41–43.

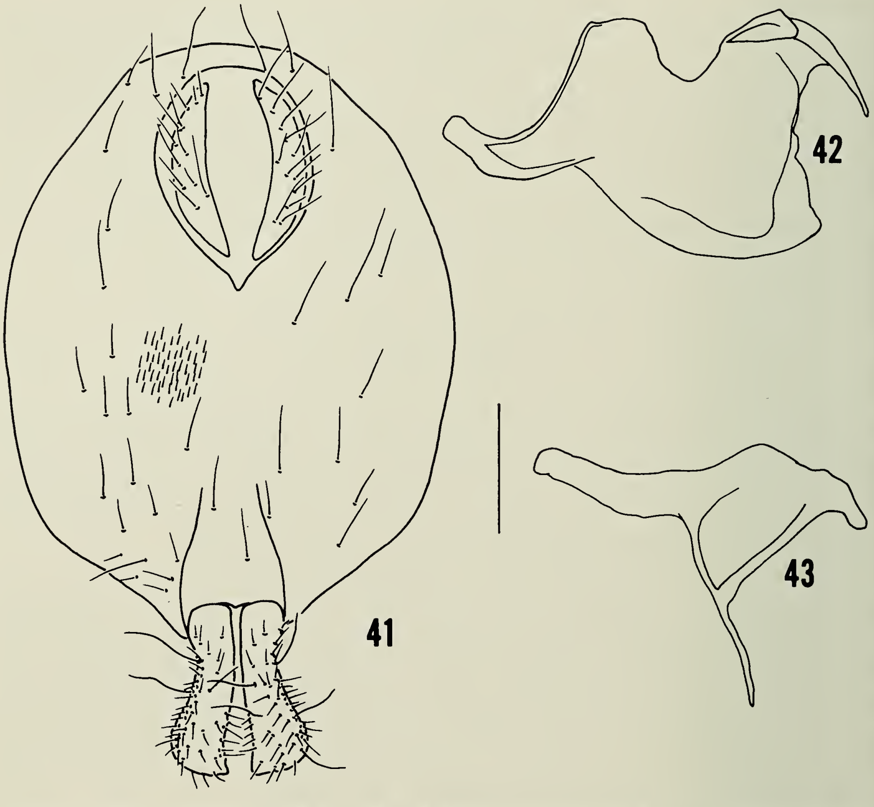
Description.—Small shore flies, length 1.61 mm (holotype).

Head: Head width-to-height ratio 1:0.70. Frons generally brown; parafrons darker in color than mesofrons; parafrons slightly cinereous to brown tinged with grayish green. Face slightly arched; interfoveal carina evident but weakly developed; antennal fovea distinct but shallowly impressed; facial color grayish brown ventrally, becoming more cinereous dorsally, particularly in antennal foveal depressions and laterad. Eye height-to-width ratio 1:0.84; eye-to-cheek ratio 1:0.14.

Thorax: Basitarsi and usually second and third tarsomeres pale, unicolorous, yellowish, contrasting distinctly with black tibiae of each leg. Wing maculation pattern (Fig. 44) as follows: cell R_1 with 4 white spots, spots at ends tending to be weaker; cell R_3 with 4 white spots; cell R_5 with 4 white spots, 2 darker brown spots aside from darker spot over anterior crossvein, each closely appressed to vein R_{4+5}; discal cell with 2–3 white spots; cell M_2 with 2 spots, basal one constricted medially; cell M_4 with 2 white spots. Wing length-to-width ratio 1:0.50; costal vein index 1:0.29; M_{1+2} vein index 1:0.66. Halter brownish yellow.

Abdomen: Male genitalia (Figs. 41–43) as follows: epandrium (Fig. 41) in caudal view generally oval, rounded dorsally and ventrally, longer than wide; surstyli small, slender, becoming slightly wider apically, close together, densely setulose; aedeagus longer than wide in profile (Fig. 42) with anteroventral projection, dorsum with V-shaped notch; aedeagal apodeme as a slender process attached to posterior portion of aedeagus.

Type-material.—Holotype male, labelled: "Knowlton Ldg. QUE 18. VII. 68 J. R. Vockeroth." The holotype is in the Canadian National Collection,



Figs. 41–43. *Limnellia sticta*: 41. Epandrium and surstyli, caudal view; 42. Aedeagus, lateral view; 43. Gonite, lateral view.

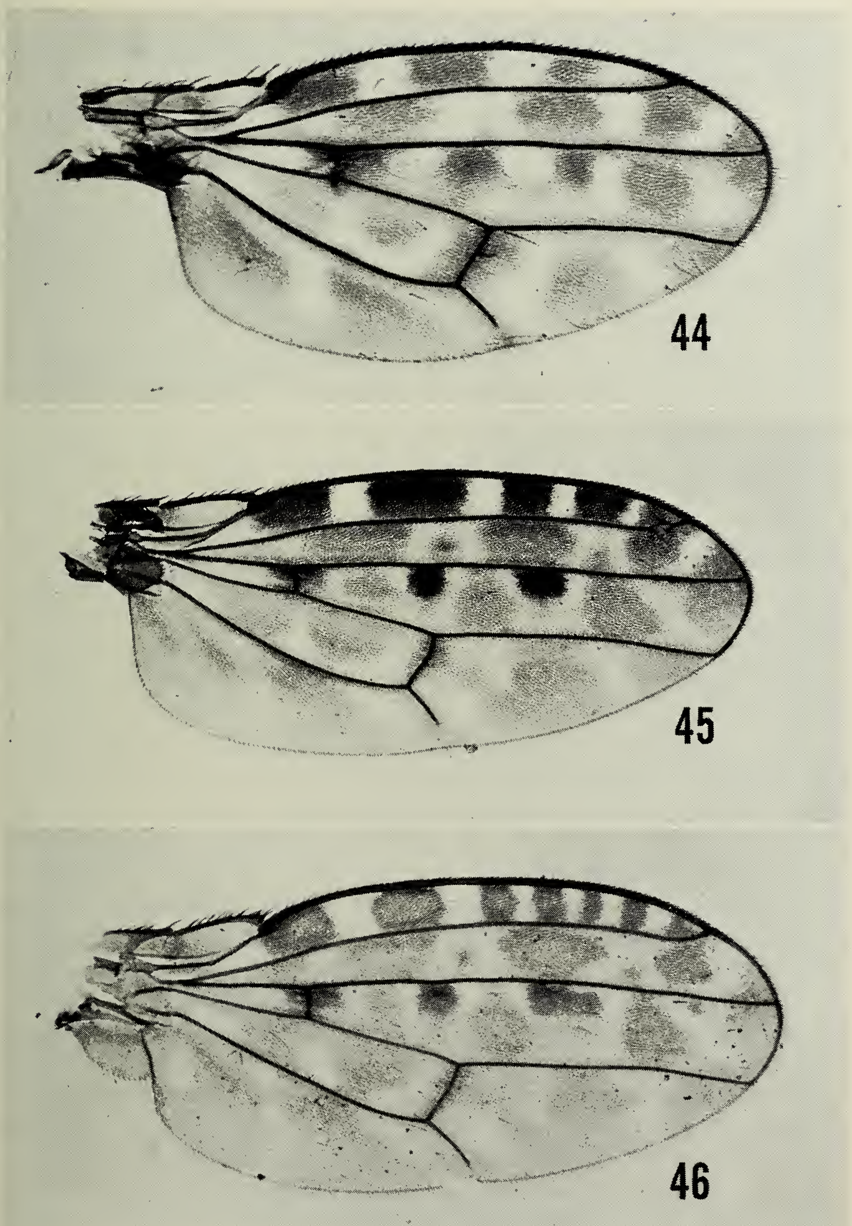
Ottawa, type number 15435. The right wing of the holotype has been removed and slide mounted; the postabdomen has been removed, dissected, and placed in an attached microvial.

Geographic distribution.—This species is known only from the type-locality.

Relationship.—I have placed this species near *L. lactea* and *L. stenhammari* as their sister-group based on similarities of the epandrium and surstyli of males of these species. Specimens of *L. sticta* differ from either congener by the paler halteres.

Etymology.—*Sticta* is derived from the Greek verbal adjective *stiktos,* meaning "spotted," in allusion to the spotted wings of specimens of this species.

Remarks.—*Limnellia sticta* is known only from the holotype specimen, and for this reason I was hesitant to describe it. But the excellent



Figs. 44–46. Wings. 44. *Limnellia sticta*; 45. *L. turneri* (Mt. Rainier—Berkeley Park, Washington); 46. *L. turneri* (Pullman, Washington).

condition of the specimen, its sex (male), the obvious differences in the shapes of the male genitalic structures, and the revisionary nature of this study justifies its description.

Limnellia turneri, new species
Figs. 45–50

Limnellia quadrata of authors, not Fallén. Osten Sacken, 1878:204 (catalogue).—Aldrich, 1905:630 (catalogue, as species of *Scatella*).—Sturtevant and Wheeler, 1954:177 (review, as species of *Scatella*).—Wirth and Stone, 1956:474 (key).—Wirth, 1965:758 (catalogue).

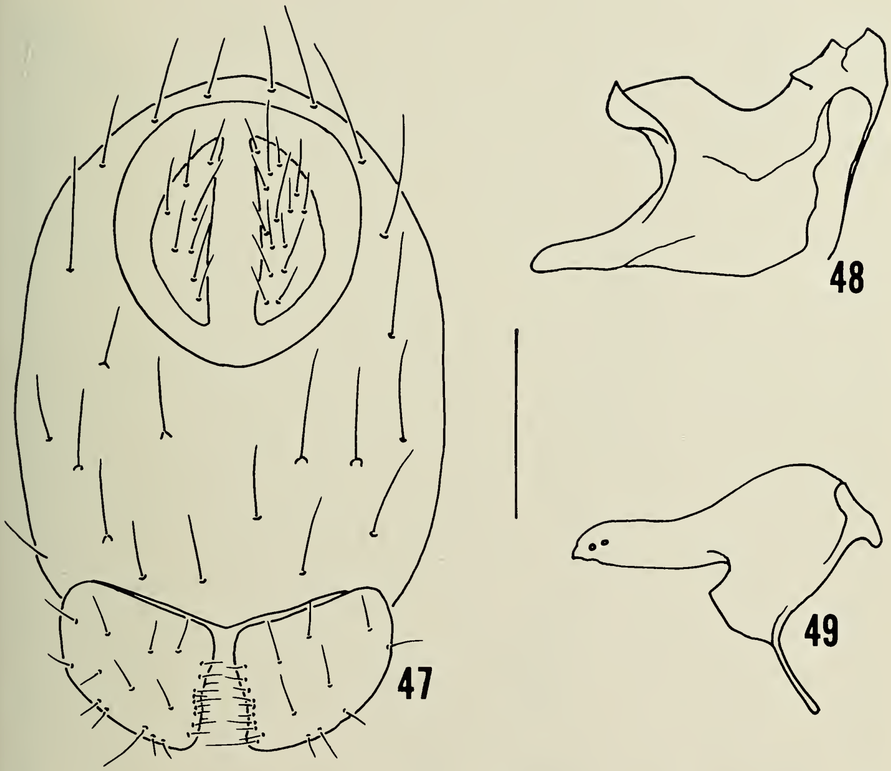
Diagnosis.—Specimens of *L. turneri* are distinguished from those of congeners by the following characters: setulose portion of face mostly unicolorous, grayish brown; antennal fovea distinctly impressed; wing maculation pattern as in Figs. 45–46; basitarsi of all legs mostly pale, yellowish to brownish yellow; halter brownish yellow to brown; male genitalia as in Figs. 47–49.

Description.—Small to moderately-small shore flies, length 1.31–2.47 mm.

Head: Head width-to-height ratio averaging 1:0.66. Frons generally brown, fronto-orbital plated darker than mesofrons; parafrons with anterior margin and linear area near vertex grayish green to cinereous; mesofrons with lighter brown, guttate areas laterad of ocellar triangle. Face generally brown; ventral margin frequently with some cinereous color, face above facial setae becoming more cinereous, cinereous color particularly evident in antennal fovea and laterad; face slightly arched transversely; interfoveal carina weakly developed but evident; antennal fovea distinct but weakly impressed. Eye height-to-width ratio averaging 1:0.87; eye-to-cheek ratio 1:0.16.

Thorax: Basitarsi of each leg generally paler, yellowish; frequently second and third tarsomeres concolorous with basitarsus, distinctly contrasting color of tibiae. Wing maculation pattern (Figs. 45–46) as follows: cell R_1 with 5–7 white spots, each more or less clearly defined; cell R_3 with 3–4 white spots, basal one weakly developed frequently, usually with 1 brown spot completely surrounded with white in line with posterior crossvein; cell R_5 with 4 white spots, usually with 2 darker brown spots, each closely appressed against vein R_{4+5}; discal cell with 2–3 white areas along posterior margin, some extending slightly anteriorly; cell M_2 with 2–3 weakly developed white areas, basal one linear or subdivided; cell M_4 with 2–3 weakly developed white spots. Wing length-to-width ratio averaging 1:0.46; costal vein index averaging 1:0.19; M_{1+2} vein index averaging 1:0.54. Halter brownish yellow to brown.

Abdomen: Male genitalia (Figs. 47–49) as follows: epandrium (Fig. 47) in caudal view longer than wide, rounded dorsally, subtruncate ventrally, larger setae very long; surstyli wider than long, not fused indis-



Figs. 47–49. *Limnellia turneri*: 47. Epandrium and surstyli, caudal view; 48. Aedeagus, lateral view; 49. Gonite, lateral view.

tinguishably with ventral margin of epandrium, median angles slightly angulate, otherwise rounded, setulose; aedeagus nearly as high as long in profile (Fig. 48); aedeagal apodeme as a slender process attached to posterodorsal portion of aedeagus.

Type-material.—Holotype male, labelled: "MtRainier WN Berkeley Park 23 Aug. 1934 A. L. Melander/ ALMelander Collection 1961." Allotype female and 28 paratypes (17♂♂, 11♀♀, USNM): with same label data as holotype. The holotype, allotype, and paratypes are in the National Museum of Natural History, Smithsonian Institution, type number 75475.

Other specimens examined.—237 specimens (89♂♂, 148♀♀). CANADA: Alberta: Laggan (1♀, USNM). British Columbia: Cultus Lake (1♂, 2♀♀, CNC); Point Grey—Vancouver (1♀, CNC); Robson (1♀, CNC); Terrace (1♂, USNM); Terrace—23 mi N (1♀, CNC); Victoria (1♂, CNC). UNITED STATES: Alaska: Anchorage (1♀, USNM). Douglas (2♀♀, ANSP, USNM). Matanuska—rotary trap (3♂♂, 2♀♀, USNM). Arizona: Coconino Co., Bill Williams (1?, USNM). California: Los Angeles Co., Altadena (1♀,

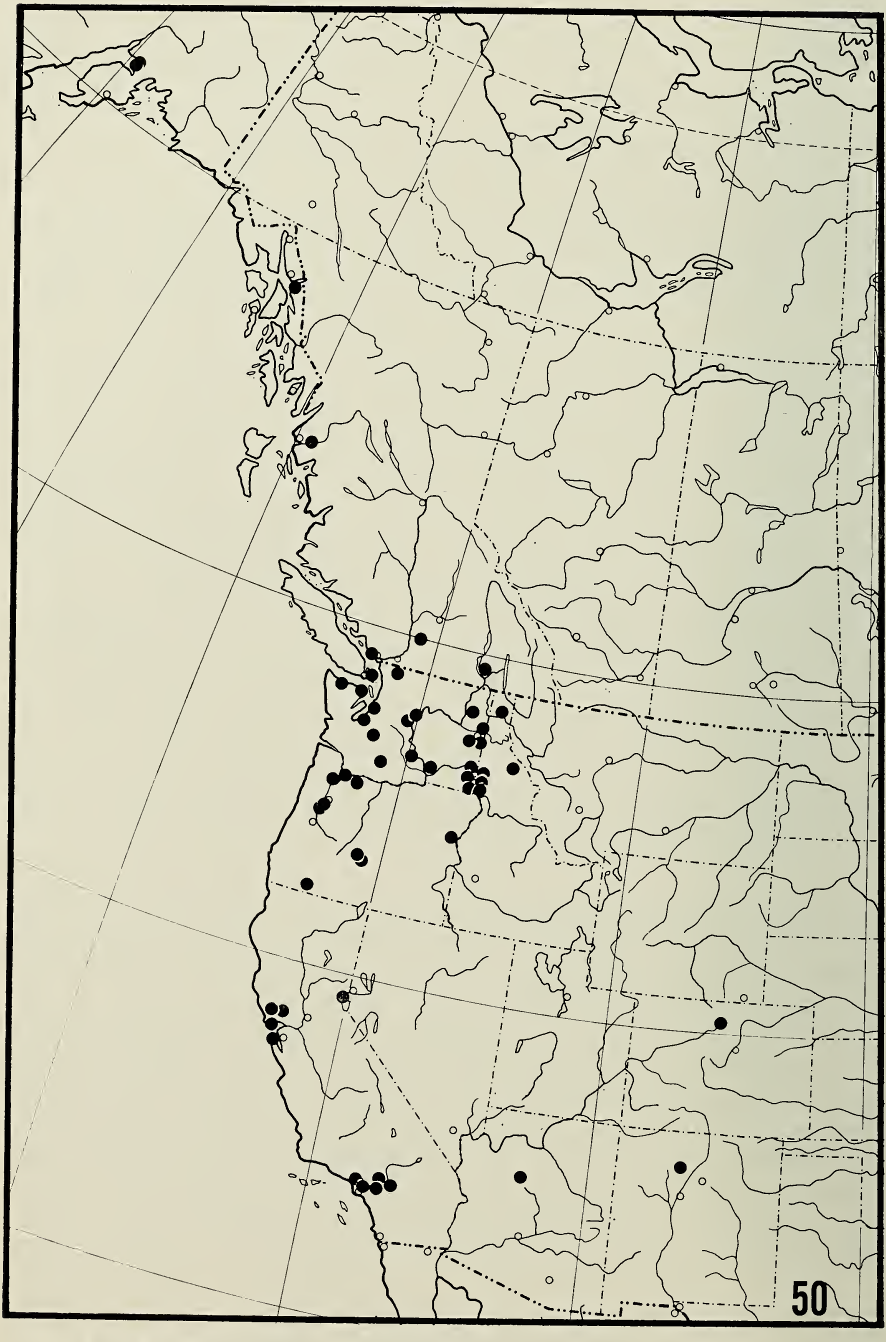


Fig. 50. Distribution map. *Limnellia turneri.*

USNM); Arcadia (1♀, USNM); Pasadena (3♂♂, USNM); Upper Santa Ana River (1♀, USNM); Whittier (1♀, USNM). Marin Co., Black Point (1♀, USNM). Mono Co., Mammoth Lakes (1♀, KU). Nevada Co., Sagehen Creek near Hobart Mills (1♀, WNM). Riverside Co., Riverside (2♀♀, USNM). San Bernardino Co., Barton Flat (2♀♀, USNM); Big Pines (4♂♂, 2♀♀, USNM); Crestline (1♀, USNM); Jenks Lake (1♂, 1♀, USNM); One-thousand Springs (1♂, USNM). San Francisco Co., San Francisco (1♂, 1♀, CAS, USNM). Sonoma Co., Santa Rosa (1♂, CAS). Yolo Co., Winters (1♀, USNM). Oak Glen (1♀, USNM). Colorado: Larimer Co., Estes Park (1♀, USNM). Idaho: Bonner Co., Priest Lake-Lookout Mountain (1♂, 8♀♀, USNM). Idaho Co., Craig Mountains (1♀, USNM). Latah Co., Moscow Mountain (11♂♂, 26♀♀, ANSP, USNM). Nez Perce Co., Lake Waha (1♂, 1♀, ANSP, USNM); Lewiston Grade (1♀, USNM); Lewiston Hill (3♀♀, USNM). Newman Lake (2♀♀, USNM). Snake River—Divide Creek (2♂♂, 1♀, USNM). New Mexico: Sandoval Co., pond 15 mi NW La Cueva-Hwy. 126, 8,500′ (1♀, CAS). Oregon: Baker Co., Anthony Lake (1♂, WNM). Benton Co., Corvallis—on mustard bloom (5♂♂, 2♀♀, USNM); Marys Peak (1♂, WNM); Sulfur Springs (2♀♀, WNM). Dechutes Co., Paulina Lake (1♀, USNM); Sisters—15 mi S (1♀, WNM). Jackson Co., Ashland (1♀, USNM). Marion Co., Breitenbush—*Ceanothus* bloom (1♀, WNM); Woodburn (5♂♂, 1♀, USNM, WNM). Multnomah Co., Portland (1♀, USNM). Mt. Hood—6,000′ (1♂, USNM). Utah: Utah Co., Aspen Grove—Mt. Timpanogos, 6,800′ (1♂, ANSP). Washington: Asotin Co., Asotin—2 mi S (1♂, WSU); Fields' Spring State Park—4 mi S Anatone—3,500–4,000′, dry ice malaise trap (5♂♂, 13♀♀, USNM, WNM, WSU). Chelan Co., Chelan (1♂, USNM); Cashmere (1♂, 1♀, USNM). Clallam Co., Fairholm—Lake Crescent (2♂♂, 2♀♀, USNM). Franklin Co., Eltopia—7 mi WSW (1♀, WNM). Garfield Co., Blue Mountains—Rose Spring (2♂♂, 1♀, USNM); Wawawai (2♀♀, USNM, WSU). Jefferson Co., Port Townsend (1♀, ANSP). King Co., Seattle (1♂, WNM). Pierce Co., Mt. Rainier National Park (1♂, WNM); Mt. Rainier—Burroughs Mt. (2♂♂, 1♀, USNM); Mt. Rainier—Fryingpan Trail (1♂, USNM); Mt. Rainier—Hansen Camp (1♂, USNM); Mt. Rainier—Narada Falls (1♂, USNM); Mt. Rainier—Paradise Park (1♂, USNM); Mt. Rainier—Van Trump Creek (1♂, ANSP); Mt. Rainier—Yakima Park (1♂, 2♀♀, USNM); Tacoma (1♂, USNM). San Juan Co., Orcas Island—Moran State Park, Lilly Pad Lake (1♂, 1♀, CAS); above Mt. Lake (5♂♂, 2♀♀, USNM). Spokane Co., Cheney (1♂, 1♀, UMI); Mica (1♂, USNM); Mt. Spokane (1♂, 2♀♀, USNM); Valley Ford (2♀♀, USNM). Steven Co., Deer Lake—3 mi NE (1♂, WSU). Whatcom Co., Mt. Baker—Skyline Trail (1♀, USNM). Whitman Co., Almota (5♀♀, WNM, WSU); Colton (3♂♂, 1♀, WSU); Union Flat (5♀♀, ANSP, USNM). Yakima Co., ANSP, USNM, WNM); Lyle Grove near Pullman (1♂, WSU); Pullman (4♂♂, 9♀♀, ANSP, USNM, WNM, WSU); Steptoe Canyon—5 mi W

Colton (3♂♂, 1♀, WSU); Union Flat (5♀♀, ANSP, USNM). Yakima Co., Mt. Adams (1♂, 1♀, USNM); Union Gap (1♀, WSU). Wyoming: Yellowstone National Park—Lewis Lake (1♀, USNM).

Geographic distribution (Fig. 50).—Limnellia turneri is a western North American species, ranging from Alaska (Matanuska) southward along the Pacific Coast in the west and the Rocky Mountains in the east to southern California (Los Angeles Co.), Arizona (Coconino Co.), and New Mexico (Sandoval Co.).

Natural history.—Several specimens were collected from the blossoms of mustard and of *Ceanothus*. In southeastern Washington, Dr. William J. Turner collected a large series from malaise traps baited with dry ice.

Relationship.—See my comments under *L. huachuca*.

Etymology.—The genitive patronym *turneri* honors my good friend and dipterist, Dr. William J. Turner, Washington State University.

Remarks.—In addition to the specimens listed above, I have examined five female specimens from the Great Smoky Mountains of North Carolina. These specimens represent either the present species or are a new, closely-related one. The wing maculation pattern of these specimens is very similar to wings of *L. turneri*, and I have deferred describing them as a new species because of the close resemblance. The Great Smoky Mountains, however, are far removed from the distribution outlined above, and these five specimens may well represent another species.

Acknowledgments

All curators and their respective institutions cited above are gratefully acknowledged for permitting me to study collections in their care. I am also thankful to Drs. Wayne E. Clark, Willis W. Wirth, and Oliver S. Flint, Jr. for critical review and suggestions of an earlier draft of this paper. Thanks are also due Miss Hollis B. Williams, who prepared all distribution maps; Miss Anne Halpern, who typed the final draft; Mr. Victor E. Krantz, who made the wing photographs; and Mr. George C. Steyskal, who assisted with the etymology sections.

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91(1), 1978, pp. 294–302

A REDESCRIPTION OF THE TROGLOBITIC ISOPOD, *CAECIDOTEA STYGIA*, FROM THE ENVIRONS OF CINCINNATI, OHIO (CRUSTACEA: ISOPODA: ASELLIDAE)

Thomas E. Bowman and David C. Beckett

Abstract.—In the second record from Ohio, *Caecidotea stygia* is reported from 3 intermittent streams near Cincinnati. The specimens collected were apparently flushed from groundwater following heavy rains. The Ohio specimens are described and illustrated in detail.

Caecidotea stygia was originally described from Mammoth Cave, Edmonson County, Kentucky (Packard, 1871). Despite numerous subsequent records, many of them summarized by Steeves (1963), this species remained inadequately characterized until a full description with a few figures of a topotypic ♂ and ♀ was given by Racovitza (1950). No mention of Racovitza's account was given by Steeves, who provided a diagnosis and illustrations of diagnostic features.

Many additional distributional records of *C. stygia* were given by Fleming (1972). Figure 1 shows the occurrences, by county, reported by Steeves (1963) and Fleming (1972). It is widely distributed in Kentucky and extends into southern Indiana and Illinois. Apparently disjunct populations have been identified by Fleming at the Kentucky–Illinois border and in the vicinity of St. Louis, Missouri. It would be of interest to reexamine these populations.

Until now, the only Ohio record for *C. stygia* has been Cedar Fork Cave, Adams Co. (Fleming, 1972). We have collected it from 3 sites near Cincinnati, Hamilton Co. (Fig. 2): (1) Mt. Airy Forest, Cincinnati, intermittent stream along west edge of White Pine picnic area near West Fork Road, leg. D. C. Beckett, 29 March 1973, 1♀. (2) Winton Woods, Hamilton Co. Park, just E of Stoney Brook Hollow picnic area, intermittent stream draining part of nearby golf course, about 12 km from Mt. Airy site, leg. D. C. Beckett, 25 Oct. 1975, 1♀, 1♂. (3) Intermittent stream near New Richmond, on property of Ralph M. Sinclair, near Laurel-Lindale Rd.; the stream flows into Hog Hollow Creek, a tributary of Twelve Mile Creek, which flows into Ohio River; site is ca. 39 km from Mt. Airy site and 45 km from Winton Woods; leg. D. C. Beckett and R. M. Sinclair, 19 March 1977, 11♀♀, 8♂♂.

All 3 collections were made from intermittent streams in hillside woodland situations. All 3 streams are dry most of the year, continual flow occurring only in the winter or early spring. Each of these collections of subterranean asellids from surface waters was made following a period of heavy rains which elevated the groundwater table, flushing out the subterranean isopods.

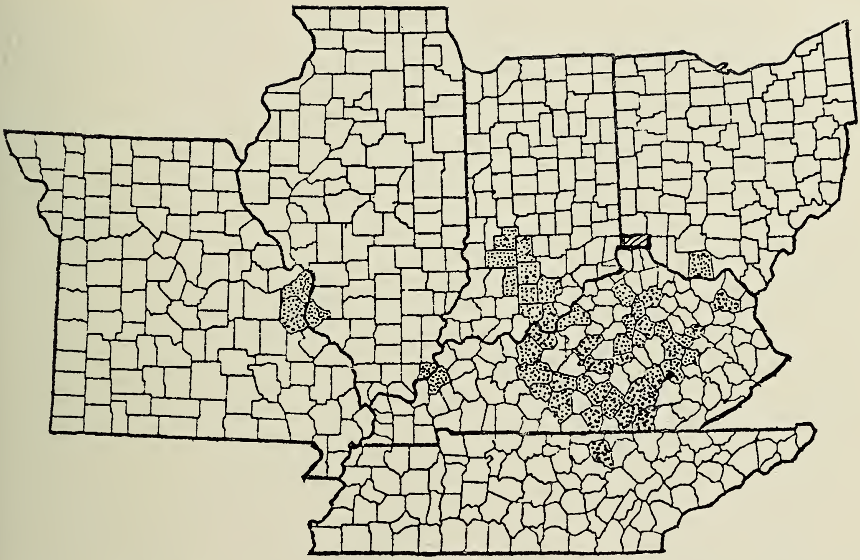


Fig. 1. Reported occurrences, by county, of *Caecidotea stygia*. Stippling = published records; hachure = new records reported herein, Hamilton Co., Ohio.

The bedrock in the area of the collection sites is a mixture of shale and limestone of Ordovician age, covered with deposits of glacial origin. This part of Ohio lacks the massive limestone development found to the south in Kentucky, and we presume that *C. stygia* lives as a phreatobite in southwestern Ohio.

We give below a description of the Hamilton Co. material, illustrating some features of *C. stygia* for the first time. The specimens are deposited in the Division of Crustacea, Smithsonian Institution.

Caecidotea stygia Packard
Figs. 3–6

Caecidotea stygia Packard, 1871:752, figs. 132–133. Type-locality, Mammoth Cave, Edmonson Co., Kentucky ["It was found creeping over the fine sandy bottom, in company with the Campodea [Thysanura], in a shallow pool of water four or five miles from the mouth of the cave"].

Asellus stygius (Packard).—Racovitza, 1950:164–176, figs. 1–13.—Steeves, 1963:472–474, figs. 2–6 [synonymy, distribution].—Fleming, 1972:249–252 [new distribution records].

For an explanation of the use of *Caecidotea* rather than *Asellus*, see Bowman (1975).

Description.—Small, eyeless, unpigmented. Length of largest specimen 6.5 mm (maximum given by Steeves, 16 mm). Body slender, linear,

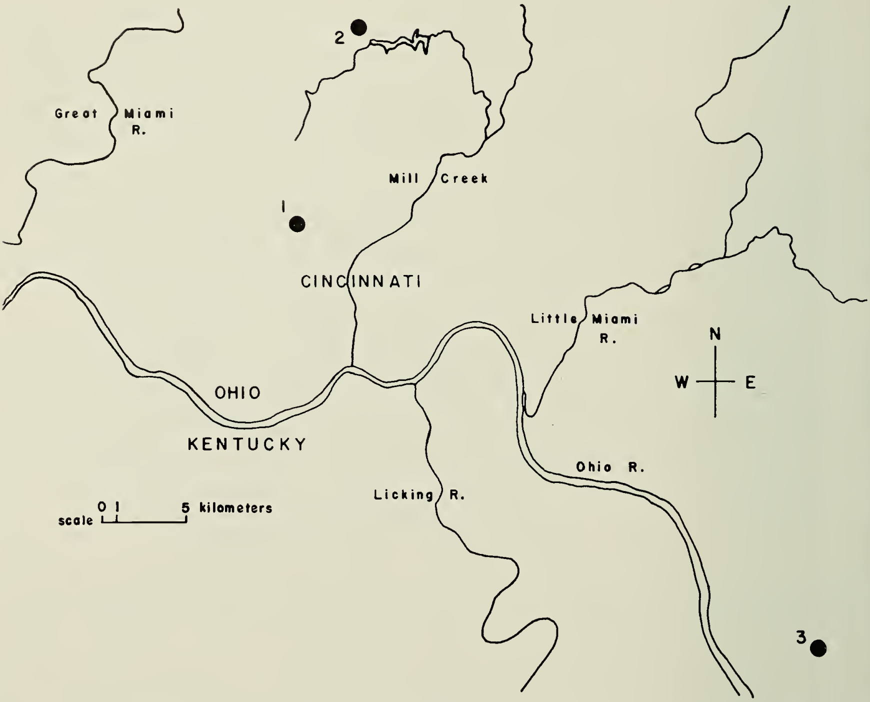


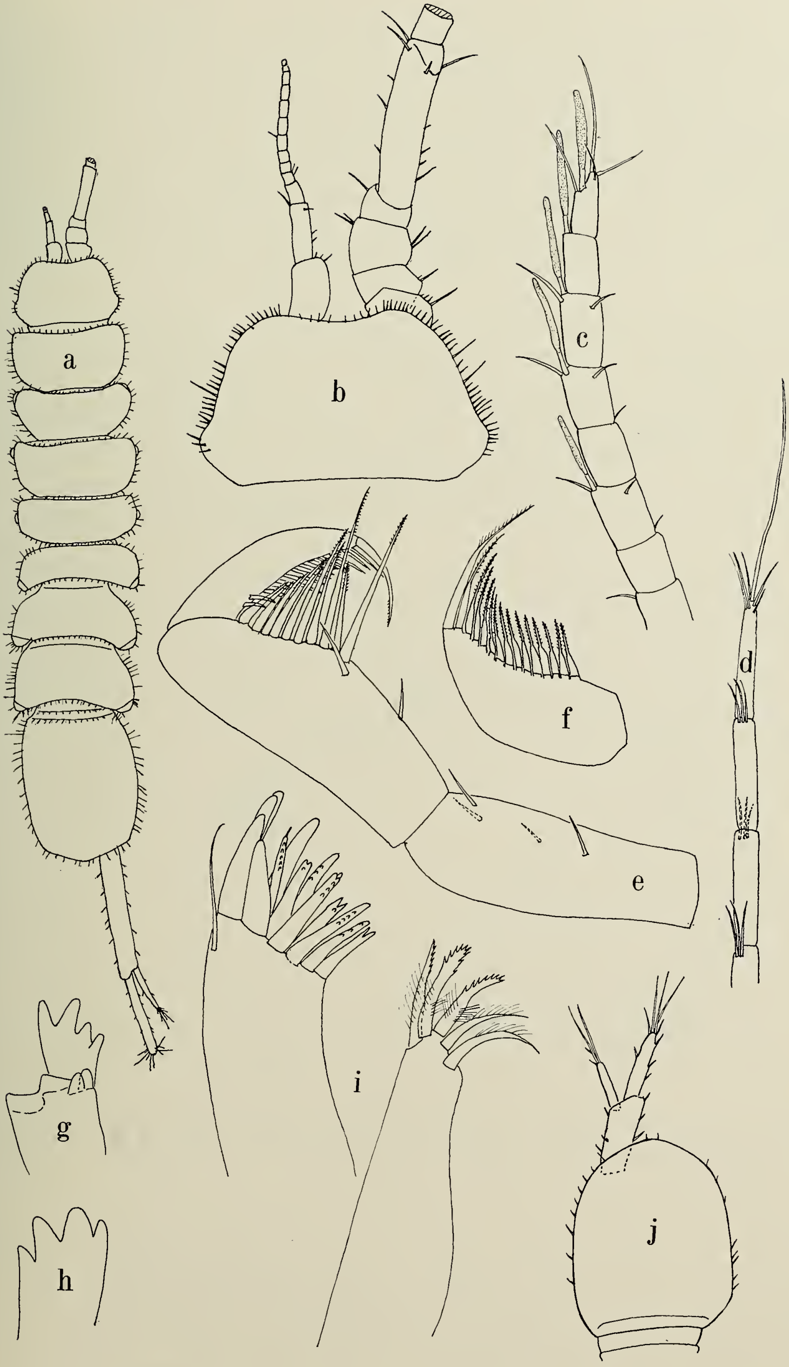
Fig. 2. Localities where *Caecidotea stygia* was collected in Cincinnati, Ohio, and vicinity. 1. Mt. Airy Forest; 2. Winton Woods; 3. New Richmond.

about 4.8× as long as wide; coxae all visible in dorsal view. Margins of head, pereon and telson setose; dorsal surface also with scattered setae (most obscured by adherent debris). Head about 1.8× as wide as long; anterior margin slightly concave, without rostrum; postmandibular lobes weakly developed. Telson about ⅓ longer than wide in 6.5 mm ♂ from New Richmond, ⅕ longer than wide in 3.2 mm ♂ from Winton Woods; sides slightly convex, caudomedial lobe poorly defined.

Antenna 1 nearly reaching distal margin of 5th peduncle segment of antenna 2; flagellum with up to 10 segments, last 6 (♂) or 3 (♀) segments each bearing esthete. Antenna 2 about as long as head + pereonites 1–6; last peduncle segment ⅓ longer than penultimate; flagellum with up to 60 segments.

→

Fig. 3. *Caecidotea stygia*. a–i, 6.5 mm ♂: a, Habitus, dorsal; b, Head dorsal; c, Antenna 1, distal segments; d, Antenna 2, distal segments; e, Mandibular palp; f, Mandibular palp, apical segment; g, Left mandible, incisor and lacinia; h, Right mandible, lacinia; i, Maxilla 1; j, Telson and uropod, 3.2 mm ♂.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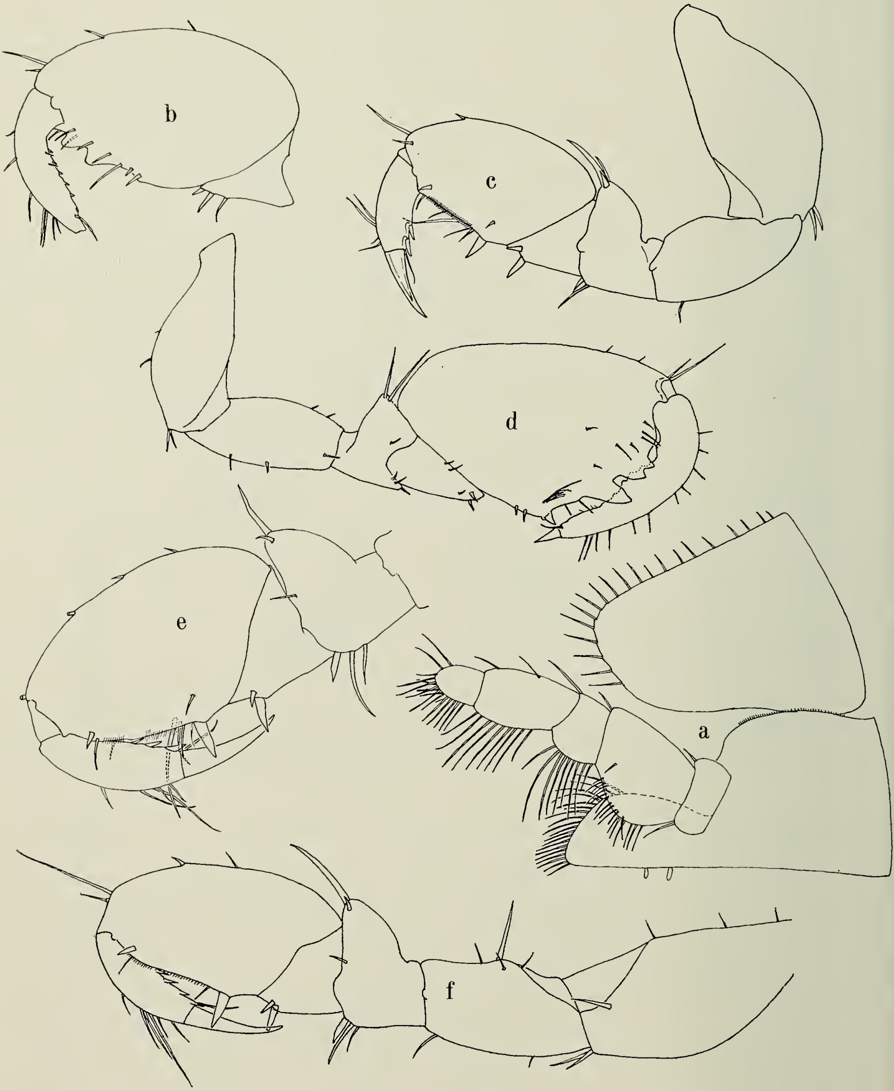

Fig. 4. *Caecidotea stygia.* a, ♀ maxilliped; b–f, Pereopod 1; b, 4.4 mm ♂, Shafer's Cave, Crawford Co., Indiana; c–f, New Richmond, Ohio: c, 3.2 mm ♂; d, 6.5 mm ♂; e, 4.4 mm ♂; f, ♀.

Mandibles with 4-cuspate incisors; lacinia of left mandible 4-cuspate; spine-row with 10 spines in right, 11 spines in left mandible; palp as in figure 3e, f. Maxilla 1, apex of outer lobe with 13 robust spines and subterminal seta; inner lobe with 5 apical plumose setae, 3 of them distally serrate. Maxilliped with 2 retinaculae; distal segment of palp rather short.

Propus of ♀ pereopod 1 with straight palm armed with close-set setules but without palmar processes, palm defined by strong proximal spine; dactyl with about 4 spines on flexor margin. Pereopod 1 of all ♂♂ except largest (6.5 mm) similar to that of ♀. Pereopod 1 of 6.5 mm ♂ with palm of propus more nearly vertical, with smaller defining spine and 2 processes separated by narrow U-shaped gap, higher proximal conical process and lower distal bicuspid process; dactyl with short claw, flexor margin with irregular teeth but without articulating spines.

Pereopods 2–7, dactyls without accessory claws; pereopod 4 identical in ♂ and ♀.

Male pleopod 1 larger than pleopod 2; protopod about half as long as exopod, with 3–4 retinaculae. Exopod about twice as long as wide, of somewhat different form in 6.5 mm ♂ than in smaller ♂♂. In latter, lateral margin concave in middle third, armed with setae decreasing in length distally, then increasing in length near rounded distal margin. In 6.5 mm ♂ lateral margin nearly straight; distolateral corner protuberant; distal margin oblique; terminal part of exopod folded back onto posterior surface.

Male pleopod 2 protopod about ⅓ longer than wide, medial margin with single seta. Exopod slightly shorter than endopod; proximal segment with 2–4 setae on lateral margin; distal segment oval in smaller ♂♂, constricted at apex in 6.5 mm ♂, with 8–14 marginal setae (8 in 3.2 mm ♂ from Winton Woods, 10 in 3.8 mm ♂ from New Richmond, 14 in 6.5 mm ♂), those on medial margin (3–4) more sparsely plumose and bent slightly distal to midlength. Endopod tip with slender, nearly straight cannula, directed laterally at angle of about 30° to axis of endopod, tip bent, acute or truncate; lateral process slightly shorter than cannula, sinuate, tip broadened (not apparent at most angles of view) and bent toward cannula; caudal process low, broadly rounded. Female pleopod 2 pyriform, with 2 setae at apex and 4 on lateral margin. Pleopod 3 exopod about twice as long as wide; distal segment about 1.6× length of proximal segment, with a few short setae on truncate distal margin. Pleopod 4 exopod with a few short setae on proximolateral margin and obliquely transverse "line." Pleopod 5 exopod divided into 2 segments by obliquely transverse suture; proximal segment with curved "line."

Uropod longer than telson. Female protopod subequal in length to endopod; ♂ protopod distinctly longer; margins armed with spines, those on medial margin more conspicuous. Endopod more than twice as long as exopod in ♂, about 1.3× as long in ♀; ♂ endopod broader than ♀ endopod.

Remarks.—Our interpretation of the endopod tip of the ♂ pleopod 2 differs from that of Steeves (1963), who did not include the low rounded lobe on the posterior surface that we identify as a caudal process. He interpreted our lateral process as a caudal process and named as lateral

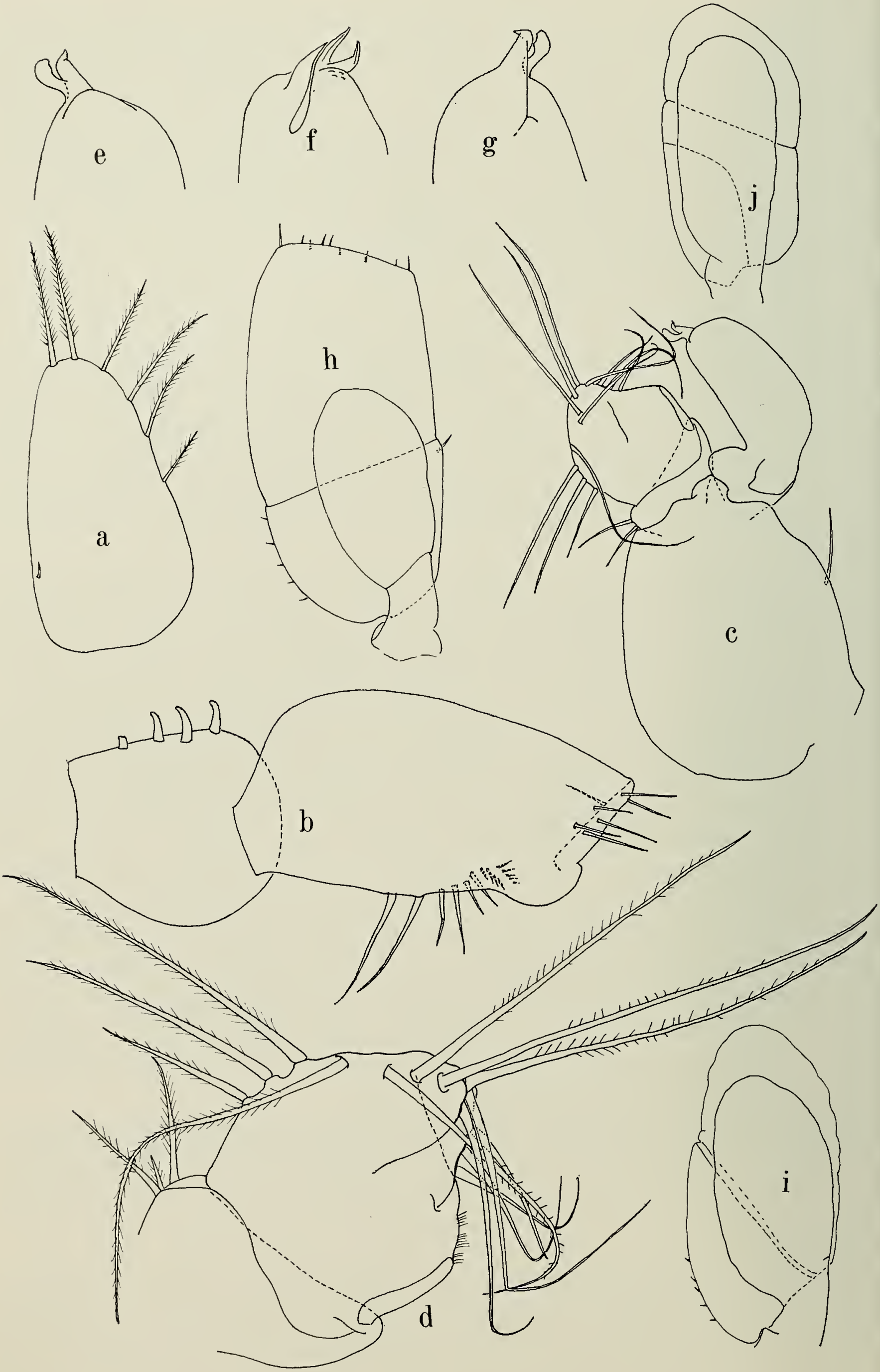
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Fig. 6. *Caecidotea stygia.* a, ♂ pereopod 4; b, ♂ pereopod 7; c, Medial margins of protopods of pleopod 1, anterior, showing retinaculae; d, Right ♂ uropod, dorsal; e, Same, ♀.

process an inconspicuous structure on the lateral margin of the fissure, not easily visible in most aspects. We wish to emphasize the importance of examining the endopod tip in several different positions, and the uncertainty of assumed homologies of tip elements among species of *Caecidotea.*

←

Fig. 5. *Caecidotea stygia.* a, ♀ pleopod 1; b, ♂ pleopod 1; c, ♂ pleopod 2, posterior; d, Exopod of ♂ pleopod 2; e–g, Endopod tip of ♂ pleopod 2: e, Posterior; f, Anterior; g, Anterolateral; h, Pleopod 3; i, Pleopod 4; j, Pleopod 5.

The delay in differentiation of the ♂ pereopod 1 is of interest, in view of the taxonomic importance commonly assigned to this pereopod. For comparison, pereopod 1 of a 4.4 mm ♂ *C. stygia* from Shafer's Cave, Crawford Co., Indiana, is shown in Fig. 4b. Here the palmar processes are partly developed, in contrast to their absence in a 4.4 mm ♂ from Hamilton Co., Ohio (Fig. 4e). In the Ohio ♂♂ without palmar processes pleopods 1 and 2 are fully differentiated, however. Thus it should not be assumed that a ♂ asellid that appears to be mature on the basis of its pleopods has a fully differentiated pereopod 1. The development of the ♂ pereopod 1 in asellids merits further attention.

Acknowledgments

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TAXONOMIC STUDY OF THE AMERICAN PLANTHOPPER GENUS *CYRPOPTUS* (HOMOPTERA: FULGOROIDEA: FULGORIDAE)

James P. Kramer

Abstract.—This study presents the first taxonomic revision of the American planthopper genus *Cyrpoptus*. Eleven species are treated. Two species are described as new: *ruficrus* from Cuba and *dubius* from Mexico. Plant associations are recorded. The distribution of the genus includes southern United States, Cuba, Mexico, and Central America. All critical diagnostic features are illustrated, and many new distributional records are included.

Within the United States species of the genus *Cyrpoptus* are striking fulgorids. Because of their relatively large size, reddish color, and occasional abundance, specimens are frequently submitted (by various workers concerned with plant-feeding insects) to the Systematic Entomology Laboratory for determination. The need to provide accurate and consistent names to specimens provided the impetus for this report.

At no time in the past were all of the species of *Cyrpoptus* studied as a unit. Species identification, of necessity based on inadequate individual descriptions, was too often uncertain or inaccurate. Dozier (1928:24) and Metcalf (1923:153) each proposed keys to the same relatively common three species, *C. belfragei* Stål, *C. nubeculosus* Stål, and *C. reineckei* Van Duzee. The keys of both authors employ characters which are either vague or lack adequate illustrations for clarification of the verbal presentation. In fairness to both Dozier and Metcalf, it should be stated that they depended heavily upon the literature with only limited study of specimens to form their ideas of species and their limits. In the course of the present study, reasonably good series of most of the species were assembled and types or lectotypes were studied and/or selected for all but one species, *C. obtusus* Valdes Ragues, the type of which was unavailable for study. All of the critical features used in the key are figured.

The economic significance of the included species is not established, but specimens of various species were taken on such diverse plants as lima beans, cotton, and pine.

Cyrpoptus Stål

Cyrpoptus Stål 1862:304. Type-species *Cyrpoptus suavis* Stål (monobasic) 1862:305.

Moderate sized to small fulgorids (10–16.5 mm); head in dorsal view about as broad as pronotum and broadly rounded to obtusely angular at apex;

coronal midlength equal to or greater than length near eyes; lateral coronal margins elevated, carinate, and slightly overlapping eyes; postocular area produced as short, blunt projection; coronal surface obliquely rugulose and/or weakly ridged; anterior coronal margin alternatingly light and dark due to series of variably defined small brown or black spots or patches; pronotum about 3× broader than long, declivant laterally, midline variably carinate, with evanescent longitudinal carina mesad of and posterior to each eye, surface rugulose; mesonotum subtriangular, declivant on lateral angles, surface rugulose and sometimes weakly ridged; pronotum and mesonotum each with pair of variably distinct small round impressions, pair on pronotum near transverse midline, pair on mesonotum closer to posterior angle than to transverse midline; forewings opaque basally and transparent distally, transparent portion usually with dark color pattern; hind wings mainly hyaline but usually yellow to red basally, colored portion variably bordered distally with black; face and crown separated by suture which decurves near eyes; frons quadrate, broadest apically, tapered toward base, lateral margins expanded at and concealing antennal bases, basal margin indented to receive clypeus; clypeus subtriangular, sides roundly expanded at base, then tapered to apex, discal portion in distal half often somewhat elevated; prothoracic femora dilated, mesothoracic femora similar, metathoracic femora not at all dilated. Male genitalia: pygofer, anal tube, and styles simple; aedeagus consisting of three pairs of inflatable lobes, each with or without apical elaborations.

Generic diagnosis.—The genus *Cyrpoptus* belongs to the subfamily Poiocerinae and tribe Poiocerini. It can be separated from all of the other genera in the tribe by the following combination of characters: the subequal widths of the head and pronotum, the blunt postocular projections, the pair of small round impressions on both the pro- and mesonotum, the dilated prothoracic femora, the (basally) opaque and (distally) transparent forewings, and the usually basally yellow to red hyaline hind wings.

Notes on the key and other comments.—The characters used in the key should work for either male or female specimens. The lengths given are the measurements taken with the wings at rest from the extreme coronal apex to the distal-most tips of the forewings. Generally, females are larger than males; but within most species, there is some overlap in size. At times one will find a large male associated with a small female, both representing the same species.

Structural features of the male genitalia, which provide the only consistent means of delimiting species in most of the families of the Fulgoroidea, appear to be of some value in the Fulgoridae or at least in the genus *Cyrpoptus*. The aedeagus consists of three pairs of inflatable lobes positioned in a vertical sequence. The shapes, lengths, and structural modifications of these lobes vary interspecifically, and these differences can be seen by consulting the illustrations.

Key to Species of *Cyrpoptus*

1\. Pronotal carina behind inner margin of each eye strongly developed and nearly reaching posterior margin in dorsal view (Fig. 80) (distribution: Panama) *obscurus* Metcalf

\- Pronotal carina behind inner margin of each eye essentially absent or only weakly developed in dorsal view (Figs. 1, 22, 30) 2

2\. Crown and thoracic dorsum mottled with fuscus or black (Fig. 6), or legs with joint of femur and tibia reddish (distribution: Cuba) 3

\- Crown and thoracic dorsum not so marked, legs not or rarely reddish as above (distribution: mainland America) 4

3\. Crown and thoracic dorsum mottled with black or fuscus (Fig. 6), costal margin of forewing slightly concave near middle (Fig. 4), joint of femur and tibia with ground color stramineous *obtusus* (Valdes Ragues)

\- Crown and thoracic dorsum with at most fine lighter and darker reticulate markings (Fig. 10), costal margin of forewing not concave near middle (Fig. 9), joint of femur and tibia with ground color reddish *ruficrus* n. sp.

4\. Forewing with distal midline solidly darkened from apex to or almost to opaque basal portion (Figs. 15, 21) 5

\- Forewing with distal midline not darkened, darkened only half distance to opaque basal portion (Fig. 38), or darkened irregularly and more extensively (Figs. 48, 57, 62) 6

5\. Forewing distinctly narrowed subapically, its distal margin slightly sinuate (Figs. 1, 15) *suavis* Stål

\- Forewing not distinctly narrowed subapically, its distal margin not sinuate (Figs. 20, 21) *belfragei* Stål

6\. Forewing with distal portion not darkened, or lightly marked with dominant marking consisting of dark stripe on midline (Fig. 38) 7

\- Forewing with distal portion extensively darkened (Fig. 48, 56, 65); or if lightly marked, dominant marking not dark stripe on midline (Fig. 29) 8

7\. Crown distinctly produced at middle (Fig. 30), opaque basal portion of forewing with faint transverse band (Fig. 28), smaller species—males 11–12 mm, females 12–13.5 mm *metcalfi* Ball (in part)

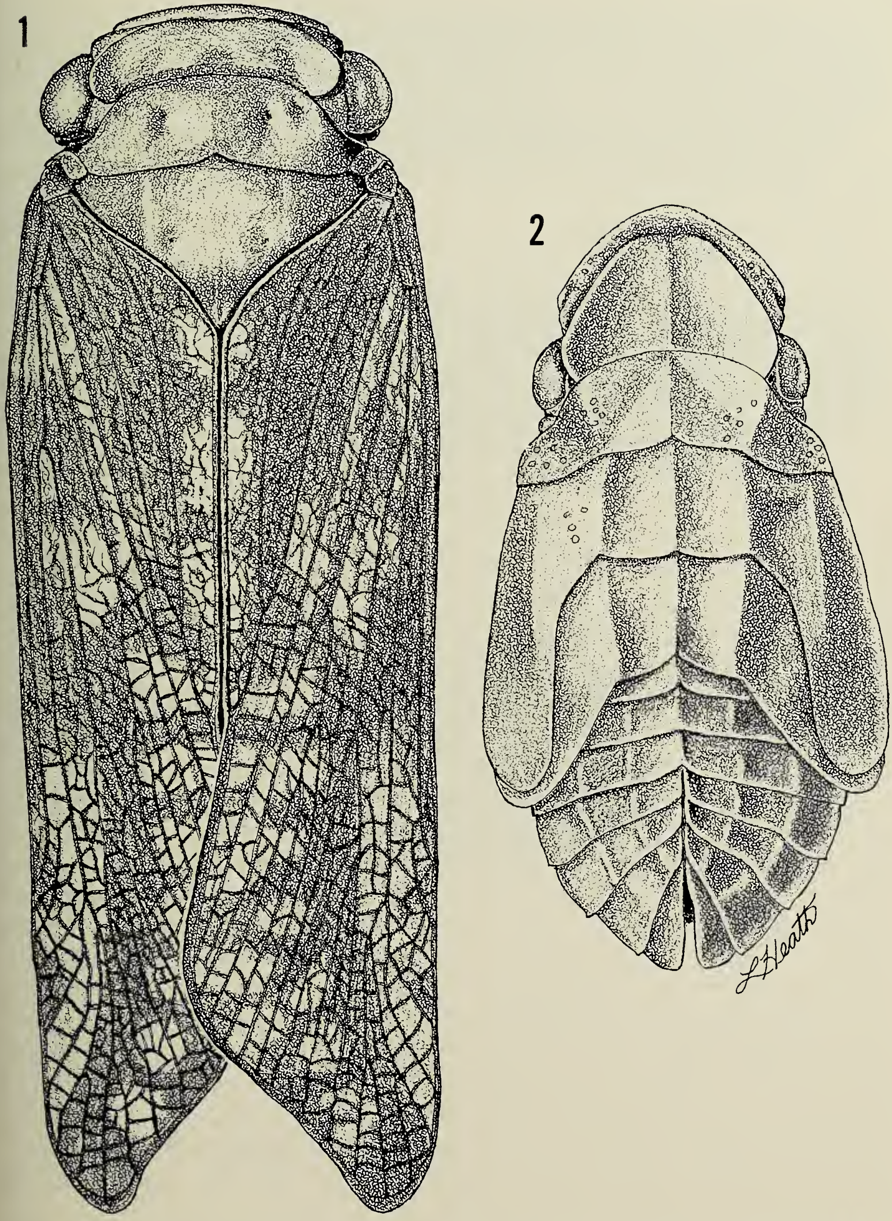
\- Crown not produced at middle (Figs. 39, 41), opaque basal portion of forewing not banded (Fig. 38), larger species—males 13–14 mm, females 14.5–16.5 mm *ferruginosus* Stål

8. Midline of crown darkened to form wide stripe or longitudinal band (Fig. 49), coronal length at middle 2× or less length next to eyes *vanduzeei* Ball
– Midline of crown not so darkened or if vaguely as above, then coronal length at middle about 2½× length next to eyes 9
9. Forewing extensively darkened distally, with distinct transparent oblique vitta from costal margin in apical portion reaching to or beyond midline (Figs. 56, 57) (distribution: So. Car., Fla., and Gulf States) *reineckei* Van D.
– Forewing extensively darkened distally or not, without transparent vitta as above (Figs. 28, 29) or vitta only vaguely indicated and not reaching to or beyond midline (Figs. 62, 65) (distribution: S Texas, western states, and Mexico) 10
10. Face in lateral view with convexity near middle (Fig. 31) or in full view with low irregular transverse ridge across middle; forewing with opaque basal portion palest at middle (Fig. 28) or entire forewing but little darkened (Fig. 29) *metcalfi* Ball (in part)
– Face in lateral or full view essentially smooth across middle (Figs. 67, 77); forewing not as above 11
11. Head in lateral view produced anteriorly for about 1½× width of eye (Fig. 64); forewing with fewer hyaline areas (Fig. 62) *dubius* n. sp.
– Head in lateral view produced anteriorly for about 1× width of eye (Figs. 67, 69, 73); forewing with more hyaline areas (Fig. 65) *nubeculosus* Stål

Cyrpoptus obscurus Metcalf
(Fig. 80)

Cyrpoptus obscurus Metcalf 1938:352.

Salient features.—Length of male 15 mm, female unknown. Crown roundly produced, longer at middle than next to eyes, surface irregularly rugulose, midline vaguely carinate; pronotum transversely rugulose, with carina on midline neither reaching anterior nor posterior margins, carina behind each eye well developed and reaching or nearly reaching posterior margin (Fig. 80); mesonotum with surface transversely rugulose; frons irregularly rugulose. Ground color stramineous washed with reddish; mesonotum with impressions and apex fuscus; veins of forewings pink or pinkish; each forewing with moderately distinct undulated brown stripe; stripe begins at midpoint of claval base, extends posteriorly to about midpoint of claval suture, then turns and extends to midpoint of discal portion, briefly continues posteriorly and evanesces; each hind wing, in-



Figs. 1–2. Dorsal habitus views. 1. *Cyrpoptus suavis* Stål, male from Costa Rica; 2. *Cyrpoptus nubeculosus* Stål, last instar nymph from Santa Rita Mts., Arizona.

cluding base, essentially hyaline; face darkest on discal portion; legs and abdominal venter mottled with various shades of brown to black.

Male genitalia.—Externally typical of genus, concealed portions not studied.

Type.—Holotype male, Barro Colorado Island, Canal Zone, 3 Dec. 1930, F. E. Lutz. Repository of holotype: American Museum of Natural History, New York City.

Records.—Known only from the type.

Notes.—The complete longitudinal carina behind each eye on the pronotum and the undulated brown stripe on each forewing provide the distinctive features of *obscurus.* In addition, this species differs from all other *Cyrpoptus* by the lack of differentiation between the basal and distal portions of the forewings and the lack of pigmentation at the bases of the hind wings.

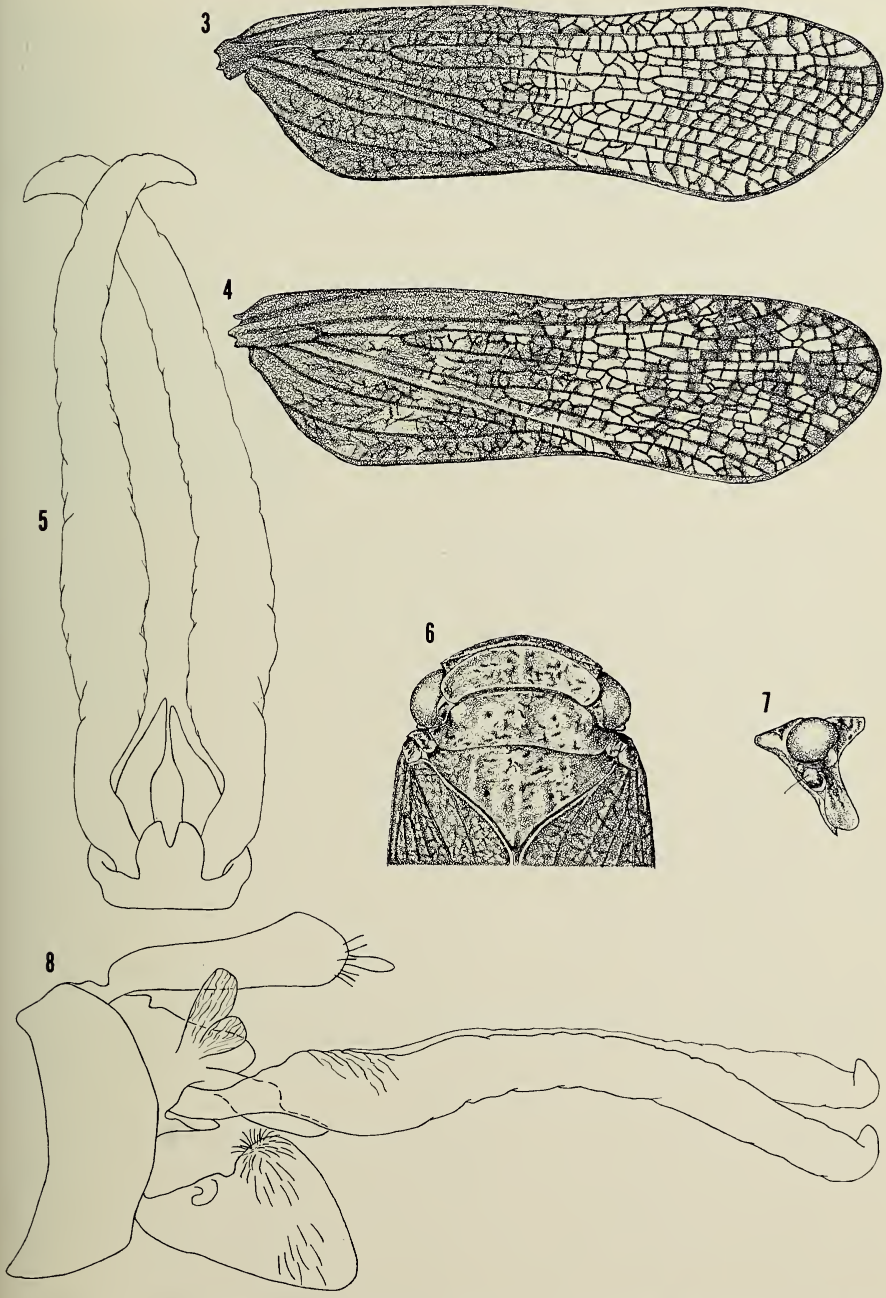
Cyrpoptus obtusus (Valdes Ragues)
(Figs. 3–8)

Caliptoprotus obtusus Valdes Ragues 1910:442.

Salient features.—Length of male 10–11.2 mm, females 10–11.5 mm. Crown roundly produced, length at middle and next to eyes about subequal, surface longitudinally rugulose or obliquely so; pronotum irregularly rugulose, usually with weakly defined median longitudinal carina, carina behind each eye poorly developed or absent (Fig. 6); mesonotum more or less transversely rugulose; frons longitudinally rugulose, in lateral view (Fig. 7) contour slightly irregular; costal margins of forewings indented near middle (Figs. 3–4). Ground color sordid stramineous to light brown, sometimes lightly washed with reddish; crown, pronotum, and mesonotum mottled with fuscus to black (Fig. 6); impressions on pronotum and mesonotum dark; opaque basal portions of forewings reddish with cells lightly to heavily fuscus; hyaline distal portions of forewings with dark pattern variable either quite light (Fig. 3), or moderately heavy with distinct pattern (Fig. 4); each hind wing red at base with red portion bordered distally with brown to black; face, legs, and abdominal venter mottled with various shades of brown to black, upper portion of face often with pair of irregular black areas on line between antennae.

Male genitalia.—Distinctive features: ventral lobes exceedingly long, about 7× mesal width of pygofer in lateral view (Fig. 8), ventral lobes in ventral view crossing near apices (Fig. 5).

Type.—Status uncertain. Valdes Ragues' (1910:442) description and type selection consists of one line: "*Caliptoprotus obtusus*, 10 mm., idem rojizo, 77." Two lines below he lists another specimen with "como el numero 77" with the number 182. These specimens are presumably in the Gundlach Collection in Havana, Cuba. Eventually a lectotype should be



Figs. 3–8. *Cyrpoptus obtusus* Valdes Ragues. 3. Forewing, light form; 4. Forewing, dark form; 5. Aedeagus in ventral view; 6. Anterior dorsum; 7. Head in lateral view; 8. Complete male genitalia in lateral view.

selected if either specimen is still extant. This species is often found determined in collections with Uhler credited as the author of *obtusus*, but Uhler's description was never published.

Records.—CUBA, Alquizar, Banes, Barrio Caobilla, C. Baraqua, Cabanas, Camaguey, Cayamas, Cristo Oriente, Guane, Habana, Jaronu, Jobabo, La Gloria, P. Soriano, Pinar Rio, Preston, Ruspoli, Santa Cruz de los Pinos, Santiago de las Vegas, San Vicente, Soledad, Trinidad, Vinales, and Wajay. Total specimens studied: 38 males and 34 females.

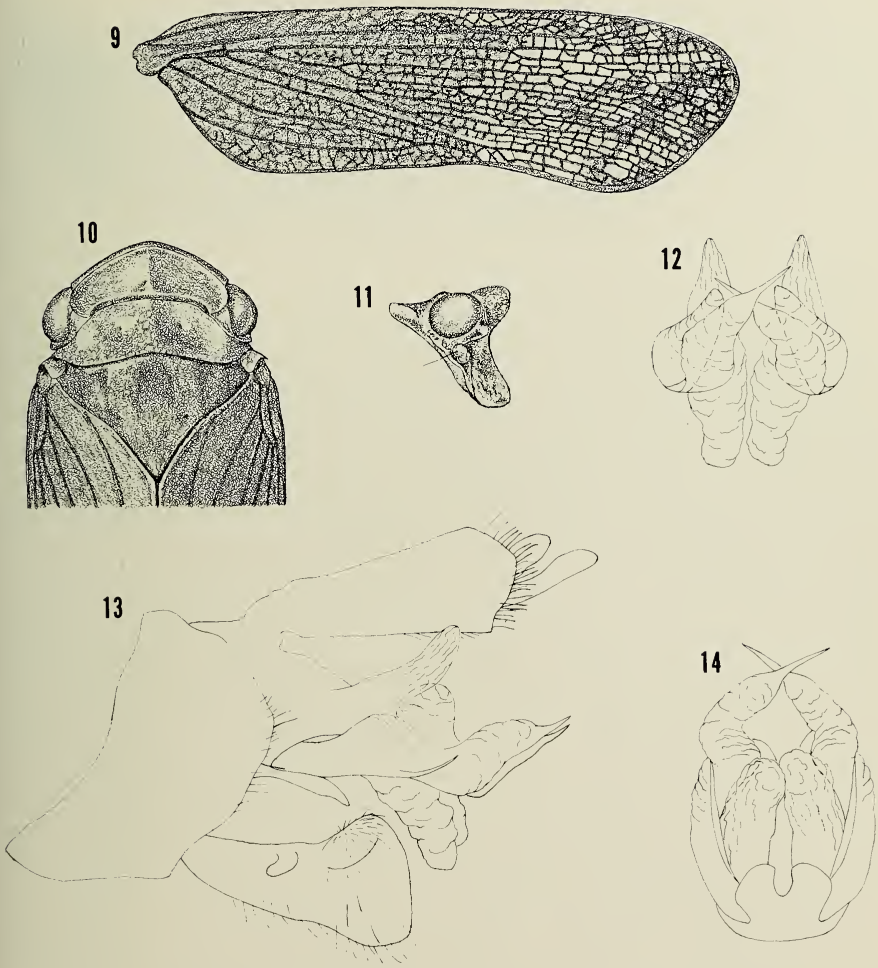
Notes.—The darkly mottled crown, pronotum, and mesonotum plus the concave area near the middle of each forewing make this species one of the most distinctive in the genus. *C. obtusus* is known only from Cuba with few plant associations. It has been taken on wild tobacco, *Glircidia* sp., "guama" and "mogote de la bandera."

Cyrpoptus ruficrus Kramer, n. sp.
(Figs. 9–14)

Salient features.—Length of male 10–11.5 mm, female 10.75–12.1 mm. Crown bluntly angular at apex, length at middle greater than length next to eyes, surface longitudinally rugulose or obliquely so, midline often weakly carinate; pronotum irregularly rugulose, midline with variably distinct carina, without carina behind each eye (Fig. 10); mesonotum more or less transversely rugulose; frons longitudinally rugulose, in lateral view (Fig. 11) contour slightly concave; costal margin of forewings not indented near middle (Fig. 9). Ground color stramineous to light brown; crown, pronotum, and mesonotum sometimes washed with reddish, rarely with fine brown reticulations in heavily pigmented specimens; impressions on pronotum and mesonotum dark; opaque basal portions of forewings reddish with cells variably fuscus; distal portions of forewings with dark pattern varying from well-developed (Fig. 9) to absent; each hind wing orange at base with orange portion bordered distally with brown or black; face, legs, and abdominal venter scarcely to rather heavily mottled with shades of brown to black; face and joints of femur and tibia pink to red.

Male genitalia.—Distinctive features: ventral lobes longest, their apices slender and needle-like (Figs. 12–14, from holotype).

Types.—Holotype male (USNM 75434), "Vinales, Cuba, April 15, 1930. S. C. Bruner, taken on trunk of *Pinus tropicalis* Moric." Paratypes: 1♂, 1♀ 12½ K. s. Pinar Rio, 12 Sept. 1913; 1♂, 1♀ Herradura, 16 March 1925, H. Osborn; 1♀ Herradura 16 Feb. 1924, H. Osborn; 1♀ Cerro Cabras near P. de R., 11 Sept. 1913; 1♂ Isla de Pines, 1923, C. H. Ballou; 1♀ Isla de Pines, 25 July 1923, C. H. Ballou; 1♀ Isla de Pines, Feb. 1923, C. H. Ballou; 1♀ Isla de Pines, 9–10 March 1939, S. C. Bruner; 1♀ L. Pelado, Cajalbana, P. del R., 1 Feb. 1951, J.A.



Figs. 9–14. *Cyrpoptus ruficrus*, n. sp. 9. Forewing; 10. Anterior dorsum; 11. Head in lateral view; 12. Aedeagus in posterior view; 13. Complete male genitalia in lateral view; 14. Aedeagus in ventral view.

Notes.—This species and *obtusus* are quite similar to the unaided eye. Both are known only from Cuba and comprise the only two species recorded from the islands of the Caribbean. The dark mottling on the crown and thoracic dorsum which is present in *obtusus* and absent in *ruficrus* will serve to separate most specimens of the two species. Heavily pigmented examples of *ruficrus* can be separated from *obtusus* by the non-indented costal margin of the forewing (compare Fig. 9 with Figs. 3 and 4).

Osborn (1926:354) reported this species as *C. belfragei* Stål from specimens he collected "on needles of long leafed Cuban pine." The economic significance of this planthopper is not established, but "pine" is the only plant from which specimens are recorded. The species name, a Latin noun in apposition, means red legs.

Cyrpoptus suavis Stål
(Figs. 1, 15–19)

Cyrpoptus suavis Stål 1862:305.

Salient features.—Length of male 10.5–13 mm, female 11.5–14.5 mm. Crown broadly rounded on anterior margin, length at middle and next to eyes about equal, surface irregularly rugulose, midline not carinate; pronotum transversely rugulose, longitudinal midline sometimes subcarinate, hind margin variably notched at middle, carina behind each eye essentially absent (Fig. 1); mesonotum mainly transversely rugulose, frons longitudinally rugulose or obliquely so, in lateral view not concave but with upper edge thick; forewing in broad view (Fig. 15) narrowed subapically with oblique distal margin slightly sinuate. Ground color stramineous to light brown; crown, pronotum, and mesonotum in paler specimens variably peppered with exceedingly minute red dots, in darker specimens these areas suffused with various shades of brown and without red color, intermediates exist between these extremes; impressions on pronotum and mesonotum usually darkened; opaque basal portions of forewings reddish with cells variably fuscus; distal midline of each forewing darkened to or nearly to opaque basal portion (Figs. 1 & 15); each hind wing orange or red at base with colored portion bordered distally with black or brown; frons and thoracic pleura marked like crown; distal half of clypeus, legs, and abdominal venter variably mottled with black or brown.

Male genitalia.—Distinctive features: ventral lobes long, slightly more than 3× width of pygofer in lateral view (Fig. 18). Figs. 16–17 show partly inflated genitalia, and Figs. 18–19 show fully inflated genitalia.

Type.—No lectotype selected. Stål mentioned only a female in the original description, but this specimen could not be located in the Riksmuseum in Stockholm. I have before me one male from that museum representing *suavis* with 6 labels: "Mexico" and "Boucard" and "paratype" (red

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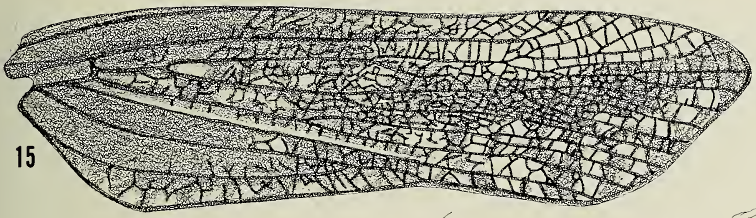
Figs. 15–19. *Cyrpoptus suavis* Stål. 15. Forewing; 16. Complete male genitalia in lateral view, aedeagus partly inflated; 17. Aedeagus in ventral view, partly inflated; 18. Complete male genitalia in lateral view, aedeagus fully inflated; 19. Aedeagus in ventral view, fully inflated.



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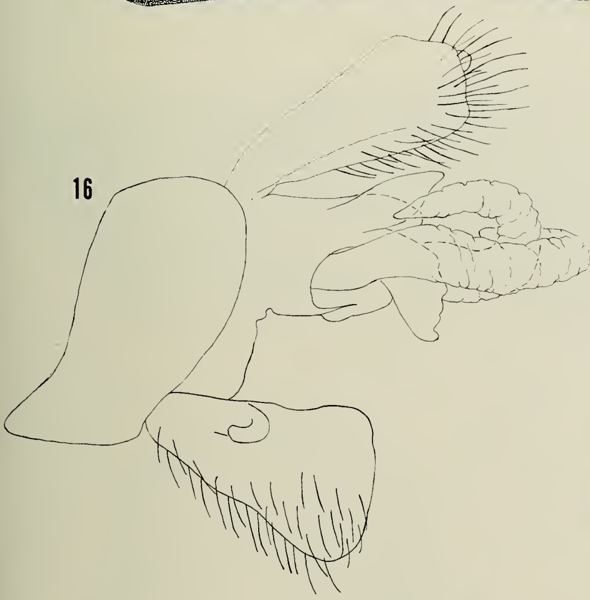

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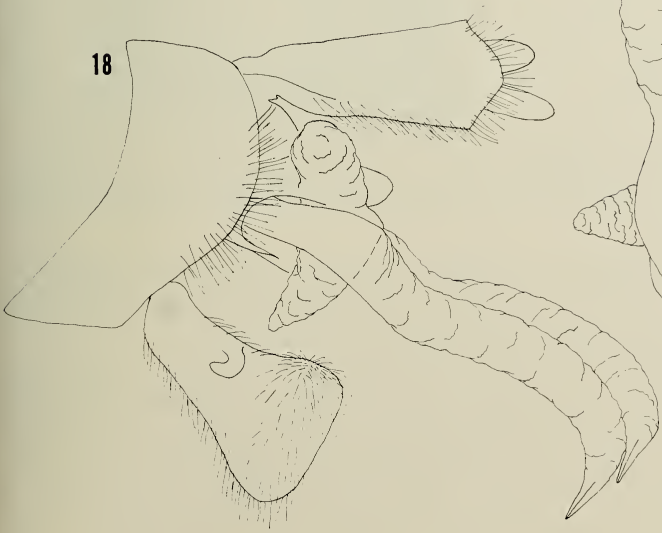

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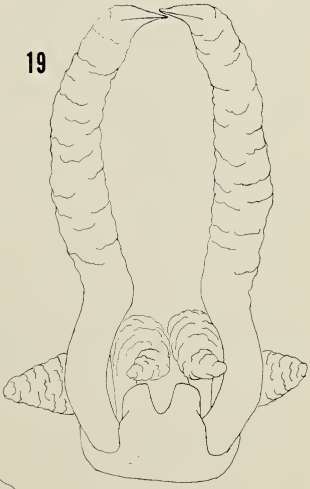


label) and "210 54" (red label) and "Riksmuseum Stockholm" and "47 26" (red label).

Records.—BRITISH HONDURAS, Punta Gorda; CANAL ZONE, Ancom, Cristobal, Ft. Kobbe, Tobago Island; COSTA RICA, Arenal, Golfito, La Caja, Piedras, Puntarenas, Tinaja, Turrialba; GUATEMALA, Morales, Pancajche: MEXICO: CHIAPAS, Laguna Montebello, Taxla Gutierrey; GUERRERO, Chilpancingo; NAYARIT, Compostela, San Blas; OAXACA, Suchilapa, Zantepec; VERACRUZ, Catemaco, Coyame. Jesus Carranza, Los Cocos, Orizaba. Total specimens studied: 28 males and 21 females.

Notes.—In addition to the features noted in the key, the short crown will further help to distinguish this species. *C. suavis* has a wide distribution in Mexico and Central America, but no plant associations are recorded.

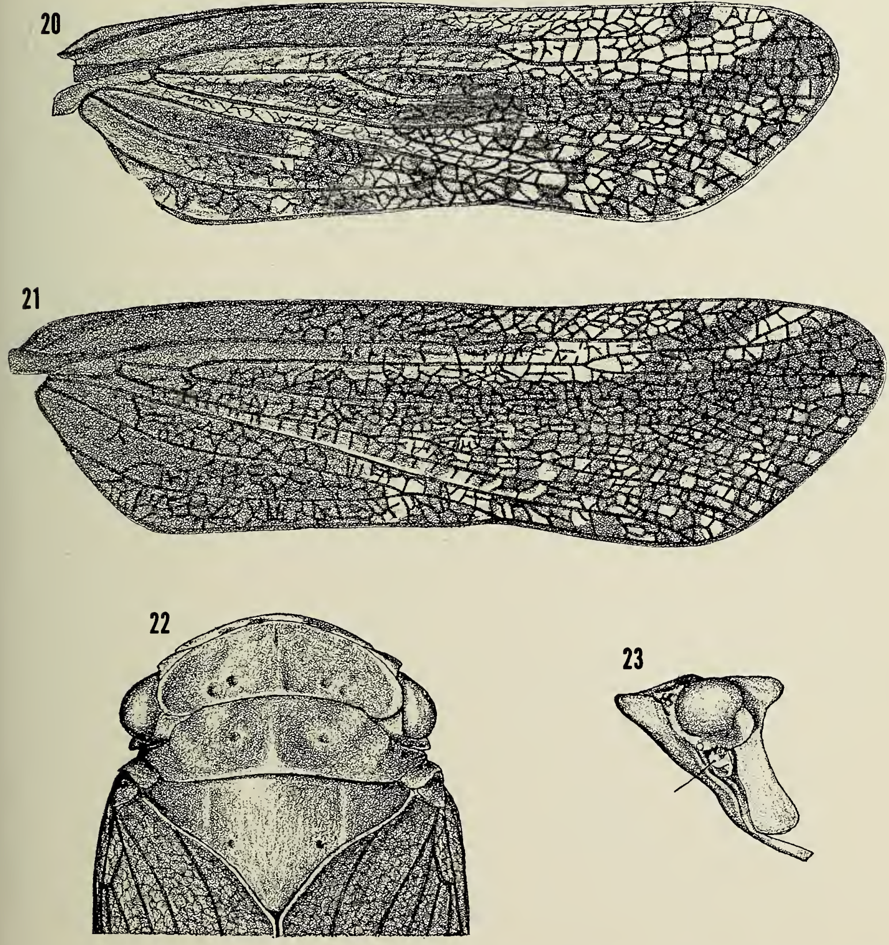
Cyrpoptus belfragei Stål
(Figs. 20–27)

Cyrpoptus belfragei Stål 1869:240.

Salient features.—Length of male 11.5–14 mm, female 14–16 mm. Crown rounded on anterior margin, length at middle greater than next to eyes, surface irregularly rugulose, midline not carinate; pronotum transversely rugulose, longitudinal midline sometimes weakly carinate, hind margin at times weakly notched at middle, carina behind each eye only partly developed (Fig. 22); frons longitudinally rugulose, in lateral view (Fig. 23) not concave with upper margin moderately thick; forewing in broad view (Figs. 20–21) narrowed toward apex with oblique distal margin not sinuate. Ground color stramineous to yellowish brown; crown, pronotum, and mesonotum usually peppered with exceedingly minute red dots and variably suffused with brown or black; impressions on pronotum and mesonotum dark; opaque basal portions of forewings reddish with cells variably fuscus; distal midline of each forewing darkened to or nearly to opaque basal portion (Figs. 20–21); each hind wing red at base with red portion bordered distally with black; frons and thoracic pleura marked like crown; distal half of clypeus, legs, and abdominal venter variably mottled with brown or black.

Male genitalia.—Distinctive features: ventral lobes long, about 3× width of pygofer in lateral view (Figs. 24 & 26). In ventral view (Figs. 25 & 27), ventral lobes either crossing apically or not.

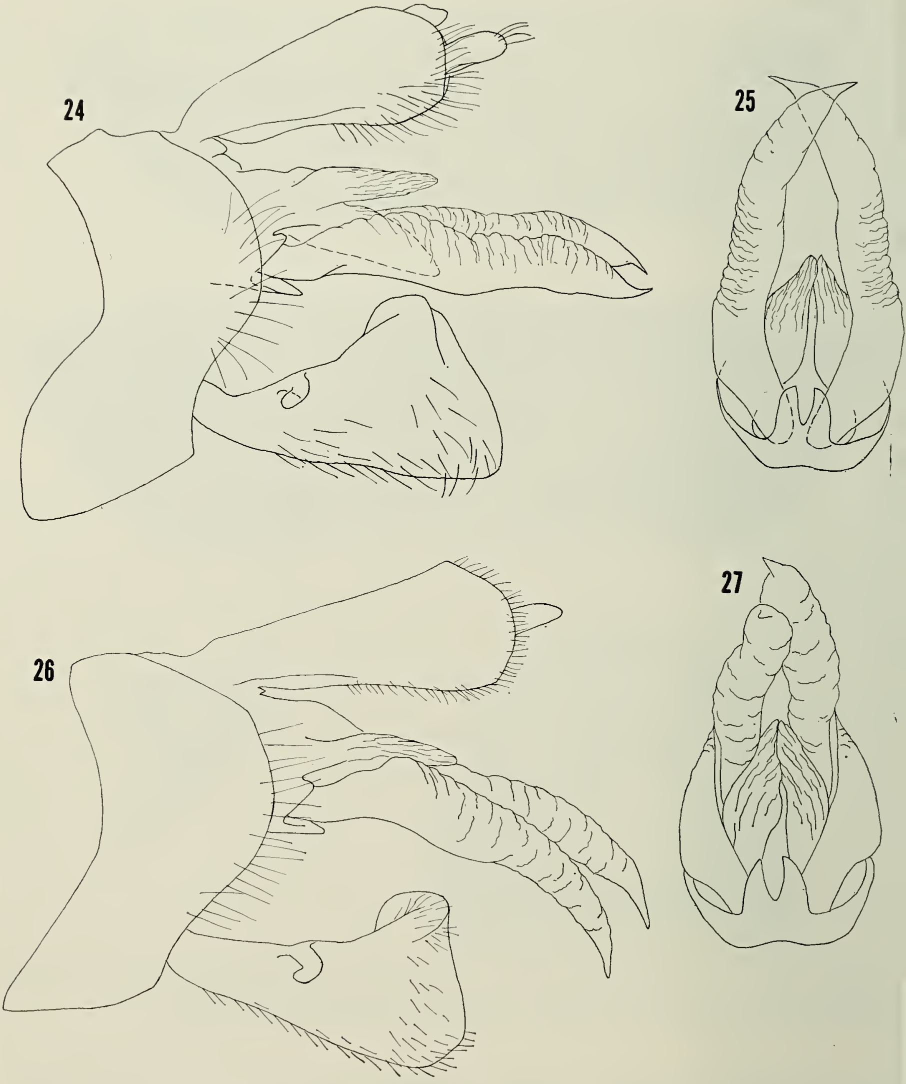
Type.—Lectotype female hereby selected has 7 labels: "Texas" and "Belfrage" and "Typus" (red paper) and "Cyrpoptus belfragei Stål" and "456 63" (red paper) and "44 76" (red paper) and "Riksmuseum Stockholm" (green paper). The specimen is mounted with all wings spread. Except for a tiny piece missing from the apex of the right forewing, the lectotype is perfect. There is a second conspecific female with data similar to the



Figs. 20–23. *Cyrpoptus belfragei* Stål. 20. Forewing, from co-type; 21. Forewing, female from So. Carolina; 22. Anterior dorsum; 23. Head in lateral view.

lectotype and bearing a paratype label (red paper). Both specimens are in the Riksmuseum Stockholm.

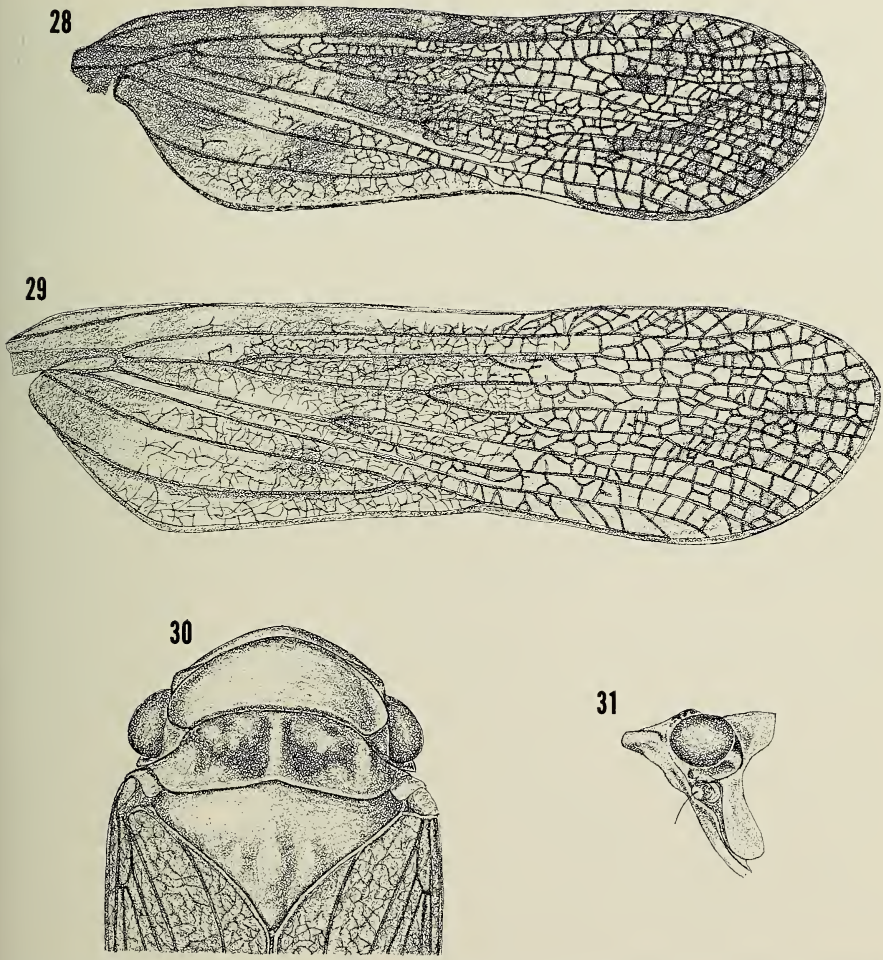
Records.—ALABAMA, Oak Grove; FLORIDA, Apalachicola Nat. Forest, Gainesville, La Belle, St. John's Bluff, Sanford, Sebring, Tall Timbers Research Station, Tampa, Torreya St. Park; KANSAS, Labette Co., Pottawatomie Co.; MARYLAND, Beltsville, Chesapeake Beach; MISSISSIPPI, Biloxi, Ocean Springs; MISSOURI, Columbia, Joplin, St. Louis; NORTH CAROLINA, Raleigh, Southern Pines, Wrightsville; SOUTH CAROLINA, Florence; TENNESSEE, Chattanooga; TEXAS, Kerr Co.; VIRGINIA,



Figs. 24–27. *Cyrpoptus belfragei* Stål. 24 & 26. Complete male genitalia in lateral view; 25 & 27. Aedeagus in ventral view.

Arlington, Falls Church, Fort Monroe, Great Falls, Vienna. MEXICO, Campeche, San Luis Potosi; HONDURAS, Trujillo. Total specimens studied: 22 males and 33 females.

Notes.—*C. belfragei* is widely distributed in the southeastern United States. Osborn (1938:286) recorded this species from two counties in southern Ohio, and I have studied specimens from as far west as Kansas and



Figs. 28–31. *Cyrpoptus metcalfi* Ball. 28. Forewing, darker form; 29. Forewing, lighter form; 30. Anterior dorsum; 31. Head in lateral view.

Texas. The species also occurs in Mexico and Honduras, but in these countries it is largely replaced by *suavis*.

Cyrpoptus metcalfi Ball
(Figs. 28–37)

Cyrpoptus metcalfi Ball 1933:147.

Salient features.—Length of male 11–12 mm, female 12–13 mm. Crown angularly rounded on anterior margin, length at middle greater than next to eyes, longitudinal midline sometimes vaguely depressed, surface longi-

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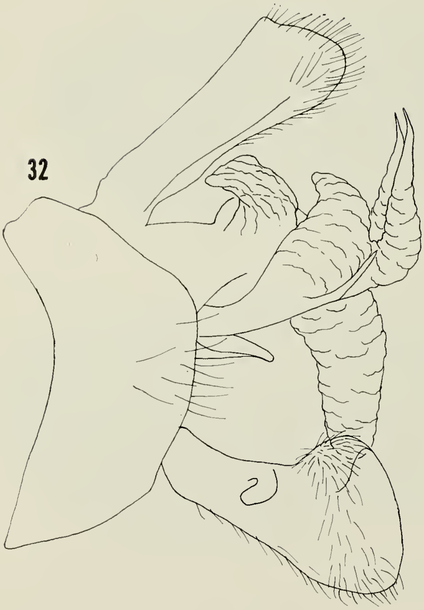

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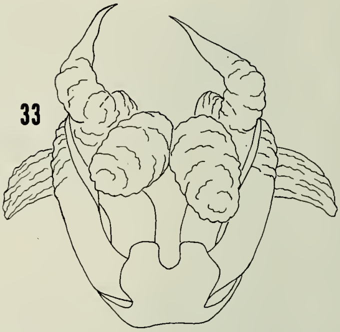

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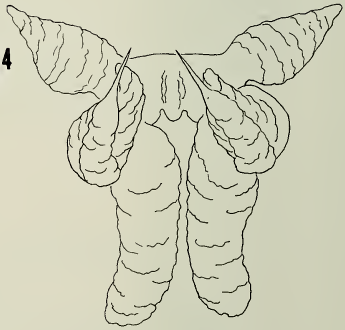

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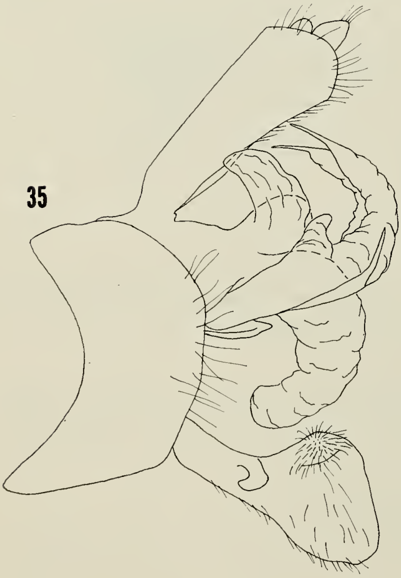

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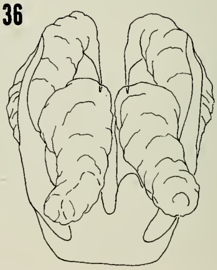

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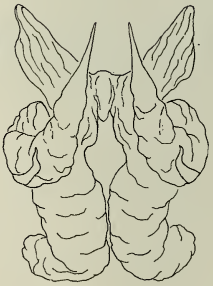

tudinally rugulose; pronotum transversely rugulose, longitudinal midline weakly carinate on central half, carina behind each eye scarcely developed (Fig. 30); mesonotum transversely rugulose; frons longitudinally rugulose, in lateral view (Fig. 31) broadly concave with variable elevation at middle; forewing in broad view (Figs. 28–29) narrowest beyond middle with apex narrowly rounded. Ground color stramineous or sordid stramineous; crown, pronotum, and mesonotum usually peppered with exceedingly minute red dots, these at times obliterated with brown or black suffusion; impressions on pronotum and mesonotum dark or not; opaque basal portion of forewings peach-colored and at times suffused with brown, with variable paler transverse patch across middle; distal portion of forewings varying from essentially unmarked to patterned with brownish (Figs. 28–29); each hind wing yellow or yellow-orange at base with colored portion partly bordered with brown; frons and thoracic pleura marked like crown; distal half of clypeus, legs, and abdominal venter variably mottled with brown or black.

Male genitalia.—Distinctive features: ventral lobes upturned near middle with apices narrowed and needle-like in lateral view (Figs. 32 & 35). In ventral and posterior views (Figs. 33–34, 36–37), apices of ventral lobes directed mesad.

Type.—Holotype female, Yuma, Arizona, 25 August 1929, E. D. Ball. The allotype male is mounted on the same pin with the holotype. These and the 14 paratypes mentioned in the original description are in the USNM.

Records.—ARIZONA, Granite Reef Dam, Phoenix, Sacaton, San Louis, Somerton, Yuma; CALIFORNIA, Bard, Calipatria, Coachella, Death Valley, El Centro, Holtville, Indio, Potholes, Thousand Palms Oasis, Westmorland; NEVADA, Glendale, Overton. MEXICO: SONORA, Hermosillo; SINALOA, Los Mochis. Total specimens studied: 67 males and 36 females.

Notes.—*C. metcalfi* is apparently a fairly common species in the southwestern portion of the United States and adjacent portions of Mexico. The only recorded plants from which specimens were taken are *Strombocarpa odorata* Torr. and *Pluchea sericea* (Nutt.).

Cyrpoptus ferruginosus Stål
(Figs. 38–47)

Cyrpoptus ferruginosus Stål 1869:240.

Salient features.—Length of male 13–14 mm, female 14.5–16.5 mm. Crown broadly rounded on anterior margin, length at middle slightly ex-

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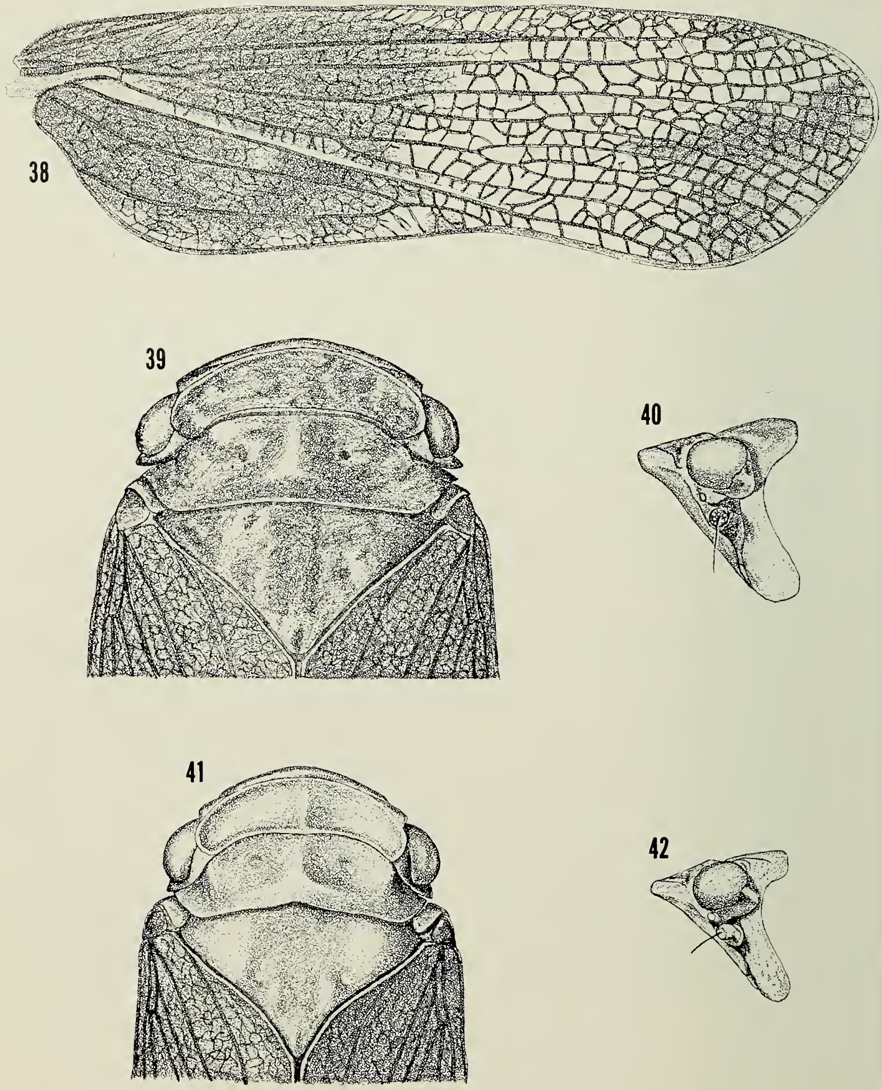
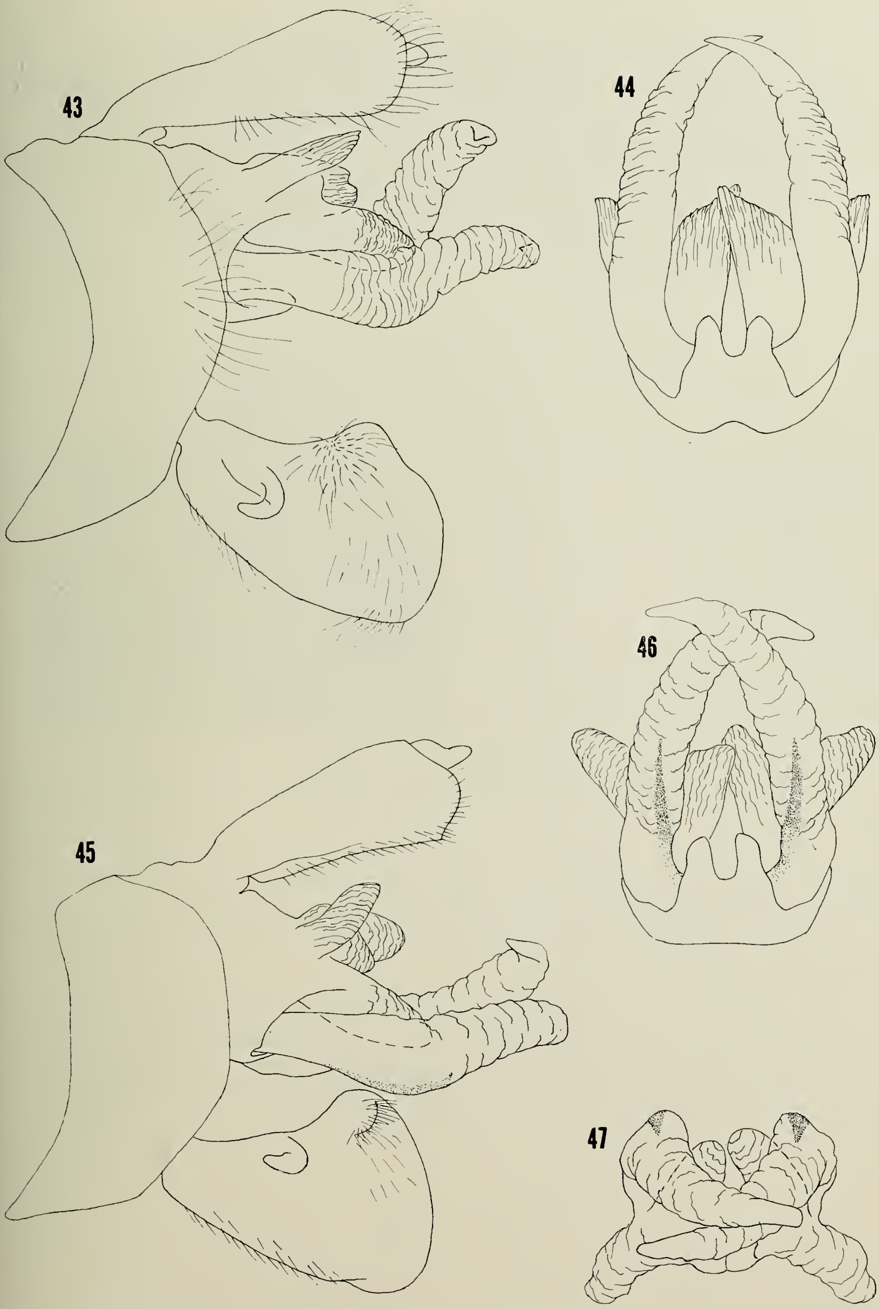
Figs. 32–37. *Cyrpoptus metcalfi* Ball. 32 & 35. Complete male genitalia in lateral view; 33 & 36. Aedeagus in ventral view; 34 & 37. Aedeagus in posterior view.



Figs. 38–42. *Cyrpoptus ferruginosus* Stål. 38. Forewing of female; 39. Anterior dorsum of female; 40. Head of female in lateral view; 41. Anterior dorsum of male; 42. Head of male in lateral view.

ceeding that next to eyes, surface longitudinally rugulose; pronotum transversely rugulose, longitudinal midline usually no more than weakly carinate, carina behind each eye only partly developed (Figs. 39 & 41), mesonotum transversely rugulose; frons longitudinally rugulose, in lateral view (Figs.



Figs. 43–47. *Cyrpoptus ferruginosus* Stål. 43 & 45. Complete male genitalia in lateral view; 44 & 46. Aedeagus in ventral view; 47. Aedeagus in posterior view.

40 & 42) scarcely concave with upper margin thick; forewing in broad view (Fig. 38) with costal margin not indented, without structurally unique features. Ground color sordid stramineous to brownish; crown, pronotum, and mesonotum peppered with exceedingly minute red dots, these at times obliterated or partly so with darker shading; impressions on pronotum and mesonotum darkened or not; opaque basal portion of forewings usually dark sordid reddish, but in lightly pigmented males this area orange or dusky orange; in males distal portion of forewings typically not darkened, in females distal portion of forewings with dominant marking incomplete dark stripe on midline (Fig. 38); each hind wing red (typical) to yellowish (pale males) at base with colored portion partly bordered with brown; frons and thoracic pleura marked like crown; distal half of clypeus, legs and abdominal venter variably mottled with brown or black.

Male genitalia.—Distinctive features: ventral lobes weakly or not upturned distally with apices flattened and sharply subtriangular in lateral views (Figs. 43 & 45). In ventral and posterior views (Figs. 44, 45–47) apices of ventral lobes crossed distally.

Type.—Lectotype female hereby selected has 7 labels: "Mexico" and "Salle" and black square of paper and handwritten "Cyproptus (sic) ferruginosus Stål" and red label "211 59" and green label "Riksmuseum Stockholm" and red label "46 76." The specimen is mounted with all wings spread. The tip of the right forewing is missing and a small piece is broken from the left forewing on the posterior margin at the apex. The hind wings are missing small pieces from their apical margins. Stål mentioned only a female in the original description with a length of 11 mm and wing expanse of 32 mm. The lectotype fits this size exactly. A male with similar data and labelled "Cyrproptus (sic) ferruginosus Stål" bearing a red typus label is obviously in error. This male is in fact an example of *nubeculosus.* Both specimens are in the Riksmuseum Stockholm.

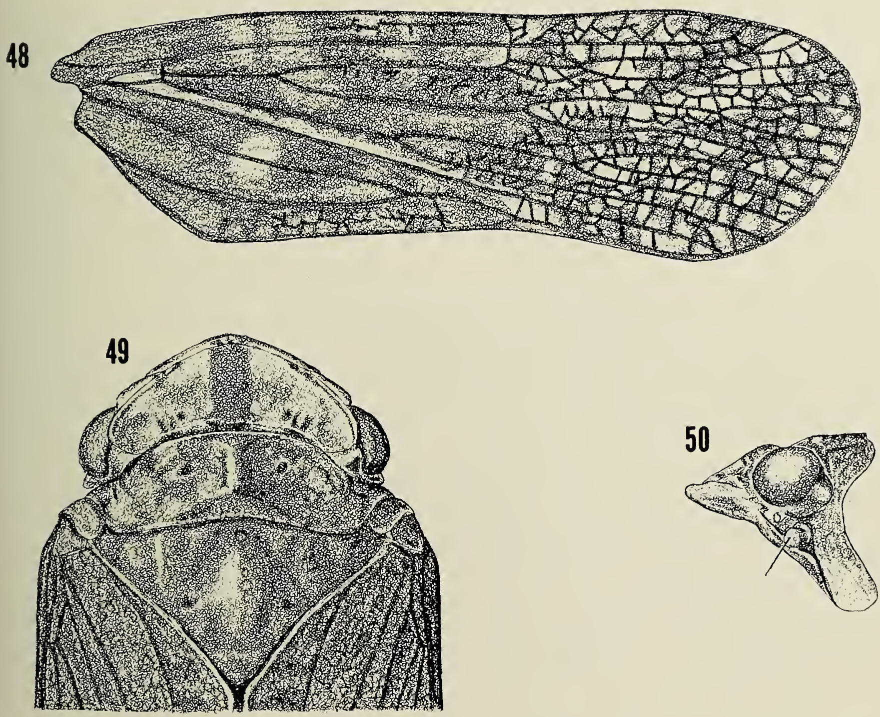
Records.—MEXICO: MORELOS, Cuautla, Cuernavaca. Total specimens studied 7 males and 16 females.

Notes.—This is one of the more robust members of the genus. The short crown and sexually dimorphic differences in the pattern of the apical portion of the forewings provide the distinctive features of the species. No plant associations are recorded for this species which is presently known only from the Mexican State of Morelos.

Cyrpoptus vanduzeei Ball
(Figs. 48–55)

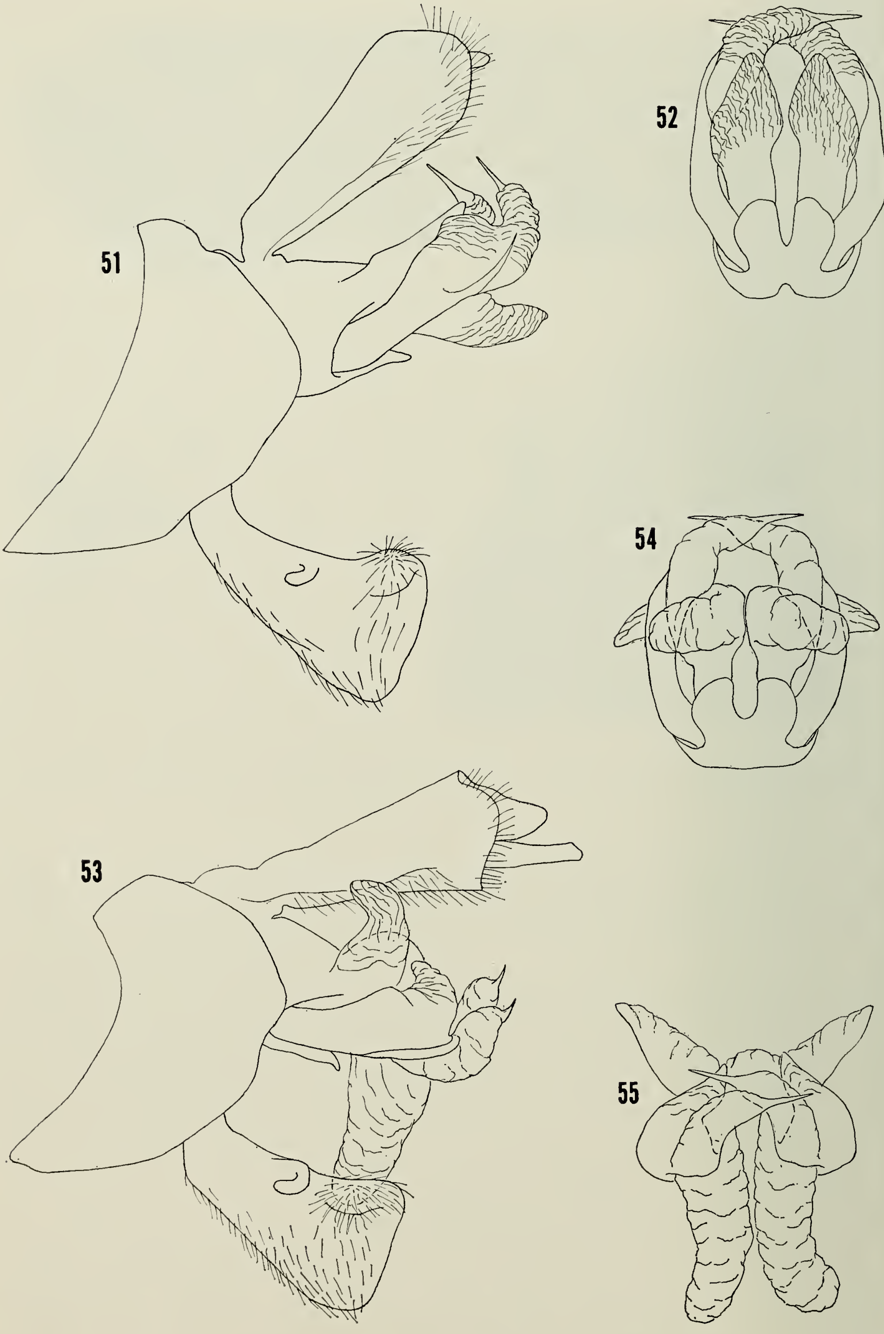
Cyrpoptus vanduzeei Ball 1933:146.

Salient features.—Length of male 10–11.5 mm, female 11–13.5 mm. Crown triangularly or subtriangularly produced with midlength about twice length



Figs. 48–50. *Cyrpoptus vanduzeei* Ball. 48. Forewing; 49. Anterior dorsum; 50. Head in lateral view.

next to eyes, surface longitudinally rugulose, longitudinal midline variably depressed; pronotum transversely rugulose, longitudinal midline carinate, carina rarely reaching anterior margin and never reaching posterior margin, carina behind each eye only partly developed (Fig. 49); mesonotum transversely rugulose; frons longitudinally rugulose, with poorly defined transverse ridge across middle and single short longitudinal ridge on each side of extreme apex, in lateral view (Fig. 50) frons angular with upper edge thick but somewhat tapered toward apex; forewing in broad view (Fig. 48) narrowest beyond middle and rounded apically. Ground color sordid stramineous or light brown; crown, pronotum, and mesonotum peppered with exceedingly minute red dots, these partly or entirely obscured by variable dark brown to black suffusion, longitudinal midline of crown darkened (Fig. 49); impressions on pronotum and mesonotum dark; opaque basal portion of forewing dark reddish and variably mottled with black, hyaline distal portion of forewings irregularly mottled with dark brown to black (Fig. 48); each hind wing at base red to scarlet with colored



Figs. 51–55. *Cyrpoptus vanduzeei* Ball. 51 & 53. Complete male genitalia in lateral view; 52 & 54. Aedeagus in ventral view; 55. Aedeagus in posterior view.

portion partly bordered with brown; frons and thoracic pleura marked like crown; distal half of clypeus, legs, and abdominal venter strongly mottled with brown to black.

Male genitalia.—Distinctive features: ventral lobes upturned distally with apices slender and needlelike in lateral views (Figs. 51 & 53). In ventral and posterior views (Figs. 52, 54, & 55) apices of ventral lobes crossed distally.

Type.—Holotype female Baboquivari Mts., Arizona, 11 April 1932, E. D. Ball in U.S. National Museum.

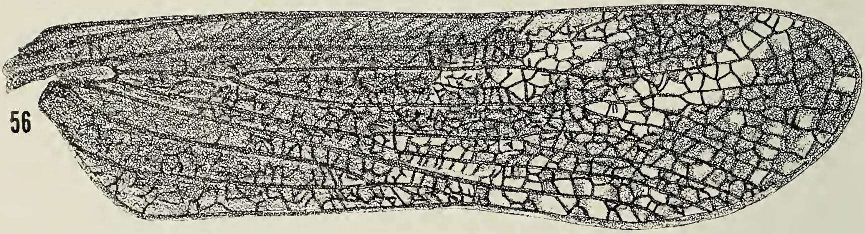
Records.—ARIZONA, Douglas, Madera Canyon, Nogales, Oracle, Portal, Redington, Sta. Catalina Mts., Tombstone, Tucson; TEXAS, Austin, Brownsville, Brownswood, Chisos Mts., Comstock, Davis Mts., Devil's River, Freer, Laredo, Port Isabel, Presidio, San Antonio, Uvalde. MEXICO: CHIHUAHUA, Camargo; SINALOA, Los Mochis. Total specimens studied: 42 males and 53 females.

Notes.—*C. vanduzeei* can be distinguished by the darkened midline of the crown coupled with the overall dark appearance and the relative small size. The holotype and type series were collected on *Muhlenbergia porteri* Scrib. or mesquite grass growing under spiny shrubs. Another plant from which specimens were taken is *Prosopis gladulosa* Torr, or mesquite. The planthopper is widely distributed from Arizona to southeastern Texas and adjacent parts of Mexico.

Cyrpoptus reineckei Van Duzee
(Figs. 56–61)

Cyrpoptus reineckei Van Duzee 1909:185.

Salient features.—Length of male 12–13.5 mm, females 11–14.5 mm. Crown triangularly produced but blunt at apex with longitudinal midlength greater than length next to eyes, surface longitudinally rugulose, longitudinal midline variably depressed; pronotum transversely rugulose, longitudinal midline variably carinate, carina behind each eye only partly developed (Fig. 58); mesonotum transversely rugulose; frons longitudinally rugulose with mesally broken, irregular, low ridge across middle; in lateral view (Fig. 59) frons nearly straight in oblique plane with slight convexity near antennal base; forewing in broad view (Figs. 56–57) without structural distinctions. Ground color stramineous to light brown; crown, pronotum, and mesonotum peppered with exceedingly minute red dots, sometimes these obsolete or obliterated by darker shading; impressions on pronotum and mesonotum dark; opaque basal portion of forewings dark red with cells usually darker, hyaline distal portion of forewings patterned with brown to leave transparent oblique vitta from costal margin in apical portion reaching to or beyond midline (Figs. 56–57); each hind wing at base scarlet to red with colored portion bordered distally with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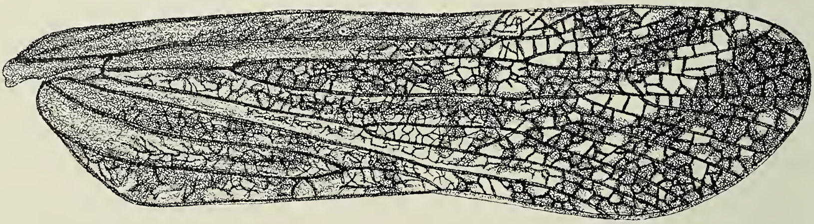
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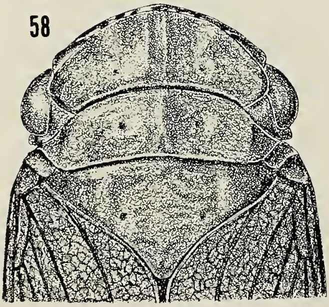
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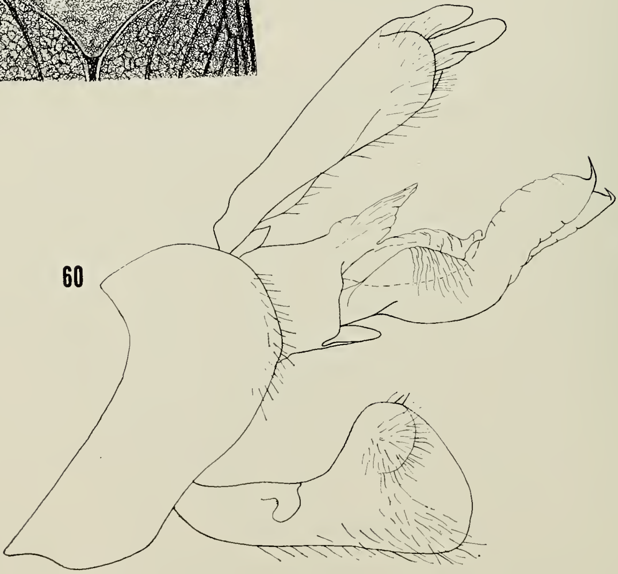
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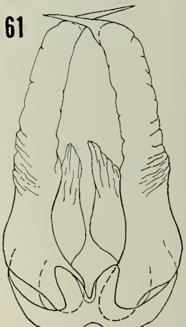
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brown; frons and thoracic pleura marked like crown; distal half of clypeus, legs, and abdominal venter variably mottled with brown to black.

Male genitalia.—Distinctive features: ventral lobes with extreme apices upturned as slender needlelike processes in lateral view (Fig. 60). In ventral view (Fig. 61) apices of ventral lobes crossed distally.

Type.—Lectotype here selected from Sanford, Florida, 27 April 1908, Van Duzee in California Academy of Sciences. This specimen was labeled by Van Duzee but his selection was never published.

Records.—ALABAMA, Mobile, Whistler; FLORIDA, Archbold Biological Station, Big Pine Key, Biscayne, Capron, Cedar Key, Clearwater, Cleveland, Coconut Grove, Crescent City, Dunedin, Enterprise, Estero, Gainesville, Grassy Key, Islamorada, Jacksonville, Key Largo, Key West, Lakeland, Lake Placid, Miami, Nokomis, Orlando, Punta Gorda, St. Augustine, St. Nicholas, St. Petersburg, Sanford, Sarasota, Seven Oaks, Stock Island, Tallahassee, Tampa, Venice; GEORGIA, Billy's Island in Okefenoke Swamp, Tifton; MISSISSIPPI, Gulfport, Long Beach, Lyman; SOUTH CAROLINA, Aiken, Charleston, Ridgeland; TEXAS, Boca Chica, La Marque. Total specimens studied: 103 males and 80 females.

Notes.—As indicated in the key to species, the markings of the distal portion of the forewings provide the best features for recognizing *reineckei.* This species is exceedingly common in Florida but apparently unusual elsewhere. Outside of Florida, the distribution appears to be limited to our coastal states of the Southeast. The plants from which specimens were collected include: *Melilotus alba* L., *Flaveria linearis* Lag., *Baccharis halimifolia* L. Lima beans, snap beans, and cotton. The specimens taken on cotton at Tifton, Ga. are extremely small males (9.5 mm) which are otherwise typical of the species.

Cyrpoptus dubius Kramer, n. sp.

(Figs. 62–64)

Salient features.—Length of female 14.2 mm. Crown strongly produced triangularly with extreme apex bluntly angular, length at middle more than twice that next to eyes, surface longitudinally rugulose; pronotum transversely rugulose, longitudinal midline weakly carinate, carina behind each eye scarcely developed (Fig. 63); mesonotum transversely rugulose; frons weakly longitudinally rugulose, in lateral view (Fig. 64) long and barely concave with upper portion 1½× width of eye; forewing in broad

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Figs. 56–61. *Cyrpoptus reineckei* Van Duzee. 56 & 57. Forewings; 58. Anterior dorsum; 59. Head in lateral view; 60. Complete male genitalia in lateral view; 61. Aedeagus in ventral view.

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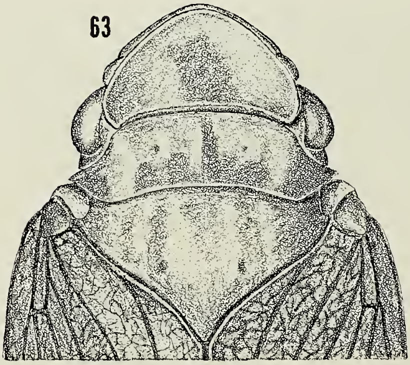

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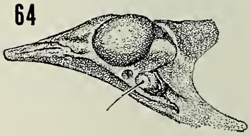

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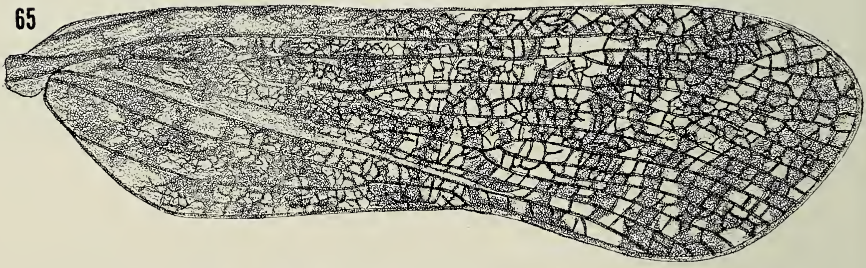

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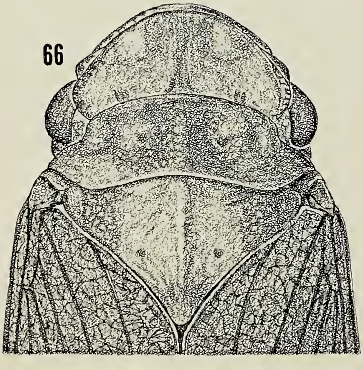

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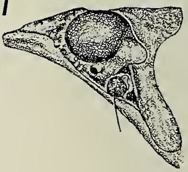

view (Fig. 62) without structurally distinct features. Ground color sordid stramineous or light brown; crown, pronotum, and mesonotum lightly peppered with exceedingly minute red dots, these more distinct laterally than mesally; impressions on pronotum and mesonotum dark; opaque basal portion of forewings reddish with cells darker, hyaline distal portions of forewings heavily marked with brown to leave few scattered small round hyaline areas (Fig. 62); each hind wing at base orange with colored portion partly bordered with brown; frons and thoracic pleura marked like crown; distal half of clypeus, legs, and abdominal venter lightly mottled with brown or black.

Male genitalia.—Male unknown.

Type.—Holotype female Tehuantepec, Oaxaca, Mexico, 13 Dec. 1947–23 Jan. 1948, T. MacDougal in American Museum of Natural History.

Records.—Known only from type.

Notes.—The shape of the head, as noted in the key to species, provides the unique feature of the species. There is the possibility that this specimen represents an extreme example of *nubeculosus*, hence the name *dubius*. However, it seems necessary to consider it a distinct species at this time.

Cyrpoptus nubeculosus Stål
(Figs. 2, 65–79, 81–84)

Cyrpoptus nubeculosus Stål 1869:240.

Salient features.—Length of male 11–13.8 mm, female 13.8–15.5 mm. Crown triangularly produced but blunt at apex with longitudinal midlength greater than length next to eyes, longitudinal midline sometimes mildly depressed; pronotum transversely rugulose, longitudinal midline weakly carinate, carina behind each eye only partly developed (Figs. 66, 68, 72, & 76); mesonotum transversely rugulose; frons longitudinally rugulose, in lateral view (Figs. 67, 69, 73, & 77) scarcely or not concave with contour regular; forewing in broad view (Fig. 65) somewhat convexly expanded beyond claval apex. Ground color brownish or stramineous; crown, pronotum, and mesonotum lightly or obscurely peppered with exceedingly minute red dots, these often obscured with darker shading; longitudinal midline of crown sometimes vaguely darkened; impressions on pronotum and mesonotum darkened or not; opaque basal portion of forewings dark red with cells variably darker, hyaline distal portion of fore-

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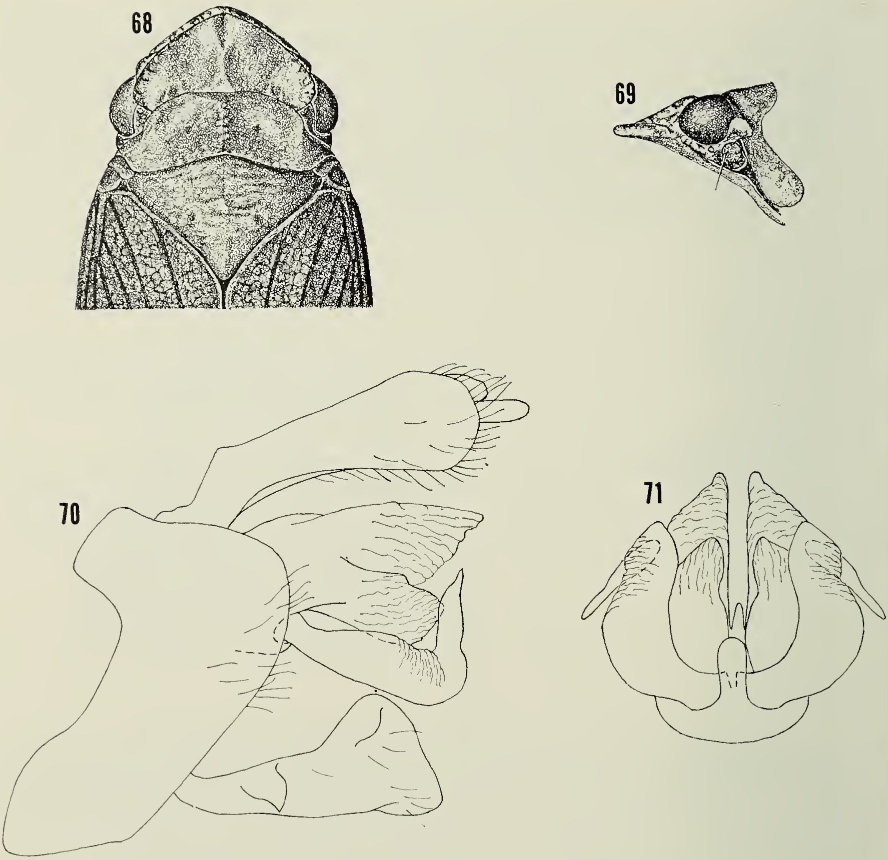
Figs. 62–67. *Cyrpoptus dubius*, n. sp. 62. Forewing; 63. Anterior dorsum; 64. Head in lateral view. *Cyrpoptus nubeculosus* Stål. 65. Forewing; 66. Anterior dorsum; 67. Head in lateral view.



Figs. 68–71. *Cyrpoptus nubeculosus* Stål. 68. Anterior dorsum; 69. Head in lateral view; 70. Complete male genitalia in lateral view; 71. Aedeagus in ventral view.

wings patterned with brown as in Fig. 65; each hind wing at base orange or red-orange with colored portion partly bordered distally with brown; frons and thoracic pleura similar in color to that of crown; distal half of clypeus, legs, and abdominal venter variably mottled with brown or black.

Male genitalia.—Distinctive features: ventral lobes with distal portion narrowed and porrect or slightly recurved in lateral view (Figs. 70, 74, 78, 81, & 83). In ventral or posterior view (Figs. 71, 75, 79, 82, & 84) apical portion of ventral lobes directed laterally or lateroventrally.

Type.—Lectotype female hereby selected has 7 labels "Mexico" and

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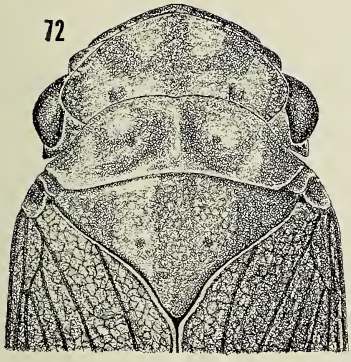

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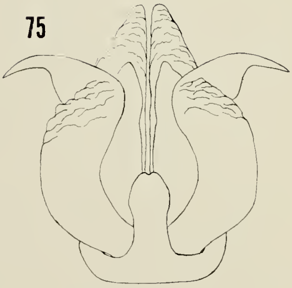

Figs. 72–75. *Cyrpoptus nubeculosus* Stål. 72. Anterior dorsum; 73. Head in lateral view; 74. Complete male genitalia in lateral view; 75. Aedeagus in posterior view.

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Figs. 76–80. *Cyrpoptus nubeculosus* Stål. 76. Anterior dorsum; 77. Head in lateral view; 78. Complete male genitalia in lateral view; 79. Aedeagus in posterior view. *Cyrpoptus obscurus* Metcalf; 80. Anterior dorsum.

Figs. 81–84. *Cyrpoptus nubeculosus* Stål. 81 & 83. Complete male genitalia in lateral view; 82 & 84. Aedeagus in posterior view.

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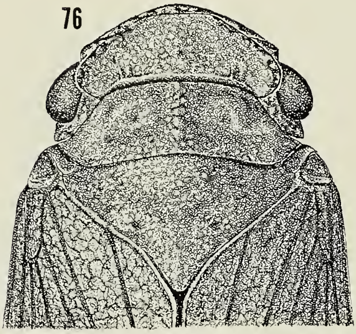

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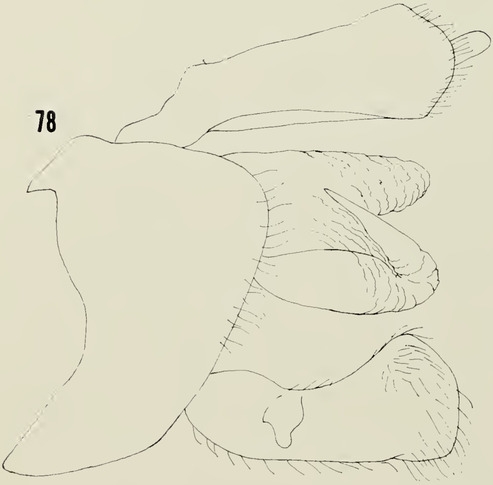

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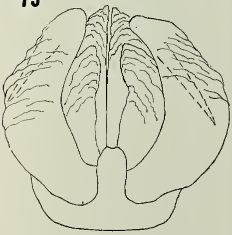

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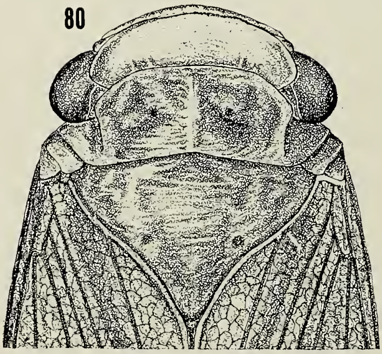

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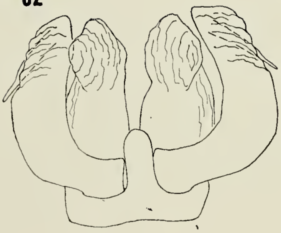

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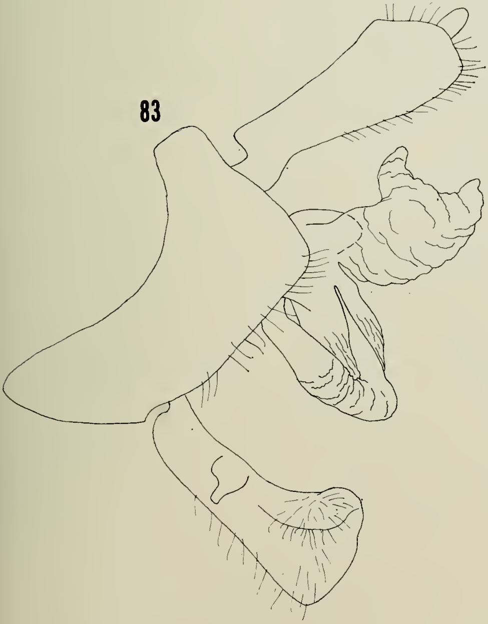

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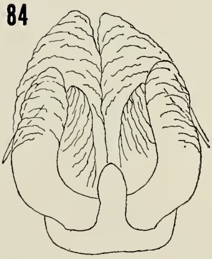

"Salle" and "Typus" (red paper) and "Cyrproptus (sic) nubiculosus (sic)" and "454 63" (red paper) and "49 76" (red paper) and "Riksmuseum Stockholm" (green paper). The specimen is mounted with all wings spread. The tip of the left forewing is missing, and a small piece is gone from the right forewing on the anterior margin at the apex. There are three other conspecific specimens in the original series before me with labels similar to those of the lectotype: 2 males, one of which bears an allotype label (red paper) and the other not type designation, and one female with a paratype label (red paper). All of these specimens are in the Riksmuseum Stockholm.

Records.—ARIZONA, Atascosa Mts., Baboquivari Mts., Blanca Lake, Madrona Canyon, Naco, Sabino Canyon, Sta. Catalina Mts., Tucson; TEXAS, Austin, Brownsville, Devil's River, Laredo, Mathis, Uvalde, Val Verda. MEXICO: CAMPECHE, Campeche; Guerrero, Buena Vista; Morelos, Antiguo, Cuantla; NAYARIT, Tepic; NUEVO LEON, Linares, Monterrey; PUEBLA, Matamoros; SAN LUIS POTOSI, Tamazunchale; SONORA, Alamos; TLAXCALA, Lake Chapala; YUCATAN, UXMAL. Total specimens studied: 41 males and 36 females.

Notes.—The crown of *nubeculosus* tends to be longer than those of its congeners, except *dubius*, and males tend to have the extreme coronal apex less broadly rounded than in females. A few specimens have a vaguely darkened longitudinal midline on the crown and resemble *vanduzeei* in this character. However, the facial contour of the two species is quite different; in *vanduzeei* the facial contour is irregular (Fig. 50), and in *nubeculosus* it is smooth (Fig. 67). The nymph (Fig. 2) resembles the adult, but the frons and crown are clearly differentiated, the mesonotum poorly defined, and both the pronotum and mesonotal areas bear a few rounded sensoria. No host or food plants are recorded for this Mexican species which also occurs in our border states of Arizona and Texas.

Checklist of *Cyrpoptus* spp. with General Distributional Data

1. *belfragei* Stål, 1869:240. Maryland to Kansas and south to Honduras.
2. *dubius* Kramer, n. sp. Mexico.
3. *ferruginosus* Stål, 1869:240. Mexico.
4. *metcalfi* Ball, 1933:147. SW U.S.A. and adjacent areas of Mexico.
5. *nubeculosus* Stål, 1869:240. SW U.S.A. and Mexico.
6. *obscurus* Metcalf, 1938:352. Canal Zone.
7. *obtusus* Valdes Ragues, 1910:442. Cuba.
8. *reineckei* Van Duzee, 1909:185. SE U.S.A.
9. *ruficrus* Kramer, n. sp. Cuba.
10. *suavis* Stål, 1862:305. Mexico south to Canal Zone.
11. *vanduzeei* Ball, 1933:146. SW U.S.A. and adjacent areas of Mexico.

Acknowledgments

Without the most generous cooperation of the persons and their institutions listed here, this study would not have been possible. To all of them I express my sincere thanks and deep gratitude for loans of specimens, types of all species, and other data vital to this study: Dr. Paul H. Arnaud, Department of Entomology, California Academy of Sciences, San Francisco; Dr. Frank W. Mead, Florida Collection of Arthropods, Gainesville; Dr. Lois B. O'Brien, Department of Entomology, Florida A&M University, Tallahassee; Dr. Per Inge Persson, Department of Entomology, Swedish Museum of Natural History, Stockholm; Dr. Randall T. Schuh, Department of Entomology, American Museum of Natural History, New York City; and Dr. David A. Young, Department of Entomology, North Carolina State University, Raleigh. Miss Linda A. Heath is due special recognition for her fine illustrations which appear throughout the revision.

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PROC. BIOL. SOC. WASH.
91(1), 1978, pp. 336–363

THREE NEW SPECIES OF *MAGELONA* (ANNELIDA, POLYCHAETA) AND A REDESCRIPTION OF *MAGELONA PITELKAI* HARTMAN

Meredith L. Jones

Abstract.—*Magelona pitelkai* Hartman from central California is redescribed and *M. hobsonae* n. sp., from Washington and British Columbia, *M. hartmanae* n. sp., from central and southern California, and *M. dakini* n. sp., from Australia, are described. These four species, along with *M. filiformis* Wilson, from England, form a discrete morphological group within the genus; a sixth species, *M. capensis* Day, from South Africa, may also be included.

Recent studies concerned with the redescription of *Magelona papillicornis* F. Müller, the type-species of the genus, showed that three additional species appeared to be closely related (Jones, 1977:254). One of the common characters of this group of four species (*M. papillicornis*, *M. californica*, *M. minuta*, and *M. pettiboneae*) is the presence of a single, invariably smaller, hooded hook adjacent to the pedicels of the lateral lamellae of the posterior region. Other than size, the small hooks are identical to the more numerous large ones.

In carrying out observations on other magelonids, a similar situation has come to light involving yet four more species. In this case, however, the smaller hooks, while having the same dentition as the larger ones, are of a somewhat different structure. The presence of this small hook has not been commented upon in the literature, but, due to Olga Hartman's faithful rendering of her observations, it appears in one of her figures in the description of *Magelona pitelkai* (Hartman, 1944a:pl. 19, fig. 3); it was further illustrated in the figure of Berkeley and Berkeley (1952:fig. 16), taken from Hartman.

The present paper is concerned with four related species, three of which are new:

Magelona pitelkai Hartman from central and southern California
Magelona hobsonae, new species, from Washington and British Columbia
Magelona hartmanae, new species, from southern California
Magelona dakini, new species, from Australia

In all cases parapodia have been individually mounted in glycerine jelly; drawings were prepared with the aid of a Wild drawing tube, a modification of the classical camera lucida.

Identified and/or type-material has been deposited in the collections of the following: Allan Hancock Foundation, Los Angeles (AHF); Australian Museum, Sydney (AM); British Columbia Provincial Museum, Victoria (BCPM); British Museum (Natural History), London (BMNH); Museum National d'Histoire Naturelle, Paris (MNHNP); National Museum of Canada, Ottawa (NMC); National Museum of Natural History, Smithsonian Institution, Washington (USNM); National Museum of Victoria, Melbourne (NMV); National Science Museum, Tokyo (NSMT); Rijksmuseum van Natuurlijke Histoire, Leiden (RNHL); Universitetets Zoologiske Museum, Copenhagen (UZMC); Zoological Institute, Academy of Sciences, Leningrad (ZIL); Zoologische Museum, Amsterdam (ZMA); and Zoologisches Museum, Hamburg (ZMH).

Magelona pitelkai Hartman
Figs. 1–25

Magelona pitelkai Hartman, 1944a:260–261, pl. 19, figs. 1–9; 1944b:320.—Berkeley and Berkeley, 1952:figs. 15–17, only.—Hartman *in* Light, 1954: 73.—Hartman, 1959:393; 1961:30.—Allan Hancock Foundation, 1965: 328.—Hartman, 1969:195–196, figs. 1–7.—Blake *in* Light, 1975:216, figs. 257–258.

Not *Magelona pitelkai*.—Berkeley and Berkeley, 1950:53; 1952:13 (text only, not figs. 15–17, see above).—Jones, 1963:24–25, fig. 60.—Kitamori, 1967:52, fig. 4.—Chew, et al., 1973:14 and 17.—Armstrong, et al., 1976: 282.

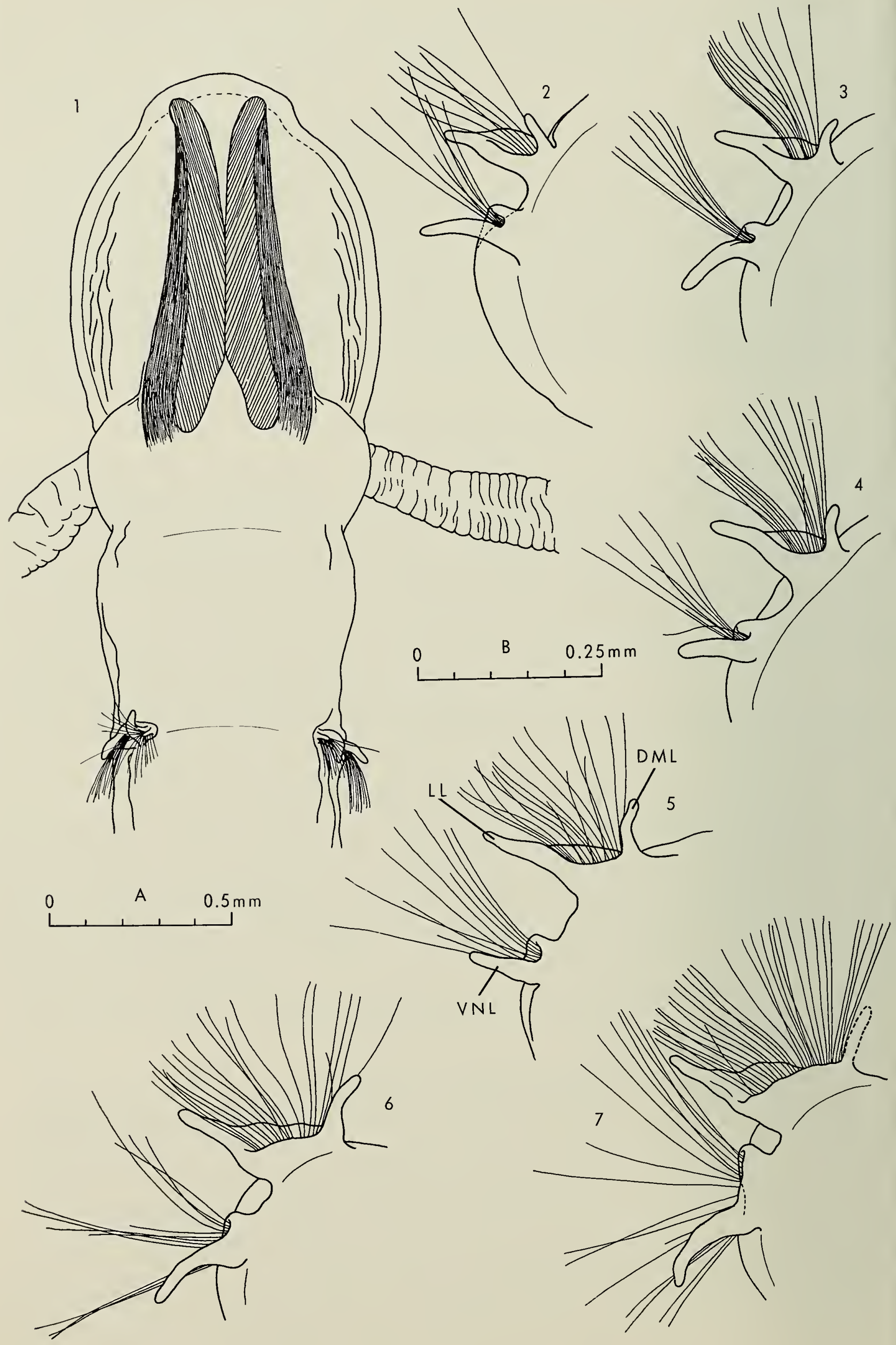
[?] *Magelona longicornis*.—Light, 1941:61. [Not Johnson, 1901.]

Differential diagnosis.—*Magelona* with rounded discrete anterior prostomial margin, lacking horns; with dorsal medial lobes on setigers 1–8; anterior notopodial lateral lamellae broadly attached from setiger 5 on; neuropodial lateral lamellae beginning on setiger 7; pennoned setae of setiger 9 with asymmetrically bilimbate tips; first few setigers of posterior region with interlamellae.

Type-locality.—"Tomales Bay [California], northern end; at low water line" (Hartman, 1944a:261).

Type disposition.—Holotype, AHF POLY 0590.

Material examined.—CALIFORNIA: Tomales Bay, clam flats, 30 May 1941. F. A. Pitelka collector (?)—(holotype, AHF 0590); White Gulch, Tomales Bay (Stat. I, 2-2), S. Obretski and W. Shepherd collectors—1 specimen (USNM 55215); Bodega Bay Harbor, intertidal sand flats, 1 September 1970, J. Cornell collector—41 specimens (USNM 55216, 55217); Doran Beach, Bodega Bay, 12 June and 9 August 1972, J. A. Blake collector—3 specimens (USNM 55218) and 2 specimens (USNM 55219), respectively. Two specimens each, from USNM 55217, have been deposited as follows: AHF,


1
2
3
4
0
B
0.25mm
DML
LL
5
VNL
0
A
0.5mm
6
7

AM, BCPM, BMNH, MNHNP, NMC, NMV, NSMT, RNHL, UZMC, ZIL, ZMA, and ZMH.

Description.—The holotype is posteriorly incomplete and is not ovigerous. It is 38 mm long for 54 setigers and 0.6 mm wide in the anterior region. Its palps extend posteriorly as far as setiger 28 and are papillated over their distal four-fifths; basally, there are 4 transverse rows of papillae and, distally, 2 rows. There are no lateral pouches anywhere along the length of the body. The specimen from Bodega Bay Harbor (USNM 55216), figured herein (Figs. 2–25), is also incomplete and is 74 mm long for 102 setigers and 0.75 mm wide in the anterior region. Other specimens from Bodega Bay Harbor (USNM 55217), all incomplete, are 57 mm long for 83 setigers, 51 mm long for 80 setigers, 49 mm long for 69 setigers, 43 mm long for 62 setigers; all are 0.75 mm wide in the anterior region. The specimen from White Gulch, Tomales Bay (USNM 55215), is incomplete and is 27 mm long for 52 setigers and 0.8 mm wide in the anterior region.

The prostomium (Fig. 1) agrees with the figure by Hartman (1944a: pl. 19, fig. 1); it is somewhat longer than wide (L:W = 1.2:1.0). The anterior margin is slightly rounded and is set off from the basal portion by paired slight indentations, suggesting a distinct anterior region, but not so well developed as to be considered "horns" (cf. Jones, 1963:figs. 1, 12, 61; 1971:1, 2, 20–25). Palps may extend posteriorly as far as setiger 28 and are papillated over their distal four-fifths. In most cases there are 4 transverse rows of papillae proximally and 2 rows distally, although there may be as many as 8 and 4, respectively. The papillae of preserved specimens retain brown pigment spots at their bases.

The anterior 8 setigers are basically similar, having notopodial lateral lamellae, dorsal medial lobes, and ventral neuropodial lobes (Figs. 2–9). Notopodial lateral lamellae are postsetal, flattened, and transversely oriented. In the first 3 setigers they are rather narrowly attached (Figs. 2–4), but from setigers 4–8, they become increasingly more broadly attached (Figs. 5–9). Further, the number of notosetae increase from about 7 in setiger 1 to about 35 in setiger 8. These setigers bear presetal, cirriform, dorsal medial lobes, closely associated with the notopodial lateral lamellae. The main structure of the first 8 neuropodia is a ventral neuropodial lobe which increases slightly in length along the anterior region and also moves from a strictly ventral to a ventral-presetal position (Figs. 2–9). The number

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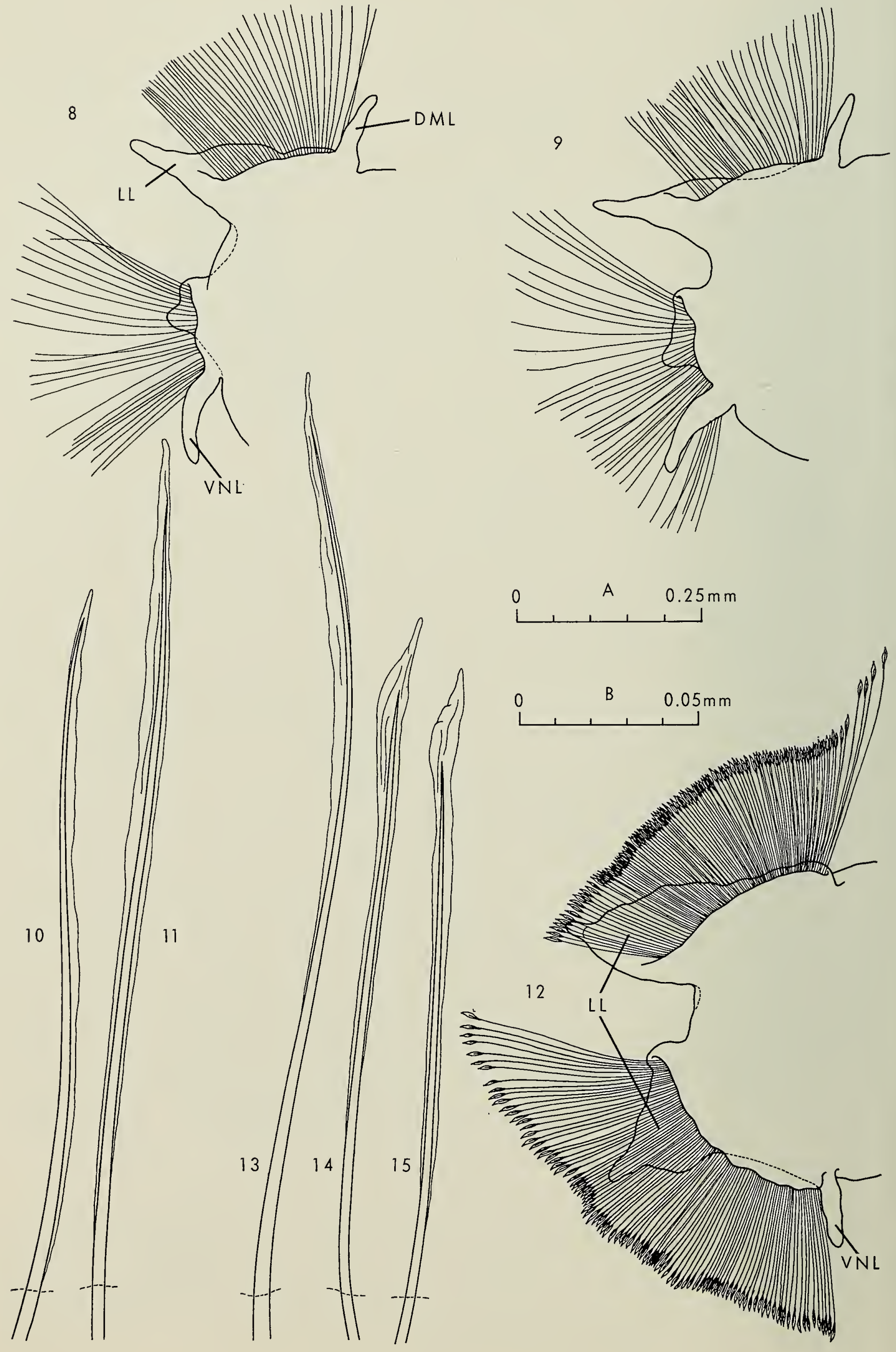
Figs. 1–7. *Magelona pitelkai* (Fig. 1, USNM 55217; Figs. 2–7, right parapodia, anterior views, USNM 55216): 1. Dorsal view of anterior end; 2. Setiger 1; 3. Setiger 2; 4. Setiger 3; 5. Setiger 4; 6. Setiger 5; 7. Setiger 6 (dorsal medial lobe dotted, lost during preparation). Fig. 1, scale A; Figs. 2–7, scale B. DML, dorsal medial lobe; LL, lateral lamella; VNL, ventral neuropodial lobe.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15

of neurosetae increases from about 7 in setiger 1 to about 35 in setiger 8, with a corresponding increase in the transverse extent of the setal fascicles. The neuropodia of setigers 1–6 bear no suggestion of lateral lamellae, but beginning with setiger 7 (Fig. 8), there is a low, postsetal lamellar structure; it is somewhat better developed on setiger 8 (Fig. 9). All setae of the first 8 setigers are uni- or bilimbate capillaries whose limbations are rather irregular and extend nearly the total length (Figs. 10, 11).

Setiger 9 lacks a dorsal medial lobe, bears a further enlarged postsetal notopodial lateral lamella, with an acute distal tip, and a subsetal, digitate, ventral neuropodial lobe (Fig. 12). The setae are all "pennoned," i.e., bilimbate, with narrow basal limbations which broaden distally and culminate in an apical area which narrows to an acute tip beyond the end of the setal shaft. In the case of *M. pitelkai* the pennoned setae are distally asymmetrical (Figs. 13–15).

From setiger 10 on, parapodia bear dorsal and ventral medial lobes and dorsal and ventral lateral lamellae (Figs. 16–19). The medial lobes are cirriform throughout and the lateral lamellae are asymmetrically lanceolate to ovate and may have truncated tips; they are borne on narrow pedicels. On the notopodia of the first few setigers of the posterior region there is a low, subtriangular, postsetal interlamella between the lateral lamella and the dorsal medial lobe (Fig. 16); the interlamella becomes reduced by setiger 18 (Fig. 17). Hooded hooks are all tridentate, but of 2 types. The larger, more numerous type is a typical magelonid hook (Figs. 20–23); these are arranged in 2 groups, vis-à-vis, in both the notopodial and neuropodial series (Figs. 16–19). The second type is much smaller than the first (Figs. 24, 25); they occur singly at the bases of the smaller pedicels (Fig. 16, arrow). The hoods of the larger hooks are elongated and more or less teardrop-shaped; those of the smaller hooks are usually nearly spherical. The shafts of the larger hooks are smooth and narrow below the main fang; those of the smaller hooks are drawn out and upward to form a cusp just below the fang, the hood appearing to arise as an upward extension of the cusp (Figs. 24, 25).

Lateral pouches are lacking in the anterior part of the posterior region, but they do occur in more posterior setigers where they are found just anterior to a given parapodium, with a posterior opening in line with

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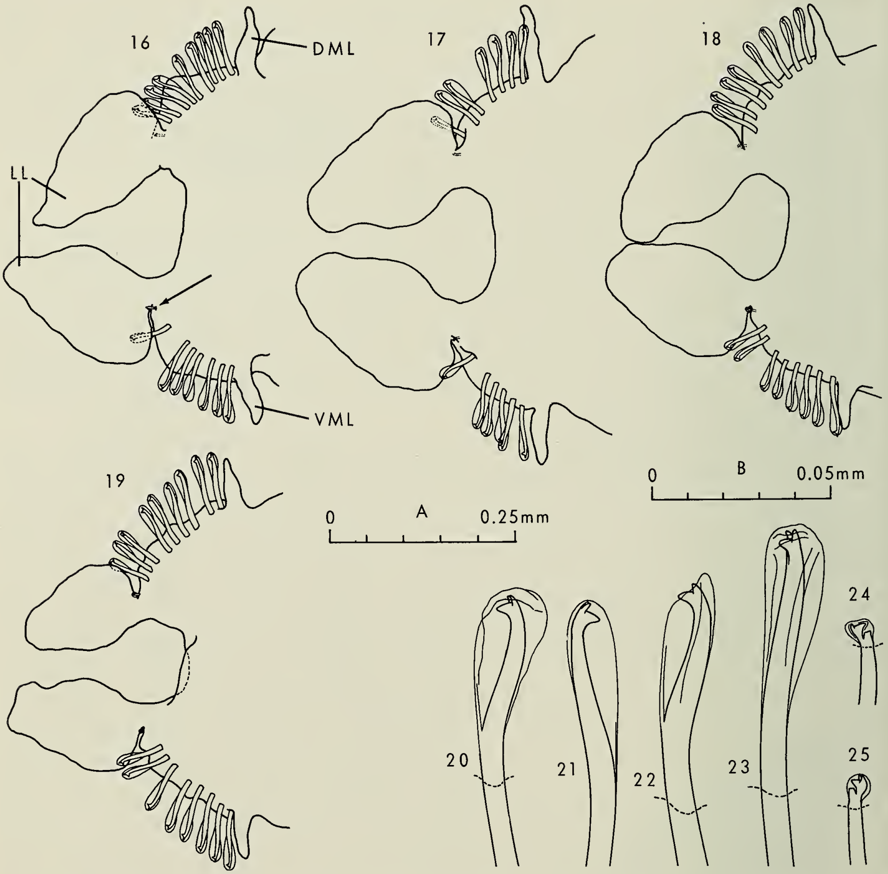
Figs. 8–15. *Magelona pitelkai* (right parapodia, anterior views, USNM 55216): 8. Setiger 7; 9. Setiger 8; 10. Notoseta from setiger 5; 11. Notoseta from setiger 8; 12. Setiger 9; 13. Neuroseta from superior part of fascicle of setiger 9; 14. Neuroseta from inferior part of fascicle, same; 15. Notoseta from superior part of fascicle, same. Figs. 8, 9, 12, scale A; Figs. 10, 11, 13–15, scale B. DML, dorsal medial lobe; LL, lateral lamella(e); VNL, ventral neuropodial lobe.



Figs. 16–25. *Magelona pitelkai* (right parapodia, anterior views, USNM 55216): 16. Setiger 10; 17. Setiger 18; 18. Setiger 38; 19. Setiger 63; 20. Near-profile view of hooded hook from setiger 18; 21. Profile view of developed, non-emergent hooded hook, same; 22. Profile view of hooded hook from setiger 38; 23. Three-quarter view of hooded hook, same; 24. Profile view of small notopodial hooded hook, same; 25. Three-quarter view of small neuropodial hooded hook, same. Figs. 16–19, scale A; Figs. 20–25, scale B. DML, dorsal medial lobe; LL, lateral lamellae; VML, ventral medial lobe; arrow indicates position of small hooded hook.

the space between the notopodial and neuropodial lateral lamellae. In four specimens in which lateral pouches have been observed, the first pouches arise between the left setigers 64–65, the right 68–69, the left 74–75, and the right 84–85. Posterior to the first pouch, subsequent ones arise in a regular pattern, alternating right and left. In the first case, above, the second pouch is between the right setigers 66–67, the third, between the left 68–69, etc.

Magelona pitelkai may be found in what appear to be sandy tubes. They are, however, fortuitously formed by the adherence of sand grains to mucus secreted by the worms as they burrow through the sand; they are not permanent tubes, such as has been described for *M. polydentata* (Jones, 1963:9).

Distribution.—*M. pitelkai* is found in low intertidal and shallow subtidal sandy beaches and flats of the central California coast and in subtidal sands (5–31 m depth) off southern California.

Discussion.—The shape of the prostomium, the distribution and form of parapodial lobes and lamellae of the anterior region, the form of the setae of setiger 9, the presence of interlamellae on the first few posterior setigers, and the presence of small hooded hooks on all posterior setigers, all serve to differentiate *Magelona pitelkai* from all other magelonids.

The previous northern records of *M. pitelkai* for Washington and British Columbia by Berkeley (1950, 1952), Jones (1963), Chew, et al. (1973) and Armstrong, et al. (1976) have been determined to represent a new species (see below, *M. hobsonae* n. sp.). Although I have not been able to examine Kitamori's material, I question his determination of *M. pitelkai* from Japan on the basis of the pronounced horns shown in his illustration of the prostomium (1967:fig. 4A). The questionable reference to *M. longicornis* is by deduction only, since no specimens identified as such by S. F. Light have been located. Light (1941:61) lists the locality for this as ". . . found in upper end of Tomales Bay near Dillon Beach . . . ," as well as ". . . found at Moss Beach, San Mateo County, or other ocean beaches of the vicinity . . . ." The former area includes the type locality of *M. pitelkai*, for the "clam flats" noted on the label of the holotype are about 2 km south of Dillon Beach and were routinely collected by his classes during his sea side courses (*fide* M. H. Pettibone and F. O. Paulson, former students of Light, personal communications). This area was studied and mapped by F. A. Pitelka and R. E. Paulson in May–June 1941. Their results, otherwise unpublished, have been reproduced as a map by Hedgpeth, as revisor of Ricketts and Calvin (1952:300, 315–316) and by Emery and Stevenson (1957:719, fig. 24). The polychaete collections of Pitelka, Paulson, and other members of the class of 1941, were given to Dr. Hartman by Dr. Light and formed the basis for the publication by Hartman (1944a) that includes the original description of *M. pitelkai*. Conjecture concerning the Moss Beach locality is not possible at this time.

As part of a summer course held at the University of California's Bodega Marine Laboratory, Mr. Bruce W. Gaspar (personal communication) carried out a series of observations on living *Magelona pitelkai*. Among these he confirmed that the method of burrowing in this species, including the movements of the prostomium and the use of the proboscis as an anchor, was the same as has been reported for *Magelona* sp. from near Woods Hole, Massachusetts (Jones, 1968). Further, he noted complete specimens of up to 125 setigers and one specimen, in a burrow adjacent to the glass of an aquarium, with a length of 155 mm and a diameter of 1.0 mm.

In spite of the intervening time since I commented upon the lateral pouches of *Magelona* sp. (Jones, 1968:275–6), I have nothing new to offer concerning their function; I *can* state that they are widespread among the Magelonidae, but not universal.

Magelona hobsonae, new species
Figs. 26–46

Magelona pitelkai.—Berkeley and Berkeley, 1950:53; 1952:13 (text only, not figs. 15–17).—Jones, 1963:24–25, fig. 60.—Chew, et al., 1973:14, 17.—Armstrong, et al., 1976:282 [Not *Magelona pitelkai* Hartman, 1944].

Differential diagnosis.—*Magelona* with nearly circular prostomium with anterior area set apart by anterolateral marginal indentations, lacking horns; with dorsal medial lobes on setigers 1–8; anterior notopodial lateral lamellae with cirriform tips; neuropodial lateral lamellae beginning on setiger 9 and continuing, in different form, on posterior setigers; pennoned setae of setiger 9 with symmetrically bilimbate tips; posterior setigers lacking interlamellae.

Type-locality.—Eagle Cove, southwest shore of San Juan Island, Puget Sound, Washington (48°27.6′N; 123°01.8′W).

Material examined.—WASHINGTON (SAN JUAN ISLAND): Eagle Cove, low intertidal sand beach, salinity 26.5‰, 25 August 1976, H. W. Kaufman collector—4 specimens, holotype (USNM 55222), figured paratype (USNM 55223), 2 paratypes (USNM 55224); Eagle Cove, low intertidal and shallow subtidal sandy beach, 24 August 1976, H. W. Kaufman collector—2 paratypes (USNM 55225); False Bay (48°29.3′N; 123°04.2′W), summer 1937, M. Miller collector—1 specimen (USNM 55226); (PUGET SOUND) North Richmond Beach, north of Seattle (47°46′40″N; 122°23′38″W), low intertidal sand, September 1974, J. W. Armstrong, et al., collectors—2 paratypes (USNM 53328); Carkeek Park, north of Seattle (47°42′45″N; 122°22′43″W), low intertidal sand, September 1974, J. W. Armstrong collector—3 paratypes (USNM 53327); West Point Beach, Seattle (47°39′45″N;

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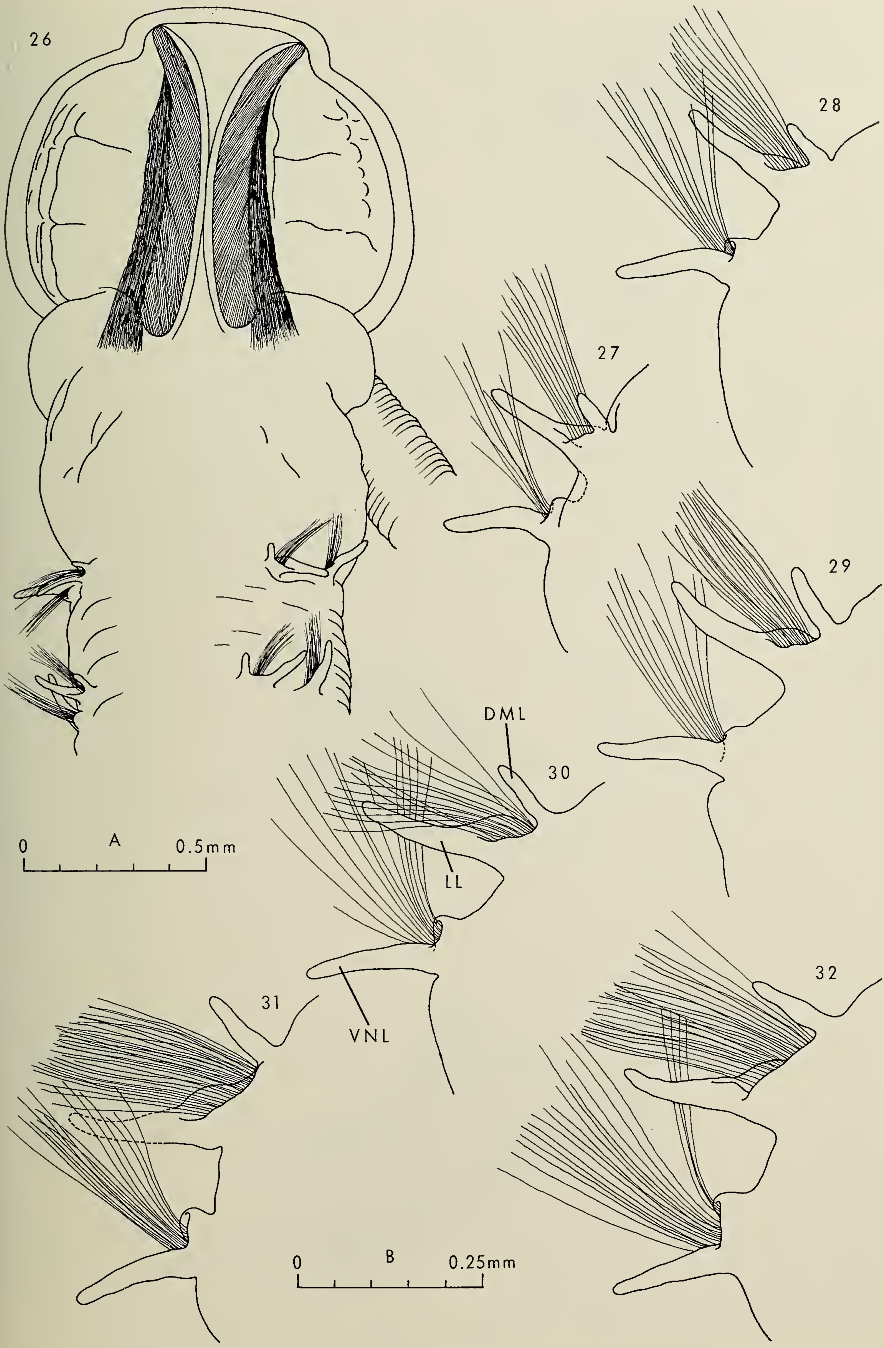
Figs. 26–32. *Magelona hobsonae* (Fig. 26, paratype, USNM 55225; Figs. 27–32, paratype, right parapodia, anterior views, USNM 55223): 26. Dorsal view of anterior end, left palp missing; 27. Setiger 1; 28. Setiger 2; 29. Setiger 3; 30. Setiger 4; 31. Setiger 5 (tip of lateral lamella dotted, lost during preparation); 32. Setiger 6. Fig. 26, scale A; Figs. 27–32, scale B. DML, dorsal medial lobe; LL, lateral lamella; VNL, ventral neuropodial lobe.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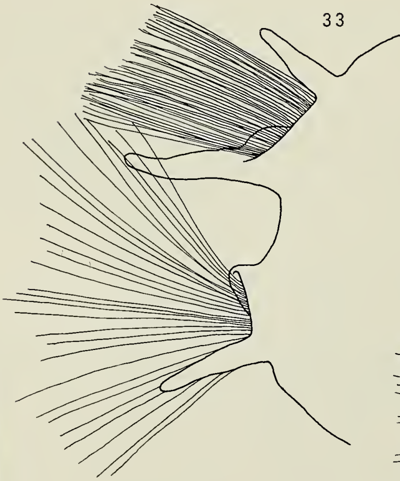

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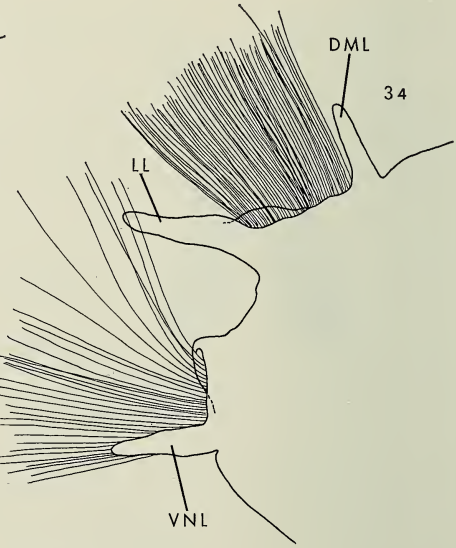

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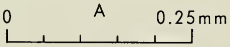

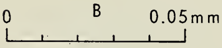

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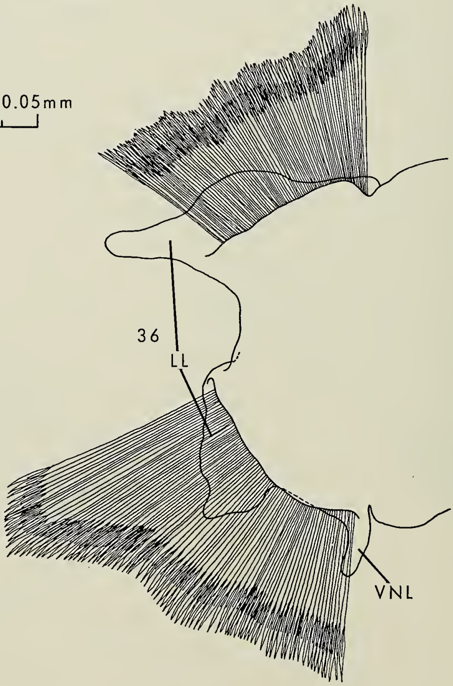

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122°26′04″W), low intertidal sand, September 1974, J. W. Armstrong collector—9 paratypes (USNM 53326). BRITISH COLUMBIA [CANADA]: Departure Bay Beach, Vancouver Island (49°13′N; 123°58′W), 26 March 1936, E. and C. Berkeley collectors—4 specimens (USNM 55227).

Description.—All specimens comprising type material are incomplete posteriorly. The holotype (USNM 55222) is 33.5 mm long for 73 setigers and 0.8 mm wide in the anterior region. The figured paratype (Figs. 27–46, USNM 55223) is 18.0 mm long for 33 setigers and 0.8 mm wide. Other representative paratypes are 58.0 mm long for 87 setigers, 1.0 mm wide (ovigerous); 56.0 mm for 68 setigers, 1.0 mm wide; 51.0 mm for 60 setigers, 1.0 mm wide; and 37.0 mm for 56 setigers, 0.9 mm wide.

The prostomium (Fig. 26) is somewhat wider than long (L:W = 0.8:1.0). The anterior margin is rather truncated and set off sharply from the otherwise subcircular major portion of the prostomium by pronounced indentations of the anterolateral margin, giving a "squared" appearance to the outer corners of the anterior area; they can not be considered to be horns. Palps may extend posteriorly as far as setiger 26. There may be as many as 8 transverse rows of papillae basally, and as many as 4 rows distally; the papillated area of the palps occupies the distal five-sixths of the length of the palp.

The anterior 8 setigers are similar; each parapodium is provided with a notopodial dorsal medial lobe, a lateral lamella, and a ventral neuropodial lobe (Figs. 27–34). Notopodial lamellae are cirriform extensions of the postsetal lamellar bases, becoming longer in the posterior part of the anterior region; notosetae increase in number from about 10 on setiger 1 to about 50 on setiger 8, with simultaneous broadening of the setal fascicle. The cirriform dorsal medial lobes increase slightly in length in the later setigers. The ventral neuropodial lobes are all cirriform, subequal in length, and usually presetal. Neurosetae increase in number from about 8 in setiger 1 to about 30 in setiger 8. Beginning with setiger 5 (Fig. 31), there is a transverse lengthening of the setal fascicle and the enclosed area from which it arises. The distal postsetal margins adjacent to the setae are not drawn out to form neuropodial lateral lamellae. All setae of the first 8 setigers are limbate capillaries, unilimbate for the most part, but bilimbate at their tips (Fig. 35).

Setiger 9 lacks a dorsal medial lobe; it bears a postsetal notopodial lat-

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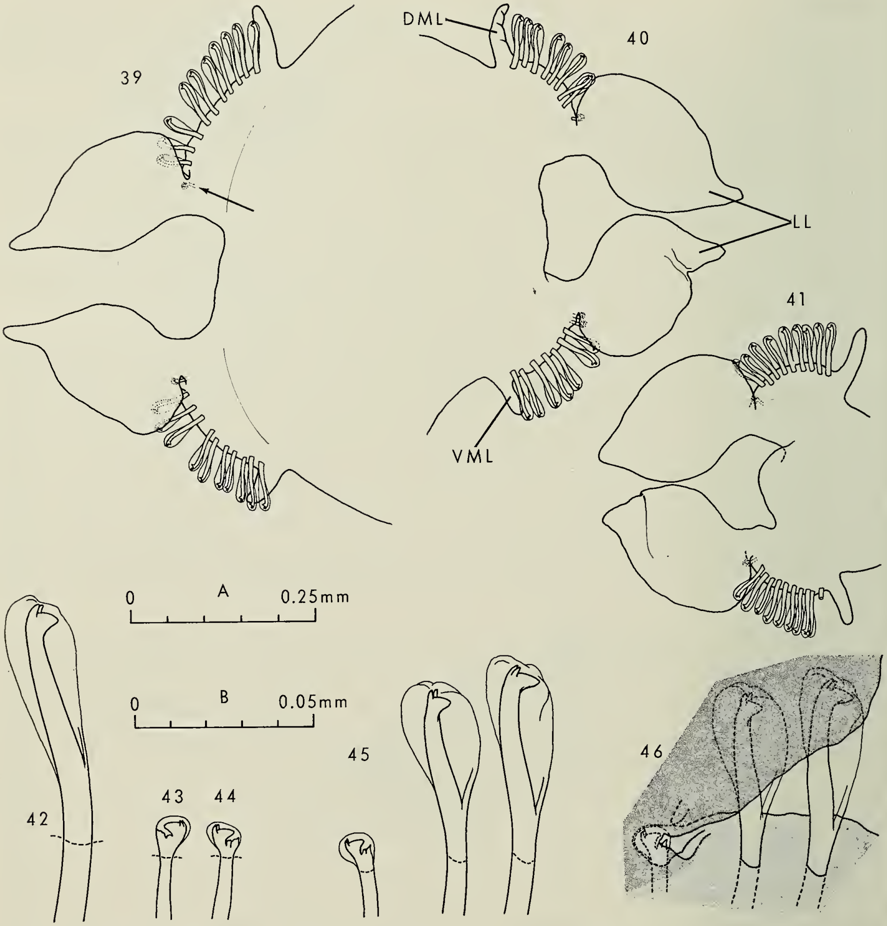
Figs. 33–38. *Magelona hobsonae* (paratype, right parapodia, anterior views, USNM 55223): 33. Setiger 7; 34. Setiger 8; 35. Seta from setiger 5; 36. Setiger 9; 37. Notoseta from central part of fascicle of setiger 9; 38. Tip of most lateral notoseta, same. Figs. 33, 34, 36, scale A; Figs. 35, 37, 38, scale B. DML, dorsal medial lobe; LL, lateral lamella(e); VNL, ventral neuropodial lobe.



Figs. 39–46. *Magelona hobsonae* (paratype, USNM 55223): 39. Right setiger 10, anterior view; 40. Left setiger 17, anterior view; 41. Right setiger 33, anterior view (distorted due to dorsoventral compression during preparation; parapodial structures unaffected); 42. Near-profile view of hooded hook from setiger 33; 43. Near-profile view of small neuropodial hooded hook of setiger 33; 44. Near-profile view of small notopodial hooded hook of setiger 33; 45. Small and two adjacent normal notopodial hooded hooks of setiger 10, in situ (surrounding tissue and structures omitted); 46. Same, including tissue of parapodial ridge (lighter stippling) and of lateral lamella and its pedicel (darker stippling), showing pocket in which small hooded hook lies. Figs. 39–41, scale A; Figs. 42–46, scale B. DML, dorsal medial lobe; LL, lateral lamellae; VML, ventral medial lobe; arrow indicates position of small hooded hook shown in Figs. 45 and 46.

eral lamella which is flattened and somewhat acuminate distally, a rather triangular postsetal neuropodial lateral lamella, and a postsetal cirriform ventral neuropodial lobe (Fig. 36). Rarely (one of 25 specimens examined), there may be a dorsal medial lobe on setiger 9; in the single exception, the lobe was on the right side only and was similar to the lobes of the anterior region. Setae of setiger 9 are symmetrically pennoned (Figs. 37, 38).

From setiger 10 on, posterior setigers bear dorsal and ventral medial lobes and dorsal and ventral lateral lamellae (Figs. 39–41). The medial lobes are cirriform, the dorsal ones being somewhat longer than those ventral. The lateral lamellae are asymmetrically lanceolate with acuminate tips. There are no interlamellae. The entire parapodial array, including medial lobes, lateral lamellae, and hooks, are borne on narrow transverse ridges. Hooded hooks are of two types: a more numerous, larger, typical magelonid hook with a teardrop-shaped hood (Figs. 42, 45, 46); and a smaller, shorter hook, with a cusp below the fang from which arises a subspherical hood (Figs. 43–46). The later hooks may be found singly in "pockets" at the bases of the lamellar pedicels (Figs. 39, arrow; 46); rarely, a pair of such small hooks are found (Fig. 40, in neuropodium). All hooks are tridentate and arranged in two groups in a fascicle, vis-à-vis.

No lateral pouches were observed in the posterior regions of any of the 25 incomplete specimens examined.

Magelona hobsonae was frequently collected in fortuitous sandy "tubes."

Etymology.—It is a bittersweet pleasure to name this species for Katherine D. Hobson, late of the British Columbia Provincial Museum, Victoria. Sweet, as a just honor to a respected colleague with a promising future; bitter, that such promise was cut short in so untimely a manner.

Type disposition.—The holotype (USNM 55222) and selected paratypes (USNM 55223, 55224, 55225) are deposited in the collections of the National Museum of Natural History, Smithsonian Institution. Other paratypes are deposited in the following collections: AHF, AM, BCPM, BMNH, NMC, NSMT, UZMC, ZIL, and ZMH.

Distribution.—*Magelona hobsonae* is found in the low intertidal levels of sandy beaches and flats throughout the Puget Sound region of Washington and British Columbia.

Discussion.—The shape of the prostomium, the distribution and form of parapodial lobes and lamellae of the anterior region, the form of the setae of setiger 9, and the presence of small hooded hooks on all posterior setigers, all serve to differentiate *Magelona hobsonae* from all other megalonids.

Certain identified specimens were not selected as paratypes. The single specimen from False Bay (USNM 55226) is in poor, but determinable, condition. The specimens from Departure Bay (USNM 55227) are distorted due to having been dried at some time; indeed, there is a note in the vial in the handwriting of E. Berkeley (*fide* M. H. Pettibone) to this effect.

The specimen from False Bay was the basis for my earlier erroneous determination of *M. pitelkai* (Jones, 1963:24–25). The upwardly curved anterior margin of the prostomium gave the appearance of horns, and critical comparisons with California specimens of *M. pitelkai* were not made. It should further be noted that figure references in the text of that earlier account differ by one from the actual figure numbers of all of the illustrations on that page (Jones, 1963:26, figs. 60–69).

Magelona hartmanae, new species
Figs. 47–68

Magelona sacculata.—Allan Hancock Foundation, 1965:138 (Station 4842-57, in part) [Not *Magelona sacculata* Hartman, 1961].

Differential diagnosis.—*Magelona* with proximal sides of prostomium nearly straight and parallel, with anterior margin sharply delimited with more or less pointed corners, rudimentary horns; with dorsal medial lobes on setigers 1–8; anterior notopodial lateral lamellae with cirriform tips; neuropodial lateral lamellae lacking on setiger 9; posterior lateral lamellae lanceolate, arising asymmetrically from their pedicels.

Type-locality.—Velero IV station 4842-57 (34°11′10″N; 119°15′50″W). Off Port Hueneme/Oxnard, California.

Material examined.—SOUTHERN CALIFORNIA: Stat. 4842-57, 45 ft. (= 12.7 m), fine olive green sand, temperature 55.0°F (= 12.8°C), salinity 33.8‰, 7 February 1957—holotype (AHF POLY 1221), figured paratype (USNM 55228), 43 paratypes (AHF POLY 1222, USNM 55229). CENTRAL CALIFORNIA: Offshore from Pajaro River, Monterey Bay (36°50.8′N; 121°49.4′W), fine sand, 15 m depth, 22 April 1977, Moss Landing Marine Laboratories collector—4 paratypes (USNM 55319).

Description.—All but one of the specimens examined are incomplete posteriorly. The holotype (AHF POLY 1221) is 9 mm long for 28 setigers and 0.3 mm wide in the anterior region. The figured paratype (USNM 55228) is 12 mm long for 38 setigers and 0.3 mm wide. The single complete paratype (USNM 55319) is ovigerous and 66 mm long for 116 setigers and

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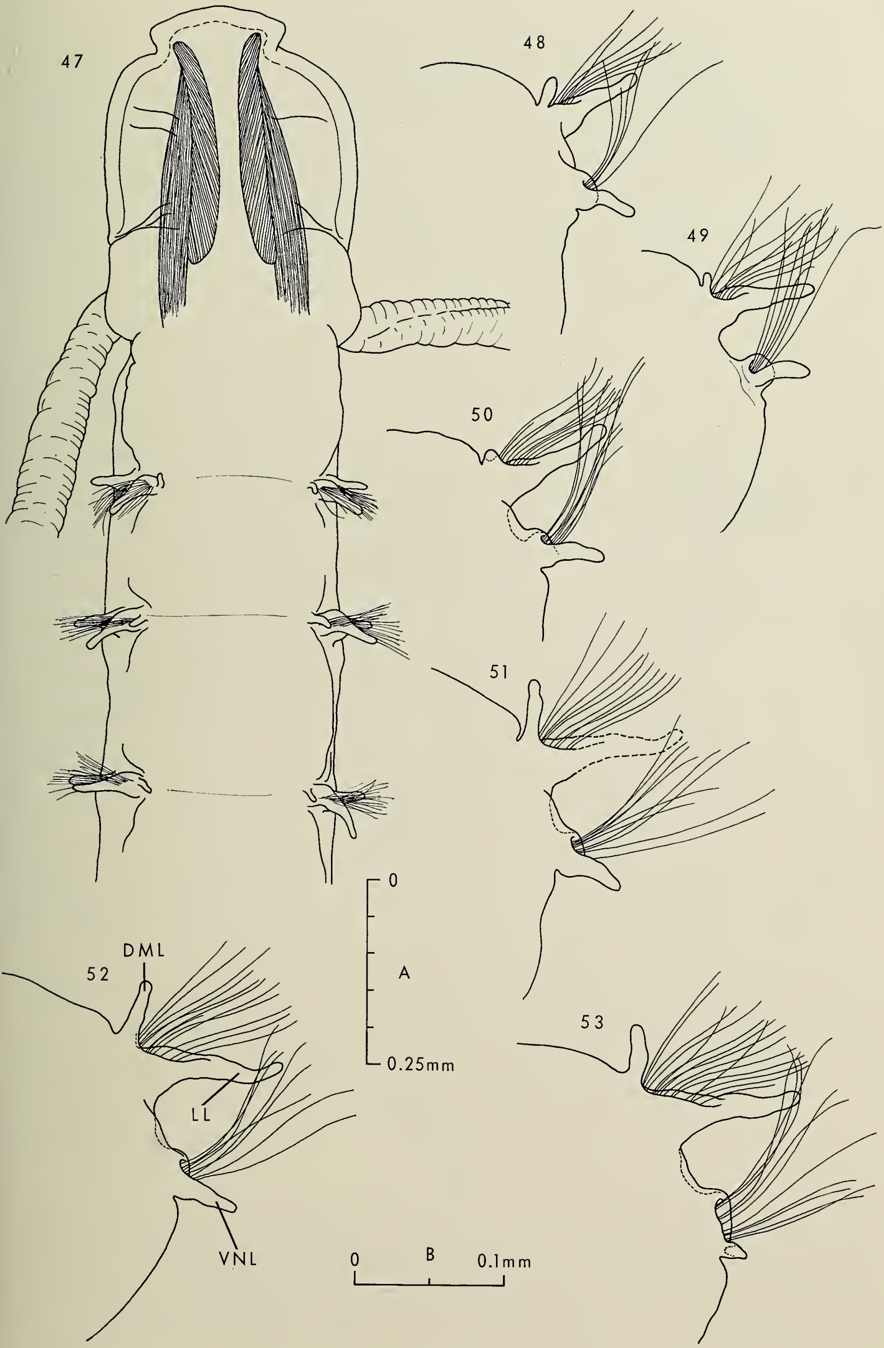
Figs. 47–53. *Magelona hartmanae* (Fig. 47, holotype, AHF POLY 1221; Figs. 48–53, paratype, left parapodia, anterior views, USNM 55228): 47. Dorsal view of anterior end; 48. Setiger 1; 49. Setiger 2; 50. Setiger 3 (dorsal medial lobe bent posteriorly); 51. Setiger 4 (tip of lateral lamella dotted, lost during preparation); 52. Setiger 5; 53. Setiger 6 (ventral neuropodial lobe bent posteriorly). Fig. 47, scale A; Figs. 48–53, scale B. DML, dorsal medial lobe; LL, lateral lamella; VNL, ventral neuropodial lobe.


47
48
49
50
51
52
DML
LL
VNL
53
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A
0.25mm
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B
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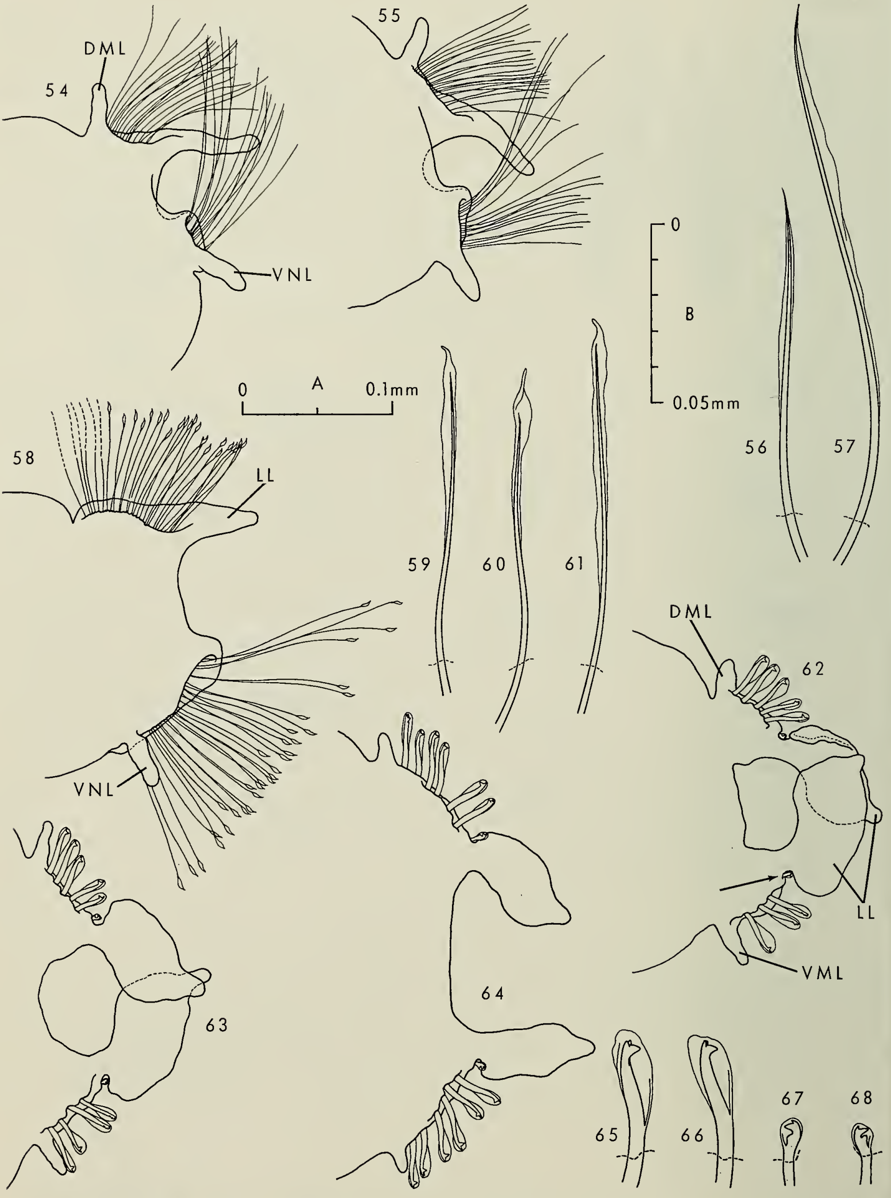

Figs. 54–68. *Magelona hartmanae* (paratype, left parapodia, anterior views, USNM 55228): 54. Setiger 7; 55. Setiger 8; 56. Notoseta from same; 57. Neuroseta from same; 58. Setiger 9 (dotted lines indicate setal tips lost during preparation); 59. Most lateral notoseta from setiger 9; 60. Central neuroseta from same (apical limbation folded to right); 61. Third most medial neuroseta from same; 62. Setiger 10 (dorsal lateral

0.4 mm wide; another paratype from Monterey Bay is 36 mm long for 69 setigers and 0.4 mm wide. Other paratypes from off southern California are 10 mm long for 24 setigers and 0.4 mm wide, and 7 mm long for 19 setigers and 0.3 mm wide.

The prostomium is slightly longer than wide (L:W = 1.1:1.0) and its lateral margins are nearly parallel (Fig. 47). The anterior region is set off sharply from the remainder of the prostomium, and its outer corners are sufficiently acute to be called "rudimentary" horns (cf. Jones, 1963: figs. 1, 61; 1971, figs. 20–25), but not so well-differentiated as to be called "well-developed" horns (cf. Jones, 1963:fig. 12; 1971:figs. 1, 2). Palps may extend posteriorly as far as setiger 26, and bear 4 transverse rows of papillae proximally, and 2 rows distally. In some cases there are irregular black pigment patches at the bases of the papillae and along the sides of the palp, proper.

The anterior 8 setigers are similar and provided with notopodial lateral lamellae, dorsal medial lobes, and ventral neuropodial lobes (Figs. 48–55). Notopodial lateral lamellae are postsetal, somewhat flattened frontally, with cirriform distal tips; their length increases from setigers 3–8. The postsetal area is not developed as a lamella, per se. Notosetae number about 7–21 per fascicle from setigers 1–8; the fascicle elongates transversely with increased numbers of setae. Dorsal medial lobes are presetal, cirriform, and are relatively short in the anterior setigers, then gradually become somewhat longer in later setigers. Neurosetae increase from about 5 in setiger 1 to about 17 in setiger 8. The ventral neuropodial lobes are all presetal, cirriform, and subequal in length, with a slight increase in length, posteriorly. There are no neuropodial postsetal lateral lamellae. Setae of the first 8 setigers are uni- or bilimbate capillaries (Figs. 56, 57).

The ninth setiger has no dorsal medial lobe; it bears a rather well-developed notopodial lateral lamella, somewhat flattened transversely, distally tapered, with a postsetal lamellar base (Fig. 58). The ventral neuropodial lobe is presetal; there is no neuropodial lateral lamella, merely a well-developed postsetal flange. The setae of the ninth setiger are arranged in broad fascicles of asymmetrically pennoned setae (Figs. 59, 60) or nearly symmetrically pennoned setae (Fig. 61). The former comprise the central and lateral setae; the latter is represented by the few most medial setae.

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lamella folded at base); 63. Setiger 21; 64. Setiger 37; 65. Near-profile view of normal-sized notopodial hooded hook of setiger 10; 66. Profile view of normal-sized neuropodial hooded hook of setiger 37; 67. Profile of small notopodial hooded hook of same; 68. Profile of small neuropodial hooded hook of same. Figs. 54, 55, 58, 62–64, scale A; Figs. 56, 57, 59–61, 65–68, scale B. DML, dorsal medial lobe; LL, lateral lamella(e); VML, ventral medial lobe; VNL, ventral neuropodial lobe; arrow indicates position of small hooded hook.

The posterior parapodia from the tenth setiger on, are borne on elevated transverse ridges. They bear relatively short, stout, medial lobes, as well as lateral lamellae on narrowed pedicels; the lamellae range from patently to slightly asymmetrically lanceolate in shape (Figs. 62–64). Hooded hooks are all tridentate and of 2 types: a longer, typical hook with a teardrop-shaped hood with an unadorned shaft below the fang (Figs. 64–66); and a shorter hook, confined to the base of the pedicel, with a rounded hood and a poorly developed cusp arising from the shaft below the fang (Figs. 67, 68). The hooded hooks are arranged in 2 groups in each series, vis-à-vis (Figs. 62–64). There is, at best, only a slight suggestion of a postsetal interlamella.

In the case of several paratypes (USNM 55319), of sufficient length, lateral pouches were observed in the posterior region. First lateral pouches were present between left setigers 46 and 47, right 42 and 43, and right 48 and 49. In the first case, the only complete specimen examined (116 setigers), the second pouch was between right 48 and 49, then left 50 and 51, and so on, with regular alternations until the pouch between left 86 and 87; subsequent pouches were irregular in occurrence, i.e., between left 86 and 87, right 87 and 88, right 90 and 91, left 92 and 93, right 94 and 95, left 95 and 96, right 97 and 98, left 99 and 100, right 101 and 102, left 102 and 103, right 104 and 105, left 105 and 106, right 107 and 108, left 108 and 109, and, the last visible pouch, between right 110 and 111. In the second case, there was a regular alternation throughout the remainder of the incomplete specimen, to the last visible pouch between left 56 and 57. In the last case there was regular alternation up to the pouch between right 64 and 65; then left 65 and 66, right 67 and 68, and, finally, left 68 and 69 of this incomplete specimen. It would appear that in the farther posterior setigers, i.e., the younger segments, relative to their formation in the pygidial region, the rigorous control over pouch appearance tends to break down.

Etymology.—It is with great pleasure that I name this species in honor of Olga Hartman, as a small posthumous gesture of thanks for her years of contributions to our understanding of the polychaetes and their classification.

Type disposition.—The holotype (AHF POLY 1221) and some paratypes (AHF POLY 1222) are deposited in the collections of the Allan Hancock Foundation, University of Southern California; the figured paratype (USNM 55228) and other paratypes (USNM 55229, 55319) are deposited in the collections of the National Museum of Natural History, Smithsonian Institution. Other paratypes have been deposited in the following collections: AM, BCPM, BMNH, MNHNP, NMC, NMV, NSMT, RNHL, UZMC, ZIL, ZMA, and ZMH.

Distribution.—*Magelona hartmanae* is known from the type-locality, off the southern California coast, near Port Hueneme and Oxnard, in 12.7 m depth and the central California coast, near Moss Landing, Monterey Bay, in 15 m depth.

Discussion.—The shape of the prostomium, the distribution and form of parapodial lobes and lamellae of the anterior region, the form of setae of the ninth setiger, and the presence of small hooded hooks on all posterior setigers, all serve to differentiate *Magelona hartmanae* from all other magelonids.

The literature account of Station 4842-57 (Allan Hancock Foundation 1965:138) lists "*Magelona sacculata* 108 [specimens]." By actual count 62 specimens of *M. sacculata* and 45 specimens of *M. hartmanae* were present.

It must be admitted that the discussion of "rudimentary" and "well-developed" horns, above, leaves much to be desired. A more rigorous definition of "horns" is necessary, but must await a thorough survey of the many named and unnamed magelonids on my shelves.

Magelona dakini, new species
Figs. 69–90

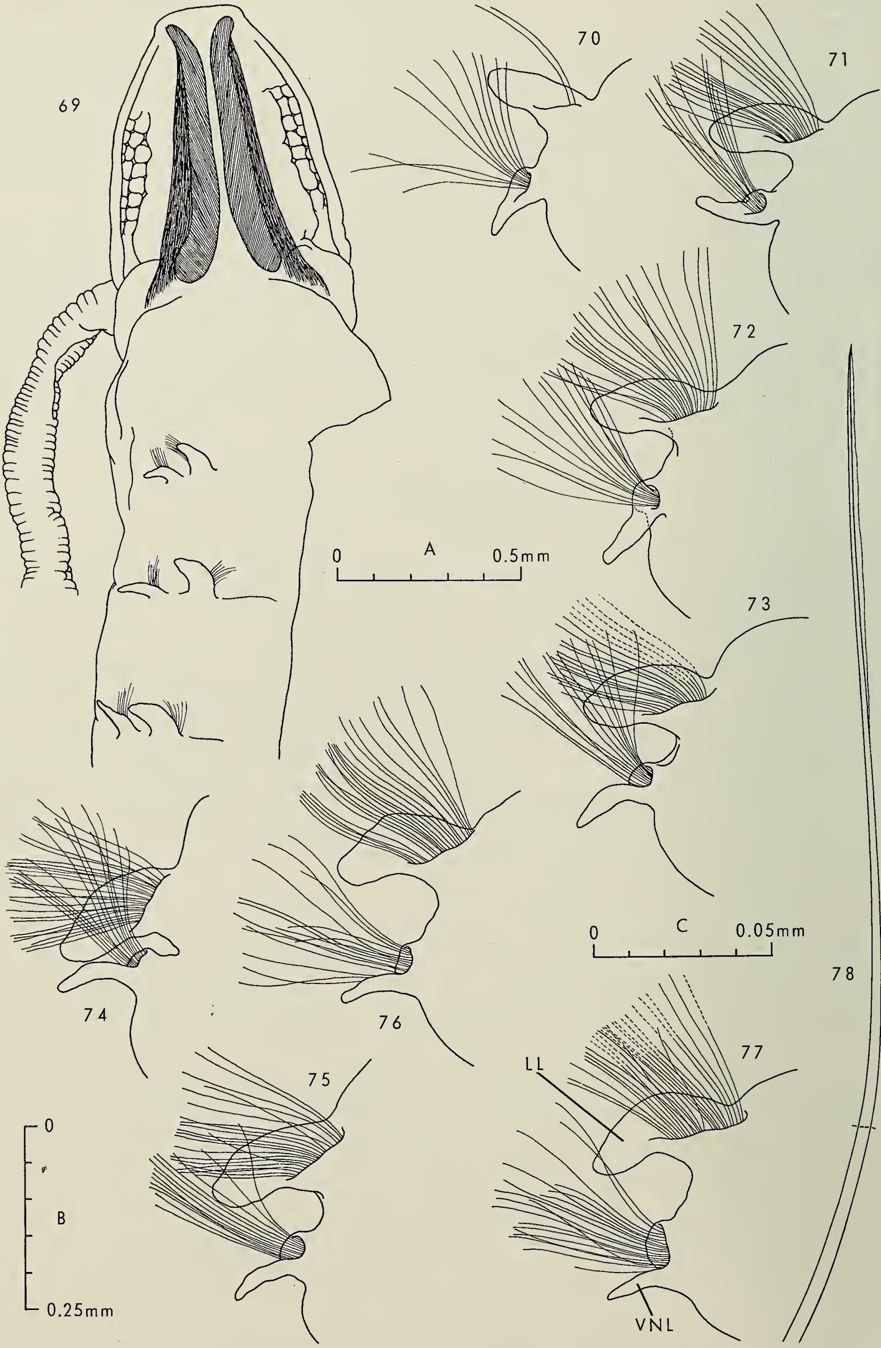
Magelona sp.—Hutchings and Recher, 1974:105, 109.

Magelona sp. 2 and sp. 4 (species numbers 254 and 352, respectively).—Poore, et al., 1975:29, 56.

Differential diagnosis.—*Magelona* with truncated anterior margin barely set off from remainder of prostomium, lacking horns; dorsal medial lobes lacking on setigers 1–8; anterior notopodial lateral lamellae flattened and broadly attached; setiger 9 lacking dorsal medial lobe, with flattened, rounded notopodial and neuropodial lateral lamellae, and cirriform ventral neuropodial lobes; setae of setiger 9 slightly pennoned; posterior parapodia with oval lateral lamellae and interlamellae.

Type-locality.—Careel Bay, southeast shore of Pittwater, Broken Bay, New South Wales, Australia (33°37′S; 151°20′E).

Material examined.—NEW SOUTH WALES, AUSTRALIA: Careel Bay, sandy beach, 6 February 1973, P. A. Hutchings collector—holotype (AM 13263), figured paratype (USNM 55230), paratype (AM W8241); Careel Bay, *Zostera*, 2 February 1972, P. A. Hutchings and H. F. Recher collectors—paratype (AM W8240); George's River, subtidal mud, L. Collett collector—Kogarah Bay, 3 (AM W7603) and 6 paratypes (AM W7619)—Tom Ugly's Bridge, 2 (AM W7521) and 1 paratype (AM W7643)—Como Bridge, 1 paratype (AM W7669)—Soily Bottom Point, 1 paratype (AM W7687); Ku Ring Gai, Pittwater Basin, *Zostera*, *Posidonia*, and sand along shoreline, 4 May 1973, P. A. Hutchings collector—1 paratype (unregistered). QUEENSLAND, AUSTRALIA: Tin Can Bay, mangrove mud flats, 30 March 1972, P. A. Hutchings collector—8 paratypes (AM W4979); Jackson Creek, Moreton Bay, Brisbane, sand flats, 12 July 1973, P. A. Hutchings collector—2 paratypes (AM W6037); Quarentine Station, Brisbane River, August


69
70
71
72
0 A 0.5mm
73
0 C 0.05mm
74
76
75
78
LL
77
VNL
0
B
0.25mm

1971, D. F. Boesch collector—3 paratypes (AM W7469); Gladstone, 9–12 February 1976, P. Saenger collector—Calliope River, 28 paratypes (AM W10237–40, AM W10243–46), Auckland Creek, 1 paratype (AM W10241), 7–9 October 1976, P. Saenger collector—1 paratype (AM W10242). VICTORIA, AUSTRALIA: Port Phillip Bay, northwest portion, offshore from Werribee, sand and silty sand, less than 10 m, Poore, et al. collectors—16 stations, 12 February 1970, 7 June and 18, 19 November 1971, 409 specimens (37 paratypes selected, USNM 55220, Marine Pollution Studies Group Cat. Nos. 4042 and 4091); Mallacoota Inlet, sandy mud, 26 April 1975, J. Kudenov collector—13 paratypes (USNM 55221).

Description.—All the specimens examined were incomplete posteriorly. The holotype (AM W13263) is 17.0 mm long for 40 setigers and 0.7 mm wide in the anterior region. The palps extend to about setiger 26; they are papillated over their distal five-sixths and bear rows of 8 papillae basally and 2 rows distally. The figured paratype (USNM 55230) is 21.0 mm long for 60 setigers, 0.6 mm wide; other paratypes from the type locality are 22.0 mm for 38 setigers, 0.5 mm wide (AM W8241) and 46 mm long for 98 setigers, 0.8 mm wide (AM W8240). Among other paratypes, from Port Phillip Bay, are the following: 18.0 mm long for 36 setigers, 0.6 mm wide (Stat. 920), 24.0 mm long for 61 setigers, 0.5 mm wide and 21.0 mm long for 54 setigers, 0.4 mm wide (Stat. 940), 11.0 mm long for 37 setigers, 0.4 mm wide and 12.0 mm long for 32 setigers, 0.3 mm wide (Stat. 1245), and 16.0 mm long for 32 setigers, 0.5 mm wide, 28.0 mm long for 53 setigers, 0.5 mm wide, and 20.0 mm long for 56 setigers (ovigerous), and 0.5 mm wide (Stat. 1236).

The prostomium is slightly longer than wide (L:W = 1.1:1.0) and its lateral margins are gently curved toward the narrowed anterior margin which is rather straight and set off from the basal portion of the prostomium by slight but perceptable paired indentations (Fig. 69). Palps may extend as far posteriorly as setiger 28 and are papillated over their distal five-sixths. Papilla are arranged in as many as 8 transverse rows, proximally, and as many as 4 rows, distally.

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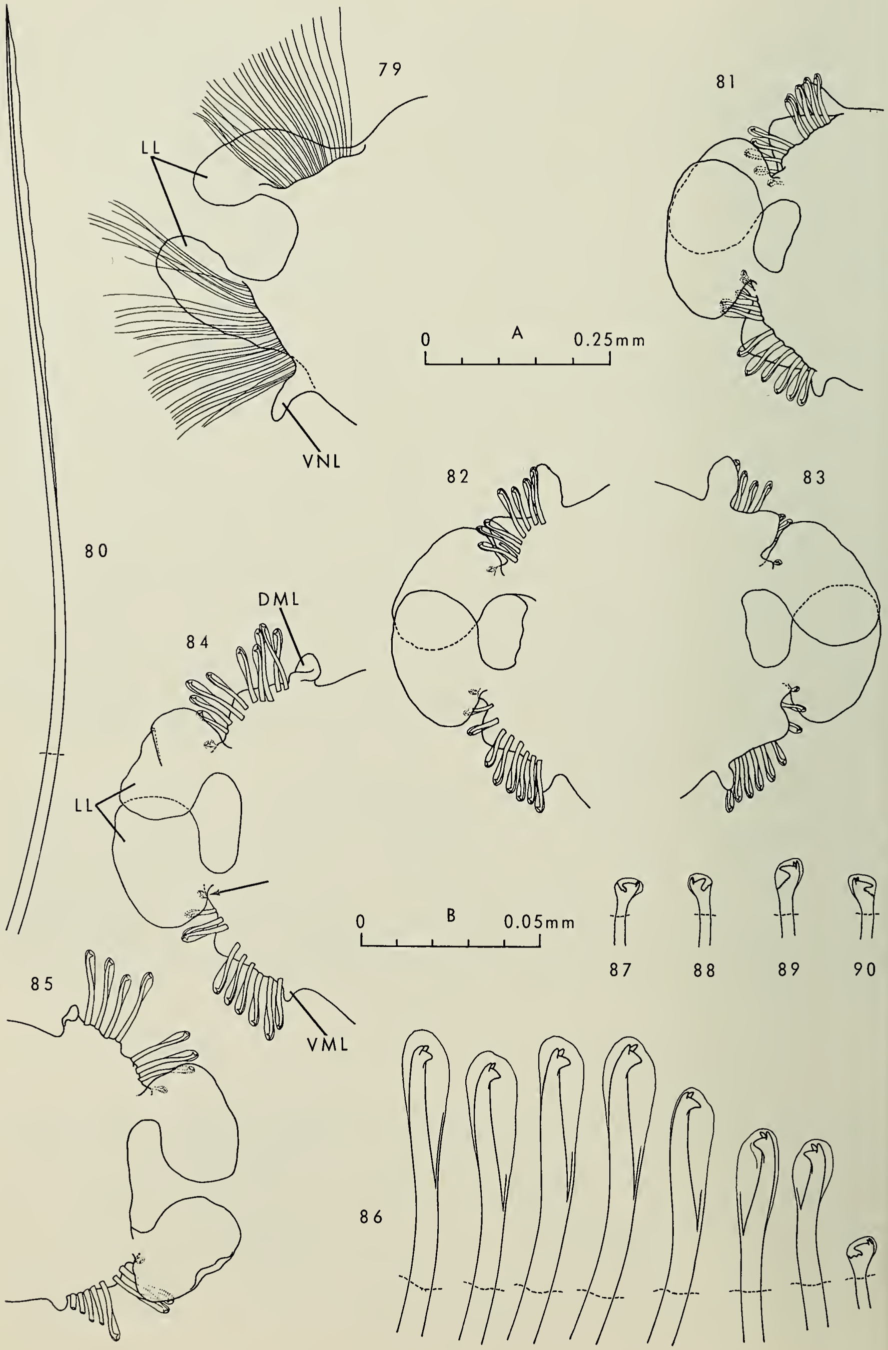
Figs. 69–78. *Magelona dakini* (paratype, right parapodia, anterior views, USNM 55230): 69. Dorsal view of anterior end (excision of right parapodia has caused a twisting of setigerous segments; right palp missing); 70. Setiger 1 (no notosetae were lost during preparation; left setiger 1 with about 10 notosetae); 71. Setiger 2; 72. Setiger 3; 73. Setiger 4 (dotted lines indicate setal tips lost during preparation); 74. Setiger 5 (slight distortion due to dorsoventral expansion during preparation); 75. Setiger 6; 76. Setiger 7; 77. Setiger 8 (dotted lines indicate setal tips lost during preparation); 78. Notoseta from same. Fig. 69, scale A; Figs. 70–77, scale B; Fig. 78, scale C. LL, lateral lamella; VNL, ventral neuropodial lobe.


79
LL
VNL
80
81
0
A
0.25mm
82
83
DML
84
LL
VML
85
0
B
0.05mm
87
88
89
90
86

The anterior 8 setigers are similar and bear notopodial lateral lamellae and ventral neuropodial lobes (Figs. 70–77). There are no dorsal medial lobes. The foliaceous lateral lamellae are postsetal with their tips rounded to somewhat lanceolate. The neuropodial lobes are cirriform and, depending upon their orientation, ventral to presetal. The setae of the first 8 setigers are all finely unilimbate capillaries (Fig. 78). Notosetae increase from about 10 in setiger 1 to 26 in setiger 8; neurosetae increase from about 10–20. Notosetae are arranged in consistently elongated fascicles, while neurosetae are in more compact, rounded fascicles.

Setiger 9 is provided with both noto- and neuropodial lateral lamellae, as well as a ventral neuropodial lobe (Fig. 79). The lateral lamellae are postsetal, rounded, and foliaceous. The neuropodial lobe is cirriform and presetal. There are approximately 30 setae in each transversely elongated fascicle; all setae of the ninth setiger are finely unilimbate, with the limbation restricted to the distal two-thirds of the setal length, suggesting a narrowly pennoned aspect, although the limbation does not extend beyond the tip of the setal shaft (Fig. 80).

The posterior parapodia, from the tenth setiger on, are on reduced transverse ridges, with oval lateral lamellae borne on narrow pedicels (Figs. 81–85). Dorsal medial lobes are somewhat larger than their ventral counterparts; there are well-developed triangular postsetal interlamellae between the lateral lamellae and the medial lobes in both the noto- and neuropodia (Figs. 81–84). The interlamellae become reduced more posteriorly (Fig. 85). Hooded hooks are all tridentate and are disposed in two series in noto- and neuropodia, vis-à-vis. There are 2 types of hooks: a longer, larger, typical hook with a teardrop-shaped hood (Fig. 86); and a shorter, smaller hook with a short rounded hood and a cusp arising from the shaft, beneath the main fang (Figs. 86–88). Those of more posterior setigers bear a much-reduced cusp and have a more typical appearance, except for their size and the shape of the hood (Figs. 89, 90). The larger hooded hooks, adjacent to the pedicels of both noto- and neuropodia, tend to be shorter than those nearer the medial lobes (Figs. 81–86).

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Figs. 79–90. *Magelona dakini* (paratype, USNM 55230): 79. Right setiger 9, anterior view; 80. Notoseta from same; 81. Right setiger 10, anterior view; 82. Right setiger 18, anterior view; 83. Same, posterior view; 84. Right setiger 38, anterior view; 85. Left setiger 48, anterior view; 86. Eight of nine neuropodial hooded hooks from setiger 18, not in situ; 87. Profile of neuropodial small hooded hook from setiger 38; 88. Same, from notopodium of same; 89. Small notopodial hooded hook from setiger 48; 90. Same, from neuropodium of same. Figs. 79, 81–85, scale A; Figs. 80, 86–90, scale B. DML, dorsal medial lobe; LL, lateral lamellae; VML, ventral medial lobe; VNL, ventral neuropodial lobe; arrow indicates position of small hooded hook shown in Fig. 87.

As mentioned earlier, all specimens examined were incomplete posteriorly. Only in the case of material from Mallicoota Inlet (USNM 55221) were the anterior fragments long enough to observe lateral pouches. In one case (63.0 mm for 118 setigers, 0.5 mm wide), a single pouch was found between right setigers 117 and 118; in another (66.0 mm for 116 setigers, 0.5 mm wide), the single pouch was between left setigers 115 and 116; in the third case (75.0 mm for 122 setigers, 0.6 mm wide), the regularity of alternation of left and right pouches, as observed in *M. pitelkai*, above, was confirmed, but there were inconsistencies in linear arrangement—the first between left 101 and 102, then right 103 and 104, left 105 and 106, right 108 and 109, left 114 and 115, right 116 and 117, left 118 and 119, and right 121 and 122.

Etymology.—I am pleased to name this species in honor of W. J. Dakin, whose studies and writings have done much to make known the biota of Australian shores to the rest of the world.

Type disposition.—The holotype (AM W13263) and many paratypes (see "*Material examined,*" above) are deposited in the collections of the Australian Museum, Sydney. Other paratypes (USNM 55220, 55221, 55230–55232) are in the collections of the National Museum of Natural History, Smithsonian Institution and AHF, BCPM, BMNH, MNHNP, NMC, NMV, NSMT, RNHL, UZMC, ZIL, ZMA, and ZMH.

Distribution.—*Magelona dakini* is found in sandy beaches, *Zostera* beds, mangrove mud flats, and subtidal sands, silty sands, and muds of Australia, in Queensland, New South Wales, and Victoria.

Discussion.—The shape of the prostomium, the distribution and form of parapodial lobes and lamellae of the anterior region, the form of setae of setiger 9, and the presence of small hooded hooks on all posterior setigers, all serve to differentiate *Magelona dakini* from all other magelonids.

Of the four species considered herein, *M. dakini* exhibits the widest tolerance to diverse habitats, and it has the longest latitudinal distribution, from 24°S (Gladstone, Queensland) to 38°S (Port Phillip Bay, Victoria). Further, it appears to be less closely related to the others than they among themselves. Although it has the small hooded hook of the pedicels in common with them, the shape of the anterior prostomial margin, the structure of the notopodial lateral lamellae of the anterior region, as well as that of the lateral lamellae, and the aspect of the setae of setiger 9, all suggest a more distant relationship of *M. dakini* from Australia to *M. pitelkai*, *M. hobsonae*, and *M. hartmanae* from the coast of the eastern Pacific.

General Discussion

Yet another species of *Magelona* possesses the small hooded hooks associated with the pedicel. Although I have not examined the holotype, as yet, specimens of *Magelona filiformis* Wilson, identified by D. P. Wilson, possess these singular hooks. These, then, in addition to the prostomium, the forms of setiger 6 and anterior setigers of the posterior region (Wilson shows setiger 13), and the structure of the setae of setiger 9 (Wilson, 1959:figs. IA, IG, II, and IJ, respectively) are similar to the prostomium of *M. pitelkai* and the setigers and setae of *M. hobsonae*. The morphology of setiger 9 of *M. filiformis* appears to differ from those of all species herein considered (Wilson, 1959:fig. IH).

A final species which may prove to be closely allied to the four species described above, as well as to *M. filiformis*, is *M. capensis* Day. I have examined material identified by Day, not type-specimens, and find a single, small, tridentate hooded hook at the base of pedicels of the posterior region. The small hooks lack the cusp beneath the main fang, and the hood is teardrop-shaped; indeed, they are identical to the accompanying normal hooks, except for size. This would appear to be the next step beyond (or short of?) the condition in *M. hartmanae* and *M. dakini*, where the cusp of the small hooks may be less well-developed in some setigers (Figs. 67, 89, 90). The prostomium of *M. capensis* is somewhat similar to those of *M. pitelkai* and *M. filiformis*; setiger 5, with its dorsal medial lobe, suggests a relationship to *M. pitelkai*, *M. hobsonae*, *M. hartmanae*, and *M. filiformis*, but the notopodial lateral lamella differs from those of the other species in its foliaceous aspect; and setiger 9 shows a morphological similarity to *M. pitelkai* and *M. hobsonae* (Day, 1961:495–496, fig. 6a, b, c). Setae of setiger 9, however, resemble those of *M. dakini* in that they are narrowly pennoned (Fig. 80).

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A NEW GENUS AND SPECIES OF RHYSODESMINE MILLIPED FROM SOUTHERN GEORGIA (POLYDESMIDA: XYSTODESMIDAE)

Richard L. Hoffman

Abstract.—The minute xystodesmid *Caralinda beatrix* is described as a new genus and species known so far only from Tifton, Georgia. Despite a somewhat disjunct gonopod structure, other anatomical features justify referral of the genus to the tribe Rhysodesmini. A key to the eight known genera of this group is given, as well as an indication of the number of species and their distribution for each genus.

The diplopod fauna of Georgia is notable for its representation of endemic monotypic genera of xystodesmids—*Dynoria*, *Stelgipus*, *Lyrranea*, and *Erdelyia*—discovered during the past four decades. That the end has not been reached is shown by the present revelation of a fifth Georgian constituent. Whereas the four genera just named can be fairly easily associated with other known groups in the Southern Appalachian fauna, the new form described here is strikingly disjunct. Although it can be placed in the tribe Rhysodesmini it occupies there a position removed from its nearest relatives both structurally and geographically.

On the occasion of describing *Lyrranea persica* (1963) I implied that field work in Georgia might be most profitable during the colder months, and that supposition has been amply vindicated through the diligence of my colleague Jerry A. Payne (Southeastern Fruit and Tree Nut Research Station, USDA, Byron, Georgia). Among other interesting finds, Dr. Payne has collected and transmitted to me not only new xystodesmid here described, but also material of a highly specialized and disjunct new parajulid genus. His generosity in making all of these specimens available to me is acknowledged with pleasure.

Family Xystodesmidae Cook
Tribe Rhysodesmini Brolemann
Caralinda, new genus

Type-species.—*C. beatrix*, new species, from Georgia.

Diagnosis.—A genus of minute xystodesmids characterized by the form of the gonopods, by the continuation of the scapuloral rim entirely across the dorsum of body segments, and by the presence of small but distinct median conical sternal processes between the 3rd and 4th pairs of legs. Labral and clypeal setae closely approximate and merging at lateral end of labrum, thence continuing along lower half of genal margin.

Sternum of 7th segment broad; that of 8th segment abruptly narrower; those of following segments gradually increasing in width back to midbody, bicruciately impressed and set with long silky macrosetae.

Gonopod aperture small but unusually extended transversely; gonopods with prominent sclerotized median sternal element; coxae somewhat flattened but otherwise unmodified; prefemora broad, flattened to concave on the ventral surface, with long, flattened, apically bifid prefemoral process; acropodite region set off from prefemur by a conspicuous transverse suture; in the form of an elongated, dorsomedially curved hood-like structure, the inner surface of which is produced into a free-standing bilobed solenomerite; entire course of prostatic groove visible in mesal aspect.

Sternum of second pair of legs of female strongly reduced in size, merging into intersegmental membrane just laterad to stigmal openings; cyphopods relatively large with subhemispheric receptacle and two large subequal valves.

Distribution.—Known so far only from the type locality of the type species, in the Coastal Plain of south central Georgia.

Etymology.—For Linda Knight Hoffman (1947–1976). Gender feminine.

Caralinda beatrix, new species

Figs. 1–10

Diagnosis.—With the characters of the genus; differing from all other known xystodesmids in the combination of small size, formation of the interzonal suture, setiferous bicruciately impressed sterna, presence of median conical processes on anterior sterna of males, and the highly disjunct form of the gonopods.

Type-material.—Male holotype, nine male and five female paratypes from Tifton, Tift County, Georgia; Jerry A. Payne leg. 13 and 27 January 1968 (Hoffman Collection).

Holotype.—Adult male, length ca. 16.5 mm, maximum width 3.8 mm, W/L ratio 23.0%. Body compact, paranota overlapping broadly, width of segments increasing rapidly from collum to 6th, thence parallel back to about 15th segment before tapering off abruptly as indicated by the following width values:

Segment 1—3.4 mm
2—3.5
4—3.7
6—3.8
8—3.8

Segment 10—3.8 mm
12—3.8
14—3.6
16—3.4
18—2.5

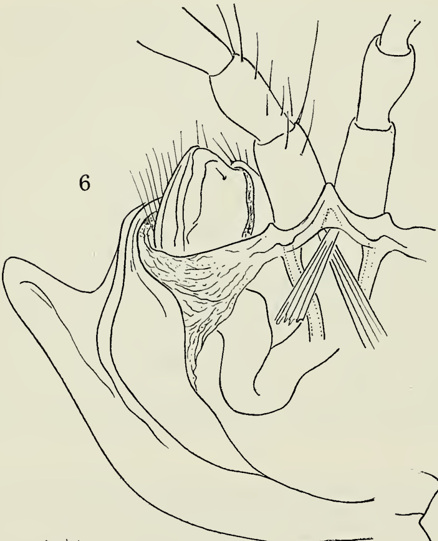
Color generally testaceous yellow, underparts lighter, shading into whitish, specimen perhaps preserved prior to maturation of color pattern.

Head of normal xystodesmid form, evenly convex, surface smooth and polished, epicranial groove indistinct, genae without evident median depression and without trace of lateral margination. Interantennal space broad (0.8 mm), equal to length of second antennomere or to length of sixth and seventh combined. Width of head across genae 2.3 mm. 2-2 widely spaced epicranial setae, members of each pair further apart than distance from inner seta to median suture; 1-1 interantennal; 1-1 subantennal; about 12-12 setae scattered in the frontoclypeal region without evident pattern; clypeal and labral series close together and difficult to count accurately but with about 14-14 in each, the two series merge laterally and continue along basal half of genal edge as a row of about eight long setae followed by several very short ones. Antennae long (3.9 mm), articles 2–6 similar in appearance, second a little longer than sixth; all sparsely setose and without evident sensory fields; seventh subhemispherical, with four small terminal cones.

Collum without special modification except for depressed area just posterior to upper craniomandibular condyle; anterolateral edge set off by distinct ridge. Body segments smooth and polished dorsally, except surface of paranota somewhat rugulose-tuberculate. Surface of prozona microscopically reticulate. Median ends of paranotal scapulorae continuous with each other completely across dorsum (Figs. 1, 2) as fine but well-defined sutural ridge which is not continuous with anterior edge of stricture on sides of segments; scapulorae submarginal at paranotal bases. Paranota set relatively high on sides, those of anterior segments depressed and continuing slope of dorsum, those of midbody region somewhat more horizontal; peritremata long and narrow, pores opening laterally just behind midlength; posterior paranotal corners right-angled on anterior segments, becoming increasing acute and caudally produced from midbody posteriad, those of segment 19 reduced to small triangular lobes scarcely exceeding apices of preceding paranota. Terminal segments without special features, epiproct short, dorsally convex, apex truncate; paraprocts smooth, the proximal discal seta set close to the median rim; hypoproct large, with prominent median projection, paramedian tubercles small.

Sterna bicruciately impressed with median and transverse grooves, the quadrate areas thus produced elevated and set with unusually long silky macrosetae. Sternum of 7th segment (behind gonopods) ca. 0.9 mm, that of segment 8 much narrower, 0.5 mm; sternum of segment 9, 0.6 mm, of segment 10, 0.8 mm.

Legs of moderate length, the podomeres stout, unmodified except for profuse long setation on ventral side of coxae and prefemora; distal spine of latter straight and acute; tarsal claw long (nearly one-third length of tarsus), compressed, the dorsal edge sharp.



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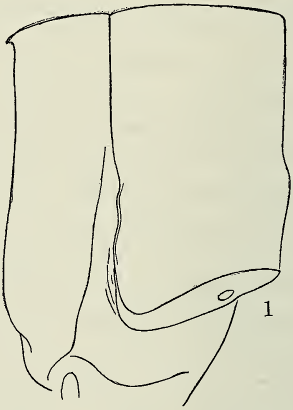

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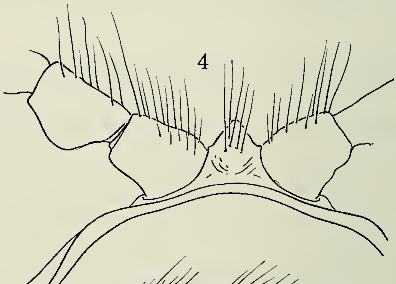

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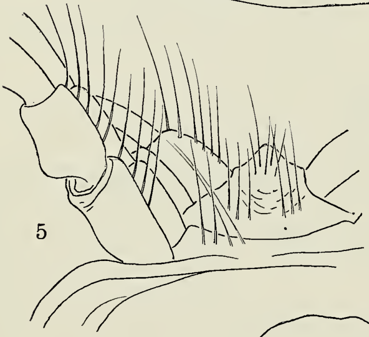

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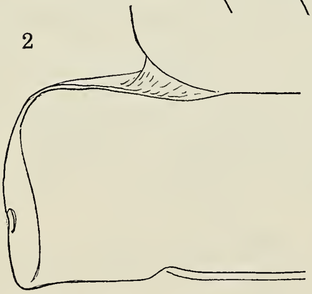

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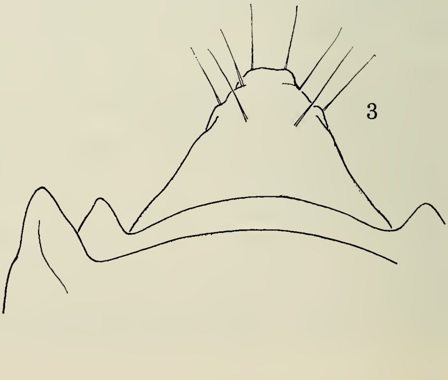

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Sides of metazona granular-coriaceous, anterior segments with small but prominent pleurosternal carinae; stigmata similar in shape, elongate vertical slits, the anterior slightly larger, both set adjacent to dorsal coxal condyles.

Anterior legs unmodified except that tarsi are somewhat shorter and tarsal claws appear relatively longer; sternum of segment 4 with a low conical median process (Fig. 4), sternum of segment 5 with a similar process between anterior pair of legs (Fig. 5), both sternal processes with some long setae on posterior side as illustrated.

Gonopod aperture transversely oval, much broader than long, the edges not modified. Gonopods very singular in form, relatively robust and massive in relation to body size. Coxae unmodified, with two dorsal macrosetae, separated by a sclerotized median sternal remnant (Fig. 8). Prefemur about half telopodite length, ventral side flattened and setose, dorsal side with large, ventrally-curved, apically bifurcate prefemoral process; acropodite region of telopodite expanded, deeply concave, set off from prefemur by prominent transverse cingulum. Prostatic groove visible for its entire length in mesal aspect, terminating on the upper half of a prominent bilobed solenomerite originating near ventral edge of acropodite, latter projecting mesad and slightly dorsad (Figs. 9, 10).

Paratype.—Adult female, similar in size, coloration, and structural details to male as described above, except antennae slightly more slender, sterna broader, and paranota narrower, than in male. Structure of genitalia as shown in Figs. 6 and 7, sternum of 2nd pair of legs considerably reduced in size, scarcely large enough to form basis for coxae; cyphopods large, with prominent cupulate receptacle; valves similar in size and shape (Fig. 7).

Relationships.—Despite a superficial similarity in gonopod structure to the pattern that occurs in the aphelorine genus *Stelgipus* (particularly in an undescribed species of the South Carolina coastal plain) I believe that *Caralinda* must be reckoned as a member of the tribe Rhysodesmini. This group is the only tribe represented in eastern United States in which a sclerotized sternal element is retained between the gonopod coxae, and in which the unusual modification of the interzonal suture line occurs

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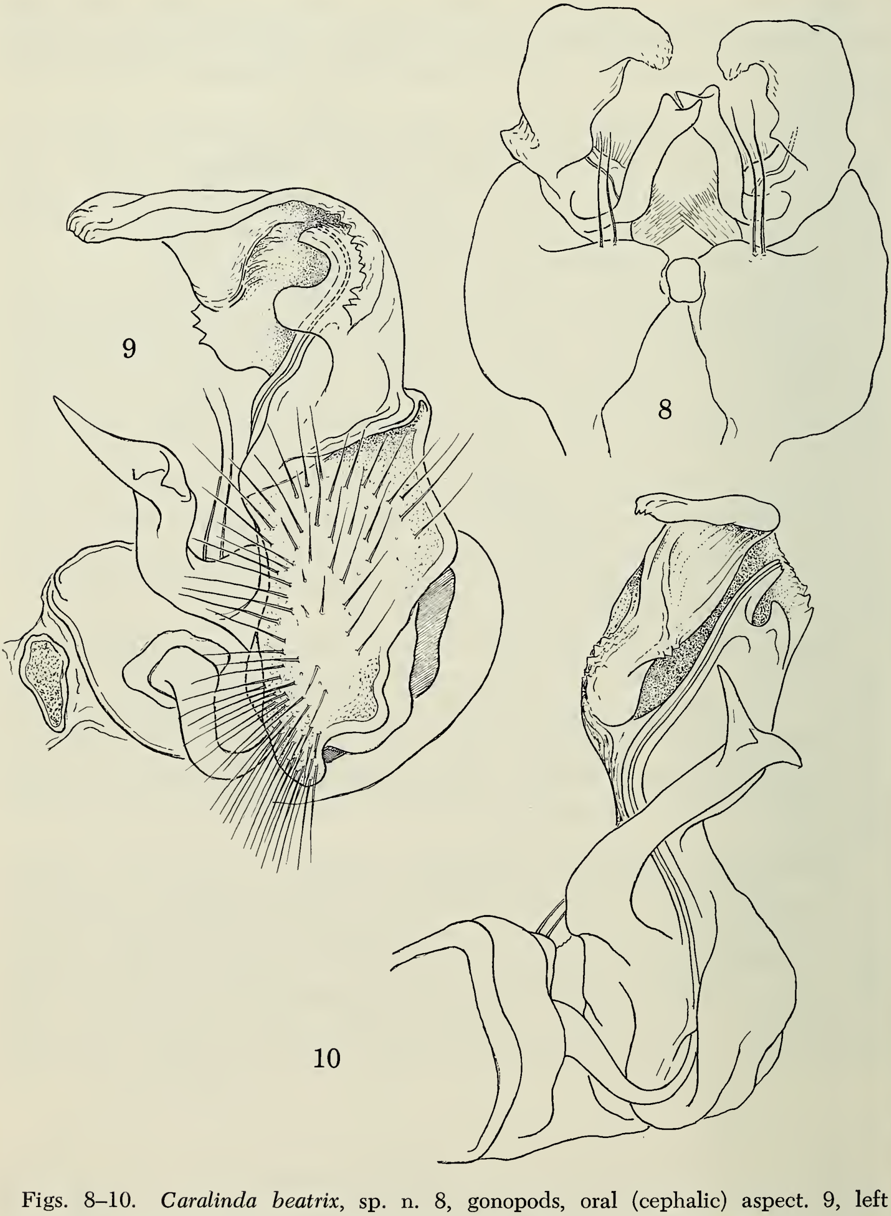
Figs. 1–7. *Carlinda beatrix*, sp. n. 1, Midbody segment, lateral aspect showing dorsal continuation of scapuloral ridge. 2, left paranotum of the same segment, dorsal aspect. 3, epiproct and paranota of segments 18 and 19, dorsal aspect. 4, sternum and bases of legs of 4th segment, aboral aspect. 5, sternum and bases of legs, 5th segment, aboral aspect. 6, sternum and bases of legs of 2nd segment, oral aspect, showing left side of pleurotergum, part of cyphopod, and oviduct, intersegmental membrane largely removed except around base of cyphopod. 7, right cyphopod, aboral aspect. Figs. 1–5 drawn from holotype, 6 and 7 from female paratype.



Figs. 8–10. *Caralinda beatrix*, sp. n. 8, gonopods, oral (cephalic) aspect. 9, left gonopod, oblique posteromedian aspect, showing sternum (stippled) and solenomerite. 10, left gonopod, median aspect, prefemoral setae omitted. Drawings from male paratype.

(in *Cherokia*, Hoffman, 1960, and two species of *Rhysodesmus*, Hoffman, 1970). Some affinity with *Cherokia* is also suggested by the prominent cingulum between prefemur and femur of the gonopod. Further, only in the Rhysodesmini is the tendency for reduction in body size expressed (*Caralinda beatrix*, *Gyalostethus monticolens*, and several species of *Rhysodesmus* are all less than 20 mm in length).

The most obvious non-rhysodesmine characters obtain in the enlarged prefemoral process and shortened, hood-like form of the telopodite which constitutes a sort of shield behind the bilobed solenomerite. In other small rhysodesmines the females are generally much larger than the males, in contrast to the present genus which shows no sexual dimorphism in size.

I believe that despite our still fragmentary knowledge of southeastern millipeds, it is justifiable to regard *Caralinda* as a disjunct member of the Rhysodesmini, with greater affinity to *Cherokia* than other local genera. Although this tribe has been mentioned several times in recent literature, there exists still no complete summary of its components, and I venture to provide here a tentative key to genera and some information on synonymy and distribution at the generic level.

Key to the Genera of the Tribe Rhysodesmini

1. Gonopod short, robust, distal half of telopodite expanded to form a shield-like, concave structure protecting the large bilobed solenomerite; prefemoral process large, stout, apically bifurcate, curved ventromesad in front of prefemur *Caralinda*, new genus
– Gonopod long and slender, telopodite becoming more slender and laminate distally, never expanded into a shield, at most with a subterminal branch; prefemoral process small, acicular, parallel to telopodite and remaining on dorsal side 2
2. Prefemur and acropodite regions of telopodite separated by a distinct transverse cingulum *Cherokia* Chamberlin
– Prefemoral region of gonopod continuous with the more distal region 3
3. Distal half of telopodite with a large and prominent subterminal branch, nearly or quite as large as the solenomerite 4
– Distal half of telopodite entirely simple or with a small apical process much inferior to the groove-bearing lobe in size 5
4. Coxae of walking legs without distal spine; ventral branch of gonopod telopodite originating as far down as prefemoral region *Pleuroloma* Rafinesque
– Coxae of walking legs with very long, retrorse hook-like spine extending proximad nearly to base of coxa; ventral branch of telopodite originating far out from end of prefemoral region *Erdelyia* Hoffman

5. Apex of gonopod telopodite with a small process located on the outer curvature just proximad to end of prostatic groove; majority of species with more than four antennal sensory cones (Mexico, Guatemala, El Salvador) *Rhysodesmus* Cook
– Apex of gonopod simple, no subterminal process; antennae with never more than four sensory cones 6
6. Distal end of gonopod telopodite slightly expanded, its edge hyaline, incised-pectinate; sterna remarkably broad, shallowly concave *Gyalostethus* Hoffman
– Distal end of gonopod telopodite simple, laminate, edge entire; sterna of moderate width and never concave 7
7. Acropodite region of gonopod relatively short (one half to one third length of prefemur), broad and flattened (eastern United States) *Boraria* Chamberlin
– Acropodite region longer (one half to two-thirds length of prefemur), relatively slender, distally attenuated, the terminal fourth usually curved mesad (Mexico) *Stenodesmus* DeSaussure

It should be emphasized that the foregoing key does not reflect actual relationships. In particular the association of *Pleuroloma* and *Erdelyia* is a matter of convenience only; the latter genus is in fact very closely related to *Boraria* both structurally and geographically. Also, *Rhysodesmus* is very close to *Boraria* and *Stenodesmus* and the distinction between these three groups remains still rather subjective. It is quite possible that all should be merged.

The following outline will summarize the present state of our knowledge of this tribe at the generic level:

Tribe Rhysodesmini Brolemann, 1916.

Rhysodesmus Cook, 1895 (syn. *Dampfaria* Verhoeff, 1932; *Aporiaria* Chamberlin, 1938; *Acentronus* Chamberlin, 1943). About 60 species, Nuevo Leon and Texas, south throughout Mexico to central Guatemala and El Salvador.

Stenodesmus DeSaussure, 1859 (syn. *Cruzodesmus* Chamberlin, 1943; *Cibularia* Chamberlin & Hoffman, 1950). Ten species, Mexico (a revision is in manuscript form).

Boraria Chamberlin, 1943 (syn. *Aporiaria* Chamberlin, 1939, non sensu Chamberlin, 1938; *Howellaria* Hoffman, 1950). Four species, eastern United States (Appalachian and Ozark regions).

Erdelyia Hoffman, 1963. One species, eastern United States (Georgia).

Gyalostethus Hoffman, 1967. One species, eastern United States.

Pleuroloma Rafinesque, 1820 (syn. *Fontaria* sensu auctt. nec Gray, 1832; *Zinaria* Chamberlin, 1939). Eleven named species, most of them probably synonyms or subspecies, eastern United States.

Cherokia Chamberlin, 1949. One species, southeastern United States.
Caralinda Hoffman, 1978. One species, southeastern United States (Georgia).

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Radford College, Radford, Virginia 24142.

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91(2), 1978, pp. 374–378

ASCAROPHIS DISTORTUS, A NEW SPIRUROID NEMATODE FROM A CHAETODONTID FISH IN THE NORTHERN RED SEA

Alan C. Fusco and Robin M. Overstreet

Abstract.—*Ascarophis distortus*, the only member of its genus known from the Red Sea or a chaetodontid fish, can be characterized by the following: rounded tails in both sexes, cervical papillae present, esophagus 9–14 percent of body length, polar plugs and filaments on eggs lacking, vulva near midbody, 4 pairs of postanal papillae, ratio of right to left spicule lengths 1:5–7, and left spicule with distally attached structure. It infected *Chaetodon paucifasciatus* in the Gulf of Elat.

Members of the genus *Ascarophis* Beneden occur nearly worldwide infecting predominantly marine fishes. Presently, over 30 species are recognized; however, authorities do not agree on the definition of the genus (e.g., Polyanski, 1952; Dollfus and Campana-Rouget, 1956; Rasheed, 1965; Chabaud, 1975). These nematodes usually attach to the host's stomach wall inflicting lesions, but seldom causing disease. The species described below represents both the first member of the genus from the Red Sea and the first one from a chaetodontid fish.

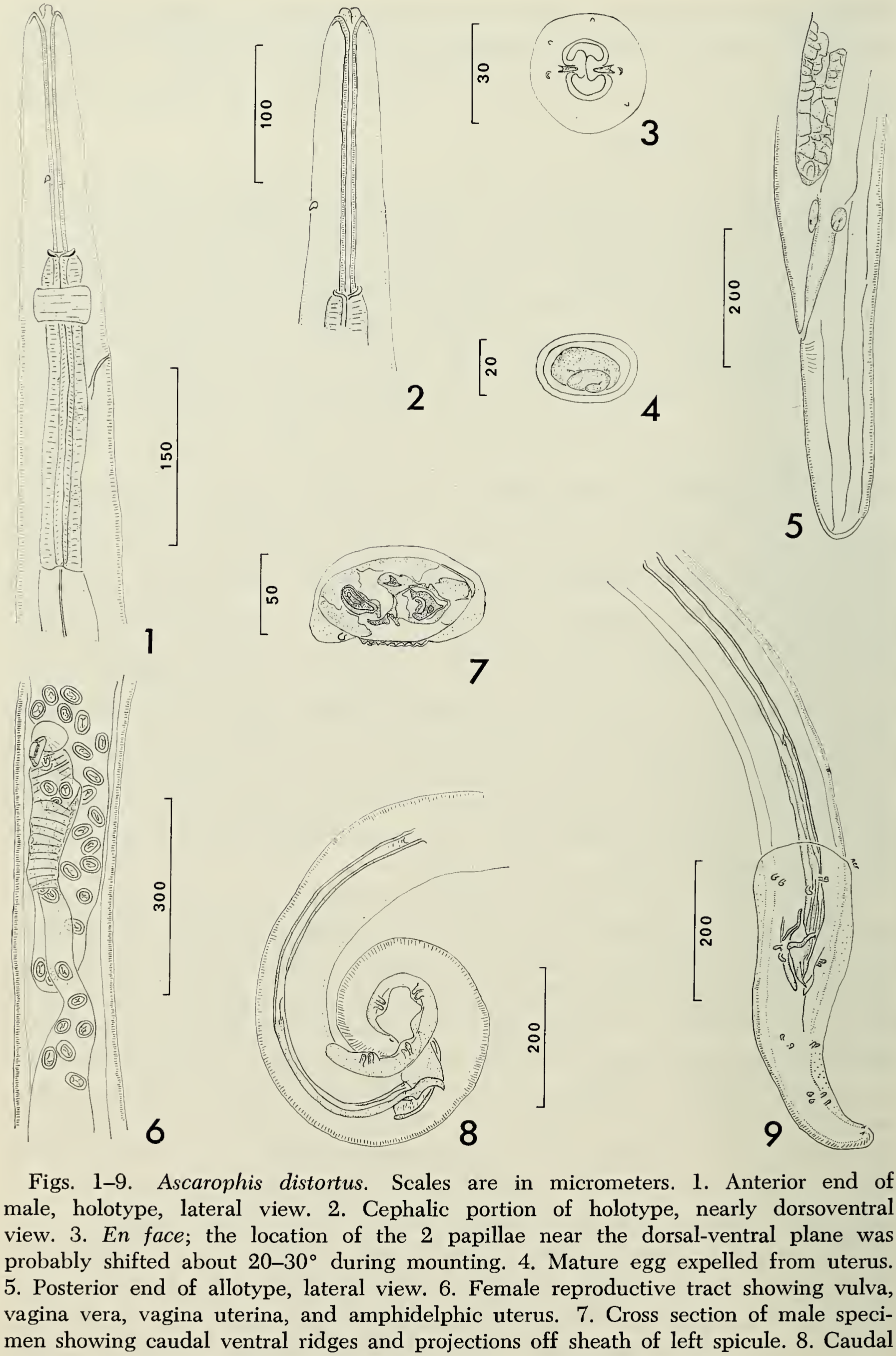
Ten specimens of *Chaetodon paucifasciatus* Ahl, 101–121 mm fork length, were collected with cages in the shallow reef area of the northern Gulf of Elat. The host is the most common butterflyfish in the region and considered *C. chrysurus* Desjardins by many ichthyologists; however, we follow John E. Randall (personal communication) for our identification. Two of these harbored an undescribed species of *Ascarophis*. The nematodes were fixed in glacial acetic acid and then washed and stored in a solution of 95 parts 70% ethanol with 5 parts glycerine. After clearing the worms in lactic acid or by evaporating the alcohol from the solution, they were measured and one was later embedded in paraffin and sectioned with a microtome. Measurements are expressed in micrometers unless otherwise stated, and figures were drawn with the aid of a camera lucida.

Ascarophis distortus, new species
Figs. 1–9

Description.—Body with region of greatest width anterior to midpoint. Lips 2 in number, oriented dorsoventrally. Cervical papillae rose-thorn shaped, on lateral axis. Amphids lateral, internal to ring of 4 cephalic papillae. Teeth a single pair at base of lips. Mouth dorsoventrally elongated. Cuticle with fine transverse striations near anterior extremity, with intervals increasing on rest of body to maximum of 3 μm. Prostom cyathiform; vestibule having scleritized collar at junction with short cylindrical muscular region of esophagus; glandular esophagus markedly elongate. Nerve ring near anterior of muscular esophagus. Excretory pore immediately posterior to nerve ring. Tail blunt.

Male (based on 6 mature specimens).—Body 9.5–11.4 mm long by 84–93 wide at junction of muscular and glandular portions of esophagus, increasing posteriorly to 131–145 at level of greatest width, 67–86 times longer than wide. Cervical papillae 104–148 from anterior end. Prostom 15–20 long by 20–26 at widest region. Vestibule 176–215 long (including prostom) by 6–9 wide, 1.6–1.9% of body length, 73–85% of muscular esophagus length. Esophagus 1,293–1,497 long, 12–14% of body length; muscular portion 215–267 long by 29–35 wide, comprising 16–18% of entire esophagus; glandular portion 1.07–1.23 mm long by 58–84 wide. Nerve ring 212–258 from anterior end, 29–35 in breadth. Excretory pore 238–307 from cephalic end, 29–49 posterior to nerve ring. Testis slightly sinuous, looping 2.2–2.4 mm from anterior end of body at anterior region of intestine. Spicules dissimilar; right spicule short, 92–126 long, blunt distally, heavily scleritized; left spicule complex, 624–662 long, pointed distally, with separate projecting scleritized portion attached to sheath in region of right spicule; spicule ratio 1:5–7, averaging 1:6.4. Caudal alae united ventrally 496–542 from posterior, supporting 8 grouped pairs of papillae; preanal papillae 4 pairs of equal length in groups of 2; postanal papillae 4 pairs of equal length in groups of 2. Longitudinal ridges occurring ventrally between alae, 5–8 in number, extending from cloaca to near level of proximal end of left spicule, short, inconspicuous in whole mounts but obvious in sectioned specimens. Phasmids paired near end of tail. Tail flexed ventrad, 265–327 long. Posterior region with 1–2 coils.

Female (based on 8 mature specimens).—Body 14.1–18.0 mm long by 90–116 wide at junction of muscular and glandular portions of esophagus, increasing posteriorly to 180–218 at level of greatest width, 74–87 times longer than wide. Cephalic papillae 104–148 from cephalic end. Prostom 20 long by 20–26 at widest region. Vestibule 162–232 long (including prostom) by 12–14 wide, 1.1–1.3% of body length, 62–82% of muscular esophagus length. Esophagus 1,328–1,828 long, 9–11% of body length; muscular portion 218–339 long by 32–44 wide, 16–18% of entire esophagus; glandular portion 1.1–1.5 mm long by 58–104 wide. Nerve ring 206–305 from cephalic end, 35–44 in breadth. Excretory pore 252–348 from anterior end, 26–43 posterior to nerve ring. Vulva situated 6.9–8.6 mm or 48–50% of body length from cephalic end. Vagina vera straight, with thick muscular wall, 90–131 long by 44–58 at widest point, extending posteriorly from vulva; vagina uterina approximately equal to or up to 3 times longer than vagina vera; uterus didelphic, amphidelphic, wide and



Figs. 1–9. *Ascarophis distortus.* Scales are in micrometers. 1. Anterior end of male, holotype, lateral view. 2. Cephalic portion of holotype, nearly dorsoventral view. 3. *En face*; the location of the 2 papillae near the dorsal-ventral plane was probably shifted about 20–30° during mounting. 4. Mature egg expelled from uterus. 5. Posterior end of allotype, lateral view. 6. Female reproductive tract showing vulva, vagina vera, vagina uterina, and amphidelphic uterus. 7. Cross section of male specimen showing caudal ventral ridges and projections off sheath of left spicule. 8. Caudal region of holotype, lateral view. 9. Caudal region of male, ventral view.

sac-like, packed with eggs; oviducts often looped; anterior oviduct 0.5–1.3 times longer than posterior one; receptacles indistinct; ovaries straight, cylindrical; posterior ovary directed anteriad; anterior ovary directed posteriorly, approximately 0.4–1.4 times longer than posterior one. Eggs smooth, nonfilamented, without polar plugs, embryonated, 32–38 long by 23–26 wide. Rectum 218–232 long with 2 rectal glands situated opposite each other at anterior of rectum. Tail 232–302 long.

Host.—*Chaetodon paucifasciatus* Ahl; butterflyfish (Chaetodontidae).

Site.—Attached to stomach wall.

Locality.—Elat, Israel.

Specimens deposited.—Holotype (male), USNM Helm. Coll. No. 73080; Allotype (female), No. 73081; Paratypes (pair) No. 73082 and (pair) Institute of Parasitology, Czechoslovak Academy of Sciences No. NP 65.

Etymology.—The Latin "distortus" refers to the distal configuration of the left spicule.

Discussion

Ascarophis remains in a confused state. Primary diagnostic generic features include the presence of two small cephalic pseudolabia each with a small tooth-like structure, a relatively long vestibule without ribs or teeth, and males with caudal alae. Even these features have not been clearly established for all species of *Ascarophis* and related genera. Filaments and plugs occur on eggs in most recognized species, but the filaments can be overlooked in densely-packed uteri or not yet developed in unembryonated eggs. As an example, they have been reported by Holloway et al. (1967) on eggs of *A. nototheniae* Johnston and Mawson, 1945b even though the filaments were originally described as not being observed. The number of postanal papillae ranges between four and ten even though Polyanski (1952) considered five as diagnostic.

Considering the lack of egg-filaments, the presence of four postanal papillae, and the presence of an equatorial vulva, *A. distortus* most resembles *A. upeneichthys* Johnston and Mawson, 1945b. That species, however, has a spicule ratio reported as 1:3 rather than 1:5–7, caudal alae more like "inflated rolls" than broad "wings," narrower eggs, a relatively shorter vestibule, and a body half as long.

Considering other species reported without filaments on eggs, *A. girellae* (Yamaguti, 1935) Campana-Rouget, 1955 is most similar to *A. distortus* in length of body, relative length of esophagus, and vulvar position. Its spicule ratio is less (reported as 1:3.3), the eggs measure narrower (33–36 μm long by 15–16 μm wide), and the postanal papillae number ten. *Ascarophis cooperi* Johnston and Mawson, 1945a is apparently similar to *A. girellae* except it has six postanal papillae and a vulva well posterior to the midbody.

Two other species resemble *A. distortus* by having a vulva nearly equatorial and eggs without filaments, but males of those species have not been described. One, *A. helix* Cobb, 1928, differs by having a cuticle with conspicuous diagonal striations. The other, *A. gymnocranii* (Yamaguti, 1935) Campana-Rouget, 1955, is twice the length of *A. distortus*, but has a tail half as long. Additionally, the tail is pointed rather than blunt, and the eggs measure 42–45 μm long by 25–28 μm wide.

Acknowledgments

We gratefully acknowledge the space and equipment provided to the second author by Dr. Ilan Paperna of the Marine Biological Laboratory of the Hebrew University in Elat, Israel, during a study funded by the United States-Israel Binational Science Foundation, Grant No. 94. Also, we thank Roswitha Buxton for sectioning a specimen.

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THE STATUS OF *CIROLANA CALIFORNIENSIS* SCHULTZ, AND *C. DEMINUTA* MENZIES AND GEORGE, WITH A KEY TO THE CALIFORNIA SPECIES OF *CIROLANA* (ISOPODA: CIROLANIDAE)

Richard C. Brusca and Marianne Ninos

Abstract.—*Cirolana deminuata* Menzies and George 1972 is reduced to junior synonymy with *C. californiensis* Schultz 1966. A revised description, new figures and new records are presented. This species ranges from southern California to the Peru-Chile Trench, from depths of 40–2,000 m, although the majority of records are from below 700 m. A key to the California species of *Cirolana* is presented.

In 1966 Schultz described *Cirolana californiensis* from 5 specimens taken by the Allan Hancock Foundation Southern California Submarine Canyon Study. He noted its resemblance to *C. cubensis* Hay and *C. gracilis* Hansen, both Caribbean species. In 1972 Menzies and George described a single gravid female as *Cirolana deminuta* from the Anton Bruun expedition to the Peru-Chile trench region. They did not discuss its affinities with other species of *Cirolana*. Both species were taken from fine sand bottoms in about 1,000 m of water. Examination by the authors of several dozen additional specimens of *C. californiensis* from California and western Mexico, as well as the types of both species, has revealed the two to be identical, and *C. deminuta* is herein made a junior synonym of *C. californiensis*.

Cirolana californiensis Schultz

Cirolana californiensis Schultz, 1966:14, pl. 8, figs. 1–8; 1969:178.
Cirolana deminuta Menzies and George, 1972:9.19, figs. 12–13 (not *Cirolana diminuta* Menzies, 1962:343, from Bahía de San Quintin, Mexico = *C. parva* Hansen—see Menzies and Glynn, 1968:38).

Description.—Cephalon immersed in pereonite I. Eyeless or eyes reduced and without pigmentation. Antenna 1 with 8–12 flagellar articles; articles bear many hair-like setae and esthetascs. Antenna 2 with 10–21 flagellar articles. Frontal lamina, clypeus and labrum as in Fig. 1; both anterior and posterior tips of frontal lamina vary slightly from round to subacute. Exopod of maxilla 1 with 12 strong spines; endopod ovate, with 3 terminal spines, each with a subapical circlet of spinules (Fig. 2). Maxilla 2 without spines; biramous exopod with long apical setae on each lobe; endopod with plumose setae (Fig. 3). Maxillipedal palp of 3 articles; endite very small, with 2 coupling hooks and plumose setae. Mandible with toothed incisor, large lacina mobilis, and large, toothed, molar process; palp of 3 articles, heavily setose.

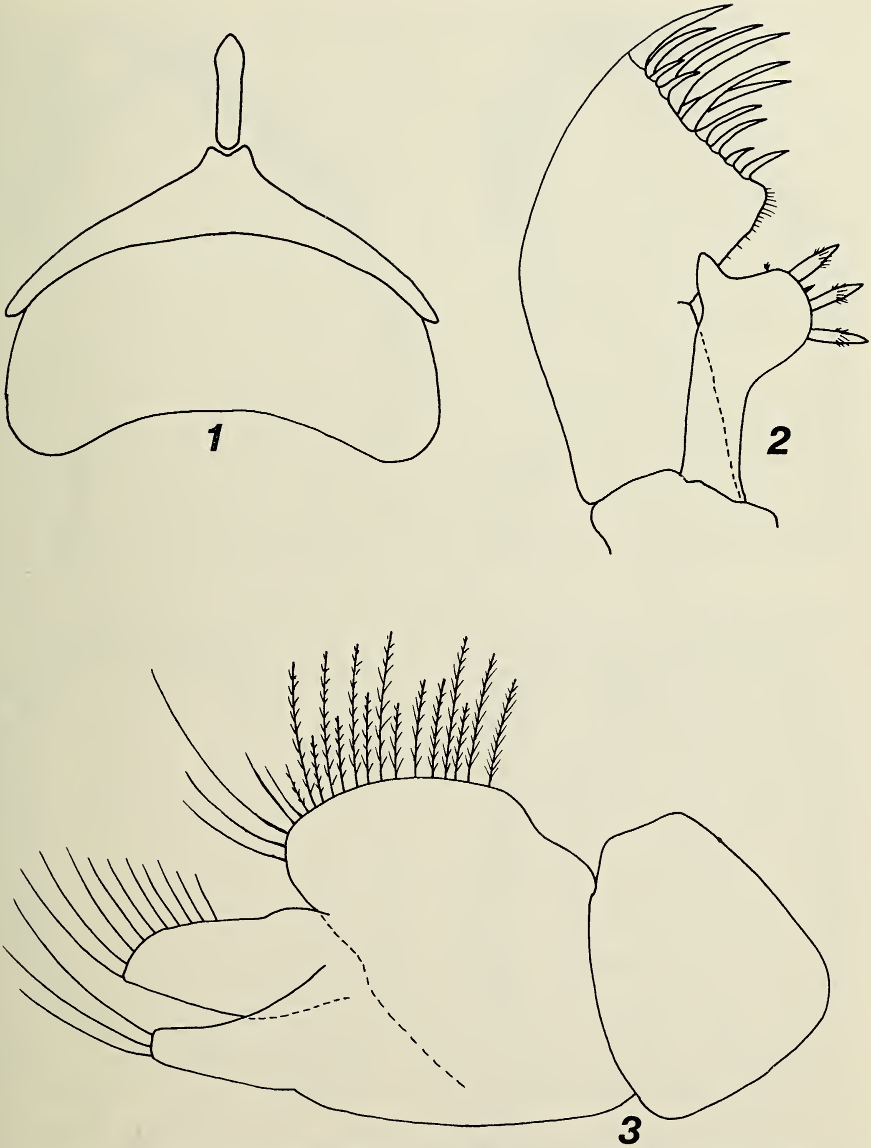
Coxal plates well developed on pereonites II–VII, usually visible on all segments but occasionally hidden from dorsal view on anteriormost pereonites; posterior coxal plates with acute posterolateral angles. Pereopods 1–3 with large dactyls; pereopods 4–7 laterally compressed, with long, plumose setae projecting from medial and lateral margins of basis, dactyls reduced. Pereopod 7 in some specimens abruptly smaller than all other pereopods, even in large individuals. Posterolateral corners of all pleonites acute; lateral margins of pleonite 5 hidden under pleonite 4. Pleotelson triangular, distally acute, with smooth margins (except for shallow notches where spines and setae are inserted); margins with 8–12 short, articulated spines and long plumose setae. Uropodal basis with produced distomedial corner; exopod and endopod both pointed, with spines and plumose setae; margins smooth except for shallow notches where spines and setae are inserted; uropods extended barely beyond posterior margin of pleotelson; endopod slightly longer than exopod. Pleonites 1–4 similar, with plumose setae on both rami (Figs. 4–6); Pleopod 5 with plumose setae on inner lamella only (Fig. 7); male appendix masculinum long, curved and without ornamentation (Fig. 6). Basis of pleopods 1–3 with plumose setae on median margin only; basis of pleopod 4 with plumose setae on both median and lateral margins; basis of pleopod 5 as figured. Length 7–19 mm.

Type-locality.—California, Coronado Canyon; *Velero* Station 6851; 812 m; 32°37′54″N, 118°55′40″W.

Additional records.—We have examined material from throughout the southern California borderland, including Coronado and Tanner Canyons and the San Diego Trough. In addition, we have material from western Baja California (near Cedros Island) and the southern Gulf of California (between La Paz and Cerralvo Island). All of this material is deposited in the Allan Hancock Foundation.

Remarks.—Nearly all specimens were taken from depths between 700 and 2,000 m, although a few collections are from depths as shallow as 40 m (off Catalina Island, California, and Cedros Island, Baja California) and 250 m (southern Gulf record). All records are from fine sands or sand-clay mixtures, usually reported as gray-green sandy mud or olive-brown silty sand.

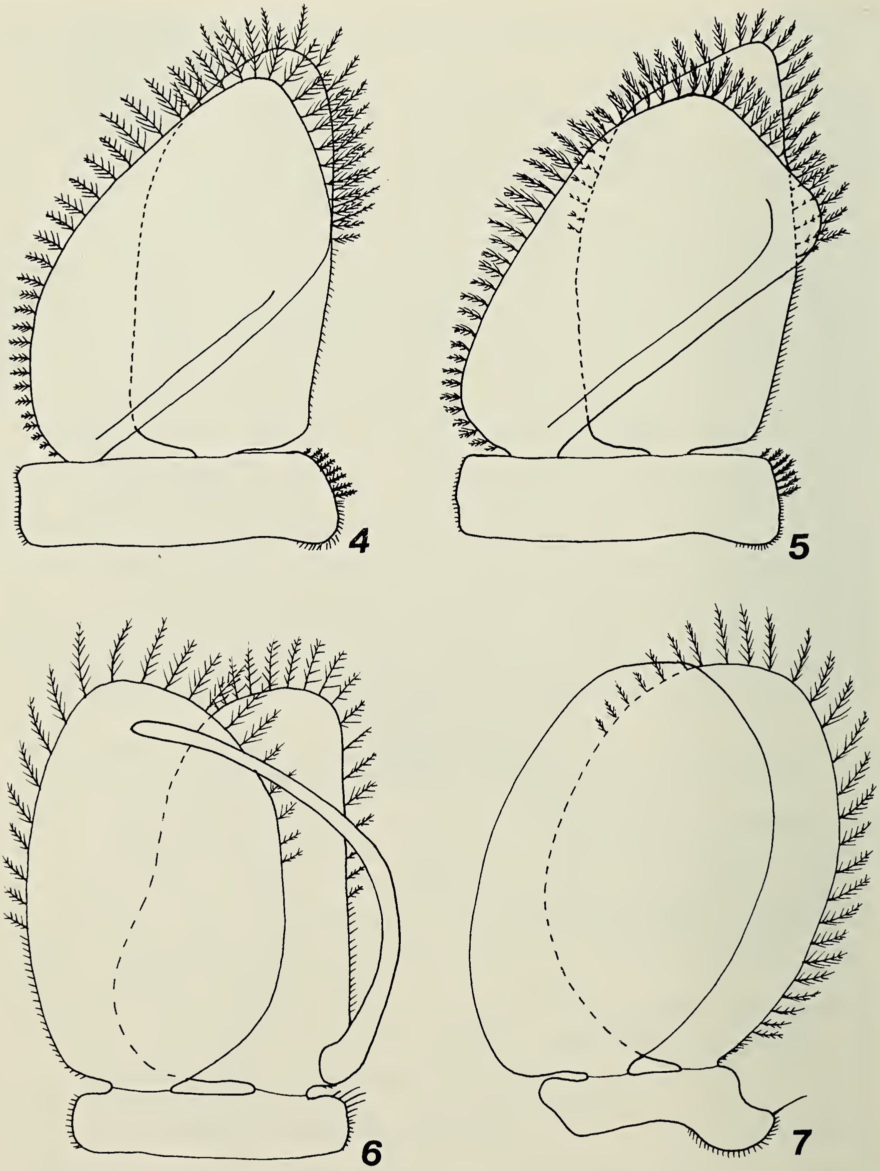
Several discrepancies exist between Schultz's and Menzies and George's original descriptions. The holotype of *C. deminuta* possesses rudimentary eyes entirely lacking in pigmentation and with few ommatidia, while the holotype of *C. californiensis* is entirely without ommatidia or pigmentation. Numerous other specimens we have examined, however, bear the unpigmented, reduced eyes characteristic of the southern hemisphere



Figs. 1–3. *Cirolana californiensis*: 1. Frontal lamina, clypeus and labrum. 2. Maxilla 1. 3. Maxilla 2.

form. Thus, it would appear that degeneration of the compound eyes is a variable feature within the species.

Menzies and George described the first antennae as having 8 flagellar articles, while Schultz found 9. In specimens we have examined the



Figs. 4–7. *Cirolana californiensis*: 4. Left pleopod 2, female. 5. Left pleopod 1, female. 6. Left pleopod 2, male. 7. Left pleopod 5, female.

number varies from 8–12. Schultz figured the uropods as being extended just barely to, or slightly beyond the distal border of the pleotelson, while Menzies and George figured them extending a considerable distance beyond the pleotelson. Examination of the holotype of *C. deminuta* has shown

Menzies and George's figure to be in error, and their specimen actually conforms to Schultz's types, as well as all of the material we have examined.

Menzies and George figured the frontal lamina, clypeus and labrum considerably different from Schultz. Examination of the types of both has revealed Schultz's illustration to be in error, and all specimens we have examined (including Schultz's types) conform to the figure presented by Menzies and George. We have redrawn these structures from Schultz's holotype (Fig. 1). Schultz's figure of the first maxilla differs conisderably from that given by Menzies and George. Examination of this appendage from both holotypes has revealed Schultz's figure to be misleading, in that he figured the exopod (outer ramus) only (see Fig. 2, this paper).

Menzies and George suggested that *C. deminuta* could represent a neotenic species, as evinced by the reduced size of the seventh pereopods. Materials we have studied, however, reveal that the reduction of the seventh pereopods is, like reduction of the eyes, a variable character. The cause of this reduction is not known; however, when reduction does occur both right and left pereopods are always affected, suggesting a genetic basis (rather than predation or some other exogenous factor).

There are now 12 species of *Cirolana* known from the eastern Pacific: *C. californiensis* Schultz 1966 (= *C. deminuta*), southern California to Chile; *C. joanneae* Schultz 1966, also known from the submarine canyons of southern California; *C. harfordi* (Lockington, 1877), a shallow water species ranging from British Columbia to central west Baja California; *C. parva* Hansen 1890 (= *C. diminuta*), a eurythermal, circumtropical, shallow water species known in western America from Point Conception (California) south at least to central west Mexico; *C. bathyalis* Menzies and George 1972, known only from the type-locality (Peru-Chile Trench); *C. natalis* Menzies and George 1972, known only from the type-locality (Peru-Chile Trench); *C. ornamenta* Menzies and George 1972, known only from the type-locality (Peru-Chile Trench); *C. albinota* Vanhoffen 1914, Chile to Antarctica; *C. chilensis* Menzies 1962, southern Chile; *C. urostylis* Menzies 1962, southern Chile; *C. robusta* Menzies 1962, Chile; and *C. concinna* Hale, Australia and Chile. *Cirolana concinna* is an Australian species. Menzies (1962) hesitated to consider the Chilean form of *C. concinna* as new, however, the disjunct distribution and the differences he describes between these western and eastern Pacific forms suggest that specific or subspecific recognition may be warranted. Lacking specimens we cannot resolve this issue at the present time.

The relationships within the eastern Pacific *Cirolana* are difficult to assess, and until the tropical southern American and central American coastal and shelf faunas are better known they will remain so. Only one other species, *C. natalis*, is "blind" (lacks ommatidia) and of the 11 other species of *Cirolana* known to inhabit the continental shelf and littoral regions of western America, *C. natalis* most resembles *C. californiensis*, sharing with it the following characters: maxilliped with 2 coupling hooks; cephalon deeply immersed in pereonite I; and, similar numbers of antennal articles. All 12 of the shelf/littoral species are similar in form, only *C. ornamenta* standing out as strikingly different from the others.

Key to the Species of *Cirolana* Known From California

1. Margin of pleotelson with fine setae but without spines; maxilliped with 1 coupling hook; edges of pleonite 5 not hidden by pleonite 4; distal margin of pleotelson truncate, but strongly scalloped *C. joanneae*

– Margin of pleotelson with spines; maxilliped with 2 coupling hooks; edges of pleonite 5 hidden by pleonite 4; distal margin of pleotelson subacute 2

2. Without eyes, or eyes unpigmented; antenna 2 with flagellum of 10–21 articles; frontal lamina narrow; pleotelson with 8–12 spines; uropods not notched apically; rarely encountered in depths less than 100 m *C. californiensis*

– Blindness extremely rare; antenna 2 with flagellum of 22–32 articles; frontal lamina broad; pleotelson with 8–32 spines; uropods notched apically, *or* not notched; rarely encountered in depths greater than 100 m 3

3. Uropodal rami with deep apical notch; pleotelson margin always with 8 spines *C. parva*

– Uropodal rami without apical notch; pleotelson margin with at least 9–32 spines *C. harfordi*

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TWO NEW LAND SNAILS OF THE GENUS *OPISTHOSTOMA* FROM BORNEO (PROSOBRANCHIA: CYCLOPHORACEA: DIPLOMMATINIDAE)

Fred G. Thompson

Abstract.—Two land snails, *Opisthostoma* (*O.*) *holzmarki* n. sp. and *O.* (*O.*) *brachyacrum* n. sp., are described from Sarawak, Borneo. These constitute the first records of the subgenus *Opisthostoma* for the island.

During 1976 Dr. Walter Auffenberg, of the Florida State Museum, visited Luzon Island to study varanid lizard ecology. He was accompanied during part of his trip by Mr. William I. Holzmark, from Sarasota, Florida. Subsequent to the completion of their work on Luzon Mr. Holzmark continued westward to Palawan Island and to Sarawak where he procured many interesting natural history specimens, including several undescribed land snails. Two of these are peculiar because of their extremely minute size and their distorted shapes. These are of special interest because they represent a subgenus, *Opisthostoma* (*s.s.*), which hitherto has been unrecorded from Borneo. I take pleasure in naming one of these after Mr. Holzmark in recognition for his efforts to assist in natural history studies on this and on other trips.

Opisthostoma (*O.*) *holzmarki*, new species
Fig. 1, A–E

Diagnosis.—A species of the subgenus *Opisthostoma* with a raised apex and abbreviate cylindrical shell, in which the last whorl reverses its direction of growth and ascends the spire so that the outer peristome encapsulates the apical whorls. A short longitudinal indentation occurs in the last whorl just beyond the constriction. The sculpture consists of sparse feeble axial ribs. Spiral sculpture is absent.

Shell.—Minute, less than 1 mm in height, and slightly more so in width. Nearly opaque, whitish. Narrowly umbilicate. The spire is abbreviate cylindrical and is partially covered by a strongly distorted last whorl. The spire consist of 4 whorls. The embryonic whorl lies at a plane slightly oblique to the shell axis. The apical 2 whorls are low and convex in outline and protrude above the third whorl for a distance about equal to the caliber of the third whorl. The body whorl (fourth whorl) is narrower but slightly larger in caliber and is constricted below the aperture. The body whorl reverses its direction of coil on the side of the shell and ascends

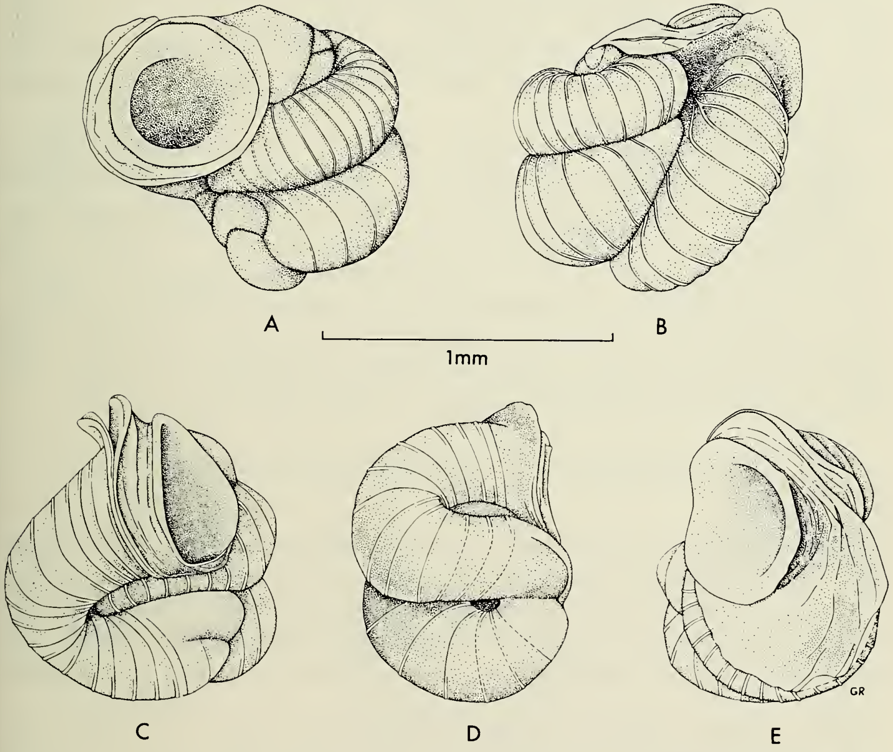

Fig. 1. *Opisthostoma holzmarki*. A, C. E, Holotype; B, Paratype (Sarawak Museum); E, Paratype (UF 24837).

the spire to the shoulder of the third whorl. The outer peristome continues over the apex by being appressed against the side and top of the first 3 whorls. At the point of constriction the body whorl bears a short narrow longitudinally impressed groove along the periphery. The sculpture of the postembryonic whorls consists of sparce, low, narrow axial ribs that are most distinct below the periphery of the last 2 whorls and continue undiminished into the umbilicus. There are 23 ribs on the penultimate whorl. Spiral sculpture is absent. The aperture is nearly circular and bears a double peristome. The opening of the aperture faces obliquely upward. The outer peristome consists of several high laminations and is uniformly wide except where it is broadly expanded over the apex of the shell (Fig. 1, E). The inner peristome is thicker and flares out nearly uniformly, except where it is appressed to and extends slightly forward on the penultimate whorl.

Measurements of the holotype: height of shell, 0.97 mm; major width, 1.07 mm; minor width 0.71 mm; aperture width, 0.53 mm; aperture height, 0.50 mm. Measurements of 3 paratypes: height, 0.97, 0.99, 0.97 mm; major width, 1.06, 1.10, 1.01 mm; minor width, 0.74, 0.83, 0.74 mm; aperture height, 0.53, 0.51, 0.48 mm.

Type-locality.—BORNEO: Sarawak; Fourth Division; limestone hill on the trail from the Niah River to Niah Cave, Batu Niah. The cave is reached by traveling down river from Niah for a distance of about 3 km and then northeast for a distance of about 4 km. The type-locality is on the trail about midway between the river and the cave. The specimens comprising the type-series were recovered from dirt removed from the umbilicus of 3 specimens of *Cyclophorus talboti* Godwin Austen. Holotype: UF 24836; collected 4 November 1976 by William I. Holzmark. Paratypes: UF 24837 (2), Sarawak Museum, Kuching (1); same data as the holotype.

Opisthostoma (O.) brachyacrum new species
Fig. 2, A–E

Diagnosis.—A species of the subgenus *Opisthostoma* with a short raised apex and a recurved body whorl that ascends the spire to the shoulder of the penultimate whorl. The aperture faces posteriorly and bears a double peristome, the outer being only moderately wider than the inner. The sculpture consists of sparse feeble axial ribs, and very thin raised spiral threads.

Shell.—Minute, about 0.9 mm high and slightly wider in major diameter, with about 4 whorls. The umbilicus is open and circular and is about 0.2 times the minor diameter of the base. The spire is abbreviate cylindrical with a shortly elevated apex that consists of about 2 whorls. The embryonic shell consists of 1.5 whorls that are distorted obliquely to the shell axis. The shell is widest at the third (penultimate) whorl and is slightly narrower below. The body whorl is slightly constricted below the aperture and then enlarges again just behind the peristome. The body whorl is strongly recurved upward and backward along its last quarter and ascends the spire to the shoulder of the penultimate whorl against which the recurved portion is appressed. The embryonic whorls are sculptured with minute granules. The postembryonic whorls bear very low widely spaced axial ribs. The ribs are nearly uniform in height and width over the surface of the shell and continue into the umbilicus. There are 23 ribs on the penultimate whorl. Ribbing is absent in the vicinity of the constriction on the body whorl. Fine, delicate, spiral threads are present between the ribs on the last part of the body whorl but are not obvious elsewhere, perhaps due to the worn condition of the holotype. The aperture is circular and is appressed against the penultimate whorl. It

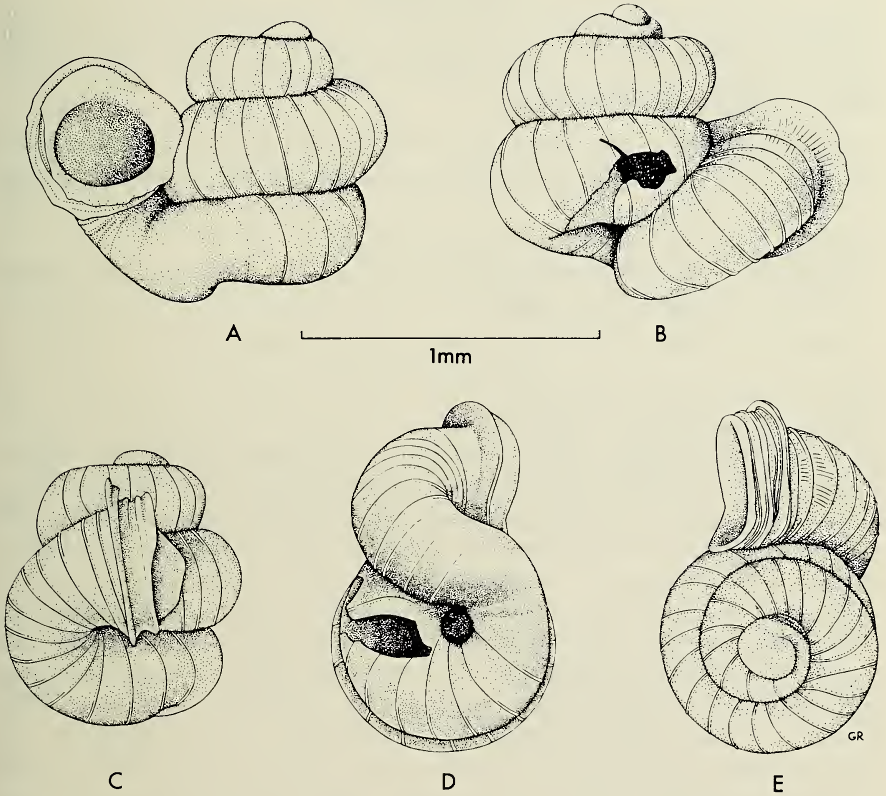

Fig. 2. *Opisthostoma brachyacrum*, Holotype.

lies in a plane facing posteriorly slightly oblique to the shell axis and bears a double peristome. The outer peristome consists of several fused lamella. It is slightly wider than the inner peristome and is nearly uniformly expanded. The inner peristome is trumpet-shaped and is nearly equally expanded around the aperture. The parietal wall of the inner peristome is appressed against the penultimate whorl and extends forward at that point.

Measurements of the unique holotype: height of shell, 0.93 mm; major width, 1.16 mm; minor width, 0.72 mm; aperture width, 0.46 mm; aperture height, 0.46 mm.

Type-locality.—BORNEO: Sarawak; Fourth Division; limestone hill on the trail from the Niah River to Niah Cave, Batu Niah. The holotype bears the same detailed locality information as that given above for *O. holzmarki.* Holotype: UF 24837; collected 4 November 1976 by William I. Holzmark.

Relationships

Jutting (1952, 1961) divided the Malayan *Ophisthostoma* (*s.s.*) into five species groups based upon the shape of the shell. This scheme is as follows, with slight amendments.

Group I.	Shell with a flat top and a recurved distal part of last whorl.
Group II.	Shell with a flat top and a straight [vertical] part of last whorl.
Group III.	Shell with very oblique whorls.
Group IV.	Shell with a somewhat elevated spire [and a recurved distal part of last whorl].
Group V.	Shell with strong remote ribs standing out like a crown.

The two new species described herein clearly belong to Group IV. This group also contains the following:

O. aspastum Jutting, 1951—Celebes; *O. deccanense* Beddome, 1875—India; *O. fairbanki* Blanford, 1866—India; *O. hemistreptum* Jutting, 1961—Malaya; *O. javanicum* Jutting, 1932—Java; *O. macrostoma* Blanford, 1869—India; *O. nilgiricum* Blanford and Blanford, 1861—India; *O. paranomon* Jutting, 1952—Malaya; *O. pauluciae* Crosse and Neville, 1879—Perak; *O. perlisanum* Jutting, 1961—Malaya; *O. supinum* Jutting, 1962—Cambodia; *O. tenerum* Jutting, 1952—Malaya; *O. holzmarki* and *O. brachyacrum* appear to be members of an indigenous Bornean subgroup. They are distinguished from all other species in Group IV, as well as species in other groups, by their feeble, widely spaced axial ribs. *O. holzmarki* is also unique within the subgenus because of the callused encapsulating shield the outer peristome forms over the apical whorls, and by the short longitudinal groove in the last whorl. *O. brachyacrum* has a less modified body whorl than does *O. holzmarki*, and is more similar in shape to other Group IV species. In this respect it resembles *O. aspastum* from Celebes but is readily distinguished from the latter by its sculpture. *O. aspastum* has closer and stronger axial ribs and has distinct spiral sculpture over the entire surface of the whorls.

Opisthostoma (*s.l.*) contains three subgenera, *Geothauma*, *Plectostoma* and *Opisthostoma* (*s.s.*). *Geothauma* is endemic to north Borneo and some satellite islands. *Plectostoma* is recorded from India, Vietnam, the Malay Peninsula and north Borneo. *Opisthostoma* (*s.s.*) is known from India, Vietnam, the Malay Peninsula, Celebes, Borneo and Java. The Group IV species complex of *Opisthostoma* (*s.s.*) has a wider geographic distribution than does any of the other species groups or than do the other subgenera. The geographic limits of the Group IV complex are coincidental with the known geographic range of the genus.

Prior to now *Plectostoma* and *Geothauma* were the only subgenera of

Ophisthostoma known from Borneo. With the addition of the two new species described above north Borneo becomes the only geographic area in which all three subgenera are known to occur. In Borneo *Plectostoma* contains fifteen described species and *Geothauma* contains ten (a recent tabulation of these is given in Jutting, 1952:57–62). Some of these have been recorded on two or more occasions and many other minute operculate snails of the genera *Arinea, Alycaeus, Diplommatina* and *Georissa* have been described from the island. It is surprising that prior to now *Opisthostoma* (*s.s.*) has not been found in Borneo. The apparent scarcity of this subgenus on Borneo probably is due to the extremely minute size of its species and not to the infrequency of their occurrence.

Acknowledgments

I wish to express my gratitude to Mr. William I. Holzmark of Sarasota, Florida, for the specimens treated in this paper. The illustrations comprising Figs. 1 and 2 were made by Ms. M. Glen Rogers. Much credit is due to her for the exactness of these illustrations.

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REVIEW OF THE INDO-PACIFIC PIPEFISH GENUS *BHANOTIA*, WITH DESCRIPTION OF *B. NUDA* N. SP.

C. E. Dawson

Abstract.—The genus *Bhanotia* Hora is diagnosed and differentiated from other syngnathine (tail-pouch) genera with similar body ridge configuration (*Syngnathus* Linnaeus, *Corythoichthys* Kaup, *Bryx* Herald) by the combination of spiny snout, protected nares, well developed pouch plates in males and presence of free bony plates in opercular membranes of subadults and/or adults. The type-species, *Bhanotia fasciolata* (Duméril), with modally 15 trunk rings, and *B. nuda* n. sp. (modally 14 trunk rings) from the Palau Is. and New Guinea are described and illustrated.

Hora's (1925) description of *Bhanotia* was not clearly diagnostic, and the status of this Indo-Pacific syngnathine (tail-pouch) pipefish genus has subsequently been in doubt. Hora considered *Bhanotia* to be closely related to *Corythoichthys* Kaup, and both Parr (1930) and Herald (1940), without pertinent comparative material, made unsuccessful attempts to clarify this relationship. Herald (1953, in Key) retained separate status for *Bhanotia*, and I have recently (Dawson, 1977a and b) compared the genus with *Corythoichthys* and clarified the nomenclature of the type-species, *Bhanotia fasciolata* (Duméril). Subsequent study of all available collections permits the present review of *Bhanotia* and description of a new species from New Guinea and Palau.

Methods and Materials

Methods follow Dawson (1977a); measurements are in millimeters (mm); proportional values are referred to standard length (SL) or head length (HL); color descriptions are from specimens preserved in alcohol. Materials examined are listed from west to east and roughly north to south; depths are in meters (m); latitude and longitude are approximations; the map delineates general localities and may not show all collection sites in immediate vicinity of symbols.

Abbreviations for repositories of examined material: AMS—Australian Museum, Sydney; BPBM—Bernice P. Bishop Museum, Honolulu; CAS—California Academy of Sciences; CAS-SU—former Stanford University specimens now housed at CAS; GCRL—Gulf Coast Research Laboratory Museum; MNHN—Muséum National d'Histoire Naturelle, Paris; RMNH—Rijksmuseum van Natuurlijke Historie, Leiden; UF—Florida State Museum, Gainesville; USNM—National Museum of Natural History, Smithsonian Institution; UZMK—Universitetets Zoologiske Museum, Copenhagen; ZSI—Zoological Survey of India, Calcutta.

Bhanotia Hora

Bhanotia Hora, 1925:463 [type-species by original designation: *Syngnathus corrugatus* Weber, 1913 (equals *Syngnathus fasciolatus* Duméril, 1870)].

Diagnosis.—Superior trunk and tail ridges discontinuous near rear of dorsal fin; lateral tail ridge ends near anal ring; lateral trunk ridge ends near anal ring, usually straight but often with a slight deflection ventrad, not reaching confluent inferior trunk and tail ridges (Fig. 5); trunk deep in subadults and adults, venter distinctly V-shaped, with or without a median ventral keel; scutella inconspicuous, without longitudinal keel, their width less than half of ring length; median dorsal snout ridge short, largely restricted to posterior third of snout, ends on anterior third of interorbital, not confluent with orbital ridges; anterodorsal portion of snout margined bilaterally by a short, diagonal, entire or spiny ridge (Fig. 3); dorsum of snout elsewhere with somewhat irregularly distributed rows of conical spines and/or short spiny ridges; nares 2-pored bilaterally, protected above by platelike bony lateral projections which terminate distally in 1–4 spiny points; lateral snout ridge absent; orbital ridges rather broad and somewhat expanded laterad; opercle with complete or nearly complete median longitudinal ridge which may be straight or angled somewhat dorsad, opercle crossed elsewhere with low ridges or striae; low ridge protrudes laterad above posterior third of opercle, another above gill opening; subadults and/or adults with one to several bony plates suspended in opercular membrane (Fig. 3); nuchal, prenuchal and frontal ridges somewhat elevated; pectoral-fin base not protruding strongly laterad, usually with indications of two longitudinal ridges; body ridges distinct, rather deeply notched between trunk rings, indented between tail rings; dorsum of trunk somewhat depressed between superior ridges, surfaces of tail slightly depressed between principal ridges; most head and body surfaces rough, ornamented with minute ridges and pocklike indentations, devoid of dermal flaps or papillae; dorsal-fin base not elevated; dorsal-fin membrane closely bound to fin-rays. Head length (HL) 8.1–11.0 in SL; snout length 2.6–3.3 in HL; length of dorsal-fin base 0.8–1.1 in HL; trunk rings 13–16; total rings 51–58; subdorsal rings 6.25–8.00, mostly on tail; dorsal-fin rays 26–35; pectoral-fin rays 12–16; anal fin present, caudal-fin rays 10. Brood pouch under tail; pouch protective plates present; brood-pouch eggs in two transverse rows and in 1–2 layers, not in continuous gelatinous matrix, covered by protective folds which meet and turn dorsad on ventral midline; brood-pouch closure the inverted type of Herald (1959). Without odontoid processes in jaws (Dawson and Fritzsche, 1975). Maximum size at least 84 mm SL. Indo-Pacific.

Comparisons.—Among syngnathine genera, the *Bhanotia* configuration of principal body ridges is shared with *Corythoichthys* Kaup, *Syngnathus* Linnaeus and *Bryx* Herald. *Bhanotia* shares the combination of pouch pro-

Table 1. Frequency distributions of trunk, tail and total rings in species of *Bhanotia.*

Species	Trunk rings				Tail rings						Total rings							
Locale	13	14	15	16	37	38	39	40	41	42	51	52	53	54	55	56	57	58
B. fasciolata																		
Andaman Is.			1	1						2							1	1
Thailand			6						2	4						2	4	
Philippine Is.		1	13				3	7	3	1				4	7	2	1	
Indonesia		1	34*				2	10*	23					3	9*	23		
New Guinea			1					1							1			
Solomon Is.			16				6	7	2	1				6	7	2	1	
Santa Cruz Is.		1	25					12	13	1					13	12	1	
New Hebrides			24	2			2	13	10	1				2	12	10	2	
B. nuda																		
New Guinea		16	1			4	7	6				4	8	4	1			
Palau Is.	1	40*			3	22*	13	3			4	21*	13	3				

* Holotype.

Table 2. Frequency distributions of dorsal and pectoral-fin rays and paired (equivalent) pectoral ray counts in species of *Bhanotia.*

Species	Dorsal-fin rays										Pectoral-fin rays					Paired pectoral counts				
Locale	26	27	28	29	30	31	32	33	34	35	12	13	14	15	16	12	13	14	15	16
B. fasciolata																				
Andaman Is.						2								2	2				1	1
Thailand				2	2	2							5	6				2	3	
Philippine Is.					2	6	5						6	5				3	2	
Indonesia					2*	6	19	7	1			2	19	20*			1	16	8*	
New Guinea								1					1	1						
Solomon Is.							5	7	3				4	14	1			2	5	
Santa Cruz Is.						2	5	6	10	3			7	27	14			2	10	5
New Hebrides					1		1	7	9	1			1	11	14				4	5
B. nuda																				
New Guinea	1	4	9	3							3	19				1	8			
Palau Is.		7	14*	13	8						3	52*	13			1	21*	4		

* Holotype.

Table 3. Frequency distributions of subdorsal trunk and tail rings in species of *Bhanotia.*

Species	Trunk rings								Tail rings							
Locale	1.75	1.50	1.25	1.00	0.75	0.50	0.25	0.00	5.50	5.75	6.00	6.25	6.50	6.75	7.00	7.25
B. fasciolata																
Andaman Is.		1		1							1	1				
Thailand				4		2				1	3		2			
Philippine Is.			1	9	2	3				3	2	7		1	2	
Indonesia		2	2	17	13	3*			1		9	10*	13	1	2	1
New Guinea				1									1			
Solomon Is.	2	4	3	5	1	1			1	1	3	6	3	2		
Santa Cruz Is.		2	2	16	4	2			1		2	8	9	5	1	
New Hebrides		2	5	13	5	3				1	2	5	7	4	7	2
B. nuda																
New Guinea				3	6	6	1	1	1	1	3	7	5			
Palau Is.				14	9*	16	1	2	1	6	8	16	7*	4		

* Holotype.

Table 4. Frequency distributions of total subdorsal rings in species of *Bhanotia.*

Species Locale	Total subdorsal rings							
	6.25	6.50	6.75	7.00	7.25	7.50	7.75	8.00
B. fasciolata								
Andaman Is.					1	1		
Thailand			1	5				
Philippine Is.		1	4	3	4		2	1
Indonesia		1	3*	6	15	10	1	1
New Guinea						1		
Solomon Is.					5	9	2	
Santa Cruz Is.			2	2	5	13	4	
New Hebrides				1	5	10	5	7
B. nuda								
New Guinea	1	2	5	8	1			
Palau Is.	2	4	14	13	8*	1		

* Holotype.

tective plates and inverted pouch closure with some species of *Syngnathus* (e.g. subgenus *Syngnathus* sensu Herald, 1959), whereas pouch plates are absent in *Corythoichthys* and pouch closure is the semi-type in both *Bryx* and *Corythoichthys.* Despite certain shared features, the spiny snout of *Bhanotia,* together with protected nares (largely concealed dorsad by overhanging bony protrusions) and occurrence of free bony plates within the opercular membrane constitute a character combination not found in other pipefishes.

Remarks.—Although usually terminating parallel to the longitudinal body axis, the lateral trunk ridge occasionally deflects 10–15° ventrad over the last 1–2 trunk rings. Among examined material, however, the lateral trunk ridge always ends well above the continuous inferior ridge.

The diagonal anterodorsal snout ridge is distinct at ×30 magnification in specimens as small as 30.5 mm SL, and the entire or spiny nature of this ridge (Fig. 3) is readily determined in all study material. Distribution of other spines or spiny ridges on dorsum of snout is variable and frequency of spines appears to increase with increasing standard length. Some well developed dorsal snout spines are present laterally and on midline in all examined specimens.

Development of bony plates in the opercular membrane is ontogenetic (Fig. 3). Plates are not usually visible in untreated specimens smaller than about 54 mm SL, whereas they are readily seen under low magnification in most *B. fasciolata* longer than about 57 mm SL. Minute bony precursors are visible at ×60 magnification in some 52 mm SL bleached and stained specimens.

Brood-pouch eggs essentially spherical, arranged in two uncrowded parallel rows and in either one or two layers; egg-rows not separated by a median longitudinal membranous septum but dorsum of pouch and inner surfaces of pouch folds with low membranous ridges; pouch folds inverted on ventral midline so that folds completely cover eggs and fold margins extend dorsad over ventral ⅓–½ of lowermost eggs. Among examined material, the smallest egg-bearing male is 47.5 mm SL, smallest male with developing pouch folds is 46.0 mm SL and maximum number of brood-pouch rings is 13.

The anal fin is very short, its breadth about equal to length; anal rays covered by fleshy integument and difficult to count but there appear to be 3 rays in most specimens; anal fin usually included within anterior extremity of brood pouch in mature males.

Ground color tan to dark brown in alcohol, head and trunk usually darker than tail; markings brown to light tan.

Although one collection (*B. nuda*) is recorded from a "mudflat," remaining samples with adequate data have all been taken in tidepool or reef habitats. One collection is recorded from "brackish" water. Although definite information is lacking for other samples, most would appear to be from marine or high salinity waters. Maximum recorded capture depth is a SCUBA collection in 13.7–16.8 m (USNM 210658; *B. fasciolata*).

Discussion.—With the exception of brief mention of snout spines, Hora's (1925) generic diagnosis could apply to a number of species commonly referred to *Syngnathus*. Unfortunately, Hora overlooked Weber and de Beaufort's (1922) reference to the protected nares in the holotype of *Syngnathus corrugatus* and failed to mention (or illustrate) the opercular membrane plates present in his adult male (ZSI F.10823-1) and in the female holotype of *Bhanotia sewelli* (ZSI F.10690-1). Similar configurations of principal body ridges and brood pouch suggest close relationship to *Syngnathus*, but the unique combination of spiny snout, protected nares and free opercular plates clearly indicates separate lineage for *Bhanotia*. Functional significance of these features is unknown but they afford strong evidence that species of *Bhanotia* are adapted to a specialized habitat not commonly occupied by other syngnathine pipefishes.

Bhanotia fasciolata (Duméril)
Fig. 1

Corythoichthys fasciculatus Kaup, 1853:231 (nomen nudum; Java).

Corythoichthys gastrotaenia: Kaup, 1856:27 [misidentification; new combination; not *Syngnathus gastrotaenia* Bleeker, 1852; description; Wahai and Ceram (incorrect locality)].

Corythoichthys fasciolatus Kaup, 1856:27 (erroneous spelling of *C. fasciculatus* Kaup, 1853; as synonym of *C. gastrotaenia*).

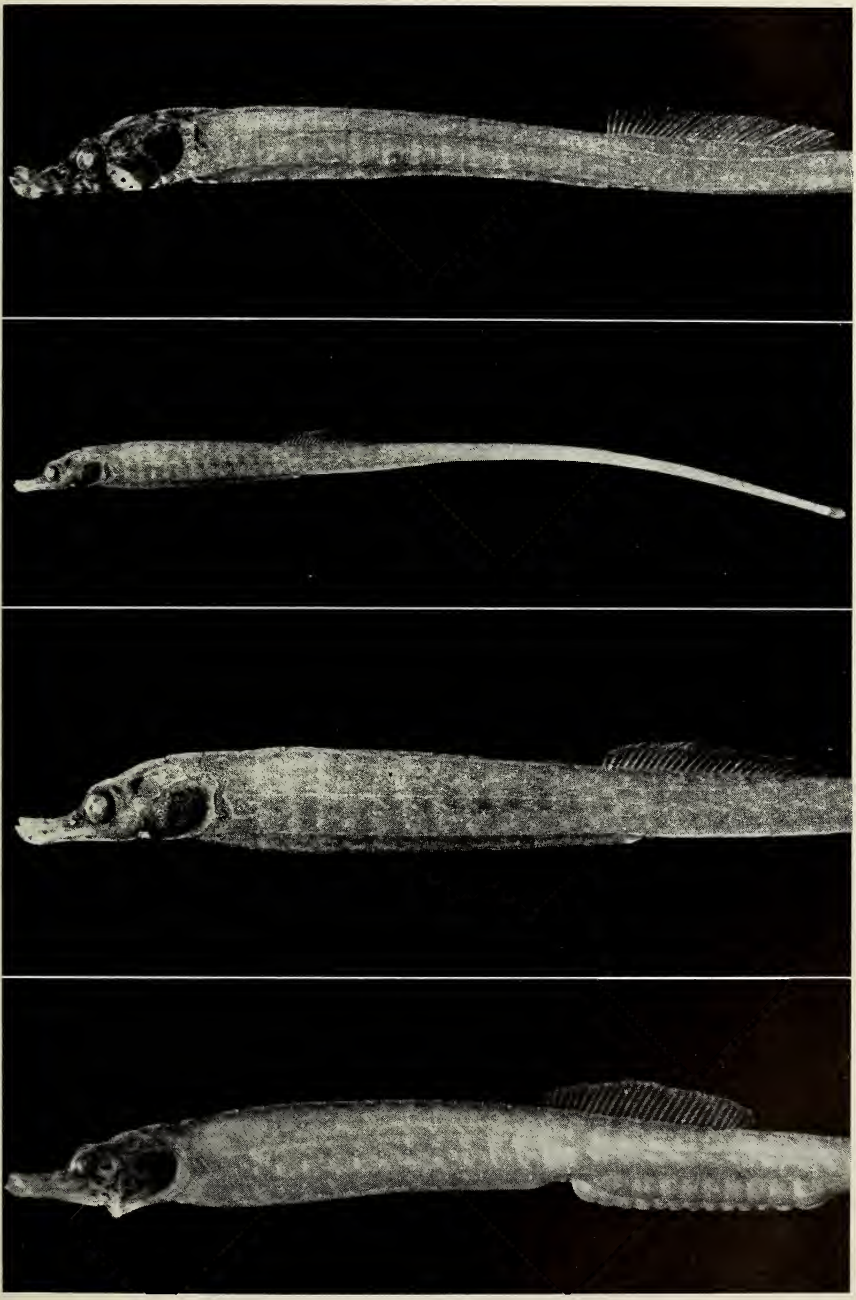

Fig. 1. Top.—*Bhanotia fasciolata*. USNM 217418 (53 mm SL, female), New Guinea. Middle pair.—*Bhanotia nuda*. GCRL 15732 (49.5 mm SL, male, paratype), New Guinea. Bottom.—*Bhanotia nuda*. GCRL 15731 (51 mm SL, male, paratype), Palau Is.

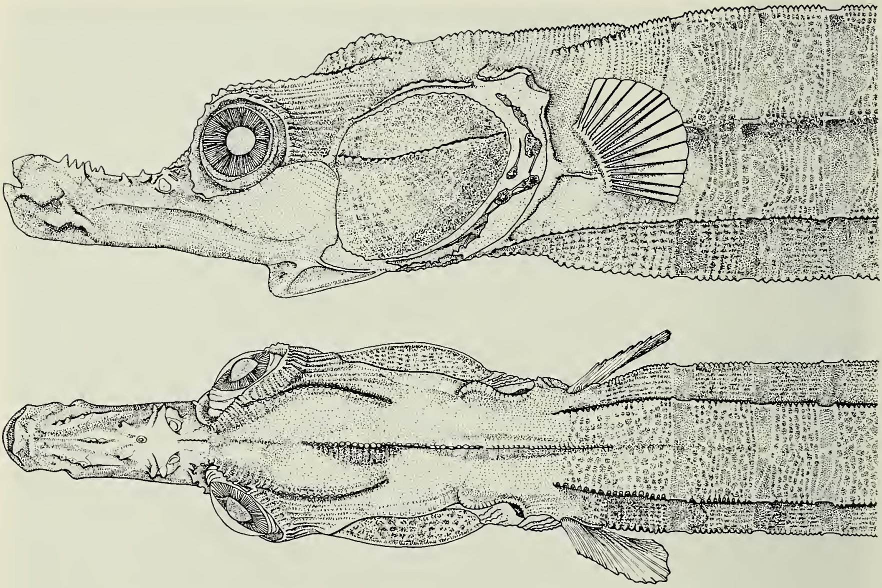

Fig. 2. *Bhanotia fasciolata.* Lateral and dorsal aspects of head and anterior trunk rings. From 69 mm SL male, GCRL 15730.

Corythoichthys fasciculatus: Bleeker, 1859:186 ("nomen tantum"; Java).
Syngnathus fasciolatus Duméril, 1870:561 (original description based on specimen described by Kaup, 1856:27; Java).
Syngnathus corrugatus Weber, 1913:112, fig. 38 (original description; Karakelang Is.).
Syngnathus fasciolatus: Duncker, 1915:86 (species dubium).
Corythoichthys corrugatus: Weber and de Beaufort, 1922:73, fig. 32 (new combination).
Syngnathus fasciolatus: Weber and de Beaufort, 1922:83 (descriptions of Kaup and Duméril compared; Java, not Wahai and Ceram).
Bhanotia corrugatus (Weber) [*Syngnathus corrugatus*]: Hora, 1925:464 (type-species of *Bhanotia* Hora, 1925, by original designation).
? *Bhanotia corrugatus*: Hora, 1925:464, text fig. 6, pl. 11, fig. 2 (description; Rutland Is., Andamans).
Bhanotia sewelli Hora, 1925:465, text fig. 7, pl. 11, fig. 5 (original description; Outram Is., Andamans).
Bhanotia fasciolata: Dawson, 1977b:786 (new combination).

Diagnosis.—Diagonal anterodorsal snout ridge with 1–5 spines; free bony plates in opercular membrane of adults readily seen under low magnification; with modal counts of 15 trunk rings, 15 pectoral and 32 dorsal-fin rays.

Description.—Dorsal-fin rays 29–35 ($\bar{x}$ = 32.4); pectoral-fin rays 13–16 (14.9); rings 14–16 + 39–42 = 54–58 (55.5); total subdorsal rings 6.5–8.0 (7.4); dorsal-fin origin usually (70.2%) at or before anterior margin of last trunk ring. Proportional data based on 20 specimens 52.0–81.5 (66.2) mm SL follow: HL in SL 9.1–11.0 (9.95); snout length in HL 2.6–2.9 (2.72); snout depth in snout length 2.1–3.1 (2.53); length of dorsal-fin base in HL 0.8–0.9 (0.83); anal ring depth in HL 2.5–3.6 (3.22); trunk depth in HL 1.9–2.5 (2.13); pectoral-fin length in HL 4.6–6.8 (5.44). See Tables 1–4 for additional counts.

Diagonal anterodorsal snout ridge (Figs. 2 and 3) with 1–5 (usually 3–4) minute but distinct spines; subadults and adults with 1–11 smooth to denticulate bony plates in opercular membrane (spines and plates best seen under ×30 magnification).

Snout light tan in front, dorsum and upper portion of side shading to brown on preorbital and supra-narial projections; side of snout with 9–10, irregularly distributed, small brown spots; lower half of snout and suborbital with 4 brown bars, separated by irregular pale interspaces, which continue across venter of head; posteriormost (broadest) interspace with subvertical median row of 3 equally spaced small brown spots; opercle with two subvertical pale bars originating below median opercular ridge and extending across venter; dorsum of head with faint indications of pale blotches across prenuchal, nuchal and frontal ridges; head elsewhere mainly brown with indistinct tan mottling. Trunk brownish with darker, somewhat ocellate, spots on scutella of lower half of side; tail mottled or tan anteriad becoming circled along posterior ½–⅔ by narrow brown bands between rings; anal fin flecked with brown, other fins hyaline. The foregoing description is from a 70.5 mm SL female (UF 23759), but preserved coloration of subadults and adults is highly variable, without apparent correlation with either sex or size. The head may be plain brownish or strikingly marked; opercular and suborbital bars may be prominent, indistinct or absent; the snout may be plain, barred, lightly or densely spotted, or both spotted and barred.

Comparisons.—See this section under *B. nuda.*

Remarks.—Bony plates are few, smooth, well separated and inconspicuous in the opercular membrane of small (ca. 55 mm SL) *B. fasciolata* (Fig. 3). In large specimens (ca. 70 mm or longer), there are usually 9–11 conspicuous, denticulate, closely spaced plates between upper opercular angle and ventral midline. The opercular membranes of large *B. fasciolata* are essentially armored with bony inclusions.

The holotypes of *Syngnathus fasciolatus* (MNHN 6023) and *Bhanotia sewelli* (ZSI F.10690-1) have bars on the snout and suborbital, but retain no trace of the spotted snout described above and for the holotype of *Syngnathus corrugatus* (Weber, 1913). Among 45 specimens examined,

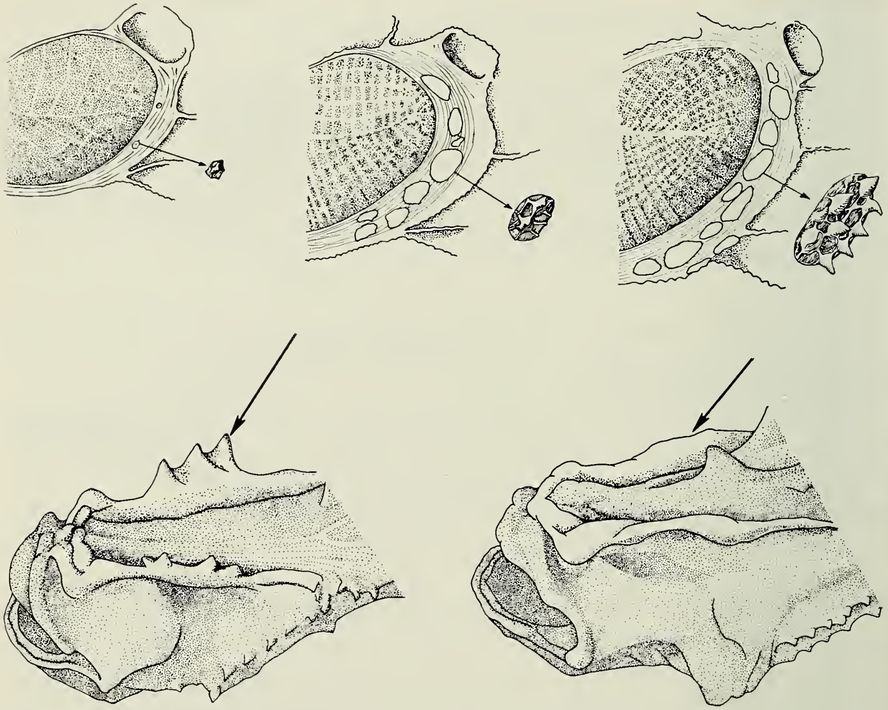

Fig. 3. Ontogenetic development of bony plates in opercular membrane of *Bhanotia fasciolata*; left to right—55 mm, 64.5 mm, 69.5 mm SL. Bottom.—Details of anterior portion of snout illustrating spiny diagonal anterodorsal ridge in *B. fasciolata* (left) and entire ridge in *B. nuda* (right).

19 (42%) have spotted snouts, whereas snout is either plain or barred in the remainder.

Counts of dorsal-fin rays and total subdorsal rings (Tables 2 and 4) indicate west to east increase in frequencies. These data are few and inconclusive but similar variation has been demonstrated for several species of *Corythoichthys* (Dawson, 1977a). I detect no evidence of geographic variation in preserved coloration.

Fifteen egg-bearing males (64–84 mm SL) have brood pouches developed beneath 10–12 tail rings; nineteen other males (63.5–82 mm SL) have pouch folds below 5–13 rings. A single layer of brood-pouch eggs was noted in 7 fish (64–82.5 mm SL) and two layers occurred in 4 fish (76.5–84 mm SL). A 64 mm SL male had 22 eggs in a single layer under the 9 anterior rings of an 11-ring pouch; a 76.5 mm fish, with two layers of eggs, had 46 eggs in the ventral layer under 11 rings of a 12-ring pouch.

On the basis of examined material, *Bhanotia fasciolata* is presently known from the Andaman Is. to the New Hebrides (Fig. 4).

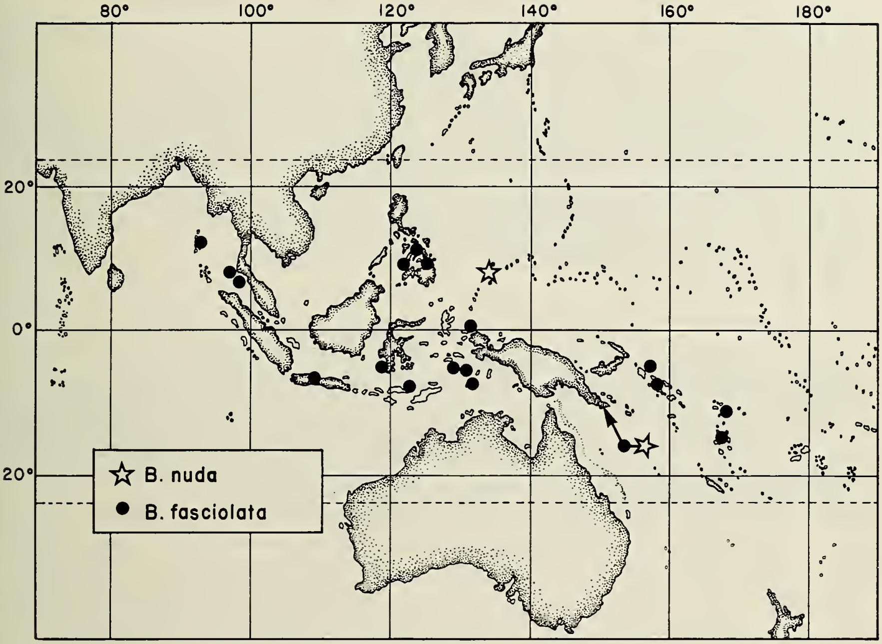

Fig. 4. Distribution of species of *Bhanotia* based on materials examined.

Material examined.—132 specimens, 37.0–84.0 mm SL, including holotype.

Holotype.—MNHN 6023 (81.0 mm SL, female), Java, Kuhl and van Hasselt.

Other material.—ANDAMAN IS.: ZSI F.10690-1 (holotype of *Bhanotia sewelli*), F.10823-1. THAILAND, Phuket: GCRL 15484. USNM 217421. Butang Is.: GCRL 15483, USNM 217419. PHILIPPINES, Negros Is.: CAS 36835, 39648, 39744. Mactan Is.: USNM 137293, 137296. Camiguin Is.: USNM 137294. Mindanao Is.: USNM 137292. Loc. uncertain: CAS 39738. INDONESIA, Macassar: USNM 137295. Flores Is.: GCRL 15725, UF 23759. Saparua: USNM 210657–58. Waigeo: CAS-SU 26699. Banda Is.: BPBM 18532. Tenimber Is.: RMNH 21103. NEW GUINEA, Milne Bay: USNM 217418. SOLOMONS, Bougainville: USNM 217420. New Georgia: CAS 19937–41. SANTA CRUZ IS., Vanikoro: CAS 39743, GCRL 15730. NEW HEBRIDES: AMS IA.784, CAS-SU 25036, UZMK P.39460–61.

Bhanotia nuda new species
Fig. 1

Diagnosis.—Diagonal anterodorsal snout ridge entire; free bony plates in opercular membranes not readily seen under low magnification; with modal counts of 14 trunk rings, 13 pectoral and 28 dorsal-fin rays.

Description.—Dorsal-fin rays 26–30 ($\bar{x}$ = 28.3); pectoral-fin rays 12–14 (13.1); rings 13–15 + 37–40 = 51–55 (52.6); total subdorsal rings 6.25–7.5 (6.9); dorsal-fin origin always at or behind anterior margin of last trunk ring. Measurements (mm) of the 61 mm SL, male holotype: HL 6.0, snout length 2.1, snout depth 0.9, length of dorsal-fin base 7.7, anal ring depth 2.3, trunk depth 3.3, pectoral-fin length 1.3, length of pectoral-fin base 1.0; see Tables 1–4 for counts. Proportional data based on 20 paratypes 36.5–61.0 ($\bar{x}$ = 50.6) mm SL follow: HL in SL 8.1–10.1 (9.26); snout length in HL 2.6–3.3 (2.80); snout depth in snout length 2.2–3.8 (2.94); length of dorsal-fin base in HL 0.8–1.1 (0.92); anal ring depth in HL 2.6–5.0 (3.41); trunk depth in HL 1.8–2.9 (2.13); pectoral-fin length in HL 4.7–6.8 (5.48).

Diagonal anterodorsal snout ridge (Fig. 3) low, occasionally somewhat emarginate but without distinct spines. Holotype (Fig. 5) with cluster of 3 spines on anterior third of snout, a large spine on midline and a small spine on either side behind; 3–4 small spines just before origin of median snout ridge and short spiny ridges laterad which are essentially confluent with prominent supra-narial projections; bony opercular membrane plates not visible at ×30 magnification. Holotype without eggs, pouch plates angled distinctly laterad, pouch folds developed below 11 tail rings.

Holotype without bars on snout, suborbital or opercle, snout essentially pale and unmarked anteriad of nares; ventral juncture of suborbital and opercle overlaid with a prominent, dark margined, pale spot (diameter subequal to that of pupil), spot circular on right but narrowed on the left side and continued ventrad on opercular membrane; snout behind vertical from nares, most of suborbital and opercle with scattered diffuse brown spots; remainder of head and trunk brown, without distinctive markings; tail mainly light tan with traces of dark bands circling margins of the last 15 or so rings; dorsal and pectoral fins mainly hyaline but closely flecked with minute translucent spots between fin-rays; anal and caudal fins hyaline.

Twenty-nine of 57 examined paratypes have one, infrequently two, pale bars on suborbital and 23 of these also have 2–3 narrow pale bars on lower half of opercle, the ocellate pale spot overlying anterior opercular angle (described for holotype) occurs in 9 specimens, 10 have brown spotted opercle and suborbital, and head is without conspicuous markings in 9 others. None of the paratypes have bars on lower half of snout, most are without snout markings and only 10 have spotted snouts.

Etymology.—Named *nuda* in allusion to the absence of spines on diagonal anterodorsal snout ridge and absence of obvious bony plates in the opercular membrane.

Comparisons.—Bhanotia nuda is best separated from its only congener, *B. fasciolata*, by modal counts of 14 trunk rings and 13 pectoral rays (both counts modally 15 in *fasciolata*) and absence of spines on the diagonal

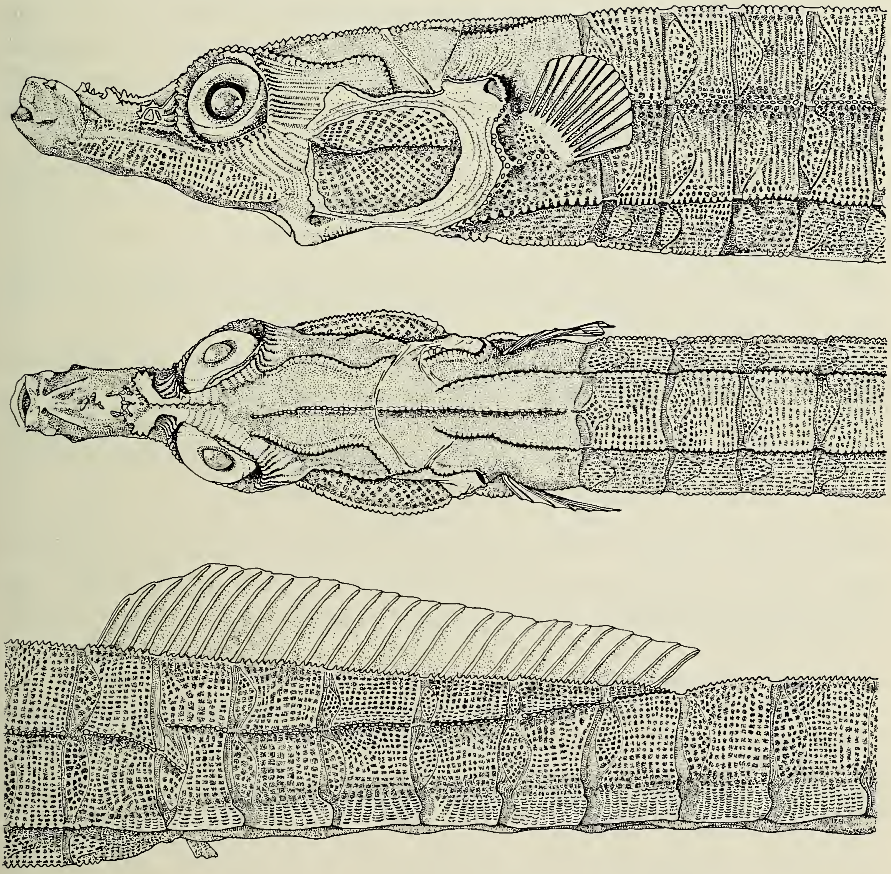

Fig. 5. *Bhanotia nuda.* Top and middle.—Lateral and dorsal aspects of head and anterior trunk rings. Bottom.—Posterior trunk and anterior tail rings illustrating ridge pattern and dorsal fin. From 61 mm SL holotype, CAS 40169.

anterodorsal snout ridges (spiny in *fasciolata*). Average counts of tail rings and dorsal-fin rays are lower in *B. nuda* ($\bar{x}$ = 38.6 and 28.3 against 40.5 and 32.4 in *fasciolata*), and dorsal-fin origin is always at or behind anterior margin of last trunk ring (usually (70%) at or before margin in *fasciolata*). Under ×30 magnification, opercular membranes are superficially naked in all examined *B. nuda*, whereas free bony plates are visible in the opercular membranes of all *B. fasciolata* above 55 mm SL. Although these species are similar in general coloration, *B. nuda* lacks bars on lower half of snout (bars present in more than 50% of examined *fasciolata*), about 14% have spotted opercle and suborbital (never spotted in *fasciolata*) and only 18% have spotted snouts (42% in *fasciolata*). Based on examined material, *B. nuda* matures at a smaller size (smallest egg-bearing male 47.5 mm SL against 64 mm in *fasciolata*), and does not attain the maximum length of *B. fasciolata* (maximum 61.5 mm SL against 84 mm). These closely related species are readily separated by characters noted here and in diagnoses.

Remarks.—Free bony plates are poorly developed in the opercular membranes of *B. nuda* and they are not visible in any of the untreated type-material. However, one or two small, smooth, plates are present below ventral margin of opercle in two bleached and stained specimens (GCRL 15731; 58–60 mm SL), and plates may well be better developed in fish larger than 61.5 mm SL.

Five egg-bearing males (47.5–61.5 mm SL) have brood pouches developed below 11–12 tail rings; 11 other males have pouch folds below 10–12 rings. A single layer of 21–22 eggs is present in two fish (47.5–51 mm SL), three (58–61.5 mm) have eggs in two layers, and the largest of these has 29 eggs in the ventral layer under 11 rings of a 12-ring pouch.

Bhanotia nuda is known from New Guinea and the Palau Is. (Fig. 4). This species is sympatric with *B. fasciolata* in New Guinea (one *fasciolata* taken with 17 *nuda*) but the Palau collections contained only *B. nuda*. The New Guinea collection is recorded from "brackish" water; Palau samples are from tidepool, reef and mudflat habitats.

Material examined.—Holotype and 58 paratypes, 30.5–61.5 mm SL.

Holotype.—CAS 40169 (61.0 mm SL, male); Palau Is., NE of Station Harbor off SE part of Arakabesan Is.; 07°20′51″N, 134°38′01″E; reef pool with coral heads, rubble and eelgrass; 0–1.8 m; GVF reg. 1853; 22 Jan. 1959; H. A. Fehlmann and Y. Sumang.

Paratypes.—NEW GUINEA: GCRL 15732 (3, 47.5–51.0) and USNM 207444 (14, 33.5–50.5); Milne Bay, Maiwara Is., W of Alotau; brackish water; 3 Sept. 1975; T. R. Roberts coll. PALAU IS.: CAS 39740 (18, 32–61.5) and GCRL 15731 (4, 51–61); off Babelthaup Is., NE of Arakatoach stream; 07°23′28″N, 134°30′32″E; coral algae, some eelgrass, sand bottom; 0–3 m; 22 Sept. 1957; GVF reg. 1397; H. A. Fehlmann and party. CAS 39741 (4, 51–56), taken with holotype. CAS 39739 (8, 41–59.5); W end of Koror Is.; 07°26′36″N, 134°28′13″E; mud and sand flat; 0–0.9 m; 9 July 1955; GVF reg. 511; H. A. Fehlmann and party. CAS 39742 (7, 30.5–53), between Koror and Byobu islands; 07°19′36″N, 134°29′06″E; mudflat with occasional blades of eelgrass and scattered patches of soft coral; 0–0.4 m; 25 July 1956; GVF reg. 814; M. R. Brittan and party.

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DESCRIPTION OF A NEW GENUS AND SPECIES OF PSEUDIONINAE (ISOPODA: BOPYRIDAE) PARASITE OF THE HERMIT CRAB *PAGURUS ANNULIPES* (STIMPSON) FROM NORTH CAROLINA

Daniel L. Adkison and Richard W. Heard

Abstract.—Specimens of the entoniscid, *Paguritherum alatum* Reinhard and the bopyrids, *Stegophryxus hyptius* Thompson, *Asymmetrione desultor* Markham and *Pseudasymmetrione markhami* n. gen., sp. n. were collected from pagurid hermit crabs in inshore marine waters near Beaufort, North Carolina. *Pseudasymmetrione markhami* was found in the left branchial chamber of *Pagurus annulipes.* The new genus is most similar to *Shiinoela* Bourdon, *Pseudionella* Shiino, and *Asymmetrione* Codreanu, Codreanu and Pike but is differentiated by the following combination of characters: (1) female dorsal segmentation medially indistinct, (2) female frontal lamina without medial notch, (3) female with last 3 pairs of pleopods uniramous, (4) male cephalon and first segment fused medially, and (5) male without pleopods. The generic position of *Pseudionella pyriforma* Shiino, 1958 is questioned. The significance of the posterolateral projection of the maxilliped, here designated as the "maxilliped spur," and the interpretation of the presence or absence of pleopods on male bopyrids are briefly discussed.

From 1963–1970 approximately 550 specimens of *Pagurus* (250 *P. annulipes* and 300 *P. longicarpus*) from inshore marine waters near Beaufort, North Carolina, were examined for epicaridean isopod parasites by R. W. Heard and C. Kellogg. Four isopods, one a member of the family Entoniscidae and 3 belonging to the family Bopyridae, were collected during this study. The entoniscid, identified as *Paguritherium alatum* Reinhard, 1945, was found in 3 *Pagurus longicarpus* and 2 *P. annulipes.* The monotypic genus *Paguritherium* occurs in the body cavity of its pagurid host and has previously been reported only from the coast of Massachusetts in *Pagurus longicarpus* (see Reinhard, 1945, and Reinhard and Buckeridge, 1950). Its occurrence in *P. annulipes* in North Carolina thus represents new host and geographical records.

The 2 bopyrids, *Stegophryxus hyptius* Thompson, 1902 and *Asymmetrione desultor* Markham, 1975, were given to J. C. Markham and are the subjects of two earlier reports (Markham, 1974; 1975). Another species of the family Bopyridae which occurred in the left gill chamber of *P. annulipes,* is described here as a new genus and species.

Pseudasymmetrione gen. n.

Figs. 1–3

Diagnosis.—Female: Body asymmetrical, cephalon dextral to main body axis. Frontal lamina entire. Segmentation medially indistinct. Coxal plates and dorsal bosses present on at least first 4 pereomeres. Pleon of 6 distinct pleomeres. Pleopods 5 pairs; first 2 pairs biramous; last 3 pairs uniramous. Uropods uniramous.

Male: Body relatively wide (width over 50% length). Cephalon laterally distinct, medially fused with pereomere 1. Pleon of 6 distinct pleomeres. Pleopods reduced or absent. Uropods and midventral tubercles absent.

Type-species.—*Pseudasymmetrione markhami* sp. n.

Etymology.—From the Greek pseudo- in combination with the generic name *Asymmetrione.* The gender is feminine.

Comparison and discussion.—The differences between *Pseudasymmetrione* and related genera are summarized by the following combination of characters: (1) female dorsal segmentation medially indistinct; (2) frontal lamina of female without notch; (3) last 3 pairs of pleopods of female always uniramous; (4) male cephalon and first segment fused medially; and (5) pleopods of male apparently absent (although the low "flap-like" ridges extending medially from lateral margins of abdominal segments might be interpreted as vestigial pleopods).

Pseudasymmetrione appears to be most similar to *Shiinonella* Bourdon, 1972, *Pseudionella* Shiino, 1949, and *Asymmetrione* Codreanu, Codreanu, and Pike, 1965. *Pseudionella* differs from *Pseudasymmetrione* by having (1) female dorsal segmentation distinct, (2) frontal lamina of female reduced or absent, (3) coxal plates of female reduced or absent, and (4) pleopods of male present and tuberculate. *Asymmetrione* differs from the new genus by having (1) female frontal lamina notched medially, (2) enlarged and characteristic pereopodal propodi of female, and (3) pleopods of female usually biramous with pleopods 1–3 always biramous. *Shiinoella* can be differentiated from *Pseudasymmetrione* by having (1) female with dorsal body segmentation distinct, (2) female with pereopods elongate with developed propodi and dactyli, (3) male with cephalon distinct from pereon, and (4) pleon of male with segments 4–6 medially indistinct.

There are some inconsistencies in the generic characters of *Pseudionella.* In Table 1 we have used morphological data only for the type-species *P. attenuata* Shiino, 1949, since the only other species in the genus, *P. pyriforma* Shiino, 1958, was described as having well-developed biramous pleopods on the female. Furthermore, even though Shiino's text indicates that a frontal lamina and coxal plates are absent on *P. pyriforma*, his illustration (p. 41) indicates the presence of these structures. The illustra-

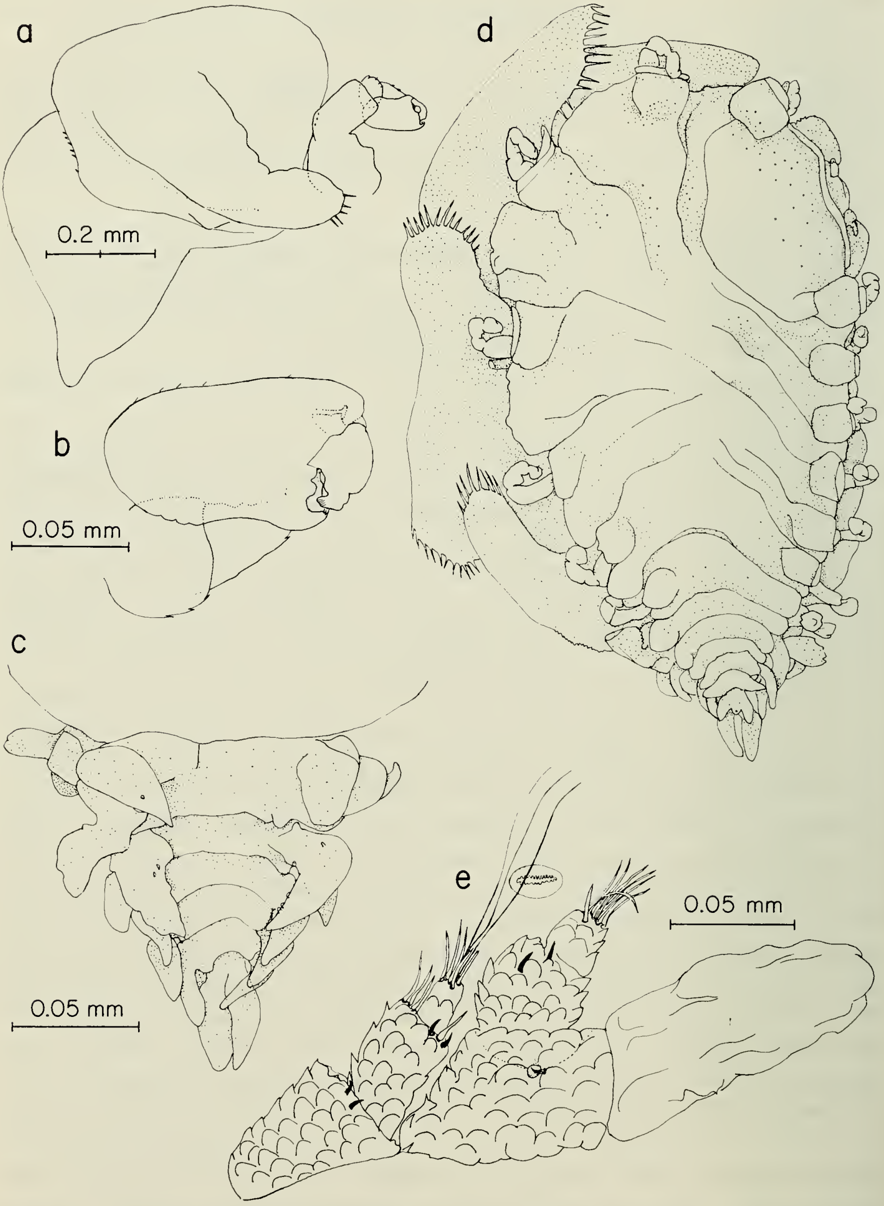

Fig. 1. *Pseudasymmetrione markhami*, female: a, Left oostegite 1, external view; b, Left pereopod 1; c, Pleon, ventral view; d, Holotype, dorsal view; e, Left antennae. Scales as indicated.

Table 1. Comparison of some genera of Pseudioninae.

	Pseudasymmetrione	*Pseudionella*	*Shiinoella*	*Asymmetrione*	*Parapseudione*	*Pseudione*
segmentation of ♀	medially indistinct	distinct	distinct	distinct	distinct	distinct
torsion	70° right	slightly left	slightly right	slightly left to 90° right	slightly left	slight, variable
frontal lamina	entire, reflexed	vestigial	entire, reflexed	notched, variable	none	present, variable
coxal plates	1–4	vestigial	1–4	present	1–4	1–4
dorsal bosses	1–4	1–4	1–4	most pereomeres	most pereomeres	most pereomeres
pleopods	1–2 biramous 3–5 uniramous	1–2 biramous 3–5 uniramous	1–2 biramous 3–5 uniramous	usually 1–5 biramous*	1–4 biramous 5 uniramous	1–5 biramous
uropods	uniramous	uniramous	uniramous	uniramous	uniramous	uniramous
♂ cephalon & 1st segment	fused	fused	distinct	distinct	distinct	distinct
pleon segmentation	distinct	distinct	4–6 medially fused	distinct	distinct	distinct
pleopods	absent (see discussion)	5 pairs tubercles	absent	5 pairs tubercles	absent	5 pairs tubercles
host group(s)	Paguridae	Paguridae	Alpheidae	Paguridae Diogenidae	Galatheidae Paguridae	Caridea Macrura Anomura
no. of species	1	2 (?)	1	7	2	49

* Shiino (1933) reported that in some female specimens of *Asymonetrione* (= *Pseudoine*) *asymetrica* the fifth and sometimes fourth pairs of pleopods were uniramous.

tion of the type-species, *P. attenuata*, also shows what appears to be a weakly developed frontal lamina. It is our opinion that these 2 species are not congeneric and that *P. pyriforma* has closer affinities with the genus *Pseudione* Kossman; however, the fusion of the cephalon with the first pereonal segment in the male of *P. pyriforma* excludes it from the genus *Pseudione* as now defined. It would be premature, however, to assign *P. pyriforma* to an existing genus or to a new genus until the type material can be studied in more detail.

Pseudasymmetrione markhami, new species

Material examined.—Morehead Channel, Carteret County, North Carolina, R. W. Heard coll. and det. of host, 26 August 1963; 1♀, (holotype), 1♂ USNM 170590. 8 December 1963; 2, 2 (host present) USNM 170591. 15 January 1964; 1♀, 1♂ USNM 170592, 1♀, 1♂ collection of authors. 21? June 1965; 1♀, 1♂ collection of authors. 19 July 1965; 1♀, 1♂ Universitetetes Zoologiske Museum, Copenhagen. 25 June 1970; 3♀, 3♂ USNM 170593, 1♀, 1♂ collection of authors.

Diagnosis.—Female: Body asymmetrical, distortion dextral and greater than 50%.

Cephalon deeply set into pleomere 1; frontal lamina entire, folded onto cephalon. Segments laterally distinct, medially indistinct. Coxal plates and dorsal bosses prominent on first 4 pereomeres.

Pleon of 6 distinct pleomeres. Pleopods 5 pairs; first biramous, endopod bilobed giving triramous appearance; second biramous; 3–5 uniramous. Uropods terminal, uniramous.

Male: Body width over 50% length, greatest width across third pereomere. Head fused medially with pereomere 1; all other segments distinctly narrower than pereon. Pleopods apparently absent. Uropods and midventral tubercles absent.

Description.—Female: (Based on 11 adult specimens) Body asymmetrical, distortion angle 55–80. Length 1.9–4.1 mm, width across third pereomere 1.3–2.4 mm.

Cephalon nearly quadrate, wider than long (length 75–85% width); deeply set in pereomere 1. Eyes apparent in some specimens. Frontal lamina entire (no medial notch), wider medially and folded onto dorsal surface of cephalon. First antenna (Fig. 1e) of 3 segments; basal segment 1–2 apical setae; second segment 4–6 apical setae, 1 subapical seta on some; distal segment 4–9 apical setae, 2–3 asthetes as long as antenna. Second antenna (Fig. 1e) of 3 segments; basal segment 1 seta in pit; second segment 1 apical seta; distal segment, 6–11 apical setae. Antennae covered with scales and second subequal in length. Pore (excretory?) located anteriolateral to antennae (Fig. 1e). Maxilliped (Fig. 2a–e) covered with short setae along margins and dorsal surfaces, deeply notched in antero-internal

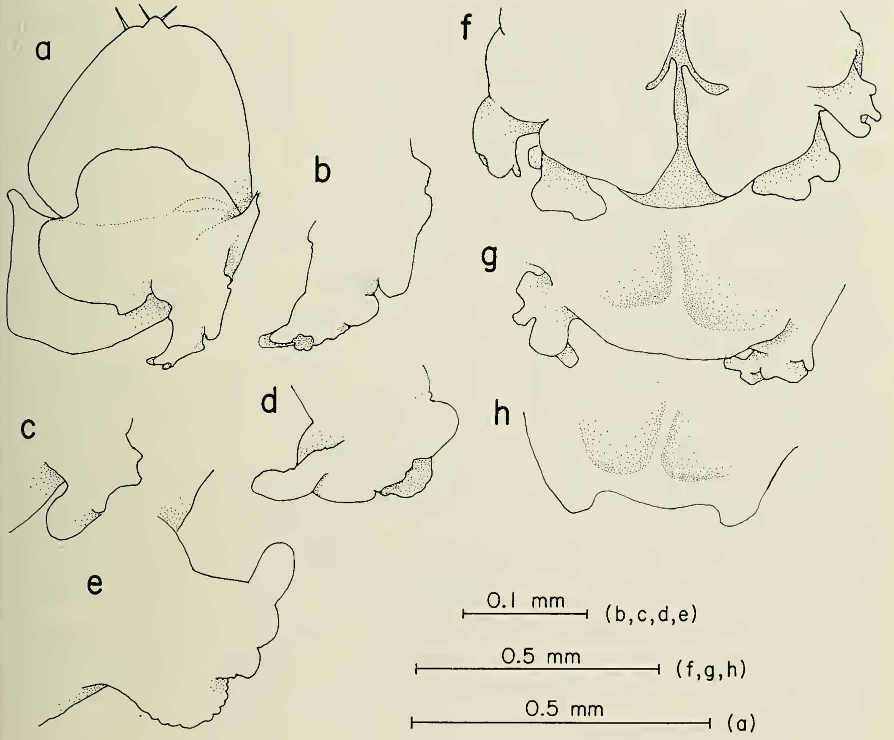

Fig. 2. *Pseudasymmetrione markhami*, female: a, Left maxilliped with spur; b, Enlargement maxilliped spur; c, Left maxilliped spur; d, Right maxilliped spur, same female as c; e, Left maxilliped spur; f, Maxilliped, spur and posterior lamina; g, Posterior lamina; h, Posterior lamina. Scales as indicated.

angle; palp vestigial, provided with several long setae; maxillular plates interlocking opposite antero-internal angle; maxillular spur (see discussion) anterior to interlocking area of plates, origin at lateral muscle attachment area, extending past posterior ventral border of head (Fig. 2a–e). Posterior lamina of cephalon 1 pair of lobes (Fig. 2f–h).

Pereon of 7 laterally distinct segments; medial segmentation generally indistinct on pereomeres 3–6 though in some specimens segmentation of pereomeres 1–3 also indistinct. Dorsal bosses present on all segments, less distinct in pereomeres 4–7. Coxal plates prominent on first 4 pereomeres. Tergal area not greatly developed. Oostegite 1 rectangular, prominent posterolateral point, internal ridge unornamented (Fig. 1a). Oostegites right side elongate; left side nearly square. Pereopods covered with scales; similar in form, increasing in size posteriorly.

Pleon (Fig. 1c) of 6 segments; length of pleon subequal to width of pleomere 1. Lateral plates small and bluntly rounded; lateral plates on pleomere 6 prominent and directed posteriorly. Pleopods; 5 pairs, decreasing in size posteriorly; first biramous, exopod reduced, endopod bilobed, external lobe lanceolate and folded posteriorly back onto itself, medial lobe reduced, smaller than exopod. Second pleopod biramous; exopod smaller than first; endopod weakly bilobed, internal lobe vestigial, external lobe lanceolate. Pleopods 3–5 uniramous, lanceolate. Uropods uniramous, longer than pleopod 3, slight expansion on basal internal edge (vestigial endopod?).

Variation: Pereomeres 6 and 7 show variation in the development of dorsal bosses and coxal plates; lateral plates, though small, present on 2 specimens (2.3 and 2.5 mm); dorsal bosses were absent. A 2.0 mm specimen had a vestigial endopod on the left uropod.

Male: Body relatively wide (width over 50% length), length 0.8–1.5 mm, width 0.5–0.8 at pereomere 3 or 4. Cephalon and pereomere 7 approximately of equal width, cephalon slightly broader.

Cephalon fused medially with pereomere 1, other segments distinct. Frontal margin broad, concave medially. Eyes apparent only in fresh material. First antenna, 3 segments; basal segment, no apical or subapical setae, lobe near base, 2–3 setae; second segment, 2–6 apical setae, 0–3 subapical setae; distal segment, 9–11 apical setae, no subapical setae. Second antenna, 5 segments; basal segment, no setae; second segment, 0–2 subapical setae; third segment, 3 or 4 apical setae; fourth segment, 3–6 apical setae; distal segment; 6–10 apical setae. Both antennae covered with scales, second antenna less than twice length of first (Fig. 3d).

Pereomeres ending in wide blunted point, pereomeres 5–7 bent increasingly posteriorly, seventh broadly V-shaped. Pereopods (Fig. 3a–c) similar in size and structure, seventh smallest.

Pleon (Fig. 3f) 6 pleomeres, distinctly narrowing posteriorly; sixth pleomere 25–50% width of first. Pleopods absent though flap-like ridges present (not visible in lateral view). Pleomere 6 slightly lobed posteriorly with scales occurring on lateral and posterior regions and 3–11 setae laterally. Uropods absent. Anal cone indistinct.

Variation: One specimen (1.5 mm) has a length to width ratio of 0.39. Other variation is minor.

Type-locality.—Morehead Channel, Carteret County, North Carolina. Depth, 2–5 meters. Bottom type, shell rubble. Salinity, 25–36‰.

Habitat.—Left branchial chamber of *Pagurus annulipes* (Stimpson, 1860).

Characteristic associated fauna.—*Corophium tuberculatum* Shoemaker, *Hexapanopeus angustifrons* (Benedict and Rathbun), *Paguristes hummi* Wass, *Pagurus pollicaris* Say, and *Trachypenaeus contrictus* (Stimpson).

Etymology.—This species is named for John C. Markham in recognition of his work on the taxonomy and systematics of bopyrid isopods.

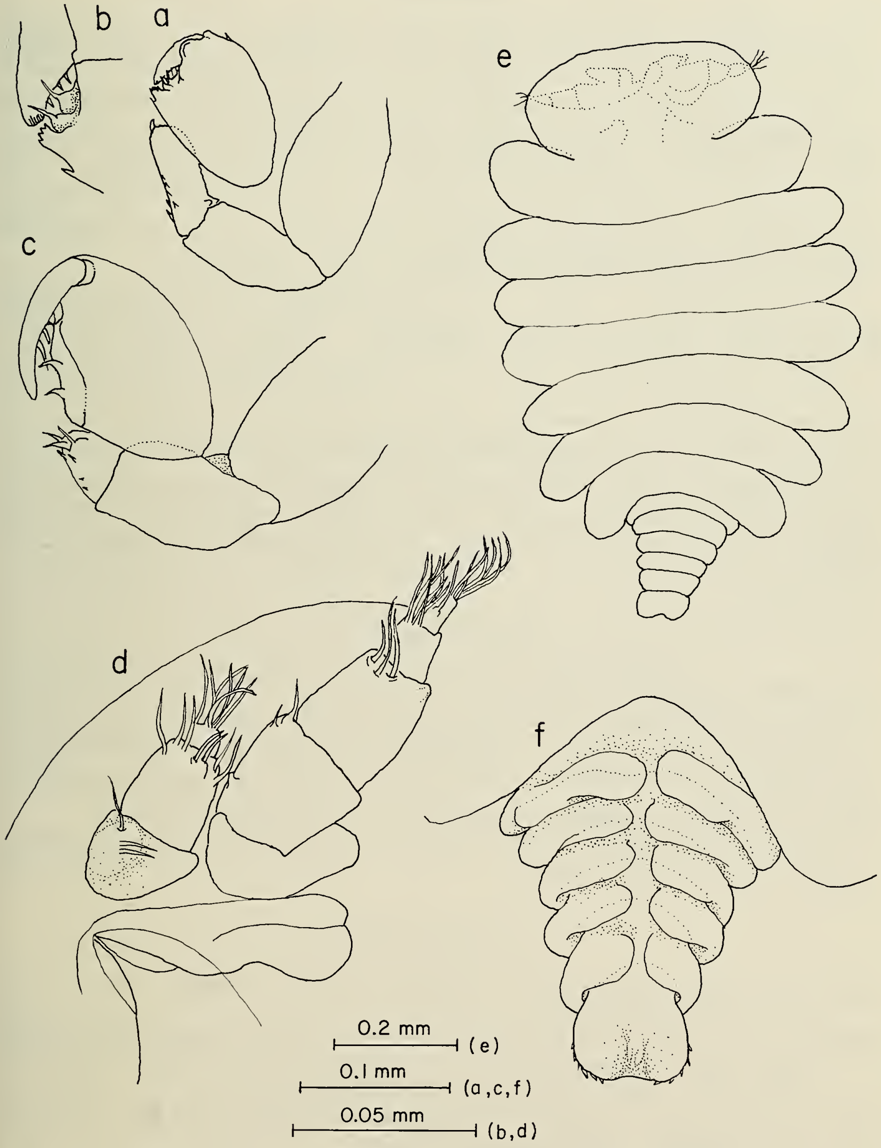

Fig. 3. *Pseudasmmetrione markhami,* male: a, Left pereopod 1; b, Enlargement of a; c, Left pereopod 7; d, Left antennae; e, Dorsal view; f, Pleon, ventral view. Scales as indicated.

Discussion

The maxilliped spur (Fig. 2a–e) is here defined as a posterior lateral projection from the muscle attachment area of the maxilliped. In *Pseudasymmetrione markhami*, the spur is clearly attached to the maxilliped and not to the cephalon. Various authors (Chopra, 1923; Richardson, 1905; Sars, 1898; and Shiino, 1950) have illustrated an anterior projection of the posterior lamina attached to the maxilliped. This projection could, in fact, be a maxilliped spur, but only Chopra (1923, pl. 12, 13, 15) mentioned that part of the posterior lamina was attached to the maxilliped.

Because pleopods of males of the Pseudioninae vary from biramous (*Propseudione* Shiino, 1933), to uniramous (*Pseudione* Kossman, 1881), to absent (*Aporobopyrus* Nobile, 1906); the question of when a swelling or tubercle on the ventral surface of the pleon should be considered a pleopod needs to be answered. *Pseudasymmetrione markhami* males do not have pleopods even though the positions of the pleopods are indicated by low flap-like ridges extending medially from the lateral margins of the pleomere (Fig. 3f). These ridges are not visible in lateral view. We suggest that a pleopod should be visible as a protuberance in lateral view of the pleon.

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Note added in proof.—Markham (1978:110) mentions an "undescribed genus and species." Examination of his material from *Iridopagurus iris* shows that the specimens are assignable to *Pseudasymmetrione* but appear to represent an undescribed species. The female differs from the female of *P. markhami* by its dextral torsion and by the shape of the maxilliped and the first oostegite. Markham's male specimen of the undescribed species assignable to *Pseudasymmetrione* differs only slightly from *P. markhami* in that the ventral ridges of the pleon are more distinct.

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NEW SPECIES OF LEPTODACTYLID FROGS OF THE GENUS *ELEUTHERODACTYLUS* FROM THE COSÑIPATA VALLEY, PERÚ

William E. Duellman

Abstract.—Five new species of the *Eleutherodactylus unistrigatus* group are named from the Amazonian slope of the Andes in Departamento Cuzco, Perú. All of the species occur in cloud forests at elevations of 1,580–2,400 m in the valley of the Río Cosñipata.

Frogs of the genus *Eleutherodactylus* are abundant as species and individuals in the montane forests of Colombia and Ecuador, but heretofore few species have been recognized in Perú. During three excursions into the Cosñipata Valley in southern Perú in 1971, 1975, and 1977, five unnamed species of *Eleutherodactylus* were discovered. These are named and described in this paper.

The narrow, heavily forested valley of the Río Cosñipata is on the northeastern slopes of the Cadena de Paucartambo, a front range of the Andean Cordillera Oriental in Departamento Cuzco. The Río Cosñipata is one of several streams originating high in the Andes and flowing into the Río Madre de Díos, a tributary of the Brasilian Rio Madeira, which flows into the Rio Amazonas. The valley of the Río Cosñipata is reached by road from the village of Paucartambo at 3,040 m in the dry upper Paucartambo Valley. The road leads north–northeastward for 25 km to Abra Acanacu (3,520) on the crest of the Cadena de Paucartambo. From the *abra* the road goes in a generally easterly direction to the Amazonian lowlands reached at Patria, 73 km from Abra Acanacu. Shortly after leaving Abra Acanacu the road enters the Río Cosñipata drainage; for the last 50 km to Pilcopata the road lies in the Cosñipata Valley (Fig. 1); several small settlements between Abra Acanacu and Patria consist of one or two houses each.

Abra Acanacu is above tree line; the vegetation is *puna* dominated by bunch grass (principally *Stipa*) with numerous low herbs, ferns, and mosses. Tree line is reached at 3,150 m. The upper reaches of the forest are characterized by low trees (*Polylepis, Baccharis*) and viney bamboo (*Chuquesia*); somewhat lower on the slopes the forest is much taller with some tree ferns and bromeliads and a luxuriant undergrowth of mosses and ferns. In the lower montane forest tree ferns are more abundant, and bromeliads and mosses are less common than at higher elevations.

In the following descriptions the designation of species groups is that of Lynch (1976), and the numerical sequence in the diagnoses follows Lynch (1974). Institutional abbreviations are: AMNH = American Museum of Natural History, KU = Museum of Natural History, University of

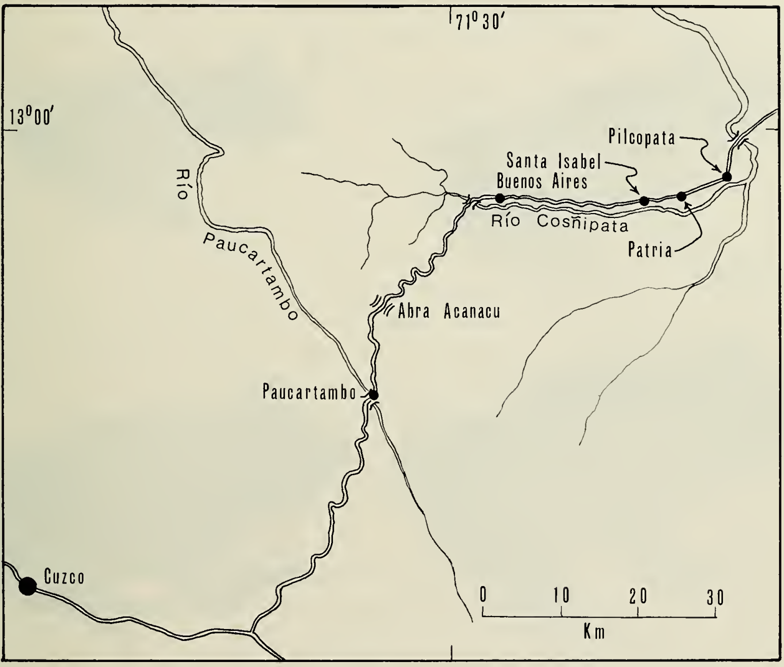

Fig. 1. Map of part of Departamento Cuzco, Perú, showing localities mentioned in text. Based on Mapa Físico Politico, República del Perú, 1:1,000,000; Instituto Geográfico Militar, Lima, 1973.

Kansas, LSUMZ = Louisiana State University Museum of Zoology, MCZ = Museum of Comparative Zoology, Harvard University, USNM = National Museum of Natural History.

Eleutherodactylus cosnipatae new species
(Fig. 2A)

Holotype.—KU 162298, an adult male, from the Río Cosñipata, 4 km SW Santa Isabel, 1,700 m, Departamento Cuzco, Perú (13°05′S; 71°18′W), obtained by William E. Duellman on 10 February 1975.

Paratypes.—KU 138876 from 2 km WSW Santa Isabel, 1,580 m, Departamento Cuzco, Perú, obtained by William E. Duellman on 14 January 1971; KU 162299–304 from the type-locality, collected by William E. Duellman, Dana K. Duellman, John E. Simmons, and Linda Trueb on 10–11 February 1975.

Diagnosis.—A member of the *Eleutherodactylus unistrigatus* group characterized by: 1) skin on dorsum shagreened with weak dorsolateral folds; skin on venter areolate; 2) tympanum and tympanic annulus prom-

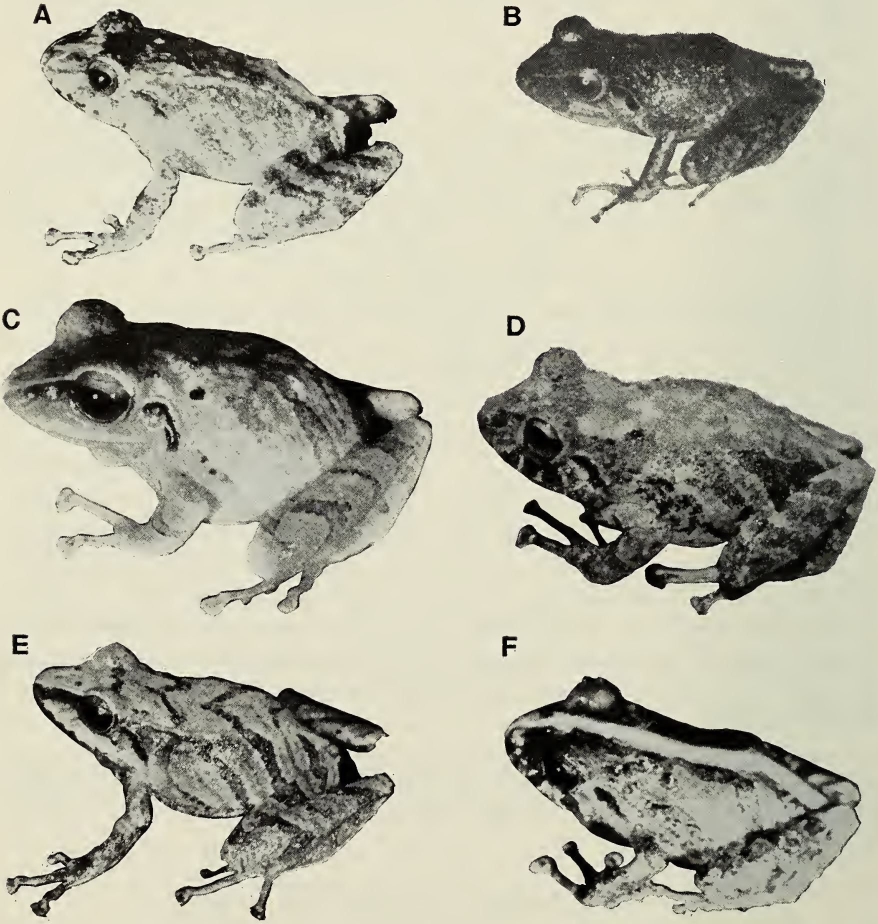

Fig. 2. New species of *Eleutherodactylus*: A. *E. cosnipatae*, KU 162298, ♂, 21.8 mm snout-vent length (SVL); B. *E. danae*, KU 138878, juv., 28.3 mm SVL; C. *E. danae*, KU 162307, ♂, 34.0 mm SVL; D. *E. lindae*, KU 162305, ♀, 39.2 mm; E. *E. pharangobates*, KU 173237, ♂, 23.8 mm SVL; F. *E. salaputium*, KU 162292, ♂, 17.9 mm SVL.

inent: 3) snout long, sloping, round in dorsal view and profile; 4) interorbital area flat, slightly wider than eyelid; crests absent; 5) prevomerine odontophores evident; 6) vocal slits present; vocal sac single, median subgular; 7) first finger shorter than second; discs truncate, twice width of digit; 8) fingers having lateral fringes; 9) ulnar folds and tubercles absent; 10) low tubercles present on tarsi; 11) inner metatarsal tubercle small, elliptical; outer tubercle small, subconical; 12) toes having lateral fringes; 13) dorsum grayish tan with bold brown markings; venter gray with white flecks; axilla, groin, and ventral surfaces of hind limbs orange-red; snout-vent length 21.8–29.5 mm in males.

Eleutherodactylus cosnipatae closely resembles *E. pharangobates*, which differs by lacking lateral fringes on the fingers and toes, by lacking the orange-red coloration of the groin and thighs and by having dorsolateral folds. Red is present in these areas in *E. altamazonicus* a lowland species with a dark venter and tuberculate dorsum. The sympatric *E. danae* is larger and has the posterior thighs dark brown with cream flecks, and *E. lindae* is a much larger frog with bold brown reticulations on the venter.

Description.—Body robust, head longer than wide; snout long, narrow, sloping, rounded in dorsal view and in profile, protruding well beyond margin of lip; top of head flat; interorbital distance 1.25 times width of eyelid; canthus angular; loreal region distinctly concave; lips rounded, nostrils slightly protuberant laterally; internarial area barely depressed. Tympanum distinct, round, its posterodorsal margin concealed under thin supratympanic fold, separated from eye by distance equal to diameter of tympanum; tympanic annulus distinct.

Forearm moderately short and robust, lacking ulnar fold and tubercles; first toe noticeably shorter than second; fingers having weak lateral fringes extending to truncate discs, which are twice width of digit; subarticular tubercles small round; palmar tubercle round, diffuse; pollical tubercle elliptical. Hind limbs moderately short and robust; two low tubercles on dorsolateral surface of tarsus; inner tarsal fold discontinuous on distal half of tarsus; inner metatarsal tubercle small, elliptical; outer metatarsal tubercle small, subconical; lateral fringes on toes extending to expanded discs; subarticular tubercles small, subconical.

Skin on dorsum finely shagreened with weak dorsolateral folds and low tubercles on eyelids and in tympanic region in all specimens and on all dorsal surfaces in some specimens; skin on throat and belly areolate; skin on other surfaces smooth. Anal opening a puckered aperture at upper level of thighs. Prevomerine odontophores small, rounded, slightly elevated structures well behind posterior margins of small round choanae; each odontophore bearing 0–4 ($\bar{x} = 2.2$) teeth; vocal slits and single, median, subgular vocal sac present.

Coloration in preservative.—Dorsum grayish tan to reddish brown with dark brown markings consisting of: broad loreal stripe, labial bars, interorbital bar, 3–4 chevrons on body, 2 bars on forelimb, 3–4 bars on each thigh, shank, and foot; 2–3 diagonal marks on flanks; belly cream; throat gray with white flecks; ventral surfaces of hind limbs orange-tan.

Coloration in life.—Dorsum grayish tan with brown markings; throat and belly with white flecks; axilla, groin, and ventral surfaces of hind limbs bright orange-red; iris bronze with median horizontal red streak.

Measurements.—The eight males comprising the type-series have the following dimensions (in mm); the holotype is the smallest individual, and the mean values are given in parentheses after the observed range: snout-vent length 21.8–29.5 (25.1), tibia length 12.2–15.6 (13.6), foot length 11.4–13.3 (12.3), head length 8.7–12.2 (10.1), head width 8.3–10.4 (9.3), interorbital distance 2.7–3.8 (3.1), width of eyelid 1.9–2.8 (2.46), eye-nostril 2.4–3.1 (2.74), diameter of eye 2.7–4.0 (3.2), diameter of tympanum 1.1–1.8 (1.43).

Remarks.—Except for one individual that was under a rock by day, all specimens were calling from low vegetation in cloud forest at night. The call is a soft "wraank."

Etymology.—The specific name is derived from the Quecchuan name for the valley—Cosñipata.

Eleutherodactylus danae new species
(Fig. 2B–C)

Holotype.—KU 162307, an adult male from the Río Cosñipata, 4 km (by road) SW of Santa Isabel, Departamento Cuzco, Perú, 1,700 m (13°05′S; 71°18′W), one of a series collected on February 1975 by William E. Duellman, Dana K. Duellman, John E. Simmons, and Linda Trueb.

Paratypes.—KU 162308–57, MCZ 93305–10, AMNH 97987–92 collected with the holotype; KU 138878 from 2.5 km WSW Santa Isabel, 1,620 m; KU 162358–65 from 6 km NE Santa Isabel 1,270 m.

Diagnosis.—A member of the *Eleutherodactylus unistrigatus* group characterized by: 1) skin of dorsum finely shagreened with faint dorsolateral folds; skin on venter coarsely areolate; 2) tympanum prominent, round, about ½ diameter of eye; 3) snout long, sloping, round in dorsal view and in profile; 4) interorbital area flat, only slightly wider than eyelid, crests absent; 5) prevomerine odontophores distinct, triangular; 6) vocal slits present; vocal sac median, subgular; 7) first finger shorter than second; terminal discs truncate, 2.5 times width of digit; 8) fingers having lateral fringes; 9) ulnar folds and tubercles absent; 10) tubercles absent on heels and tarsi; 11) inner metatarsal tubercle large, flat, elliptical; outer metatarsal tubercle minute, subconical; 12) toes having lateral fringes and basal webbing; 13) dorsum brown with dark brown chevrons; anterior and posterior surfaces of thighs dark brown with cream flecks; venter white with or without gray flecks; 14) snout-vent length 27.3–33.8 mm in males, 37.5–45.8 mm in females.

In coloration, *E. danae* is similar to *E. conspicillatus* and *E. peruvianus*, both of which have dorsal chevrons and dark thighs with orange or red flecks. Both of those species are members of the *Eleutherodactylus fitzingeri* group and have smooth venters and the first fingers longer than the second.

Description.—Body moderately robust; head slightly longer than wide; snout round in dorsal view and in profile; snout protruding well beyond margin of lip, top of head flat; interorbital distance slightly greater than width of eyelid; canthus angular; loreal region barely concave; nostrils slightly protuberant laterally; internarial region flat; lips not flared. Tympanum distinct, round, separated from eye by distance nearly equal to diameter of tympanum, bordered above by thin supratympanic fold.

Forearm slender, lacking folds and tubercles; first finger barely shorter than second; fingers having lateral fringes extending to discs, which are truncate and 2.5 times as wide as digit; subarticular tubercles large, subconical; palmar tubercle large, round; pollical tubercle quadrangular. Hind limbs long, slender; tubercles absent on heels and tarsi; inner tarsal fold weak, extending about half length of tarsus; inner metatarsal tubercle large, flat, elliptical; outer metatarsal tubercle minute, subconical; lateral fringes on toes extending to expanded discs; basal webbing between third, fourth, and fifth toes; subarticular tubercles large, subconical.

Skin on dorsum finely shagreened; weak dorsolateral folds posteriorly; skin on belly and proximal posteroventral surfaces of thighs; skin on other surfaces smooth. Anal opening a puckered aperture at midlevel of thighs, bordered below by granules. Prevomerine odontophores small, elevated, triangular, widely separated medially behind level of small round choanae; each odontophore bearing 1–3 teeth. Vocal slits and median subgular vocal sac present.

Coloration in preservative.—Dorsum tan to brown with dark brown interorbital bar and three or four chevrons (98.6% of 72 specimens) and a pair of black spots in scapular regions; narrow diagonal dark bars on limbs. Narrow cream canthal line bordered below by dark brown; supratympanic spot black; lips tan with brown bars. Anterior and posterior surfaces of thighs dark brown with cream flecks. Venter white with black spots on belly (50%) and throat (28%).

Coloration in life.—The dorsum is yellowish tan to dark reddish brown with dark brown chevrons. The venter is pale yellow. The hidden surfaces of the thighs are dark brown with pale yellow spots. The iris is reddish copper.

Measurements.—The holotype, an adult male, has the following dimensions (in mm): snout-vent length 34.0, tibia length 19.6, foot length 17.9, head length 14.0, head width 12.8; interorbital distance 4.4, width of eyelid 3.8, eye-nostril 4.3, diameter of eye 4.7, diameter of tympanum 2.5. Measurements and proportions of 30 males followed by those of three females (means in parentheses) are: snout-vent length (SVL) 27.3–33.8 (30.9), 37.5–45.8 (41.9); tibia length/SVL .533–.642 (.594), .600–.626 (.614); foot length/SVL .493–.583 (.536), .531–.567 (.551); head length/SVL .374–.424

(.398), .410–.440 (.424); head width/SVL .341–.402 (.365), .381–.397 (.389); interorbital distance/head width .297–.388 (.338), .260–.383 (.311); eye-nostril/head length .296–.369 (.323), .321–.372 (.353); tympanum/eye .417–.575 (.506), .517–.617 (.557).

Remarks.—*Eleutherodactylus danae* is known only from elevations of 1,270–1,700 m in the Río Cosñipata Valley on the lower Andean slopes in southern Perú. All specimens were perched on low (<50 cm) herbs and ferns in cloud forest at night.

Etymology.—The specific name is a patronym for my daughter, Dana K. Duellman, in recognition of her youthful enthusiasm for collecting frogs in the Andes.

Eleutherodactylus lindae new species
(Fig. 2D)

Holotype.—KU 162305, an adult female, from the Río Cosñipata, 4 km SW Santa Isabel, 1,700 m, Departamento Cuzco, Perú (13°05′S, 71°18′W), obtained by Linda Trueb on 11 February 1975.

Diagnosis.—A member of the *Eleutherodactylus unistrigatus* group characterized by: 1) skin on dorsum shagreened; skin on venter coarsely areolate; 2) tympanum and tympanic annulus prominent; 3) snout long, sloping, round in dorsal view and in profile; 4) interorbital area flat, one-third again as wide as eyelid, crests absent; 5) prevomerine odontophores prominent; 6) vocal slit condition unknown; 7) first finger shorter than second; terminal discs truncate, twice width of digit; 8) fingers having lateral fringes and basal webbing; 9) ulnar tubercles present; 10) tubercles absent on heels and tarsi; 11) inner metatarsal tubercle large, ovoid, spatulate; outer tubercle small, round; 12) toes having lateral fringes; 13) dorsum tan; venter cream with dark brown reticulations; 14) snout-vent length 39.2 mm in female.

Superficially, *E. lindae* resembles *E. ventrimarmoratus*, a species with shorter, more robust limbs, and large, irregular, black blotches on the belly and ventral surfaces of the shanks. The ventral coloration in other species of *Eleutherodactylus* in the southern Andes consists of either nearly uniform dark color (*E. platydactylus*, *E. salaputium*), uniform light color (*E. mendax*), or with gray or brown flecks (*E. cosnipatae*, *E. granulosus*, *E. pharangobates*). The sympatric *E. danae* has dense dark flecking ventrally, but the posterior surfaces of the thighs are dark brown with cream flecks (uniform dark brown in *E. lindae*).

Description.—Body robust; head wider than long; snout long, sloping, round in dorsal view and in profile, protruding slightly beyond margin of lip; top of head flat; interorbital distance one-third again width of eyelid; canthus rounded; loreal region barely concave; lips rounded; nostrils slightly protuberant laterally; internarial area barely depressed. Tympanum round, its posterodorsal margin concealed by a supratympanic fold, separated from eye by distance equal to about 1.25 times diameter of tympanum; tympanic annulus distinct.

Forearm moderately slender, bearing row of low round tubercles on ventrolateral edge; first finger barely shorter than second; fingers having lateral fringes extending to discs, which are truncate and twice as wide as digit; fingers webbed basally; subarticular tubercles moderately large, subconical; palmar tubercle tripartite; pollical tubercle elliptical. Hind limbs moderately short, robust; tubercles absent on heels and tarsi; inner metatarsal fold curved on distal third of tarsus, encompassing two small spatulate tubercles; inner metatarsal tubercle large, ovoid, spatulate; outer metatarsal tubercle small, round; lateral fringes on toes extending to expanded discs; toes not webbed; subarticular tubercles small, subconical.

Skin on dorsum finely shagreened with low fold from posterior corner of eyelid to scapular region, two low tubercles posteroventral to tympanum, and one tubercle on top of head midway between anterior corners of eyelids; skin on chest, belly, and posteroventral surfaces of thighs coarsely areolate; skin on other surfaces smooth. Anal opening a puckered aperture at upper level of thighs, surrounded by many small tubercles. Prevomerine odontophores large, round, narrowly separated prominences behind level of posterior margins of small round choanae, each having 5–6 teeth.

Coloration in preservative.—Dorsum pale tan with diffuse dark brown spot on head between posterior half of eyelids, pair of dark brown spots in scapular region, diffuse irregular dark brown marks in sacral region, dark brown bars on lips, and dark brown supratympanic stripe curving downward behind tympanum; limbs tan with distinct brown transverse bars; anterior and posterior surfaces of thighs brown; ventral surfaces of limbs tan; flanks, throat, and belly cream with bold dark brown reticulations.

Coloration in life.—Dorsum tan with dark brown markings; posterior thighs and ventral surfaces of hind limbs dark brown; throat pinkish cream with black flecks; flanks and belly cream with black reticulations; iris bronze with median horizontal dark reddish brown streak.

Measurements.—The holotype, an adult female, has the following dimensions (in mm): snout-vent length 39.2, tibia length 19.2, foot length 18.8, head length 14.1, head width 15.3, interorbital distance 5.0, width of eyelid 3.7, eye-nostril 4.5, diameter of eye 4.5, diameter of tympanum 1.4.

Remarks.—The only known specimen was on a bush at night in cloud forest.

Etymology.—The specific name is a patronym for Linda Trueb in recognition of her extensive collecting of frogs in South American cloud forests.

Eleutherodactylus pharangobates new species
(Fig. 2E)

Holotype.—KU 173236, an adult male, from Buenos Aires, 2,400 m, Departamento Cuzco, Perú (13°07′S; 71°28′W), one of a series collected by William E. Duellman and David C. Cannatella on 19 January 1977.

Paratopotypes.—KU 173237–54, same data and collectors.

Diagnosis.—A member of the *Eleutherodactylus unistrigatus* group characterized by: 1) skin on dorsum shagreened with dorsolateral fold; skin on venter areolate; 2) tympanum prominent; 3) snout long, sloping, acuminate in dorsal view, round in profile; 4) interorbital area flat, half again as wide as eyelid; crests absent; 5) prevomerine odontophores present or absent; 6) vocal slits present; vocal sac single, median, subgular; 7) first finger shorter than second; terminal discs truncate, twice width of digit; 8) fingers lacking lateral fringes; 9) ulnar folds and tubercles absent; 10) tubercles absent on heels and tarsi; 11) inner metatarsal tubercle low, flat, elliptical; outer tubercle small, round; 12) toes lacking lateral fringes; 13) dorsum yellowish tan to grayish tan with brown chevrons on body and diagonal marks on limbs; labial stripe and dorsolateral stripe (present or not) cream; venter gray with cream flecks; 14) snout-vent length 21.4–25.4 mm in males, 27.8–29.5 mm in females.

Eleutherodactylus pharangobates is like *E. cosnipatae* in size and general coloration, but the latter lacks dorsolateral folds and has lateral fringes on the fingers and toes and orange-red in the groin and thighs. *Eleutherodactylus danae* also has dorsolateral folds, but it has fringes on the fingers and toes and pale flecks on dark brown posterior surfaces of the thighs. The sympatric *E. granulosus* lacks dorsolateral folds and does not have the terminal digital discs expanded.

Description.—Body robust; head slightly longer than wide; snout long, sloping, acuminate in dorsal view, round in profile, projecting well beyond margin of jaw; top of head flat; interorbital distance 1.5 times width of eyelid; canthus angular; loreal region flat; lips rounded; nostrils slightly protuberant laterally; internarial area flat. Tympanum distinct, round, its upper margin covered by supratympanic fold, separated from eye by distance equal to half diameter of tympanum; tympanic annulus distinct.

Forearm moderately robust and short, lacking ulnar fold and tubercles; first finger slightly shorter than second; fingers lacking lateral folds; terminal discs truncate, twice width of digit; subarticular tubercles small round; palmar tubercle bifid; pollical tubercle large, ovoid, diffuse. Hind limbs moderately long, robust; tubercles absent on heel and tarsus; inner tarsal fold present on distal half of tarsus; inner metatarsal tubercle low, flat, elliptical; outer metatarsal tubercle small, round; lateral fringes absent on toes; subarticular tubercles small, round.

Skin on dorsum shagreened with single dorsolateral fold on each side and minute spinules on posterior part of body and dorsal surfaces of shanks; skin on throat, belly, and ventral surfaces of thighs coarsely areolate; skin on other surfaces smooth. Anal opening a puckered aperture at mid-level of thighs. Prevomerine odontophores absent in males; small oblique processes bearing 2–3 teeth in females; choanae small, round, widely separated; vocal slits, and large, single, median, subgular vocal sac present.

Coloration in preservative.—Dorsum grayish tan with dark brown markings consisting of: loreal stripe extending from tip of snout to eye and postorbital bar from eye to insertion of arm, usually short transverse stripe or pair of spots on snout, elongate mark between eyes, three chevrons on body, pair of bars in inguinal region, narrow transverse bars on limbs, and diagonal bars on flanks; dark marks narrowly bordered by cream or not; dorsolateral cream stripes in two (10%) of the specimens; edge of lip cream; anterior and posterior thighs brown; anal region dark brown. Throat dark gray brown with cream flecks; belly cream with gray flecks.

Coloration in life.—Dorsum yellowish tan to olive-tan with brown chevrons on back and diagonal marks on flanks, dorsolateral stripe (if present) and labial stripe pale yellowish tan, dorsum of hind limbs more orange in some individuals; canthal stripe dark brown. Groin and proximal anterior surface of hind limb pale orange or yellowish orange with grayish brown mottling; throat and belly yellow with gray spots to gray with yellow spots; ventral surfaces of hind limbs yellowish tan; iris bright bronze with broad red horizontal band; venter in juveniles bright yellow.

Measurements.—The dimensions (in mm) of the male holotype, range of variation in 11 males (means in parentheses), and one female are: snout-vent length 23.3, 21.4–25.4 (23.5), 27.8; tibia length 13.4, 12.7–14.5 (13.5), 16.8; foot length 12.2, 10.5–13.3 (12.1), 15.2; head length 9.1, 8.9–10.3 (9.4), 11.3; head width 8.8, 8.1–9.9 (8.7), 10.2; interorbital distance 3.1, 2.5–3.4 (3.05), 3.6; width of eyelid 2.4, 1.7–2.6 (2.13), 2.6; eye-nostril 2.7, 2.4–3.0 (2.71), 3.3; diameter of eye 2.8, 2.7–3.4 (2.91), 3.3; diameter of tympanum 1.4, 1.4–2.1 (1.52), 1.6. Seven juveniles have snout-vent lengths of 16.8–18.8 ($\bar{x} = 17.6$) mm.

Remarks.—Seventeen specimens (LSUMZ 32267, 32269–84) from Hacienda Huyro, 1,720 m elevation in the Umasbamba Valley, Departamento Cuzco, are referred to this species. This locality is ≈150 km W of Buenos Aires. Included in the series are six gravid females having snout-vent lengths of 31.5–35.4 ($\bar{x} = 33.7$) mm.

A single male (AMNH 82514) was obtained in elfin forest at 1,870 m in the isolated Serranía de Sira, Departamento Huánuco. This locality is ≈385 km NW of Buenos Aires. One specimen (USNM 146587) was taken in a bromeliad at 1,820 m, 10 km N Limbo, Departamento Cochabamba, Bolivia, which is ≈880 km SSE of Buenos Aires. Thus, *E. pharangobates* has an extensive range along the Cordillera Oriental and associated ranges from central Perú to northern Bolivia.

At the type-locality all individuals were found on the cool, misty night of 19 January 1977; they were perched on low vegetation, principally ferns, on a moss-covered cliff. The call is a loud chirp with intermittent short squeaks. At Huyro, Richard Thomas found the frogs on herbaceous vegetation on a steep bank on 23 August–2 September 1974.

Etymology.—In allusion to the steep slopes inhabited by this species, the epithet is derived from the Greek *pharanx* and *bates*, and means one who frequents ravines.

Eleutherodactylus salaputium new species
(Fig. 2F)

Holotype.—KU 162292, an adult male from the Río Cosñipata, 4 km SW Santa Isabel, 1,700 m, Departamento Cuzco, Perú (13°05′S; 71°18′W), one of a series collected by William E. Duellman on 10 February 1975.

Paratopotypes.—KU 162291, 162293–97, collected by William E. Duellman and Linda Trueb on 10–11 February 1975.

Diagnosis.—A member of the *Eleutherodactylus unistrigatus* group characterized by: 1) skin of dorsum finely shagreened with small tubercles in scapular region; skin of venter weakly areolate; 2) tympanum and tympanic annulus prominent; 3) snout short, round in dorsal view and profile; 4) interorbital area flat, wider than eyelid; crests absent; 5) prevomerine odontophores nearly concealed in buccal tissue; 6) vocal slits present; vocal sac single, median, subgular; 7) first finger shorter than second; terminal discs truncate, three times width of digit; 8) fingers having lateral fringes; 9) ulnar tubercles present; 10) tubercles present on heels and tarsi; 11) inner metatarsal tubercle large, flat, elliptical; outer metatarsal tubercle small, conical; 12) toes having lateral fringes and basal webbing; 13) dorsum tan with dark brown markings; venter brown; 14) snout-vent length 16.3–18.6 mm in males.

The small size, dark venter, and absence of yellow or orange spots in the groin immediately distinguish *E. salaputium* from other upper Amazonian and southern Andean *Eleutherodactylus.*

Description.—Body moderately robust; head slightly longer than wide; snout short, bluntly rounded in dorsal view, round in profile, barely protruding beyond margin of lip; top of head flat; interorbital distance 1.2 times width of eyelid; canthus round; loreal region distinctly concave; lips round; nostrils slightly protuberant laterally; internarial area distinctly depressed. Tympanum distinct, round, its upper edge partially concealed by a supratympanic fold, separated from eye by distance slightly greater than diameter of tympanum; tympanic annulus distinct.

Forearm slender with row of low tubercles on ventrolateral edge; first finger noticeably shorter than second; fingers having lateral fringes extending to discs, which are truncate and about three times as wide as digit; subarticular tubercles moderately large, round; palmar tubercle tripartite; pollical tubercle ovoid. Hind limbs moderately long and slender with one low subconical tubercle on heel and two on outer edge of tarsus; inner tarsal fold present on distal one-fourth of tarsus; inner metatarsal tubercle large, flat, ovoid; outer metatarsal tubercle small, conical; lateral fringes on toes extending to expanded discs; basal webbing between third, fourth, and fifth toes; subarticular tubercles small, subconical.

Skin on dorsum finely shagreened with low tubercles in scapular region, in tympanic area, on dorsal surfaces of limbs, and in some specimens on back (see *Remarks*); skin on belly and ventral surfaces of thighs weakly areolate; skin on other surfaces smooth. Anal opening a puckered aperture at upper level of thighs. Prevomerine odontophores nearly concealed in buccal tissue, small prominences, each bearing 1–2 teeth, widely separated well behind posterior margins of small round choanae. Vocal slits and single, median, subgular sac present.

Coloration in preservative.—Dorsum pale brown with darker brown markings consisting of transverse bars on limbs, bars on upper and lower lips, supratympanic mark, and dorsal markings on body in four specimens consisting of brown interorbital mark, diagonal brown marks in scapular area and chevron in sacral region; in two specimens middorsal cream stripe bordered by dark brown; in one specimen entire dorsum reddish brown with brown longitudinal streaks and dorsolateral black borders. Flanks and thighs creamy tan with brown bars on thighs. Venter dusky tan to reddish brown.

Coloration in life.—Dorsum reddish brown with dark brown markings; middorsal stripe, if present, orange; groin and dorsal surfaces of thighs yellowish green with dark brown markings; venter gray; iris dull bronze with median horizontal reddish brown streak.

Measurements.—Five males have the following dimensions (in mm); the measurements of the holotype are given first, followed by the range of variation and the mean in parentheses: snout-vent length 17.9, 16.3–18.6 (17.4); tibia length 8.8, 8.4–10.0 (9.2); foot length 8.6, 7.8–8.6 (8.3); head length 7.0, 6.7–8.5 (7.3); head width 6.5, 6.2–7.6 (6.7); interorbital distance 2.1, 2.1–2.5 (2.2); width of eyelid 1.9, 1.7–1.9 (1.84); eye-nostril 2.0, 1.8–2.2 (1.96); diameter of eye 2.3, 2.1–2.5 (2.24); diameter of tympanum 1.0, 0.9–1.1 (0.98). Two juveniles have snout-vent lengths of 12.8 and 14.8 mm.

Remarks.—The three color morphs have different patterns of tubercles on the dorsum. The morph with the brown diagonal marks in the scapular area has small tubercles associated with the marks. In the two specimens, one of which is the holotype, having a middorsal stripe a row of tubercles is present on either side of the stripe. The individual having a reddish brown dorsum with black dorsolateral borders has a row of prominent tubercles associated with the border and small tubercles associated with the dark streaks on the dorsum.

All individuals were found on low herbaceous plants in cloud forest at night.

Etymology.—The specific epithet selected for this small frog is the Latin *salaputium*, meaning dwarf.

Acknowledgments

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MORPHOLOGY OF THE BONY STAPES (COLUMELLA) IN OWLS: EVOLUTIONARY IMPLICATIONS

Alan Feduccia and Charles E. Ferree

Abstract.—The morphology of the bony stapes in owls (Aves: Strigiformes) is examined. Similar derived stapes occur in *Tyto* and *Phodilus*, supporting the concept of their close affinity. Another type of derived stapedial morphology occurs in some species of *Strix*, but most species of Strigidae exhibit the primitive avian stapes.

The owls (order Strigiformes) represent a notably homogeneous avian assemblage. Although many are diurnal, two-thirds of the 130 living species are crepuscular or nocturnal, and all are supposed to have evolved from nocturnal ancestors (Pumphrey, 1948:40). Enhanced visual and auditory acuity is essential for their existence as predators.

The earliest reliable record dates from the Paleocene (Rich and Bohaska, 1976), and by the Eocene at least two distinct strigiform genera are known to have existed. During the early to middle Tertiary, the diversification of many forms of small mammals probably accelerated the adaptive radiation of owls (Burton, 1973:30).

Although the members of the Strigiformes may be easily distinguished from those of other orders; the familial, subfamilial, and generic relationships within the order are much less certain. At present, the most widely accepted classification is that of Peters (1940), which separates the order into two families, the typical owls (Strigidae) and the barn owls (Tytonidae). The Strigidae is further subdivided into two subfamilies, Buboninae and Striginae; the Tytonidae is subdivided into the Tytoninae and Phodilinae. The last taxon has been the source of debate for many years, with some authors choosing to ally *Phodilus* with the strigids rather than the tytonids. In hopes of resolving this controversy, the primary concern of this paper will be to determine the relationship of *Phodilus* to other owls using the morphology of the columella or stapes. The occurrence and evolution of bilateral ear asymmetry in owls and its bearing on their systematics is discussed by Norberg (1977).

Morphology of the Stapes

The avian columella, consisting of the bony stapes and the cartilaginous extracolumella (or extrastapes), functions to transform airborne vibrations. The avian element, although broadly homologous with the hyomandibular cartilage of fishes and the stapes of mammals, most closely resembles the reptilian columella. In fact, these elements are so similar that the development and the primitive adult morphology of the avian stapes may be considered typically reptilian.

Although the columella describes a piston-like motion in all birds (Pohlman, 1921), in many species it also acts as a lever. The majority of owls possess the primitive type of avian stapes, very similar to that of many other birds and consisting of a relatively flat footplate and a nearly straight shaft emanating approximately from the center of the footplate (see Feduccia, 1975). In a number of species, however, the shaft has shifted towards the periphery (for example, *Aegolius funereus, Otus asio,* and others), presumably functioning to lengthen the short arm of the lever and therefore increase the magnitude of response to perturbations at the distal end (for discussion of this function see Feduccia, 1975). Also, some species (e.g. *Aegolius funereus*) have the footplate slightly expanded, but such variation is not considered markedly modified.

In addition to this variation, another type of derived morphology of the stapes is known which is of particular interest here. This condition is characterized by a prolongation of the inner aspect of the footplate into an almost hemispherical knob. Krause (1901) was the first to describe this variation, and Schwartzkopff (1955:342–343) has commented on its possible function: "Since the movements of this lever (the stapes) produce considerable turning moments at the remarkable velocity of the sonic vibrations, the pressure upon the hinge, namely the elastic connection with the footplate in the oval window (annulus fibrosus), must be reduced. This is done through 'mass equilibration': the inner surface of the footplate is prolonged into a tip which projects into the perilymph of the inner ear; and the tip has a special shape which prevents the formation of eddies." Schwartzkopff was mistaken, however, in assuming that all owls possess this derived morphology of the stapes footplate. Illustrations by Krause (1901) show the presence of the flat footplate (primitive condition) in both *Athene noctua* and *Otus asio.* Although he confirms the presence of a derived morphology in *Strix aluco*, though a problem of nomenclature he attributes this variation also to *Strix flammea,* but this name was previously used for *Tyto alba* and is not equivalent to the *Asio flammeus* of modern usage. Krause's illustration clearly shows the derived stapes of *Tyto alba* and not the primitive condition of *Asio flammeus.*

We have examined the bony stapes of 27 species from 17 of the 24 living genera of the order Strigiformes (Table 1). A derived condition of the footplate occurs in only three genera: *Tyto, Phodilus,* and some species of *Strix* (Figs. 1 and 2). The other genera examined all possess a relatively flat footplate, although in *Ciccaba woodfordii* (the African wood owl) there is a slightly convex protuberance on the inner aspect. With the possible exception of *C. woodfordii,* all of the species possessing a derived morphology of the stapes also possess asymmetrically placed ear openings (Table 1).

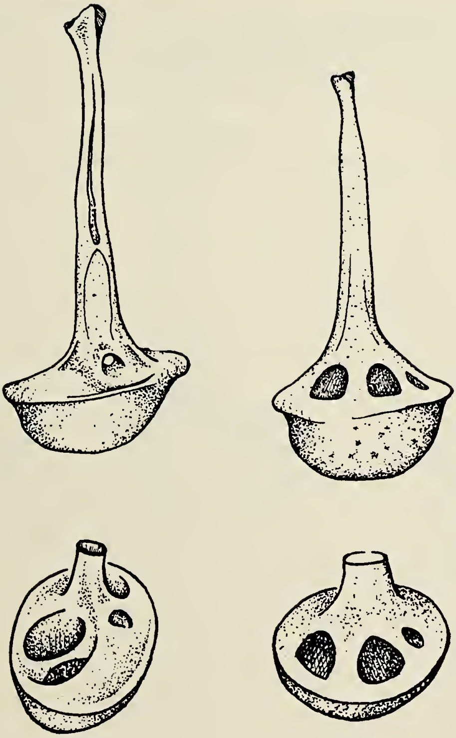

Fig. 1. Top: lateral views of the bony stapes of *Phodilus badius* (left), and *Tyto alba* (right). Bottom: views looking down upon the footplates of each, respectively. In mesial view the extended footplate region of *Tyto* tapers distally, that of *Phodilus* is more evenly rounded and does not taper so abruptly. All figures are drawn to the same approximate scale; actual lengths are 3–4.5 mm.

Upon close examination of the derived morphology of *Tyto*, *Phodilus* and *Strix* two features became obvious: (1) although the stapedial footplates of *Tyto* and *Phodilus* are very similar (Fig. 1), they differ markedly from those of *Strix*; (2) in the three species of *Strix* examined (*nebulosa*, *occidentalis*, and *varia*) the degree of protrusion of the footplate varies from almost none in *S. nebulosa* to a very marked protrusion in *S. varia* (Fig. 2).

Thus, the modified morphology of the stapes in *Strix* appears to have evolved independently of that of *Tyto*, particularly since none of the other genera of Strigidae possess such a character. There also appears to be a great deal of evolutionary experimentation with respect to stapes morphology within the genus *Strix*, evidenced by the wide range of variation of this character among the different species. The retention of the primitive condition in *S. nebulosa* also argues for independent evolution of the pro-

Table 1. A list of the species of owls for which the bony stapes was examined in this study, comparing those which exhibit asymmetry of the bony external ear openings and some modification of the stapedial footplate morphology.

Species	Skull asymmetry	Modified stapedial footplate
Phodilus badius	yes	yes
Tyto alba	yes	yes
Otus asio	no	no
Otus bakkamoena	no	no
Otus clarkii	no	no
Otus nudipes	no	no
Bubo virginianus	no	no
Bubo bubo	no	no
Bubo africanus	no	no
Pulsatrix perspicillata	no	no
Ketupa zeylonensis	no	no
Nyctea scandiaca	no	no
Surnia ulula	no	no
Glaucidium perlatum	no	no
Glaucidium cuculoides	no	no
Athene brama	no	no
Ninox scutulata	no	no
Speotyto cunicularia	no	no
Ciccaba woodfordii	no	possible?
Strix occidentalis	yes	yes
Strix varia	yes	yes
Strix nebulosa	yes	no
Asio otus	yes	no
Asio flammeus	yes	no
Asio capensis	yes	no
Pseudoscops grammicus	no	no
Aegolius funereus	yes	no

truding footplate in *Strix*. The extreme similarity of the stapes in *Tyto* and *Phodilus* suggests that the derived condition in these two genera is homologous, indicating that *Phodilus* is more closely related to *Tyto* than to any of the Strigidae. Other evidence supporting such a relationship follows later.

The derived morphology of the footplates of *Tyto* and *Phodilus* differs from that in *Strix* not only in the degree to which the footplate protrudes into the oval window, but also in the means of its attachment to the shaft. In both *Tyto* and *Phodilus* the shaft broadens at the base to meet the footplate at its periphery, making the shape of the stapes similar to that of an inverted ice cream cone (Figs. 1 and 2). In contrast, the shaft of *Strix* attaches nearer the center of the footplate, causing the stapes to appear umbrella-shaped.

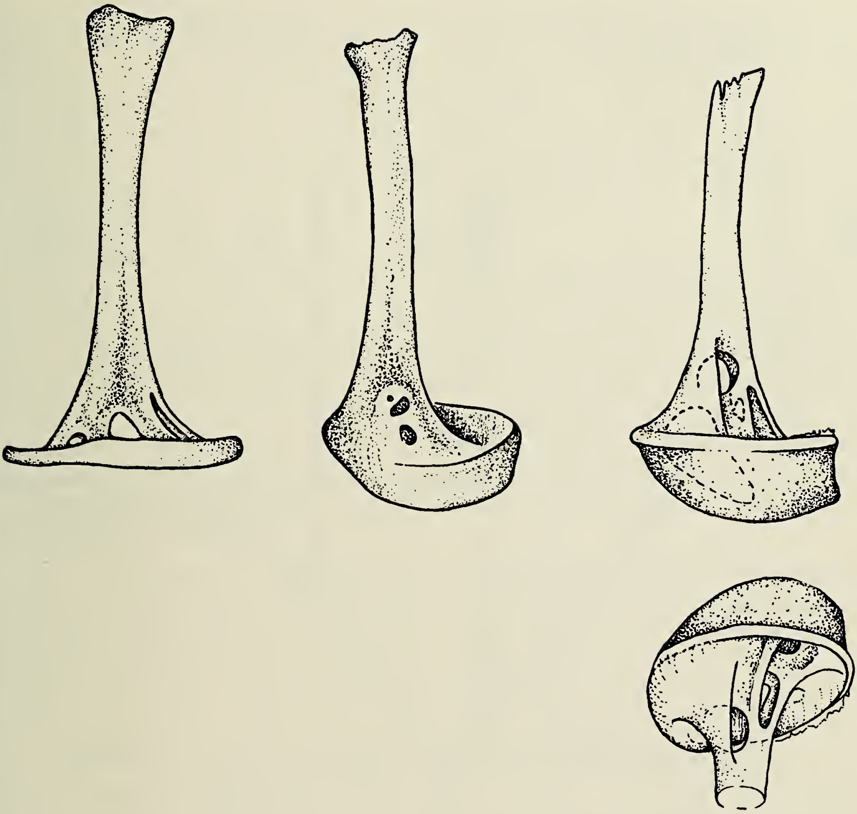

Fig. 2. Left to right: lateral views of the stapes of *Strix nebulosa* (primitive avian condition), *Strix occidentalis*, and *Strix varia*. Lower right, view looking down upon the footplate region of S. *varia* to show the "inverted umbrella" appearance of the attachment of the shaft of the bony stapes to the footplate region. All figures are drawn to the same approximate scale; actual lengths are approximately as those in Fig. 1.

Until recent years, only one species of *Phodilus* was recognized, *Phodilus badius*, ranging from northern India to Indonesia. In March, 1951, however, a second species was discovered in the eastern Congo and named *Phodilus prigoginei* (Burton, 1973:59). The genus *Phodilus* has been variously considered as a member of the Strigidae (Beddard, 1890; and Pycraft, 1903a, 1903b), a member of the Tytonidae (Nitzsch, 1867; Peters, 1940; Ford, 1967), or as a separate family (Marshall, 1966). A number of characters have been used as evidence for these various classifications, but it is often difficult to determine which of these are valid indices of evolutionary relationships. For example, the weak, unfused clavicles of

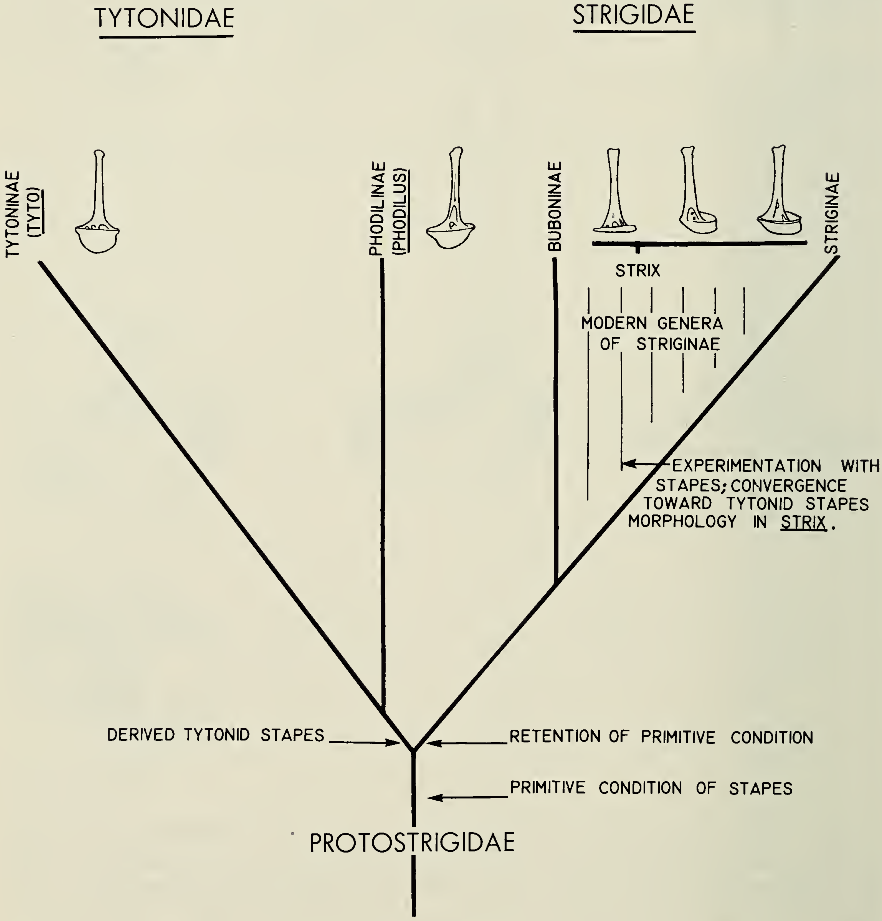

Fig. 3. Hypothetical phylogeny of the Strigiformes based on the morphology of the stapes and other lines of osteological evidence. This phylogeny assumes homology of the bony stapes of *Phodilus* and *Tyto*, and follows Ford (1967). The phylogeny also assumes convergence in the extended footplate of the stapes between certain species of *Strix* and the Tytonidae.

Phodilus have been used to ally it with the Strigidae, since some genera of this family (*Aegolius*, *Athene*, *Surnia*) possess similar characters.

Other features of *Phodilus* which have been used to indicate relationship with the Strigidae are: (1) broad, flat skull with a prominent forehead, (2) relatively large orbits, (3) posterior margin of the sternum with 4 notches, and (4) pterylography similar to that of certain strigids (Ford, 1967:31–37).

In regard to the first two of these features, Ford (1967:32–33) has remarked that, in addition to its similarity to the skulls of certain strigids, the skull of *Phodilus* also resembles that of *Tyto tenebricosa,* both of which have somewhat flattened cranial roofs, relatively steep foreheads, and large orbits characteristic of many strigids. The fact that a tytonid also possesses these features strongly suggests that "the cranial characters that have been used to ally *Phodilus* with the Strigidae are not significant at the family level" (p. 33).

Finally, the pterylography of *Phodilus* has been considered by at least one author to resemble that of a strigid. Although Nitzsch (1967) remarked on the similarity of the feather tract patterns of *Phodilus* and *Tyto,* he provided no illustrations or specific descriptions. Pycraft (1903b) considered the pterylography of *Phodilus* to be most like that of *Asio,* although Ford (1967:36–37) disagrees. After examination of Pycraft's illustrations of the feather tract patterns of *Phodilus badius, Tyto alba,* and *Asio flammeus,* Ford states that "the arrangement and size of the feather tracts of the dorsal side of *Phodilus* appear to be more like those of *Tyto* than those of *Asio.*"

Other characters of both the skull and postcranial skeleton of *Phodilus* resemble those of *Tyto.* Among these are similarities in the coracoid, tarsometatarsus, phalanges of the foot, interorbital septum, and mandible (Ford, 1967:23–30). As mentioned earlier, the bony external ears of *Phodilus* and *Tyto* exhibit the same type of asymmetry, except *Phodilus* lacks an operculum. The tympanic cavities of each are open above, and both genera lack a temporal groove. Ford (p. 39–40) further states, "The plumage texture of *Phodilus* is like that of *Tyto.* Its facial disc, though forming unique 'teddy-bear ears' dorsally (Marshall, 1966:237 and Fig. 2), is nevertheless more similar to the heart-shaped disc of *Tyto* than to that of any strigid."

It seems that the large number of morphological similarities between *Phodilus* and *Tyto* including that of the stapes argue strongly for monophyly of the two genera. On the basis of the available evidence we believe that the genus *Phodilus* is correctly classified as a member of the Tytonidae, as reflected by the taxonomy of Peters (1940). A hypothetical phylogeny of owls based on stapedial morphology and other primarily osteological evidence is shown in Fig. 3.

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Mengel (Univ. of Kansas) for permitting Feduccia to use skeletal collections under their care. The drawings for Figs. 1 and 2 were rendered by Ms. Melissa Marshall, and Fig. 3 by Ms. Virginia Shoonover. Much of this study was supported by grants from the University of North Carolina Research Council. We wish to thank Helmut Mueller and Douglas Richards for helpful comments on the manuscript.

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ON A NEW SPECIES OF OCTOCHAETID EARTHWORM FROM MEXICO

G. E. Gates

The earthworm family Octochaetidae is represented in this hemisphere north of Panama by species of four genera. Six indigenes of Washington and Oregon still are in the Australian genus, *Megascolides*, where they do not belong. Ten (or more?) supposed endemics of Mexico, Guatemala, Honduras, El Salvador and Costa Rica were referred to the large, unrevised, African genus, *Dichogaster*, where they may not belong. Seven autochthones currently are recognized in the American genus *Trigaster* that reaches from Mexico into Cuba, Puerto Rico and the Virgin Islands. All other ocotchaetid natives currently are in an American genus (with a Hindu patronymic!), *Ramiellona*, that extends from the Mexican provinces of Chiapas and Oaxaca (with four species) into Guatemala (with 7), Honduras (1) and El Salvador (3). Not a single oligochaete is known to have been collected anywhere in all of Nicaragua. Indeed, the only record of any kind for that country is of a single individual (of a peregrine moniligastrid) obtained by inspectors of the U.S. Bureau of Plant Quarantine from soil with an avocado plant supposedly from Nicaragua.

Most octochaetid indigenes of America are known only from their original descriptions. Types always are few, sometimes more or less macerated. Some accounts contained grave errors. Even for the best characterized, additional data are needed of their distribution and ecology as well as of their basic anatomy. Hopefully, some of those deficiencies can be rectified before pressures of a rapidly increasing human population, of industrialization, as well as of the competition provided by numerous introduced earthworms, exterminate an interesting fauna.

Octochaetidae

Ramiellona Michaelsen, 1935

Ramiellona lavellei, new species

Material.—México, Chiapas: San Cristóbal de Las Casas, Bosque encino, 2,300 m, 29 August 1977, 0-0-1. W. D. Edmonds per P. Lavelle. Holotype deposited in Tall Timbers Research Station, Tallahassee, Florida.

External characteristics.—Length, 427 mm. Diameter, 13 mm. Segments, 408. Peristomium, with deep longitudinal rugosities throughout all of its circumference and dorsally extending onto the large prostomium. As the latter seems to be demarcated posteriorly by a slight, rather irregular furrow about at level of the anterior margin of segment i, the organ is thought to be prolobous. Segment ii also has marked longitudinal rugosities in all of its circumference. Segment iii has faint traces of a near-midsegmental, secondary furrow in the dorsum only. Secondary furrows; on each of iv–xii completely circumferential, probably slightly postsetal, nearly as deep as the intersegmental grooves, behind the clitellum recognizable only dorsally and gradually disappearing in region of xxiii–xxx. Tertiary furrows, slight, one in each secondary annulus of the preclitellar region. Setae; small, closely paired, unrecognized in ii–vii, only an occasional ventral couple seen in viii–xii, all of the lumbricid 4 pairs present throughout the clitellar region where every lateral pair is a tiny white area (of unmodified epidermis?) at bottom of a very slight depression, both ventral couples of xviii present, shortly behind the clitellum, *AB* = *CD*, *AA* ca. = *BC*, *DD* ca. = ½ C, near the hind end *DD* seems to be greater than ½ C. First dorsal pore, at 12/13. Nephropores, unrecognized.

Spermathecal pores, obvious transverse slits, probably about in region of *AB*, just behind 7/8 and 8/9 from which they are separated only by their finely-lobed, anterior margins. Female pores, paired, median to *A* at eq/xiv. Male pores, not seen. Clitellum, saddle-shaped (except possibly in region of xiii/2-xiv?), about 25 mm long, xiii/2-xxii. Seminal grooves between eq/xvii and eq/xix, unusually deep as each is located between 2 longitudinal ridges, the median of which turns mesially at eq/xvii and eq/xix to unite with the rounded copulatory protuberances of its side that apically bear an obvious aperture from each of which 2 penial setae protrude as much as 2 mm. Slicing off the tip of one copulatory porophore of xvii revealed 2 small, rather slit-like spaces. Removal of another slice then revealed one of those spaces occupied by 2 circular areas, each with a minute central lumen. Close by there eventually was recognized a third circular, perforated disc of similar size but of different appearance and texture. The 2, first-seen porophores probably are cross sections of ectal portions of the penisetal follicles. Yet the central pit does appear to be too small for the shafts that were seen externally. Genital markings, rather small, paired, almost longitudinally elliptical but with pointed ends, across 15/16, 16/17, 19/20 and 20/21, about in region of *AB* or about in line with the seminal grooves. Each marking comprises a circular, central, slightly tumescent, whitish, opaque area and a translucent, clearly demarcated, band-like rim.

Internal anatomy.—Septa, 4/5 present, transparent and very delicate, 5/6–11/12 thickly muscular, enlarged, funnel-shaped, posteriorly directed and close together, delicate back from 12/13. Special longitudinal muscle band at mD, sharply defined, perforate over site of each dorsal pore. Pigment, unrecognized in sections through body wall. Circular muscle layer, faintly greenish (alcoholic preservation), still translucent but now reddish brown after treatment with picric acid solution. Trans-segmental, strong, muscular cords are present in the first 15 segments. Wider, intrasegmental and also strong muscular bands in region of the male terminalia are inserted at each end in the parietes, the ventrals near the nerve cord. Each of the anteriormost pair, in xvii, is 2 mm wide and their dorsal insertions are at a level slightly below that of the cords from the penisetal follicles. Narrower bands just behind 17/18 pass up diagonally to their dorsal insertions. Bands just in front of 18/19 are like those of xvii in size and have similar dorsal insertions. The last pair, just behind 19/20, have their dorsal insertions just in front of 20/21.

Pregizzard part of the esophagus in v, wide, anteroposteriorly flattened, reaching well onto the gizzard and beyond it on each side, the anterior wall thinner than the posterior. Gizzard, in v, large and strong. Extramural calciferous glands lacking but white, longitudinal, (calciferous?) lamellae extend back from shortly behind the gizzard to xii. Intestinal origin, in xiv or xv. Whether an intestinal evagination into xvi on each side of the esophagus was normal is unknown. Typhlosole, beginning rather gradually almost in the first intestinal segment, gradually becoming as much as 3 mm high. On each side closely spaced vertical folds extend from the gut roof down almost to a brownish cord on the ventral face of the typhlosole. Between each 2 consecutive ridges is a deep groove. Frequently the distal end of a lateral ridge is flattened so as to have a T-shape. The typhlosole ends abruptly in the 302nd segment, leaving 106 intestinal metameres atyphlosolate. Lateral typhlosoles, not seen. Intestinal caeca, light yellowish and in marked contrast to the intestinal brown color, paired, from a dorsal part of the gut, in xxii–xxx.

Dorsal blood vessel, single, bifurcating under the brain. Ventral blood vessel, also complete, bifurcating over the subpharyngeal ganglion, each branch passing dorsally along with the circumpharyngeal nervous commissures. Supra-esophageal, recognized only in x–xii. Subesophageal trunks, not closely paired, interconnected by a transverse vessel in region of x, reaching back at least into xiii. Extra-esophageals, present. Subneural, not seen and presumably lacking. Hearts, of x lateral, of xi-xii lateroesophageal.

Excretory system, meronephric. One large, horseshoe-shaped mass of nephridial tubules is on the anterior face of 4/5. Postclitellar nephridia, in a single row of ca. 18–20 on each side of each segment, extending from near the nerve cord almost to mD, so close together as often to have the appearance of a single pair of really large organs per segment. The medianmost nephridium on each side, at least in the posterior segments, has a small preseptal funnel.

Metandric, no male funnels in x. Funnels of xi large but tightly flattened against the anterior face of 11/12. Male gonoducts, no epididymis, with muscular sheen and an appearance of straight muscular cords on the ventral body wall. Seminal vesicles, large, much lobed, one pair in xii. Prostates, tubular, with central lumen recognizable to the ental end. One of xvii is ca. 40 mm long, its duct with muscular sheen, 10+ mm long, passing into the parietes behind and close to a copulatory body. The latter is markedly protuberant into the coelom and with muscular sheen. From its conical apex a strong muscular cord passes to the body wall near mD. Penial setae, 2 per follicle, to 5+ mm long, the major part of the shaft band-like, a short terminal part very gradually narrowing almost to a filament. Attempting to dissect off some tissue clinging to the entalmost portion of the shaft, a single filament was accidentally broken apart and then could be separated from the shaft down to the region where the narrowing begins. Thereupon the remainder of the shaft was deliberately separated into its remaining 3 filaments. The narrowed and seemingly solid terminal portion is variously curved or bent.

Spermathecae, erect, in viii and ix. Ampulla, transversely ellipsoidal but with a slight and shallow circumferential groove at its middle, joined asymmetrically by the equally short and thick duct with a central slit-like lumen. Diverticula and seminal chambers, none found. GM glands, none seen.

Etymology.—The species is named for the donor of the type, in the hope that interest in his namesake will impel P. Lavelle, on his return to Mexico, to enable provision of much needed information.

R. lavellei is distinguished from each of its known Mexican congeners, *R. mexicana* Gates, 1962, *setosa* and *wilsoni* Righi, 1972, by its complete metandry. Relationships at present seem to be closest to the Guatemalan *R. americana* Gates, 1957. The latter is known only from a possible posterior amputee intercepted in soil supposedly from Guatemala. Differences between the two specimens, as to size, segments, secondary annulation, setae, septa, calciferous lamellae, typhlosoles, etc., are all small but numerous. Further material may enable subspecies status in *R. americana.*

Remarks.—The tight coiling and strong contraction of an otherwise well-preserved specimen resulted in some asymmetrical distortion and much handicapped its dissection and study.

When first examined the type seemed to have a faint greenish hue that also characterized only the circular musculature of the body wall. Red, blue and brown color in earthworms usually is associated with parietal pigmentary solids. Green color as in *All. chlorotica* and several species of the oriental octochaetid *Eutyphoeus* never was associated with solids that could be recognized with the binocular dissecting microscope.

A whitish, mucus-like substance surrounded the ingesta in an anterior part of the intestine, like a peritrophic membrane. Similar material was found in some of the yellow, intestinal caeca.

The conical copulatory bodies that protrude conspicuously into the coelom were at first suspected of being copulatory chambers, perhaps partially eversible or protrusible to the exterior. Absence of any real lumen seems to rule out eversion. The external porophore, as well as its setae, do seem too delicate to be allowed to remain outside during ordinary activity, and especially during locomotion. The strong muscularity of the internal body and its apical cord to the parietes suggest that the external penial body must in some way be retracted or folded over into some parietal depression ordinarily.

Systematics.—The taxa now in *Ramiellona* have been in two different families, the Acanthodrilidae and Octochaetidae (or their equivalents). Some once were in an unrelated Hindustan genus, *Ramiella*, that (with its development of rolled-tube, penial setae and calciferous lamellae) may have been evolving similarly. *Ramiellona* cannot be properly defined, with special reference to its somatic rather than its genital anatomy, as now is necessary. Many additional collections, in much better condition than often was available in the past, must be obtained to provide the requisite revision for what may have been important constituents of a poorly known soil fauna.

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THE NOMENCLATURAL STATUS OF THE TAXA OF FOSSIL BIRDS ATTRIBUTED TO AUGUSTE AYMARD

Storrs L. Olson

Abstract.—The taxa of fossil birds traditionally attributed to Auguste Aymard are absolute *nomina nuda* as originally proposed by him, and their proper usage depends on the treatment afforded them by Milne-Edwards in his *Oiseaux Fossiles de la France.* The nomenclatural and bibliographic problems arising from this are discussed.

Throughout the literature of avian paleontology, Auguste Aymard (1856) is cited as the author of four generic and six specific names of fossil birds from Lower Oligocene deposits at Ronzon, Dept. of Haute Loire, France. Milne-Edwards (1867–1871) discussed these taxa and illustrated most of them, attributing the names to Aymard. Apparently, all subsequent authors except Cracraft and Rich (1972) have followed Milne-Edwards without examining Aymard's publication, which is evidently quite scarce. Lambrecht (1933) specifically states that he did not examine the original reference, and likewise Brodkorb (pers. comm.) had not seen it before he published the first three parts of his *Catalogue of Fossil Birds* (Brodkorb 1963, 1964, 1967).

I have been able to obtain photocopies of Aymard's publication made from an original in the library of Columbia University, New York. The paper is in the form of a report on the geology and paleontology of the Haute Loire region, and was presented in the minutes of two separate *séances* of the Congrès Scientifique de France held at Puy, September 1855. Because of the rarity of the publication and the fact that avian paleontologists have seldom examined it, the brief portions of the text concerning fossil birds are reproduced here.

[p. 233] La classe des oiseaux comprend divers ordres, dans lesquels se répartissent au moins quinze espèces reconnaissables à diverses pièces, telles qu'ossements, plumes et oeufs. La presque totalité de ces restes signalent des oiseaux de grande et de moyenne taille, comprises entres celles que présentent aujourd'hui les flamands et les grues, et celles des harles et dernes ou hirondelles de mer. Les ordres qui ont surtout des représentants parmi ces espèces sont, comme ces oiseaux palustres, des échassiers et des palmipèdes sans exclure les rapaces. C'est au dernier de ces ordres qu'appartient un oiseau de proie diurne, de la tribu des faucons, que j'ai nommé *ieracus littoralis.* Au nombre des échassiers, je puis citer aussi le *camaskelus palustris.* Aym., voisin des pluviers; l'*elornis grandis.* A., qui se rapprochait, par la taille et par les formes, des fla- [begin p. 234] mands; les *elornis* (?) *littoralis.* Aym. et *elorn.* (?) *antiquus* Aym.; et parmi les palmipèdes de la famille des longipennes, le *dolicopterus viator.* Aym.; enfin, dans les lamellirostres, un palmipède qui est très-voisin des harles et que, par cette raison, M. Gervais a dénommé provisoirement *mergus* (?) *ronzoni.*

[p. 267] On connait très-peu d'oiseaux fossiles, et leur classement n'est pas assez avancé pour qu'on doive considérer comme propres au Velay les espèces qui y ont été recueillies. Tout ce qu'on peut dire, c'est que la plupart des genres déterminés jusqu'a ce jour qui proviennent de Ronzon, n'ont pas encore été recontrés ailleurs; tels sont un oiseau de proie diurne, l'*ieracus littoralis*, un échassier voisin des pluviers (*camaskelus palustris*), quelques autres voisins des flamands (*elornis*), et un palmipède longirostre (*dolicopterus viator*).

These are Aymard's only allusions to fossil birds and his paper does not illustrate specimens. It is clear that all of Aymard's names are absolute *nomina nuda* and have no nomenclatural standing whatever. Thus, the status and orthography of these names rests entirely with Milne-Edwards' (1867–1871) treatment of them and he must be regarded as their author. The citations to these names are complicated by the fact that Milne-Edwards' work was issued at intervals in separate *livraisons*, the plates often not appearing simultaneously with the text.

Milne-Edwards had access to Aymard's notes and specimens, but unfortunately the fossils cannot now be located (Lambrecht, 1933; Cracraft and Rich, 1972). Thus, for the present, all we can know about these taxa is that which is derivable from Milne-Edwards' descriptions and illustrations.

Aymard's material included several fossils that were regarded as a new genus of flamingo, *Elornis*. Milne-Edwards concurred that these belonged to the Phoenicopteridae and his illustrations (Milne-Edwards, 1868, pl. 90), while not greatly detailed, indicate that this assignment is probably correct.

Elornis littoralis Milne-Edwards was based on incomplete tarsometatarsi, tibiotarsi, furculae, and a pelvis. Milne-Edwards regarded a humerus that Aymard had intended as the type of *Elornis antiquus* as certainly belonging to the same species, and so he treated *antiquus* as a synonym of *littoralis*. Because *Elornis antiquus* Milne-Edwards was proposed as a synonym, it does not meet the criteria of availability as set forth in Article 11d of the International Code of Zoological Nomenclature. Thus, the humerus just mentioned is to be regarded as part of the type material of *Elornis littoralis* Milne-Edwards. Although Brodkorb (1963:272) cites Lydekker (1891:80) as suggesting this humerus as lectotype of *Elornis littoralis*, there is nothing in the latter reference that I can interpret to this effect, and the species should still be regarded as being founded on a series of syntypes.

Milne-Edwards did not illustrate the specimen that Aymard had intended to represent the species *Elornis grandis,* and described it only as a large humerus "au moins aussi grande que celui d'un Flamant" (text vol. 2, p. 87). This barely elevates *Elornis grandis* beyond the rank of *nomen nudum,* and only because the humerus of *Elornis littoralis* was described on the preceding page as "a peu pres d'un quart plus petit que son homologue chez le Flamant."

Because the plate depicting *Elornis littoralis* was published prior to the text, the original reference to the genus *Elornis* becomes the caption of the plate. As only *E. littoralis* was depicted, this species becomes the type by monotypy of the genus *Elornis,* and it is therefore unnecessary to cite Lydekker's (1891) subsequent designation of *littoralis* as the type. In the same work, Lydekker (1891:80) named a new species, "*Elornis* (?) *anglicus,*" from the Upper Eocene of England. Harrison and Walker (1976) have recently synonymized this with *Actiornis anglicus* Lydekker 1891, formerly placed in the Phalacrocoracidae, which they transferred to the Threskiornithidae; our knowledge of *Elornis* therefore still rests solely on the lost material from Ronzon.

Milne-Edwards used two spellings for the genus called *Dolicopterus* by Aymard. The etymologically correct rendering *Dolichopterus* appeared in the caption of his plate 57, which was published in 1867, whereas the spelling *Dolicopterus* appears in the text, published in 1868. Thus, on grounds of both priority and purism, the spelling *Dolichopterus* should be used.

Aymard regarded his species *Dolichopterus viator* as a member of the Laridae and intended it to be based on a coracoid and the distal portion of a wing. The species *Camaskelus palustris* was to have been founded on a tarsometatarsus that Aymard attributed to a shorebird. Milne-Edwards considered that this specimen probably belonged to the preceding species and listed "*Camaskelus palustris*?" as a synonym of *Dolichopterus viator,* a treatment in which he has been followed by later authors. Thus the name *Camaskelus palustris* Milne-Edwards was proposed as a synonym and, like *Elornis antiquus,* is unavailable under the terms of Article 11d.

Milne-Edwards' illustrations show the material of *Dolichopterus viator* to be poorly preserved, and he himself assigned the species to a higher category with great reservation, comparing its proportions with that of a plover ("*Charadrius pluvialis*"). Lambrecht (1933) listed *Dolichopterus* as a genus *incertae sedis* under the Charadriinae, with the comment "Gattungsdiagnose unmöglich." Brodkorb (1967) listed it under the Charadriinae without comment. The evidence for the affinities of this bird is at present too poor to permit its being carried as anything other than *Avis incertae sedis* until the specimens can be located and studied anew.

Concerning Aymard's "*ieracus littoralis,*" Milne-Edwards (1871:453) says only: "Les marnes calcaires de Ronzon, près du Puy, ont fourni à M.

Aymard un oiseau qu'il rapproche des Faucons et auquel il a donné le nom de *Teracus* [*sic*] *littoralis*." This species would have remained a *nomen nudum* had not Milne-Edwards provided figures (pl. 185) of the coracoid and femur, upon which the name was based. Unfortunately, he used the nonsensical spelling "*Teracus*" throughout, and this must therefore be followed, even though Aymard's name is obviously derivable from the Greek "*hierax*," a hawk.

Cracraft and Rich (1972) correctly have pointed out that "*ieracus littoralis*" Aymard is a *nomen nudum*, and have recognized Milne-Edwards as the author of *Teracus littoralis*. They maintained that there is no evidence that the femur and coracoid attributed to *Teracus littoralis* are from the same species and I agree with them that the species cannot be considered as providing a valid record of the Cathartidae (= Vulturidae), in which family Brodkorb (1964) placed it. Until the types of *Teracus littoralis* can be restudied, the familial and even ordinal positions of the genus must be considered uncertain.

The following, in the format of Brodkorb's catalogue, are the proper citations for the three genera and four species that are the only validly proposed taxa of the ten hitherto attributed to Aymard:

Family Phoenicopteridae Bonaparte 1831
Genus † *Elornis* Milne-Edwards

Elornis Aymard, 1856, Congr. sci. France, vol. 1, p. 234 (*nomen nudum*).—Milne-Edwards, 1868, Ois, Foss. France, atlas vol. 1, pl. 90 caption (type by monotypy *Elornis littoralis* "Aymard" Milne-Edwards).

Helornis Lydekker, 1891, Ibis, ser. 6, vol. 3, p. 396 (emendation).

Elornis littoralis Milne-Edwards

Elornis (?) *littoralis* Aymard, 1856, Congr. sci. France, vol. 1, p. 234 (*nomen nudum*).—Milne-Edwards, 1868, Ois. Foss. France, atlas vol. 1, pl. 90 caption, figs. 1–7 (types from Ronzon, tarsometatarsi, tibiotarsi, furculae, pelvis, and humerus, present location unknown).

Elorn[*is*] (?) *antiquus* Aymard, 1856, Congr. sci. France, vol. 1, p. 234 (*nomen nudum*).—Milne-Edwards, 1868, Ois. Foss. France, atlas vol. 1, pl. 90 caption (unavailable, proposed as synonym of *E. littoralis*).

Elornis grandis Milne-Edwards

Elornis grandis Aymard, 1856, Congr. sci. France, vol. 1, p. 233 (*nomen nudum*).—Milne-Edwards, 1870, Ois. Foss. France, text vol. 2, sheet 11, p. 87 (type from Ronzon, proximal part of a humerus, present location unknown).

Aves Incertae Sedis

Genus † *Teracus* Milne-Edwards

Ieracus Aymard, 1856, Congr. sci. France, vol. 1, p. 233 (*nomen nudum*).

Teracus Milne-Edwards, 1871, atlas vol. 2, pl. 185 caption [not pl. 135 as stated in footnote 1, p. 453 of text vol. 2] (type by monotypy *Teracus littoralis* "Aymard" Milne-Edwards).

Teracus littoralis Milne-Edwards

Ieracus littoralis Aymard, 1856, Congr. sci. France, vol. 1, p. 233 (*nomen nudum*).—*Teracus littoralis* Milne-Edwards, 1871, atlas vol. 2, pl. 185 caption (types from Ronzon, femur and coracoid, present location unknown).

Genus *Dolichopterus* Milne-Edwards

Dolicopterus Aymard, 1856, Congr. sci. France, vol. 1, p. 234 (*nomen nudum*).—*Dolichopterus* Milne-Edwards, 1867, Ois. Foss. France, atlas vol. 1, pl. 57 caption (type by monotypy *Dolichopterus viator* "Aymard" Milne-Edwards).

Camaskelus Aymard, 1856, Congr. sci. France, vol. 1, p. 233 (*nomen nudum*). —Milne-Edwards, 1867, Ois. Foss. France, atlas vol. 1, pl. 57 caption (unavailable, proposed as synonym of *Dolichopterus*).

Dolichopterus viator Milne-Edwards

Dolicopterus viator Aymard, 1856, Congr. sci. France, vol. 1, p. 234 (*nomen nudum*).—*Dolichopterus viator* Milne-Edwards, 1867, Ois. Foss. France, atlas vol. 1, pl. 57 caption (types from Ronzon, fragmentary coracoid, radius, carpometacarpus, vertebrae, and tarsometatarsus, present location unknown).

Camaskelus palustris Aymard, 1856, Congr. sci. France, vol. 1, p. 233 (*nomen nudum*).—Milne-Edwards, 1867, Ois. Foss. France, atlas vol. 1, pl. 57 caption (unavailable, proposed as synonym of *Dolichopterus viator*).

Acknowledgments

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ADDITIONAL RECORDS FOR TWO EASTERN ATLANTIC STOMATOPOD CRUSTACEANS

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Abstract.—Identifications are corrected for two deep water stomatopods, *Parasquilla ferussaci* (Roux) and *Meiosquilla pallida* (Giesbrecht), erroneously reported in the literature as *Pseudosquilla ciliata* (Fabricius) and *M. desmaresti* (Risso), respectively, from localities between southern Portugal and northwestern Morocco.

After the proofs had been corrected for a review of the West African stomatopods (Manning, 1977), I came across a reference to the occurrence of the tropical *Pseudosquilla ciliata* (Fabricius) off southern Portugal and northern Morocco in depths between 175–185 m and 685–715 m (Pérès, 1974). *Pseudosquilla ciliata* is a widely distributed shallow water species, which off West Africa is not known to occur north of Sénégal and the Cape Verde Islands. This distribution suggested that the records of this species in Pérès (1964) were based on some other stomatopod, but from his account there was no way to determine which species might be involved.

In October 1977 I visited the Muséum National d'Histoire Naturelle, Paris and examined several lots of unidentified stomatopods. Among these were three of the lots reported by Pérès from off Portugal, Spain and Morocco. Corrections are made below of two of the three identifications of stomatopods by Pérès. I thank J. Forest for the loan of this material.

A third species reported from off Morocco by Pérès, *Squilla mantis* (Linnaeus, 1758), was taken at two stations in depths of 175–185 m and 180–200 m. This species occurs from the Mediterranean southward to Angola (Manning, 1977); its occurrence off Morocco already is well documented.

Parasquilla ferussaci (Roux, 1830)

Pseudosquilla ciliata.—Pérès, 1964:6 [discussion], 23, 26, 28 [not *P. ciliata* (Fabricius, 1787)].

Reported occurrences.—*Président-Théodore-Tissier* stations: L.356: SW of Cabo de Santa Maria, Portugal; 36°47′N, 08°11.2′W to 36°48′N, 08°04.3′W; trawl; 450–490 m; mud with *Actinauge richardi*; 2 December 1959.—L.364: W of Cabo Trafalgar, Spain; 36°07.5′N, 06°54.5′W to 36°02.5′N, 06°51.5′W; trawl; 685–715 m; slightly muddy sand of terrigenous and organic origin; 4 December 1959.—L.368: NW of Mehdia, Morocco; 34°39.6′N, 06°54.5′W to 34°33.5′N, 06°56′W; 260–500 m; compact bathyal mud; 5 December 1959; several specimens.—L.369: NW of Mehdia, Morocco; 34°33.5′N, 06°52′W to 34°39′N, 06°50′W; 175–185 m; coastal terrigenous mud; 5 December 1959; 6 specimens, taken together with *Squilla mantis.*

Remarks.—Specimens from the first two stations were examined. That from station L.364 is a young female, 78.5 mm long, and that from station L.356 appears to be an adult female 106 mm long. The smaller specimen lacks oblique dorsal carinae on the telson as well as the posterolateral spine on the fourth abdominal somite. Both specimens have spines on the submedian and lateral carinae of the sixth abdominal somite and on the intermediate and marginal carinae of the fifth somite, as well as 8 movable spines on the outer margin of the proximal segment of the uropodal exopod.

Parasquilla ferussaci occurs in the Mediterranean and in the adjacent Atlantic south to the Gulf of Guinea. The most recent Mediterranean record is that of Arena & Li Greci (1973), who reported the species from off western Sicily in 505–650 m. Previous Atlantic records include that by Figueiredo (1962) off Sesimbra, Portugal, ca. 38°40′N, 09°10′W, in 252–550 m and two records from the Gulf of Guinea (Manning, 1977): off Portuguese Guinea (Guinea-Bissau) in 183 m, and off the Ivory Coast in 100 m.

The present records extend the known depth range for *P. ferussaci* to about 700 m and demonstrate that it is a true bathyal species.

In the shallower part of its depth range, on the outer shelf, *P. ferussaci* occurs together with *Squilla mantis.* The two species were taken at sta. L.369 in 175–185 m.

Off Sicily and off southern Portugal *P. ferussaci* was collected on mud with the actinian *Actinauge richardi* (Marion).

Meiosquilla pallida (Giesbrecht, 1910)

Squilla desmaresti.—Pérès, 1964:29 [not *M. desmaresti* (Risso, 1816)].

Reported occurrence.—*Président-Théodore-Tissier* station L.371: NW of Larache, Morocco; 35°28′N, 06°28.1′W to 35°15.2′N, 06°18.5′W; trawl; 180–230 m; coarse shelly sand; 6 December 1959.

Remarks.—A single female of *M. pallida,* 51.5 mm long, taken at this station, is in the collection at Paris. As in other specimens reported from the NW African coast, the claw is slender, there are 5 movable spines in the outer margin of the proximal segment of the uropodal exopod, the postanal keel is present, and the lateral carinae of the fourth abdominal somite are armed; the abdominal spine formula is 6, 5–6, 4–6, 4–5. The corneal index is 500. The antennular peduncle is longer than the carapace and rostral plate combined.

As pointed out by Manning & Froglia (in press), all records of *M.*

desmaresti from depths in excess of about 100 m, like those of Forest & Guinot (1956) from off Tunisia in 170 and 200 m, probably are based on the deeper dwelling *M. pallida.*

This species, which occurs in the western Mediterranean southward to the Ivory Coast, was reported from off NW Morocco by Monod (1925) and Manning (1977).

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A RE-EVALUATION OF THE OPISTOCYSTIDAE (OLIGOCHAETA) WITH DESCRIPTIONS OF TWO NEW GENERA

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Abstract.—A comparison of the genital characters of three species of Opistocystidae has required the formation of two additional genera. *Crustipellis* gen. nov. is erected for the placement of *Opistocysta tribranchiata* Harman, 1969, and *Trieminentia* gen. nov. for *Opistocysta corderoi* Harman, 1969. The reproductive system of *C. tribranchiata* is described. *Opistocysta serrata* Harman, 1969 is declared a *species incerta sedis.* A key to immature individuals of Opistocystidae is provided.

Opistocysta tribranchiata Harman, 1969, was described from sexually immature individuals from Mississippi and Louisiana. This was the second species of Opistocystidae to be found in North America, the first being *Opistocysta flagellum* (Leidy), which Harman (1969) relegated to the status of *species inquirenda.*

Since the description of *O. tribranchiata,* its range has been extended somewhat; specimens in the Louisiana State University collection referable to this species have been collected from North Carolina, Florida and central Mexico. The distribution of the Opistocystidae in North America appears restricted to the eastern and southeastern United States and Mexico. Records from the literature place *Pristina flagellum* (= *O. flagellum*) in Illinois (Smith, 1900), Tennessee (Collins, 1937) and Virginia (Falls, 1975). In each case, however, the diagnosis was either inadequate for modern species placement, or was lacking.

A collection from Madison County, Mississippi, 5 June 1975, contained 4 sexually mature individuals of *O. tribranchiata,* as well as several additional immature specimens. Based on the positions of the gonads and the associated reproductive structures revealed by serial sectioning and their comparison to features of other known species of Opistocystidae, a reevaluation of this family is warranted.

Gates (1974) stated that somatic characters are more conservative than genital characters in megadriles. This is certainly the situation in the Opistocystidae, where the known species are almost identical in the sexually immature stages, each bearing the characteristic 3 caudal appendages, a prostomial extension, and dorsal setal bundles containing hair setae from segment II. The species differ by setal measurements, presence or absence of needle setae, and serrations on the hairs, among other characters.

In mature worms, however, the variation in the location and structure of the reproductive apparatus are considerably different.

Only a few oligochaete families (such as the Naididae) have specific or even generic differences recognizable in immature individuals. In other monogeneric families, such as the Phaeodrilidae and the Sparganophilidae, the differences in reproductive anatomy among the known species are by no means as great as those among the presently recognized species of *Opistocysta.* In genera where the location of the reproductive segments differs consistently from the remainder of the family (e.g. *Aulodrilus* in the Tubificidae, *Pristina* in the Naididae), subfamilial separations are recognized. Anterior displacement of genitalia by one or 2 segments is well documented in the Oligochaeta, but not to the extent found in Opistocystidae. Differences in the construction of the male reproductive tracts on a par with those of the Opistocystidae are major considerations for generic differentiation in other oligochaete families (e.g. Tubificidae). It is therefore proposed, as was suggested by Harman (1969) and Brinkhurst (1971), that new genera be erected in the Opistocystidae to reflect the differences in the location and structure of the genital apparatus of the known species.

Taxonomy

The erection of additional genera unfortunately must result in excluding 2 of the 5 species of *Opistocysta. Opistocysta flagellum* is a *species inquirenda* (Harman, 1969), as the result of Leidy's (1880) presently inadequate description; the continuation of this species in that status is desirable. *Opistocysta serrata* Harman, which was described from immature individuals, must now be collected and examined in the sexually mature form before proper generic placement can be determined; it is hereby declared a *species incerta sedis*, but left in *Opistocysta* pending description of its genitalia.

Family OPISTOCYSTIDAE Cernosvitov, 1936

Type-genus.—Opistocysta Cernosvitov, 1936.

Diagnosis.—Eyeless: Prostomium formed into a proboscis. Three ciliated caudal appendages: 2 longer ventro-laterals and one shorter dorso-median. Dorsal setae from II consisting either of hair setae or of hair and needle or needle-like setae. Ventral setae bifid crotchets. Testes and ovaries paired but may be diffuse in the reproductive state; testes one segment anterior to the ovaries. Sperm funnels in septum posterior to testes segment, atria and penes in segment with ovaries. Spermathecae one segment posterior to atria and ovaries. Asexual reproduction by budding; 5 segments formed anteriorly.

Opistocysta Cernosvitov, 1936

Type-species.—*Opistocysta funiculus* Cordero, 1948.

Diagnosis.—Prostomium forming a proboscis. Three ciliated caudal appendages. Dorsal setae from II, consisting of hair setae or hair and needle setae. Testes and male funnels in XXI, atria and ovaries in XXII. Atria covered by diffuse prostate; eversible penes. Spermathecae in XXIII.

Opistocysta funiculus Cordero, 1948

Fig. 1

Opistocysta flagellum.—Cernosvitov, 1936.—Marcus, 1944.—duBois-Reymond Marcus, 1947.

Opisthocysta funiculus Cordero, 1948.—duBois-Reymond Marcus, 1949.—Brinkhurst, 1966; 1971.—Brinkhurst and Cook, 1966.—Harman, 1969.

Diagnosis.—l = 5–12 mm. s = 40–106. Prostomium forming a proboscis up to 785 μm long. Three caudal appendages: ventro-laterals longer and thicker than dorso-median, frequently asymmetrical. Dorsal setae begin in II, consisting of 2–3 simple-pointed needles and 2–3 hairs per bundle; needles with a nodulus, 90–105 μm long; hairs 150–160 μm long with thick serrations. Ventral setae 3–5 per bundle with the distal tooth longer and thinner than the proximal; lengths 120 μm in II, 104 μm in III-V, 116–120 μm midbody, 128–130 μm posteriorly; nodulus median in II-V, distal posteriorly. Clitellum milk-white in living worms; XXI-23/24; saddle-shaped anteriorly, encircling the body on XXIII. Testes in XXI; ovaries in XXII. Sperm funnels on septum 21/22; atria oval with diffuse prostate; penes eversible; male pores in XXII. Spermathecae paired in XXIII; spermathecal pores open ventrally just posterior to septum 22/23.

Distribution.—Argentina, Brazil, Africa (?).

Opistocysta serrata Harman, 1969, species incerta sedis

Pristina flagellum.—Michaelsen, 1905.

Opisthocysta flagellum (part).—Cordero, 1948.

Opistocysta serrata Harman, 1969.—Brinkhurst, 1971.

Distribution.—Paraguay.

Opistocysta flagellum (Leidy, 1880), species inquirenda

Pristina flagellum Leidy, 1880.—Smith, 1900; 1918.—Collins, 1937.—Pennak, 1953.

Opisthocysta flagellum, Goodnight, 1959.—Brinkhurst, 1964; 1971.—Brinkhurst and Cook, 1966.—Harman, 1969.—Falls, 1975.

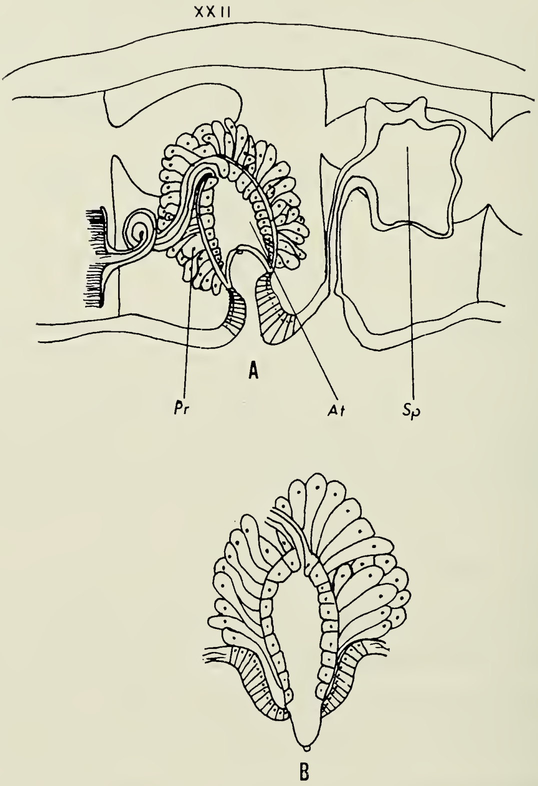

Fig. 1. Reproductive structures of *Opistocysta funiculus.* (After Cernosvitov, 1936.) A: Penis within atrial cavity. B: Penis everted. At: atrium, Pr: prostate, Sp: spermatheca.

Trieminentia gen. nov.

Type-species.—*Opistocysta corderoi* Harman, 1969.

Diagnosis.—Prostomium forming a proboscis. Three ciliated caudal appendages. Dorsal setae from II consisting of hairs and possible needles. Testes and male funnels in XIV or XV, atria and ovaries in XV or XVI. Proximal position of atria with thickened walls and diffuse prostate. Eversible pseudopenes. Spermathecae in XVI or XVII. Sexual reproduction by budding, 5 segments formed anteriorly.

Etymology.—So named because of the three caudal projections.

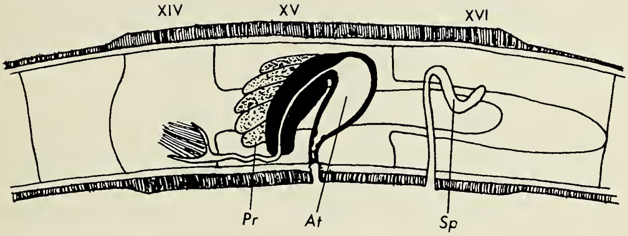

Fig. 2. Reproductive structures of *Trieminentia corderoi*. (After Cordero, 1948.) At: atrium, Pr: prostate, Sp: spermatheca.

Trieminentia corderoi (Harman, 1969)
Fig. 2

Opisthocysta flagellum, Cordero, 1948.
Opistocysta corderoi Harman, 1969.—Brinkhurst, 1971.

Diagnosis.—l = 10–12 mm. s = 56–76. n = 22–23. Prostomium forming a proboscis ca. 660 μm long. Three caudal appendages: laterals up to 900 μm long, 150 μm wide at base; median ca. 190 μm long, 72 μm wide. Foreign matter adhering to cuticle. Dorsal setae begin in II, consisting of unserrated hairs, 2 per bundle, 72 μm long in III, up to 360 μm in XII-XII, and 1–2 needles(?), ca. 30 μm long. Ventral setae 4–5 per bundle, ca. 80 μm long; distal tooth thinner than proximal; distal nodulus. Clitellum whitish, encircling the body, XV-XVI. Testes in XIV or XV, ovaries in XV or XVI. Sperm funnels on 14/15 or 15/16. Proximal portion of atria with thickened walls, reflexed, with diffuse prostate on anterior surface. Median portion of atria with abrupt expansion and thin walls; distal portion constricted, forming eversible pseudopenes. Male pores in XV or XVI, female pores in XV or XVI, paired, opening in a groove in the clitellum. Spermathecae in XVI.

Distribution.—Uruguay. New Record: Costa Rica, Heredia Province, ca. 1 mi NE Los Chiles. 8 July 1965. K. A. Arnold (LSU 1262).

Comments.—Immature specimens collected from Costa Rica agree in every detail with the characteristics (setal lengths, etc.) given by Harman (1969). Cordero (1948) states that although there were no needle setae present, the hairs were unequally long. In specimens in this collection there are isolated segments free of external foreign matter where there are 1–2 hair setae extending beyond the body wall and 1–2 additional setae within the body wall. The latter are not, in all cases, distinguishable from replacement hairs, but there is a strong possibility that they are extremely fine, simple-pointed needles with a distal tapering nodulus that rarely extend beyond the body wall and its coat of adhering foreign matter.

Crustipellis, gen. nov.

Type-species.—*Opistocysta tribranchiata* Harman, 1969.

Diagnosis.—Prostomium forming a proboscis. Three ciliated caudal appendages. Dorsal setae from II consisting of hairs and needles. Testes and male funnels in XI. Atria and ovaries in XII. Diffuse prostate covering atrium. Protrusible penes. Spermathecae in XIII. Asexual reproduction by budding, 5 segments formed anteriorly.

Etymology.—Refers to the encrustation of foreign matter on the body wall.

Crustipellis tribranchiata (Harman, 1969)

Fig. 3

Opistocysta tribranchiata Harman, 1969.—Brinkhurst, 1971.

Diagnosis.—l = 1.7–2.9mm. s = 15–30. n = 18–19. Prostomium forming a proboscis up to 180 μm long. Three caudal appendages: ventro-laterals up to 300 μm long, 70 μm wide; dorso-median to 90 μm long, 30 μm wide. Dorsal setae from II, 1–4 hairs and 1–4 needles per bundle. Hairs finely serrated (ca. 2 μm apart), 155–370 μm long; needles simple-pointed, without a nodulus, 35–65 μm long. Ventral setae 3–5 per bundle (usually 4), 70–87 μm long, with the distal tooth thinner and longer in anterior segments, with the teeth approaching equal length posteriorly. Clitellum XI or 11/12 to XIII or XIV, saddle-shaped. Testes in XI, ovaries in XII. Sperm funnels on 11/12. Atria in XII, pear-shaped, covered with diffuse prostate. Penes well formed, protrusible. Male pores in XII. Spermathecae in XIII.

Distribution.—Louisiana, Mississippi. New records: 1. Mexico: Veracruz; 11.7 mi S Rio Tecolutla—Mex 180. 29 December 1974. R. M. Blaney & P. K. Blaney (LSU 1419).—2. Florida: Citrus Co. Pond along Fla. 200. 1.8 mi NE Hernando. 6 September 1975. W. J. Harman & M. S. Loden (LSU 1466).—3. Florida: Alachua Co. roadside ditch along I-75. 1.8 mi N jct I-75 and Fla. 200. 6 September 1975. W. J. Harman & M. S. Loden (LSU 1467).—4. North Carolina: Chatham Co. Buckhorn Creek. 13 October 1973. M. S. Loden (LSU 1842).

Comments.—This description incorporates information on *C. tribranchiata* collected since the original description. Harman (1969) judged needle setae to be absent; the cuticle of this species, like *T. corderoi* has an affinity for foreign matter, which often obscures the surface of the body, and renders an analysis of the setae most difficult. Since the species was originally described several specimens have been collected that have needle-like setae

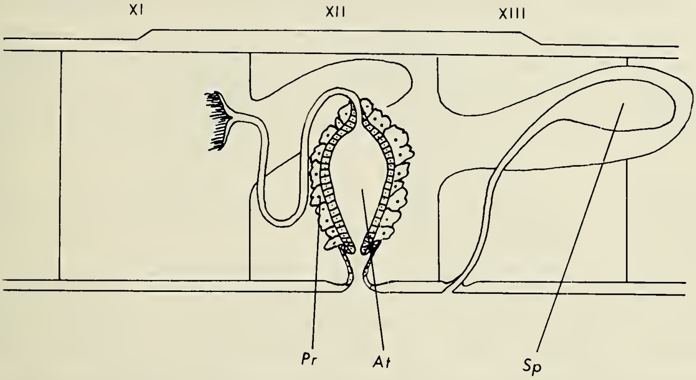

Fig. 3. A reconstruction of the genital segments of *Crustipellis tribranchiata*. At: atrium, Pr: prostate, Sp: spermatheca.

evident in the dorsal bundles. These setae are relatively stable in length, and it is now judged that the dorsal bundles contain simple-pointed needle setae that lack a nodulus.

Discussion

A reconstruction of the reproductive system of *C. tribranchiata* is presented in Fig. 3. The clitellum extended from near the middle of segment XI to the middle of XIII; it covered the worm dorsally and laterally to just above the ventral setae. (One sexually mature specimen from Mexico had the clitellum from intersegmental groove 11/12 to the middle of segment XIV, but other visible genital characters, including the location of the genital pores, of this whole-mount specimen were as in the Mississippi material.) The testes were in segment XI; although no compact structures identifiable as paired testes were present, the coelom of segment XI was virtually filled with spermatozoa. The sperm sac was formed from septum 11/12 and extended to a point just anterior to septum 12/13.

The male ducts were paired. The funnels were located dorso-laterally just anterior to septum 11/12. The vasa deferentia descended along the posterior to walls of the septum, and ascended prior to joining the atria at their mid-dorsal surface. The atria were pear-shaped, thin-walled, and covered by a diffuse prostate. The ventral lips of the atria formed the penes. The paired male pores were in the line of the setae at either side of mid-ventral.

The ovaries were located in segment XII, but as with the testes, no compact gonadal mass was evident; the coelom contained developing ova. No oviduct could be distinguished. The ovisac was formed from septum 12/13 and extended posteriorly to segment XIV.

Table 1. Location of genital structures of known species of Opistocystidae.

	Opistocysta funiculus	*Trieminentia corderoi*	*Crustipellis tribranchiata*
Clitellum	XXI-XXIII	XIV-XIX	XI-XIV
Testes	XXI	XIV or XV	XI
Ovaries	XXII	XI or XIV	XII
Spermathecae	XXIII	XVI or XVII	XIII

The spermathecae were paired and located in segment XIII. The ampullae were within the ovisac, extending posteriorly to segment XIV. The ducts entered segment XIII, and the spermathecal pores were just posterior to septum 12/13. Spermatozoa were within the ampullae, but no organized spermatozeugmata could be detected.

Of 5 described species of *Opistocysta*, the genital structures of only 2 species other than *C. tribranchiata* are known. The genitalia of *O. funiculus* were described by Cernosvitov (1936) as being those of *O. flagellum.* Those of *T. corderoi* were described by Cordero (1948), also as being those of *O. flagellum.*

The differences among the locations of the reproductive structures of the species of Opistocystidae differ greatly (Table 1). As much as 10 segments separate 2 of the species.

The structures of the male reproductive tract differ considerably among the 3 species (summarized in Table 2). Both *C. tribranchiata* and *O. funiculus* have thin-walled atria covered by diffuse prostate, but the latter differs in the structure and function of the penes (Fig. 1). In *O. funiculus* the penes are eversible; according to Cernosvitov's diagram, the penes are thin-walled organs that are normally held within the atrial cavities, and evaginated during copulation (Figs. 1A and B). In *C. tribranchiata* the penes are formed from the ventral lips of the atria, have thicker walls, and are protrusible. These species differ also in the histological composition of the penial chambers. In *O. funiculus* a layer of columnar epithelium lines a chamber, while in *O. tribranchiata* a chamber is lined by squamous epithelium that apparently allows for the collapse of the chamber during penial protrusion.

The differences between *C. tribranchiata* and *T. corderoi* are similarly considerable. In *T. corderoi* the clitellum encircles the body rather than covering only the dorsal and lateral surfaces as does the clitellum of *C. tribranchiata* and the anterior portion of the clitellum of *O. funiculus.* The illustration of *T. corderoi* by Cordero (Fig. 2) shows a pseudopenis, a non-preformed eversible portion of the male duct (Stephenson, 1930), formed from the distal part of the atrium and of a different structure from the protrusible true penes of *C. tribranchiata.* Another unique feature of

Table 2. Characters of the male reproductive apparatus of the known species of Opistocystidae.

	Opistocysta funiculus	*Trieminentia corderoi*	*Crustipellis tribranchiata*
Penis	eversible	eversible pseudopenes	protrusible
Atrium	thin, oval	reflexed, thick-walled proximally	thin, pear-shaped
Prostate	covers atrium	proximal part of atrium	covers atrium

T. corderoi is the shape of the atrium; the proximal part is reflexed, approaching the ventral body wall. The wall of the proximal part is thickened, with prostate tissue on the anterior surface. In *O. funiculus* and *C. tribranchiata* the atria are thin, covered with prostate tissue; both species have the vasa deferentia entering dorsally.

Key to Immature Individuals of Opistocystidae

1. Hair setae serrated 2
– Hair setae smooth *Trieminentia corderoi*
2. Dorsal bundles with both hair and needle setae 3
– Dorsal bundles with hair setae only *Opistocysta serrata* (*sp. incerta sedis*)
3. Ventral seta 70–87 μm long; needle setae 35–65 μm long, without a nodulus *Crustipellis tribranchiata*
– Ventral setae 104–130 μm long; needle setae 90–105 μm long, with a nodulus *Opistocysta funiculus*

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ETHEOSTOMA AQUALI, A NEW PERCID FISH (SUBGENUS *NOTHONOTUS*) FROM THE DUCK AND BUFFALO RIVERS, TENNESSEE

James D. Williams and David A. Etnier

Abstract.—*Etheostoma aquali*, a new percid fish, is described from the Duck and Buffalo rivers, tributary to the Tennessee River in central Tennessee. It is compared to *Etheostoma maculatum sanguifluum* from the Cumberland River System in Tennessee and Kentucky. The new species differs from other species of the subgenus *Nothonotus* in details of squamation and pigmentation. Recent distribution records of three species of the subgenus *Nothonotus* are reported.

During the past 15 years the rather considerable research conducted on the systematics of darters of the subgenus *Nothonotus* (genus *Etheostoma*) has resulted in the description of five new species. This research was summarized by Zorach (1972) who discussed relationships within the subgenus. In this paper we describe the coppercheek darter, a new species, from the Duck and Buffalo river systems, Tennessee River drainage, Tennessee. This brings the number of species assigned to the subgenus *Nothonotus* to twelve. The three allopatric subspecies of *Etheostoma maculatum* may eventually be recognized as species. In addition, extant specimens from collections taken some years ago may represent undescribed taxa that have been eliminated or drastically reduced by impoundments and decreasing water quality (see Zorach, 1972:431, and Distribution section in this paper).

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Comparative material of *E. m. maculatum*, *E. m. vulneratum*, and *E. m. sanguifluum* from the UAIC, USNM, and UT collections was utilized in preparing this description. One to three collections of all species of the subgenus *Nothonotus* were examined for various meristic, pigmentation, and squamation characteristics during the course of the study. Methods of Hubbs and Lagler (1958) were used in obtaining counts and measurements except diagonal scale counts (anal fin to first dorsal fin and second dorsal fin to anal fin) described by Raney and Suttkus (1964). Vertebral counts follow Bailey and Gosline (1955).

Etheostoma aquali, new species
Coppercheek Darter
(Fig. 1)

Etheostoma microlepidum. Raney and Zorach, 1967:93–94, 97–98, 103. Misidentification of specimens from the Duck River, Tennessee River drainage.

Etheostoma sp. Zorach, 1972:445. Undescribed species from Duck River system.

Holotype.—Adult male, TU 105479, 55 mm standard length (SL), Flat Creek, tributary to Duck River at Tennessee Highway 64, Bedford Co., Tennessee, 13 April 1967.

Allotype.—Adult female, TU 105480, 43 mm SL, taken with holotype.

Paratopotypes.—Paratypes taken with primary types are TU 105481 (3). Additional paratypes taken at the type-locality are USNM 218001 (6), 1 October 1967; UAIC 2826 (6), 3 February 1968; and UAIC 2856 (1), 29 March 1968.

Other paratypes.—Duck River system, Tennessee: UAIC 2700 (18), Duck River at Shelbyville, Bedford Co., 1 October 1967; UT 91.228 (7), Duck River at U.S. Highway 231, Shelbyville, Bedford Co., 20 October 1968; TU 32989 (6), Duck River 13.4 miles NW of Tullahoma on U.S. Highway 41A, Bedford Co., 17 July 1964; UT 91.749 (1), Duck River at Cortners Mill, River Mile 245, Bedford Co., 4 October 1972; TU 95729 (1), Duck River below bridge just above mouth of Buffalo River, Humphreys Co., 10 September 1975; Illinois Natural History Survey 77826 (3), Duck River at mouth of Hurricane Creek, Humphreys Co., 29 August 1973; Florida State Museum 24499 (9), Duck River at first bridge above I-40, one river mile above I-40, Hickman Co., 10 October 1972; University of Michigan Museum of Zoology (UMMZ) 201716 (1), Duck River at I-40 crossing, Hickman Co., 10 March 1968. Buffalo River system, Tennessee: UMMZ 201717 (2), Buffalo River at mouth of Grinders Creek, Lewis Co., 10 July 1970; UT 91.1282 (5), same locality, 27 April 1974; UT 91.622 (1), Buffalo River at Perry Co. 6242, SE of Lobelville, 8 September 1971; USNM 218002 (2), Buffalo River at Metal Ford, River Mile 100, about 2 miles above mouth of Grinders Creek, Lewis Co., 22 July 1976.

Diagnosis.—*Etheostoma aquali* is a member of the *E. maculatum* species group (Zorach, 1972:442) of the subgenus *Nothonotus*. It differs from *E. acuticeps* in having the opercles and anterodorsal portions of cheeks scaled.

Fig. 1. *Etheostoma aquali* new species, paratype, UT 91.1282, male, 64 mm SL.

Black marginal bands present on the anal, caudal, and soft-rayed dorsal fins of *E. maculatum vulneratum**, *E. microlepidum*, *E. moorei*, and *E. rubrum* males are lacking in *E. aquali*. Differs from *E. m. maculatum* in having red or orange in the anal fin (males only). Most similar to and probably most closely related to *E. maculatum sanguifluum*, from which it differs in having wavy copper-colored lines on the cheeks of both sexes and in lacking a dark suborbital bar. In *E. m. sanguifluum* the coppery lines are absent and a suborbital bar is present. In males of *E. aquali* bright red spots on the sides are usually restricted to the posterior three-fourths of the body, whereas in all subspecies of *E. maculatum* these red spots extend forward to the head. Females of *E. aquali* appear to resemble those of *E. m. maculatum* in not developing red spots on the sides; these spots are typically detectable in *E. m. sanguifluum* and *E. m. vulneratum*. Lateral-line scales (Table 2) average 62 (57–67) in *E. aquali* and 58 (51–67) in *E. m. sanguifluum*.

Description.—*Etheostoma aquali* is a robust, moderate to large species (Fig. 1) of the subgenus *Nothonotus*. The largest specimen we have seen is a male 67 mm SL; adult males are typically about 60 mm SL. Adult females are typically about 50 mm SL, with the largest seen up to 56

Table 1. Measurements in thousands of SL of *Etheostoma aquali* new species. $\bar{x}$ = mean, *W* = range of values.

	TU 105479 holotype	USNM 218001, FSM 24499 UT 91.1282 5♂		USNM 218001, FSM 24499 UT 91.1282 5♀	
		$\bar{x}$	*W*	$\bar{x}$	*W*
Standard length	55.2	61.6	58.5–65.7	50.6	45.1–55.2
Body depth dorsal origin	237	230.0	220–245	209.4	189–233
Caudal peduncle depth	141	144.4	138–161	127.6	109–140
Caudal peduncle length	204	209.1	203–222	201.2	166–221
Pelvic fin length	172	179.6	174–189	183.4	146–199
Pectoral fin length	207	206.0	198–211	211.4	189–225
Head length	265	251.2	242–256	253.2	224–265
Snout length	74	64.8	60–68	64.0	58–71
Orbit length	62	59.2	56–62	59.8	55–64
Upper jaw length	90	84.2	80–91	80.2	72–86
Longest dorsal spine	123	137.8	129–147	130.6	115–156
Longest dorsal ray	156	155.6	145–162	135.0	115–146
1st anal spine	89	92.2	85–101	93.0	86–100
Longest anal ray	138	142.6	131–149	130.2	117–142

mm SL. Greatest body depth just anterior to spinous dorsal fin; greatest body width just posterior to opercle. Morphometric data appear in Table 1.

Lateral line complete with 57–62 ($\bar{x}$ = 62.2, holotype = 60) scales (see Table 2). Diagonal scale count from origin of soft dorsal fin to anal fin base 13–17 (14.95, 14). Caudal peduncle scale rows 21–26 (22.3, 22). Diagonal scale count from anal fin origin to base of dorsal fin 16–20 (17.9, 16). Scale rows above lateral line 5–8 (6.9, 7, see Table 2).

Dorsal fin with XII–XIV (12.9, 12) spines and 11–14 (12.7, 13) soft rays. Total dorsal rays 24–27 (25.5, 25, see Table 3). Anal rays 8–10 (9.2, 10, see Table 3). Pectoral rays 12–16 (13.6, 14). Vertebrae 38–40 (38.96, 39). Cephalic sensory canals typically with little variation between left and right sides. Pore counts (left side of 25 individuals) are as follows: supratemporal canal with 3 pores; lateral canal pores 5 (23 specimens) or 6 (2); supraorbital canal pores 3; coronal pore single; infraorbital canal pores 8 (24) or 9 (1); preoperculomandibular canal pores 10 (24) or 11 (1). Gill membranes separate; branchiostegal rays 6-6. Frenum broad.

Body scaled except for nape, prepectoral area, breast, and occasionally anterior portion of belly. Opercles completely scaled, scales absent elsewhere on head. Cheeks with about 3–5 ctenoid (occasionally cycloid) scales associated with dark spot behind eye. Zorach (1972:430) noted the presence of these scales in *E. moorei* and *E. rubrum*. We find them to also be con-

Table 2. Frequency distribution of selected scale counts in *Etheostoma aquali* and *E. maculatum sanguifluum*. Counts for *E. maculatum sanguifluum* from Zorach and Raney (1967).

	Lateral line scales																	
	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	$\bar{x}$
E. aquali							1	1	3	7	17	6	6	4	6	3	3	62.18
E. m. sanguifluum	1		1	5	4	6	8	4	10	8	5	2	1	1		1		58.07

	Scales above lateral line					
	5	6	7	8	9	$\bar{x}$
E. aquali	3	14	21	14		6.89
E. m. sanguifluum		2	27	24	4	7.53

sistently present in *E. microlepidum* and the three subspecies of *E. maculatum*. They are absent in other species of *Nothonotus* and in *E. juliae*, a species which may have affinities with *Nothonotus*.

Coloration.—Life colors of males and females collected in February, April, July, and October showed little seasonal variation. Males (Fig. 1) with body grayish to dark olive brown. Dark horizontal lines between scale rows conspicuous on caudal peduncle, extending slightly forward of anal fin below lateral line and to under middle of spinous dorsal fin above lateral line. About 20–35 bright red spots on sides, these spots approximately equal in number above and below lateral line. Each spot confined to area between horizontal lines and occupying much of exposed field of single scales or occasionally two scales in horizontal series. Humeral scale iridescent greenish black. Belly grayish brown. Breast grayish. Gill membranes darker than breast. Cheeks with 2–3 characteristic copper-colored lines (occasionally broken into a series of dashes) that extend, with less intensity, onto opercles. Position, width, and intensity of marks on head somewhat variable. Most prominent mark extends from above angle of jaw posteriodorsad to near junction of preopercle and opercle, where it splits, forming 2 distinct lines. Upper line extends posteriad across upper part of opercle, terminating near dorsal base of opercular spine. Lower line extends posterioventrally, terminating near middle of suboperculum. Another mark, usually less prominent, extends from behind and slightly below angle of jaw posteriad across cheek, its continuation on gill cover at symphysis of suboperculum and interoperculum. In some individuals 2–3 additional coppery dashes extend from posterioventral margin of orbit across upper margin of cheek and opercle. Small copper-colored spots may occur on snout and interorbital area, these spots occasionally confluent. Dark preorbital bars extend ventral to nares and terminate immediately

Table 3. Frequency distribution of selected fin-ray counts on *Etheostoma aquali* and *E. maculatum sanguifluum*. Counts for *E. maculatum sanguifluum* from Zorach and Raney (1967).

	Total dorsal rays					
	23	24	25	26	27	$\bar{x}$
E. aquali		4	24	25	5	25.53
E. m. sanguifluum	2	10	35	8	2	24.97
	Anal rays					
	7	8	9	10		$\bar{x}$
E. aquali		2	42	15		9.22
E. m. sanguifluum	4	40	12	1		8.18

lateral to frenum. Spinous dorsal fin dark olive to dark gray at base and progressively paler toward clear margin. Proximal half of first one or two interradial membranes darker than posterior membranes. Distal halves of first and last membranes (and often 1–2 adjacent membranes) bright red. Base of soft dorsal fin dark olive green grading to grayish orange toward the narrow, clear margin. Some individuals with slashes of reddish interradial pigment in central portion of fin. Basal one-fourth of anal fin dark olive to dark gray. Distal three-fourths of fin bright red except for narrow margin which is white anteriad, becoming clear posteriad. Bright red pigment of anal fin covers both rays and membranes on anterior two-thirds of fin; on remainder of fin red confined primarily to membranes. Caudal fin with narrow clear margin; bright red on 2–3 principal dorsal and ventral rays and associated membranes. Distal three-fourths of middle 8–10 caudal rays and membranes with red slightly less intense than adjacent dorsal and ventral areas. Basal fourth of middle 8–10 caudal rays dark olive, forming a quadrate blotch at base of fin. Procurrent caudal rays dark olive. Pectoral fins with grayish to dark olive base gradually changing to reddish orange (primarily on membranes) toward margin. Pelvic fins bright red with dark olive to grayish base. Pelvic spine white to cream colored.

Female bodies olivaceous with scattered brownish to dark gray blotches. Horizontal dark lines between scale rows less conspicuous than on males, typically not extending forward of anal and soft dorsal fin, and occasionally obsolescent. Red spots have not been observed on females. Belly, breast, and opercular membranes olive to grayish. Cheeks and opercles dark olive to light brown, with cheeks paler than opercles and marked with copper-colored reticulations that tend to be less bold than those of males. Median fins pale yellow, occasionally tinged with green, and liberally covered with dark olive to dark gray spots. Spots on soft dorsal and anal fins scattered on rays and mebranes. Spinous dorsal fin with distinct spots conspicuous near margin, pigment more uniform toward base of fin. Caudal fin spots confined to rays, arranged in 5–6 irregular vertical rows. Base of caudal fin with dorsal and ventral pale areas separated by median dark mark or pair of adjacent submedian dark marks. Spots on pectoral and pelvic fins aligned in irregular vertical rows, restricted to rays of former and occurring on both rays and membranes of latter. Varying amounts of light reddish orange pigment occasionally present on paired and/or median fins of some individuals.

Distribution and habitat.—The coppercheek darter is known only from the Duck and Buffalo rivers, tributaries to the Tennessee River in central Tennessee. Within the Duck River it occurs only in the main channel and lower portions of a few larger tributaries in Bedford, Maury, Hickman, and Humphreys counties. In the Buffalo River, it has been taken only in the main channel in Lewis, Wayne, and Perry counties. *Etheostoma aquali* has been confused with other species of the subgenus *Nothonotus.* The record of *E. microlepidum* (TU 32989) reported from the Duck River by Raney and Zorach (1967) was based on specimens of *E. aquali*, as pointed out by Zorach (1972:445). Gilbert's (1891) record of *E. maculatum* from the Duck River is probably based on specimens of *E. aquali*, but this could not be confirmed since these specimens are apparently lost. Raney and Zorach (1967) examined the 5 specimens in USNM 36670, taken in Shoal Creek, Florence, Alabama, in 1884 by Gilbert and Swain, and identified 3 as *E. rufilineatum* and 2 as *E. microlepidum.* In 1972, Zorach realized that the Duck River specimens identified earlier as *E. microlepidum* represented an undescribed species. We have reexamined these specimens and are of the opinion that the two specimens identified as *microlepidum* are neither that species nor are they *E. maculatum vulneratum* or *E. aquali.* This conclusion is based primarily on the absence of scales behind the eye in both specimens. These two specimens (USNM 36670) along with a single specimen (TU 30271) from the Elk River at Fayetteville, Lincoln Co., Tenn., may represent an undescribed taxon. All three specimens are from the same geographic area and have similar meristics and squamation. Body shape, pigmentation, and the presence of 63–64 lateral scale rows in the specimens suggests that their affinities are with the *E. maculatum* species group. While these populations may be extinct, we believe that additional collecting effort in the southern bend of the Tennessee River drainage in northern Alabama and southern Tennessee may provide fresh material which hopefully would clarify the status of the Shoal Creek and Elk River specimens. The scarcity of material may be due in part to the difficulty of adequately sampling the large stream habitat typically occupied by the subgenus. This may also account for *E. tippecanoe* (Bedford Co.) and

E. camurum (Maury Co.) being taken recently in the Duck River after many years of collecting effort. Similarly, *E. microlepidum* was recently taken for the first time from the Red River in Robertson Co., Tenn. The habitat of *E. aquali* is similar to that described for the subspecies of *E. maculatum.* It is typically taken from large streams and rivers in shoal areas 0.3–1 m deep with moderate to swift current. Substrate is typically a mixture of gravel and cobbles with some large, unconsolidated rocks. The coppercheek darter is most often found among the large rocks.

Conservation.—The coppercheek darter is presently protected as a threatened species by Tennessee and is being considered for similar status by the Department of Interior, U.S. Fish and Wildlife Service. The recently completed Normandy Dam in the upper Duck River is expected to reduce or eliminate populations in the vicinity of the dam. The controversial Columbia Dam, currently being built on the middle portion of the Duck River, will eliminate populations in that area. It is not possible to predict the precise effect of discharges from a completed Columbia Reservoir on the extremely diverse and complex riverine fauna occupying the approximately 120 river miles of the Duck River below Columbia Dam site. We can be assured that the net effect will be a reduction of species diversity. Since endangered and threatened species often achieve that status because of their inability to cope with habitat alteration, we expect this loss of species diversity to have a disproportionately adverse effect on the threatened fishes and endangered and threatened mollusks of the river. Members of the subgenus *Nothonotus* are not tolerant of reservoirs and appear to have only limited tolerance of tailwater habitats. Portions of the Duck River, and to a lesser extent the Buffalo River, are also suffering from the polluting effects of inadequately treated industrial and municipal sewage.

Etymology.—The species epithet, *aquali,* is suggested by and shortened from the Cherokee word "agaquali," which, according to Alexander (1971) means "cheek." Its use is intended to call attention to the cheek region which in life has copper-colored markings that are a diagnostic feature of the species.

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Footnote

* John Ramsey has correctly pointed out (in Lit.) that part of the color description of *E. m. vulneratum* (Zorach and Raney, 1967:318) is based on his color notes for *E. chlorobranchium* (JSR field notes 63-24) rather than his notes for *E. m. vulneratum* (JSR 63-19). In particular the sentence describing the median fins as having a "black margin bordered by lemon-yellow," and the preceding and following sentence clearly pertain to *E. chlorobranchium* and not to *E. m. vulneratum.*

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THE REASSIGNMENT OF *CAMBARINCOLA ELEVATUS* GOODNIGHT, 1940, (CLITELLATA: BRANCHIOBDELLIDA) TO THE GENUS *SATHODRILUS* HOLT, 1968

Perry C. Holt

Abstract.—*Cambarincola elevatus* Goodnight, 1940, is transferred to the genus *Sathrodrilus* Holt, 1968, redescribed, illustrated, its affinities discussed and its distribution recorded.

We have long known that *Cambarincola elevatus* Goodnight, 1940, widespread and common in the Midwestern states of the United States, is not a member of the genus *Cambarincola* (Hoffman, 1963:276). An attempt at an adequate diagnosis and a redescription of the species would seem, then, to be overdue. This paper is written to redress my oversight in not including *elevatus* in the report in which I erected the genus *Sathodrilus* (Holt, 1968b) and to fulfill Hoffman's promise that I would do so. Although no effort will be made herein to speculate about the relationships of the genera *Cambarincola*, *Sathodrilus* and their relatives, this report may incidentally contribute to a clarification of these related, speciose and taxonomically confusing genera.

Other than Hoffman's (1963) passing reference to *elevatus* and the possibility of its mention in keys to the invertebrates of the area or compendia that I have not seen, nothing has been written about the species since Goodnight's (1940:35) original description.

Many specimens from 48 collections taken in 8 states have been studied, but the principal material, including two sets of serial sections, on which the following is based was collected in Olmstead County, Minnesota. All of this material is in the collections of the Center for Systematics Collections, Virginia Polytechnic Institute and State University, identified by the initials "PCH." All collections, unless otherwise credited, were taken by my wife and me. Drawings were done with the aid of a camera lucida and all are oriented with the anterior part to the reader's right. Measurements taken with an ocular micrometer are best regarded as approximations. Locality data include hosts in most cases; for some collections the hosts were not received by me or were (e.g., those taken with the Popes in 1956) inadvertently discarded or lost.

I am indebted to the National Science Foundation (grants 4439 and 9828) and the Department of Biology, VPI & SU, for financial support. Dr. Horton H. Hobbs, Jr., identified the host crayfishes and reviewed the manuscript. Prof. Richard L. Hoffman first called my attention to the

inappropriateness of the generic assignment of the species. My wife, Virgie F. Holt, contributed to the collecting. I am grateful to all.

Sathodrilus elevatus (Goodnight, 1940), new combination
Figs. 1–4

Cambarincola elevata Goodnight, 1940.
? *elevata*.—Hoffman, 1963.

Type-specimens.—"Holotype: From Leaf River, Ill. on *Cambarus virilis*. Paratypes: From Macoupin Creek near Carlinville, Ill., on *Cambarus virilis*; Buck Creek near Penfield, Ill., on *C. virilis*; Leaf River near Byron, Ill., on *C. virilis*; Seven Mile Creek, Rock River Drainage, Ill., on *C. virilis* and *C. propinquus*; and Lake Geneva, Wis., on *C. virilis* . . . . The holotype will be deposited in the United States National Museum and paratypes in the collection of Dr. H. J. Van Cleave, of the University of Illinois, and in the collection of the writer" (Goodnight, 1940:35).

Diagnosis.—Small to medium-sized branchiobdellids (average length of 5 typical specimens, 2.2 mm); with dorsal ridge on segment VIII, none on major annuli of other segments; lips with slight median emarginations; no oral papillae; jaws small, dental formula 5/4; bursa elongate, both ectal and ental ends less in diameter than median part; approximately ⅗ body diameter in length; penial sheath about ⅔ total bursal length; spermiducal gland long, approaching body diameter in length, without deferent lobes; prostate present, prominent, about ⅔ spermiducal gland in length, subequal in diameter; spermatheca about body diameter in length, with spermathecal bursa, with thick, muscular ectal duct, with glandular cylindrical bulb with narrow lumen, no ental process.

Description.—*Sathodrilus elevatus* is composed of rather stout worms which are of moderate size among its congeners. Five specimens from the Olmstead County, Minnesota, locality have the following approximate dimensions in mm (averages followed by ranges in parentheses): total length 2.2 (1.9–2.5); greatest diameter 0.4 (0.3–0.5); head length 0.4 (0.4–0.4); head diameter 0.3 (0.2–0.3); diameter segment I 0.3 (0.2–0.3); diameter sucker 0.3 (0.2–0.3).

The body outline (Fig. 1) is smooth, with the exception of the dorsal ridge of segment VIII, which is provided with 3 or 4 strands of supernumerary muscles which the other segments lack. The anterior nephridiopore is not prominent. The peristomium is divided into dorsal and ventral lips, each with a slight median indentation: there are no lobes of the lips or oral papillae. The head is usually marked by one weak external sulcus exclusive of the peristomial one; internally there is one pharyngeal sulcus. The jaws are small, usually light in color, and the teeth are dif-

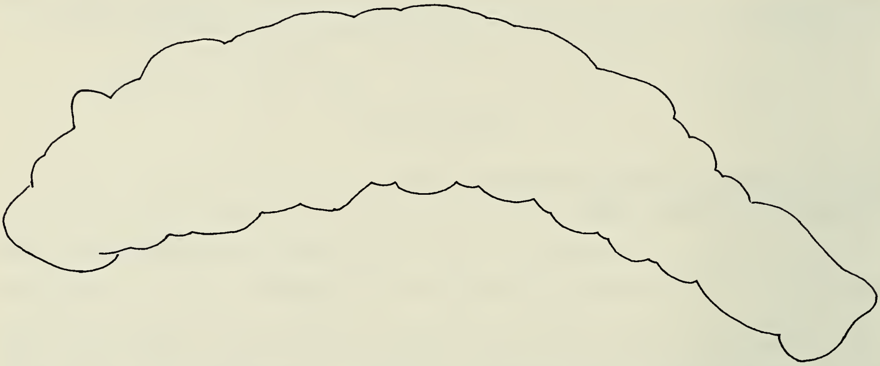

Fig. 1. *Sathodrilus elevatus.* Outline of specimen from Olmstead County, Minnesota (PCH 792).

ficult to count. In specimens mounted entire, it is usually impossible to count them, but in some the dental formula is 5/4 and this is probably the characteristic number for the species. The bases and anterior faces of the jaws are concave and the undamaged teeth (many are broken or worn) are, relative to the size of the jaws, sharp and prominent.

The spermiducal gland is long and thick without deferent lobes (Fig. 2) and tapers markedly to its juncture with the ejaculatory duct (cf. Fig. 3a). In both illustrations, this feature was impossible to fully present because of the relative positions of the organ. Otherwise, the gland is without peculiarities. The prostate is large, lying along the mid-portion of the spermiducal gland. It is subequal in diameter to the latter at its mid-length and entally there is a prostatic bulb. Adhering closely to the middle third of the spermiducal gland, the prostate thus arises at some distance from the junction of the spermiducal gland and the ejaculatory duct.

The ejaculatory duct is a muscular tube, noticeably expanded along its mid-length, narrowing towards its ental and ectal junctions with the spermiducal gland and bursa (Fig. 2). The mid-portion of the duct, in addition to an outer layer of longitudinal muscle, is furnished with a thick layer of radial muscles (cf. Holt, 1977:123, Fig. 3).

The bursa is long, noticeably wider at the junction of its penial sheath and atrial parts. The penial sheath comprises about ⅔ of the organ and encloses the eversible penis (Fig. 4). The latter is a double-walled, eversible cuticular sac, with cytoplasmic strands connecting its inner and outer walls. Entally, the lumen of the penis, near the point where it becomes the lumen of the ejaculatory duct, is thrown into folds and is surrounded by denser tissue, presumably a continuation of the epithelial lining of the ejaculatory duct.

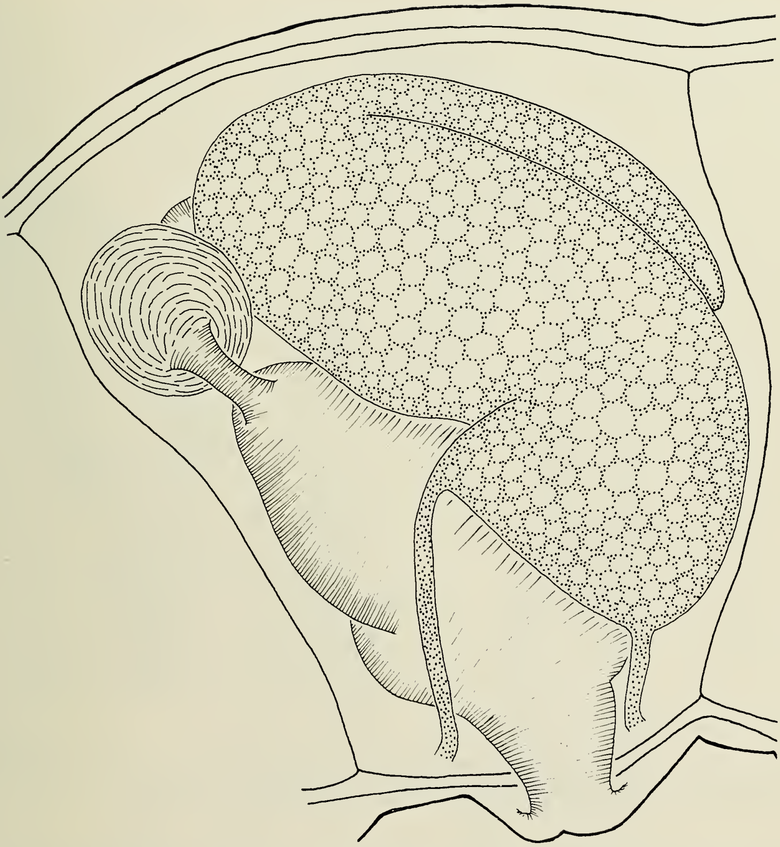

Fig. 2. *Sathodrilus elevatus.* Lateral view of male reproductive system (PCH 792).

The spermatheca (Fig. 3b) is prominent. Its ectal part (the ectal duct) is heavily muscular with a spermathecal bursa (Holt, 1960:64) which continues entally, beyond an expended lumen similar to the atrial region of the bursa, as a muscular spermathecal duct of comparable diameter. The spermathecal bulb is set off from the spermathecal duct by a deep annular constriction. The bulb encloses a narrow lumen; its bulk is principally composed of a columnar epithelium. The inner ends of the cells composing this epithelium almost obliterate the lumen of the organ. Only a few masses of spermatozoa are normally found in the lumen of the bulb. There is no ental process of the spermatheca.

Variation.—There is the usual amount of apparent variation attributable to the position of the organs of the reproductive systems at death, degree

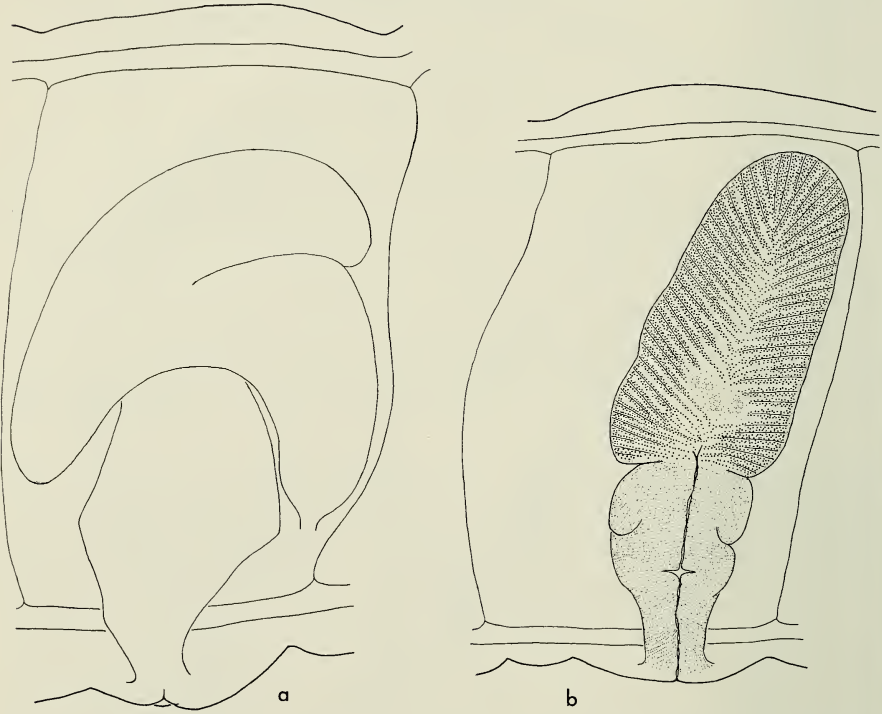

Fig. 3. *Sathodrillus elevatus*. Lateral views of reproductive systems. *a*, Outline of male organs; *b*, Optical section of spermatheca (PCH 792).

of contraction and differences produced by different killing-preservative agents (the description presented above is based upon animals collected in ethanol-formalin). In some specimens the jaws are much darker in color than in most; as noted the teeth are often broken and in many specimens the dental formula appears to be, but probably is not, ½. The unwary may be misled as to the point of origin of the prostate: in specimens in which the ectal end of the spermiducal gland is obscured, the two glands may appear to arise from their juncture with the ejaculatory duct. Among the specimens collected by my wife and myself, there is no consistency of apparent variations with geographical distribution; among those collected by others the variability is attributable to the use of weaker solutions of alcohol as a killing-preservative agent.

Affinities.—Sathodrilus elevatus is the twelfth species to be assigned to the genus (Holt, 1968; 1973; 1977) and other species are known to me, but remain for future naming and description. Among these 12 species with a recognizable prostate (Holt, 1977:121), *S. norbyi* Holt, 1977, is provided

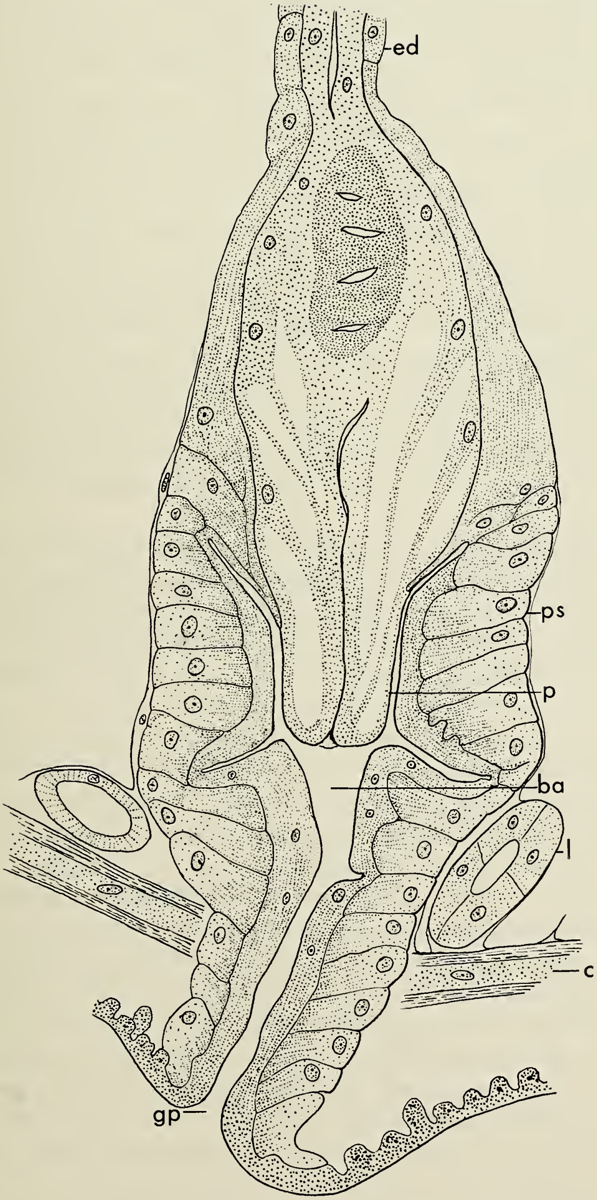

Fig. 4. *Sathodrilus elevatus*. Median section of bursa and penis from transverse sections (PCH 792). Abbreviations: *ba*, bursal atrium; *c*, circular muscle of body wall; *ed*, ectal end of ejaculatory duct; *gp*, male gonopore; *l*, longitudinal muscle of body wall; *p*, penis; *ps*, penial sheath of bursa (PCH 792).

with a dorsal ridge on segment VIII. S. *elevatus* is slightly larger in both length and diameter than *norbyi* (Holt, 1977:126), though the two are externally quite similar. The prostate of *norbyi* is an obscure lobe of the ental end of the spermiducal gland; the ejaculatory duct and bursa are proportionately somewhat smaller than those of *elevatus.* The wall of the bursal atrium of *norbyi* is furnished with only one "atrial fold" as opposed to two in *elevatus* (cf. Holt, 1977, Fig. 4d with Fig. 4 herein). The spermatheca of the two are alike in general structure (Holt, 1977:127), but that of *elevatus* is markedly proportionately larger and its ectal bursa and duct are much more prominent and muscular. The other species of *Sathodrilus* with a patent prostate (S. *prostates* Holt, 1973; S. *dorfus* Holt, 1977; S. *lobatus* Holt, 1977; S. *virgiliae* Holt, 1977) all lack the dorsal ridge on segment VIII and are different from *elevatus* in such features as lobation of the peristomium (S. *lobatus*), the ental process of the spermatheca (S. *dorfus*, S. *lobatus*), the divergent prostate and an unusual spermatheca with a thin-walled median portion (S. *virgiliae*). On the basis of present knowledge, S. *norbyi* is the nearest relative of S. *elevatus*, but no phylogenetic conclusions are implied by this remark.

Hosts.—*Sathodrilus elevatus* is known to be associated with 7 species of crayfish: *Cambarus* (*Lacunicambarus*) *diogenes diogenes* Girard, 1852; *C.* (*Puncticambarus*) *robustus* Girard, 1852; *Orconectes immunis* (Hagen, 1870); *O. obscurus* (Hagen, 1870); *O. propinquus* (Girard, 1852); *O. rusticus* (Girard, 1852); *O. virilis* (Hagen, 1870). As usual, there is no evidence of host specificity.

Distribution.—Goodnight (1940:35) reported, in addition to the localities for the type-series, that material of S. *elevatus* from Farmington, Missouri; the Iowa River in Iowa; and Oxford, Ontario, Canada, had been examined. I am a little doubtful of the Missouri record; I have material (PCH 1467) from Wayne County, Missouri, almost due south of Farmington, Francois County, of a species of *Sathodrilus* with a dorsal ridge on segment VIII that definitely is not conspecific with *elevatus.* Goodnight's records of the species from Iowa and Ontario can be provisionally accepted. Only additional collecting can determine the exact range of S. *elevatus,* but as the localities listed below attest, *elevatus* is an inhabitant of the upper Mississippi River, the Red River and the Great Lakes drainages. Since most of this area was repeatedly glaciated during the Pleistocene epoch, it is fruitless to say more about the original provenance of the species than that it was at the southern border, or south of, its presently known home: refugia in "driftless areas" do not appeal to me as an answer to biogeographical problems as long as there are any other possible answers.

Remarks.—Goodnight (1940), and most prior students of the branchiobdellids of North America, tended to ignore the not well understood structures of the reproductive systems of the animals. His descriptions of the external appearance and jaws of S. *elevatus* are entirely concordant with mine; his remarks about the reproductive systems require comment. Mostly, they apply to almost all North American branchiobdellids and can be ignored, but he said (1940:35): "Bursa but not penis eversible." This statement was almost surely an inference based on previous observations of species of *Cambarincola*. The bursal atrium of members of *Cambarincola* and *Sathodrilus* (and that of members of most other genera) is everted; the penis may be everted or protruded (Hoffman, 1963:288–289). The penis, as well as the bursal atrium, of S. *elevatus* is eversible. This statement is itself an inference from the structure of the bursal-penial complex (Fig. 4). In other members of *Sathodrilus* (Holt, 1973:98–101) with bursae and penes anatomically strictly congruent with those of S. *elevatus*, everted penes have been seen and illustrated, confirming the inference amounting to prediction in the original diagnosis of the genus (Holt, 1968:294). There are, nonetheless, problems related to the eversibility of the penis in *Sathodrilus* and other genera that must await future resolution; the question before us is the conspecificity of the animals studied by Goodnight and myself.

In addition to the evidence presented above and the comparison of the holotype of *elevatus* with my material by Hoffman and myself, Goodnight (1940:35) also said "spermatheca in V consists of three parts, a short muscular portion near the spermathecal pore, a short middle tubular portion, and large dorsal globose part. . . ." This statement, allowing for differences in language and the fact that the bulb of the spermatheca of *elevatus* is cylindrical, not globose (a superficial examination of specimens in which the spermathecal bulb does not lie in the optical plane as observed would lead to its characterization as "globose") is significant. The spermathecae of species of *Cambarincola* do not have a spermathecal bursa. *Sathodrilus elevatus* is a congener of those species now assigned to the genus that have a prostate gland and not a congener of those species of *Cambarincola* represented by the type of the genus, C. *macrodontus* Ellis, 1912, as emended by Holt and Hoffman (1959). The combination of an eversible penis, a prostate that arises entad to the commissure of the spermiducal gland and the ejaculatory duct, a spermathecal bursa, the small size of the worms, the delicate jaws; these features are not consonant with the concept of the genus *Cambarincola* (Holt and Hoffman, 1959).

Material examined.—The holotype; ILLINOIS: 2 specimens, PCH 897, on *Orconectes virilis* from Smallpox Creek, 17.05 km W of Elizabeth, Jo Daviess Co., C. H. Pope, S. H. Pope, P. C. Holt, V. F. Holt, 13 May 1956. Two specimens, PCH 898, on O. *propinquus* from Apple River, Apple River Canyon State Park, Jo Daviess Co., C. H. Pope, S. H. Pope, P. C. Holt, V. F. Holt, 13 May 1956. Ten specimens, PCH 894, on O. *virilis* from Kilbuck Creek, 17.2 km W of Kingston, Ogle Co., C. H. Pope, S. H. Pope,

P. C. Holt, V. F. Holt, 12 May 1956. Two specimens, PCH 805, on *O. immunis*, *O. propinquus*, and *O. virilis* from 14.8 km N of Danville, Vermillion Co., 25 July 1958. INDIANA: 2 specimens, PCH 803, on *O. propinquus*, 4.5 km SE of Fowler, Benton Co., 25 July 1958. One specimen, PCH 1199, on *O. propinquus*, 10.6 km W of Butler, DeKalb Co., 2 August 1960. Nine specimens, PCH 802, 10.3 km N of junction of Ind. Rte. 47 and Ind. Rte. 234 near Crawfordsville, Montgomery Co., 24 July 1958. One specimen, PCH 799, 2.8 km W of county line on U.S. Rte. 60, near Valparaiso, Porter Co., 24 July 1958. IOWA: 5 specimens, PCH 896, 15.9 km N of Saint Donatus, Dubuque Co., C. H. Pope, S. H. Pope, P. C. Holt, V. F. Holt, 12 May 1956. Six specimens PCH 895, on *O. propinquus* from S of St. Donatus at junction of Iowa Rte. 528 and Rte. 670, Jackson Co., C. H. Pope, S. H. Pope, P. C. Holt, V. F. Holt, 12 May 1956. MICHIGAN: 6 specimens, PCH 1177, on *O. propinquus* and *O. virilis* from 3.7 km W of Schoolcraft County line on Mich. Rte. 28, Alger Co., 29 July 1960. Seven specimens, PCH 1187, on *O. virilis* from Big Creek, 4.2 km N of junction of Mich. Rte. 65 and U.S. Rte. 23, near Twining, Arenac Co., 31 July 1960. Six specimens, PCH 1188 on *O. propinquus*, 2.7 km NE of Standish, Arenac Co., 31 July 1960. Two specimens, PCH 1190, on *O. propinquus* and *O. virilis* from Muskegon River, NW of Temple on Mich. Rte. 61, Clare Co., 1 August 1960, 3 specimens, PCH 1189, on *O. propinquus* from Molasses River, E of Gladwin, Gladwin Co., 31 July 1960. One specimen, PCH 1185, on *O. propinquus* from AuGres River, 5.0 km W of junction of Mich. Rte. 55 and Mich. Rte. 65, Iosco Co., 31 July 1960. Six specimens, PCH 1186, on *O. propinquus* and *Cambarus* (*P.*) *robustus* from 4.5 km N of Arenac County line, Iosco Co., 31 July 1960. Three specimens, PCH 1178, on *O. propinquus* from Sage River, Luce Co., 29 July 1960. Eight specimens, PCH 1193, on *O. propinquus* from Twin Creek, 17.7 km N of Baldwin, Lake Co., 1 August 1960. Five specimens, PCH 1180, on *O. propinquus* from Hay Meadow Creek, near Atlanta, Montmorency Co., 31 July 1960. Ten specimens, PCH 1181, on *C.* (*P.*) robustus and *O. propinquus* from Thunder Bay River, Montmorency Co., 31 July 1960. Seven specimens, PCH 1184, on *C.* (*P.*) *robustus* and *O. propinquus* from West Branch Rifle River, 11.9 km E of West Branch, Ogemaw Co., 31 July 1960. Five specimens, PCH 1191, on *O. propinquus* and *O. virilis* from Middle Branch Muskegon River near Marion, Osceola Co., 1 August 1960. Two specimens, PCH 1192, on *O. propinquus* and *O. virilis*, 1.0 km E of Tustin, Osceola Co., 1 August 1960. Five specimens, PCH 1182, on *O. propinquus* and *O. rusticus* from tributary to Au Sable River, 0.8 km N of Mio, Oscoda Co., 31 July 1960. Seven specimens, PCH 1195, on *O. propinquus*, 21 km NW of Hudsonville, Ottawa Co., 1 August 1960. MINNESOTA: 4 specimens, PCH 1146, on *O. virilis* from Buffalo River, 25.7 km E of Moorhead, Clay Co., 22 July 1960. Three specimens, PCH 1152, on *O. virilis* from Saint Francis River, 4.3 km NE of Foley, Benton Co., 26 July 1960. Five specimens, PCH 1154, on *O. virilis* from Ground House River at Ogilvie, Kanabec Co., 26 July 1960. Five specimens, PCH 1153, on *O. virilis* from West Branch Rum River, 4.2 km SW of Milaca, Mille Lacs Co., 26 July 1960. Eight specimens, PCH 792, on *Cambarus (L.) d. diogenes* and *O. virilis*, 9.5 km W of Eyota, Olmstead Co., 21 July 1958. Six specimens, PCH 1148, on *O. virilis* from Bluff Creek at Bluffton, Otter Tail Co., 23 July 1960. Five specimens, PCH 1149, on *O. virilis* from Leaf River between Bluffton and Wadena, Otter Tail Co., 23 July 1960. Five specimens, PCH 1150, on *O. virilis* from Wing River, 1.9 km NW of Verndale, Wadena Co., 23 July 1960. One specimen, PCH 790, on *O. virilis* from Clearwater River at crossing of Minn. Rte. 152, Wright-Stearns Co. line, A. G. Luker and P. C. Holt, 20 July 1958. OHIO: 7 specimens, PCH 1202, on *O. rusticus* from 2.4 km E of Wyandot County line on Rte. U.S. 30N, Crawford Co., 3 August 1960. Four specimens, PCH 1205, on *O. obscurus* from Beach Creek, 5.3 km W of Alliance, Stark Co., 3 August 1960. Five specimens, PCH 1204, on *O. s. sanbornii* 9.5 km W of Riceland, Wayne Co., 3 August 1960. Four specimens, PCH 1200, on *O. rusticus* 3.1 km W of Crawford County line on U.S. Rte. 30N, Wyandot Co., 3 August 1960. SOUTH DAKOTA: 7 specimens, PCH 789, on *O. virilis* and *O. immunis* at E side of Watertown, Coddington Co., 19 July 1958. WISCONSIN: 2 specimens, PCH 1160, on *O. virilis* from Bear Creek, 4.2 km N of Rice Lake, Barron Co., 27 July 1960. Five specimens, PCH 1162, on *O. virilis* from Duncan Creek, 6.6 km N of Bloomer, Chippewa Co., 27 July 1960. Twelve specimens, PCH 797, on *O. propinquus* and *O. virilis* from Crawfish Creek, Columbia Co., 22 July 1958. Eight specimens, PH 262, Picnic Point, Lake Mendota, Dane Co., Leath, Rogers, Talbot 28 August 1949. Three specimens, PCH 900, Blake Fork River, near Bloomington, Grant Co., C. H. Pope, S. H. Pope, P. C. Holt, 13 May 1956. Fourteen specimens, PCH 798, on *O. propinquus* from Rock River, Watertown, Jefferson Co., 22 July 1958. Six specimens, PCH 899, 4.0 km S of Darlington, Lafayette Co., C. H. Pope, S. H. Pope, P. C. Holt, V. F. Holt, 13 May 1956. Eight specimens, PCH 795, on *C. (L.) d. diogenes* and *O. virilis*, 18.3 km E of Monroe-LaCrosse County line, Monroe Co., 22 July 1958. Five specimens, PCH 1171, on *O. propinquus* from Oconto River at confluence with Waupee River, Oconto Co., 22 July 1960.

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A NEW GENUS AND SPECIES OF BOPYRID ISOPOD PARASITIC ON THE WESTERN ATLANTIC PORCELLANID *PACHYCHELES ACKLEIANUS* A. MILNE EDWARDS

John C. Markham

Abstract.—A description is given of the pseudionine bopyrid isopod *Kolourione premordica*, new genus, new species, a branchial parasite of the porcellanid crab *Pachycheles ackleianus* A. Milne Edwards from the Gulf of Mexico, Hispaniola, St. Lucia and Curaçao. The new genus occupies an advanced position in the subfamily Pseudioninae and is highly distinctive in that the female's pleon is concave posteriorly.

KOLOURIONE, new genus

Diagnosis.—Female: Pseudionine bopyrid. Body only slightly distorted, both dextral and sinistral forms in single species. Maxilliped with nonarticulated palp. Frontal lamina and coxal plates prominent. Pleon of only 5 pleomeres, terminal one embedded in fourth, leaving posterior margin concave. Pleonal lateral plates reduced or absent. Pleopods biramous, rami lanceolate, those of pleomere 4 much reduced; no pleopods or uropods on pleomere 5. Male: Body about 3 times as long as broad, sides nearly parallel. Head, pleon and pereomeres distinct. No midventral pereonal tubercles. Pleon fused and lacking appendages.

Etymology.—From Greek stems meaning "cut-off tail" + generic name "*Ione*." Gender feminine.

Type-species, *Kolourione premordica*, n. sp.

Kolourione premordica, new species

Figs. 1, 2

"Pseudioninae sur *Pachycheles ackleyanus* A. Milne Edwards."—Bourdon, 1976:238.

Material examined.—Infesting *Pachycheles ackleianus* A. Milne Edwards. University of Miami ship R/V *John Elliott Pillsbury* Sta. P-1283, near Enriquillo, Dominican Republic, 17°31′N, 71°32′W, 18–26 m, 19 July 1970: 1♀, holotype, USNM 150711, 1♂, allotype, USNM 150712, 1♀, 1♂, paratypes, USNM 150713. *Pillsbury* Sta. P-895, near St. Lucia, 14°06′N, 61°01′W, 18 m, 8 July 1969: 2♀, 1♂, USNM 150714. Gulf of Mexico, D. L. Adkison, coll., 15 Oct. 1976: 5♀, 5♂, MESC. U.S. Fish Commission Steamer *Fish Hawk* Sta. 7124, off Tampa Bay, Florida, 25°50′15″N, 82°41′45″W, 38 m, 2 April 1901, dredged on sand; 1♀, 1♂, USNM 29232. From sponge *Spheciospongia vesparia* (Lamarck), Mer Frappée, Haiti,

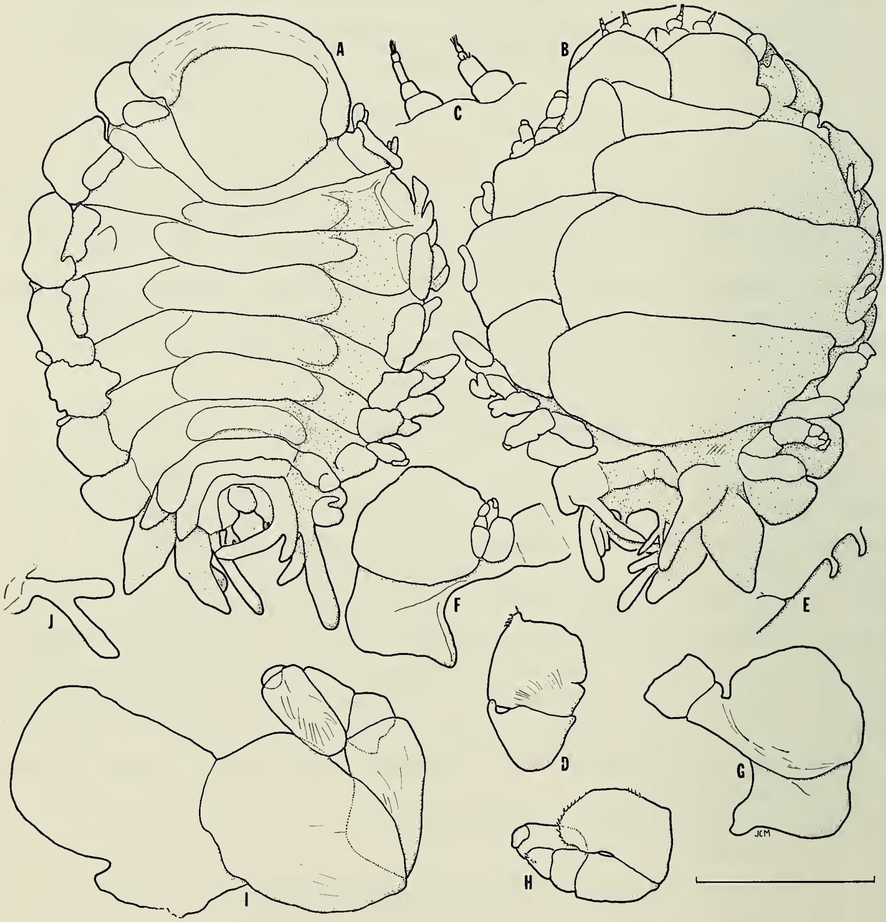

Fig. 1. *Kolourione premordica*, holotype female: A, Dorsal; B, Ventral; C, Right antennae; D, Left maxilliped; E, Left posteroventral border of head; F, Left oostegite 1, external; G, Same, internal; H, Left pereopod 1; I, Left pereopod 7; J. Left pleopod 4. Scale: 1.0 mm for A, B, D, F, G; 0.4 mm for C, H, J; 0.6 mm for E.

May 1964, A. Veillet, coll.: 5♀, 5♂, RMNHL. Unknown specific locality, Haiti, A. Veillet, coll.: 6♀, 4♂, MNHNP. From *Spheciospongia vesparia*, unknown specific locality, 3 m, Curaçao, 13 April 1976. E. Westinga and P. Hoetjes, coll. 2♀, ZMA.

Description of holotype female (Fig. 1).—Length 2.6 mm, maximal width 2.0 mm, head length 0.8 mm, head width 1.0 mm, pleon length 0.4 mm (all measurements excluding frontal lamina and pleonal appendages). Distortion of body axis 22°. Outline nearly oval without abrupt changes in width, margins covered by prominent frontal lamina and coxal plates. All body regions and segments clearly defined (Fig. 1A, B).

Head rather large, suboval but somewhat more pointed posteriorly. Frontal lamina very large, enclosing all of anterior and anterolateral margins of head. Eyes absent. Antennae (Fig. 1C) prominent, each of 4 segments; each antenna tipped with tuft of setae, antenna 1 also with scattered setae on second segment. Maxilliped (Fig. 1D) distinctly bisegmented, straight anteriorly, rounded posteriorly; setose nonarticulated palp extending forward from anterolateral corner; slender extension of anterolateral corner of posterior segment overreaching anterior segment. Posteroventral margin of head (Fig. 1E) with 2 simple slender comma-shaped projections at each side and straight central margin.

Pereomeres all of nearly same size, lateral margins of each covered by large coxal plates slightly better developed on convex side. Anterolateral bosses immediately medial to coxal plates on both sides of first 4 pereomeres. Broad flat middorsal swellings on pereomeres 2–7. Oostegite 1 (Fig. 1F, G) rounded anteriorly, somewhat pointed posterolaterally, anterior lobe and posterior region about equally long; internal ridge unornamented. Oostegites 2–5 tightly overlapping and enclosing brood pouch. Pereopods (Fig. 1H, I) all of about same proportions but doubling in size posteriorly; basal segments of all pereopods larger than other segments combined; pereopod 1 with sparse marginal setae, others nonsetose.

Pleon of 5 pleomeres. Short pointed lateral plates on pleomeres 1–2, none on others. Biramous pleopods with lanceolate rami on pleomeres 1–4, those on pleomere 4 (Fig. 1J) much smaller than others. Pleomere 5 embedded in pleomere 4 so posterior margin of pleon concave; pleomere 5 visible only dorsally, lacking appendages.

Description of allotype male (Fig. 2A–F).—Length 1.65 mm, maximal width 0.65 mm, head length 0.24 mm, pleon length 0.25 mm. All body regions and pereomeres distinctly separated. Sides of pereon nearly parallel, head and pleon narrowing rapidly (Fig. 2A, B).

Head subovate, rounded anteriorly and very obtusely angled posteriorly. Eyes absent. Antennae (Fig. 2C, D) well developed, those of second pair extending far beyond margin of head (in allotype only, right antenna 1 missing); antenna 1 of 3 segments, antenna 2 of 5; each antenna tipped with tuft of setae, also bearing sparse setae on penultimate and antepenultimate segments.

Pereomeres separated for about ¼ of distance in from each side. Pereomere 3 broadest but only slightly so. No midventral tubercles on any pereomeres. Pereopods (Fig. 2E, F) all of nearly same size, but pereopods 1–4 with dactyli proportionately much larger and carpi proportionately much smaller than same segments of pereopods 5–7; sparse setae on carpi and occasionally on other segments.

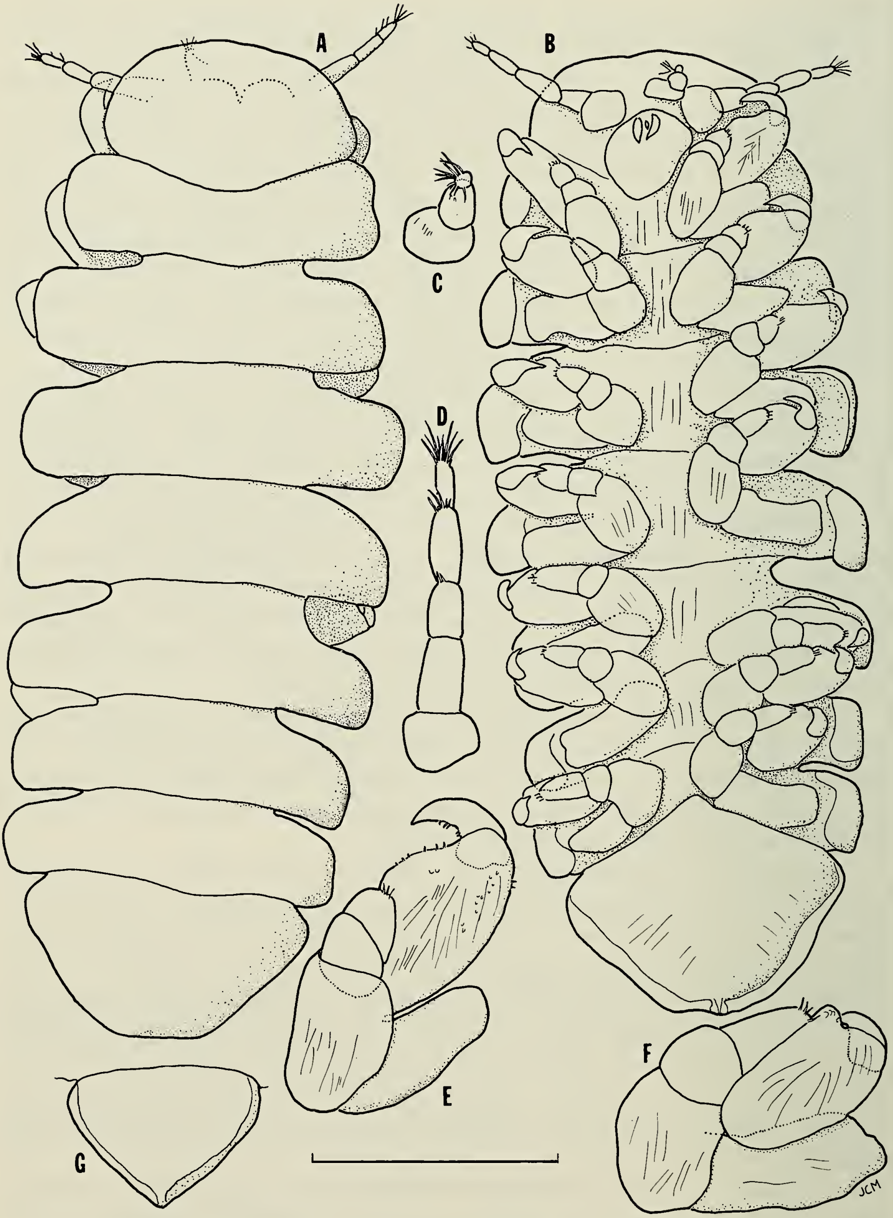

Fig. 2. *Kolourione premordica*, A–F, allotype male; G, paratype male. A, Dorsal; B, Ventral; C, Left antenna 1; D, Left antenna 2; E, Left pereopod 1; F, Left pereopod 7; G, Pleon, dorsal. Scale: 0.4 mm for A, B, G; 0.2 mm for C–F.

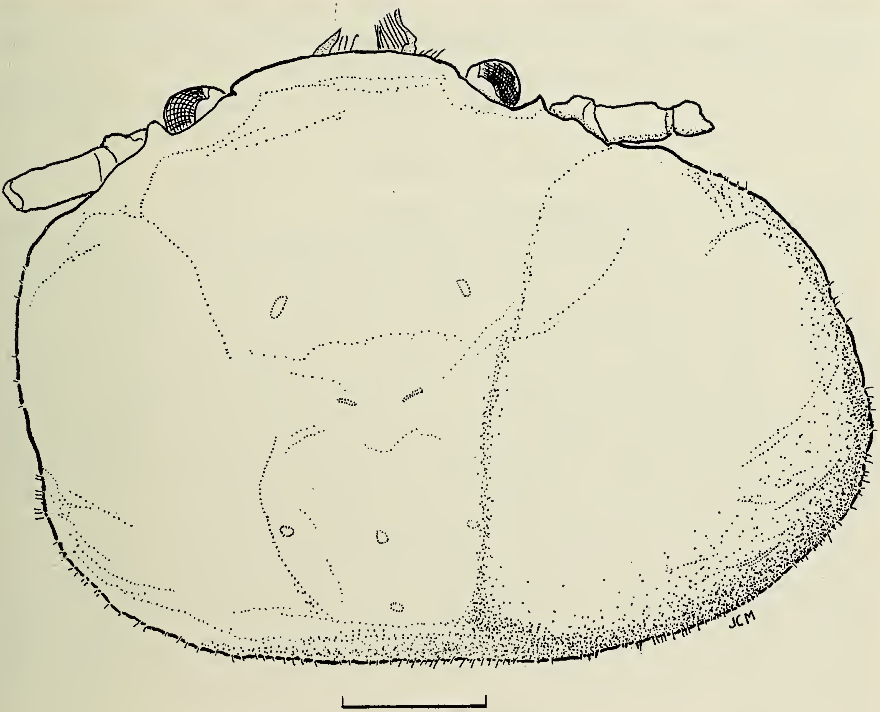

Fig. 3. *Pachycheles ackleianus* infested by *Kolourione premordica.* Scale: 1.0 mm.

Pleon of single fused piece, straight anteriorly, rounded posteriorly. Ventrally, anterior margin extended into prominent triangular point reaching forward and down. No pleonal appendages or any rudiments of them.

Etymology.—The specific name *premordica,* meaning "bitten off," refers to the concave posterior margin of the female.

Discussion.—The most conspicuous character of this new species, the peculiar concavity of the female's pleon, immediately excludes it from any existing genus, so, on that basis alone, the creation of a new genus appears fully justified. As Shiino (1965) has suggested, the major evolutionary trends in the Bopyridae are probabaly a progressive fusion of body segments and loss of appendages in both sexes. By those criteria, *Kolourione* belongs at a rather advanced level in the Pseudioninae, the least evolved subfamily. Characters of the female which indicate this are the lack of articulation of the maxilliped palp, the absence of ornamentation from the posteroventral border of the head and the internal ridge of the first oostegite; and, especially, the presence of only 5 pleomeres. The reduction of lateral plates and posterior pleopods and the lack of uropods also signify an advanced condition. In the male, the most important character is the fused pleon which completely lacks traces of appendages and segmentation; this, too, indicates an advanced position in the Pseudioninae.

Another genus whose female has 5 pleomeres is *Balanopleon* Markham (1974), but it has a reduced frontal lamina and coxal plates but distinct uropods, in contrast with those of the female of *Kolourione*. The male of *Balanopleon* has 2 pleomeres rather than one.

Variations among individuals of *Kolourione premordica* are minor. Most of the other males and many of the females bear slit-shaped dark eyes close to and parallel to the posterolateral margins of their heads. This is probably the normal condition in this species, the eyes of the types having lost their pigment during preservation. A few females are relatively broader and, in some, the posterior concavities are less pronounced. Males show some variation in pleon shape (Fig. 2G), but no other significant differences. Those males still attached to their mates were clinging to the ventral surfaces of their pleons between their pleopods, heads forward. This is a common site of attachment among bopyrids.

The occurrence of *Kolourione premordica* on male and female hosts and in dextral and sinistral forms is about equal. Among those specimens in which such characteristics could be determined, 10 infested females, 7 males, 10 were dextral and 9 sinistral. There was little correlation between the lengths of the female parasites and their hosts' carapaces (of 16 measured, female length $= 0.31 \times$ host carapace length $+ 0.92$, $r = 0.114$), although in other species I have found a high correlation between such lengths. Similarly, the lengths of males did not correlate with the lengths of hosts ($n = 14$, $r = 0.219$) or of females ($n = 13$, $r = 0.113$).

K. premordica seems to have little or no effect on the fecundity of female hosts. Of the 7 parasitized females examined, all bore eggs in various stages of development, their numbers ranging from one to 39. Such a phenomenon has previously been recorded (Markham, 1975) for another western Atlantic parasite of a porcellanid, *Aporobopyrus curtatus* (Richardson) infesting *Porcellana sayana* (Leach). The branchial swelling of the host's carapace (Fig. 3) is quite conspicuous, as it is in *Petrolisthes armatus* (Gibbes) (Markham, 1975).

Bourdon (1976) earlier reported bopyrid infestation of *Pachycheles ackleianus*, by *Pleurocryptosa calypso* Bourdon in Brazil. This geographical pattern of infestation is similar to that of another wide-ranging western Atlantic porcellanid, *Petrolisthes armatus*, which is infested by *Aporobopyrus curtatus* along the eastern coast of North America and in the Caribbean but by a different species in Brazil and by yet a third in the eastern Pacific (Markham, 1975).

With the description of *Kolourione premordica*, the number of bopyrid species known to infest porcellanids in the northwestern Atlantic is now

4. In addition to *K. premordica* and *Aporobopyrus curatus, Astalione cruciaria* Markham (1975) infests *Clastotoechus vanderhorsti* (Schmitt) at St. Croix, and *Pseudione trilobata* Nierstrasz & Brender à Brandis (1925) infests *Pisosoma angustifrons* Benedict at Curaçao.

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Note added in proof.—The specimens listed as coming from the "Gulf of Mexico" (MESC collection) were taken in depths of from 25–55m off the coast of Florida at four localities: 20°40′N, 87°37′W; 27°38′N, 83°59′W; 28°32′N, 84°19′W; and 28°36′N, 84°37′W.

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DANTYINAE, A NEW SUBFAMILY OF OSTRACODA (MYODOCOPINA: SARSIELLIDAE)

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Abstract.—Dantyinae, a new subfamily of the Sarsiellidae (Ostracoda, Suborder Myodocopina) is proposed for *Dantya magnifica*, a new genus and species of marine ostracode from Carrie Bow Cay, Belize, and 2 previously described species (1 in open nomenclature). The new genus and species is described and illustrated. The phylogenetic relationships of the new subfamily are discussed.

The Smithsonian Institution is at present sponsoring a study, under the leadership of Dr. Klaus Ruetzler, of the coral barrier reef off Carrie Bow Cay, Belize. We are participating in this project by studying the myodocopid Ostracoda collected in the vicinity of the reef. Among ostracodes collected during May 1976 by the junior author were 2 females having a morphology sufficiently different to warrant proposal of a new subfamily, the Dantyinae, in the family Sarsiellidae. We also refer to the Dantyinae, a species collected near Ceylon and identified as *Sarsiella*(?) *ornithoides* (n. sp.) by Brady (1902:189), and a species collected probably in the Indonesian region and identified as *Sarsiella* sp. by Müller (1906:30).

Methods.—The aluminum stub used in mounting specimens for placement in the SEM was modified as follows: A narrow slit was cut across the flat top surface of the stub with a diamond saw, and a round glass cover-slip was cut in two with a diamond point. Half of the cover slip was glued into the slit in the stub, and the specimen, in a position perpendicular to the flat upper surface of the stub, was glued to the edge of the cover-slip (pl. 7e). In the usual method, in which the specimen is mounted close to the stub, the stub often creates background clutter and glare. This is avoided by the method used herein. When using SEM equipment capable of a 10° tilt in the direction opposite the usual 70–90° tilt, the new method has an additional advantage in permitting pictures perpendicular to both sides of the specimen, even when the specimen is mounted as much as 10° from the perpendicular. In the usual method of mounting the specimen close to the stub, the stub blocks off part of one side of the specimen if it is not mounted perpendicular. In yet another previous method that has been used by the authors and others, the specimen is glued to a slender wire mounted perpendicular to the cover slip. The new method is somewhat easier to use, once the stub has been modified, but use of the wire has an advantage in being flexible, permitting it to be bent in order to position the mounted specimen perpendicular to the face of the stub.

SARSIELLIDAE Brady and Norman, 1896

The Sarsiellidae is comprised of 2 subfamilies, Sarsiellinae Brady and Norman, 1896, and Dantyinae, new subfamily herein.

Key to Subfamilies of the Sarsiellidae (females and juveniles only)

With prominent rostrum; mandible with 2 stout claws on each of the 3 endopodial joints	Dantyinae, new subfamily
Without rostrum or with minute rostrum; mandible with 1 stout claw on each of the 3 endopodial joints	Sarsiellinae

DANTYINAE, new subfamily

Diagnosis.—Carapace of female with prominent rostrum.

Mandible: Endopodite: 1st and 2nd joints with 2 stout ventral claws; end joint with 2 stout terminal claws and 1 small dorsal claw.

Rod-shaped organ: Elongate, segmented.

Furca: Each lamella with 1st claw united to lamella and remaining claws separated from lamella by suture.

In the description of his new species *Sarsiella*(?) *ornithoides* Brady, 1902, of which he had only 1 specimen, Brady stated (p. 189), "The characters of the caudal laminae seem to associate this species with *Sarsiella*, the shell also bearing some distant resemblance to that genus, but its position here must be regarded as purely provisional." The holotype is apparently lost, as is a specimen of *Sarsiella ornithoides* listed, but not described, by Scott (1905:367) from Karativo Paar, Ceylon. The description of the species by Brady is incomplete.

Müller (1906:30–32, Pl. 4: Figs. 10–18) identified a juvenile male as *Sarsiella* sp. He recognized that the specimen differed considerably from juvenile males of previously described species of *Sarsiella* and discussed the differences (Müller, 1906:32). Müller (1906) did not give locality data for the specimen, but it is probably from the Indonesian region, where the other ostracodes described in his paper were collected. Many ostracodes collected during the Siboga Expedition are at the Zoological Museum of the University of Amsterdam, but according to Sjouk Pinkster (in litt., 1978) the specimen identified by Müller as *Sarsiella* sp. is not there. The inclusion of Brady's and Müller's species in the Dantyinae will be discussed in a subsequent paper in which a new genus will be proposed for both species.

Dantya, new genus

Dantya [Kornicker and Cohen] *in* Anonymous, 1977:66, unnumbered figure [nomen nudem; unauthorized publication of news items containing copy of our illustration (Fig. 1, herein) and our generic name].

Fig. 1. *Dantya magnifica*, holotype, juv. ♀, USNM 157129, complete carapace, length 1.05 mm.

Etymology.—The genus is named in honor of Bernard and Michael Danty; the latter assisted in the collections of Ostracoda at Carrie Boy Cay, Belize. Gender feminine.

Type-species.—*Dantya magnifica*, new species herein.

The following diagnosis of the genus is based on juvenile females, probably the A-1 stage. Only those characters have been used in the diagnosis that probably hold for the adult female. Differences should be expected for the adult male.

Diagnosis.—Carapace with prominent rostrum and caudal process; rostral infold with spinous bristles forming row; caudal process with broad spinous bristles forming row.

First antenna: 2nd joint with 1 dorsal bristle; 3rd joint short, fused to 4th.

Second antenna: Prodopodite without medial bristle. On type-species many exopodial joints with basal spines, and slender spines forming row near distal margin.

Mandible: Coxale endite large for famly. Exopodite minute with single terminal bristle. Endopodite: ventral margins of 1st and 2nd joints with 2 stout claws; end joint with 2 long claws and 1 short dorsal claw.

Maxilla: Similar in morphology to that of members of the Sarsiellidae and Rutidermatidae.

Fifth limb: 3 endites present. Exopodite: 1st joint with several stout teeth; 2nd joint with large broadly triangular tooth.

Sixth limb: 4 endites present; end joint with anterior bristles either bare or with short marginal spines, and posterior bristles with long marginal hairs. Limb of type-species with 1 bristle on posterior margin considered to be epipodial bristle.

Seventh limb: Limb of type-species with 8 bristles, and terminus with comb opposite small peg.

Furca: Claw 1 united to lamella, remaining claws separated from lamella by suture. Each lamella of type-species with total of 5 or 6 claws, and with claw 4 stouter than claw 3.

Eyes: Type-species with small lateral eyes and slightly larger medial eye.

Rod-shaped organ: Elongate with proximal sutures.

Upper lip: Consisting of lobe with slender spines.

Dantya magnifica, new species
Figs. 1–5, Pls. 1–7

Dantya [Kornicker and Cohen] *in* Anonymous, 1977:66, unnumbered figure [unauthorized publication of news item containing copy of our illustration (Fig. 1, herein) and our generic name].

Etymology.—From the Latin "magnificus" meaning "noble, magnificent."

Holotype.—USNM 157129, juvenile female on slides and in alcohol.

Type-locality.—Carrie Bow Cay, Belize, 16°48′N, 88°05′W, station AC-CBC-25, 15 May 1976, inner slope of outer ridge in outer fore-reef zone of Transect I, silty sand patch sheltered by coral, depth about 20 m, water temp. 28°C, small aquarium net bumping surface of sediment.

Paratype.—USNM 157756, 1 juvenile female on slides and in alcohol; from station AC-CBC-70, Carrie Bow Cay, Belize, 25 May 1976, spur-and-groove system of inner fore-reef zone of Transect I, small patch of silty sand in coral rubble between coral heads, depth about 9 m, surface of sediment scooped into plastic Whirl-pack bag.

Description of juvenile female (Figs. 1–5, Pls. 1–7).—Carapace elongate with prominent rostrum and caudal process (Figs. 1, 2a, b, d, e, Pls. 2, 6a, b).

Ornamentation (Fig. 1, Pls. 1–5): Each valve with several ribs: anterodorsal rib extending from rostrum to middle of valve near dorsal margin; upper lateral rib extending from rostrum to pointed process at posterodorsal corner of valve; lower lateral rib extending from anteroventral

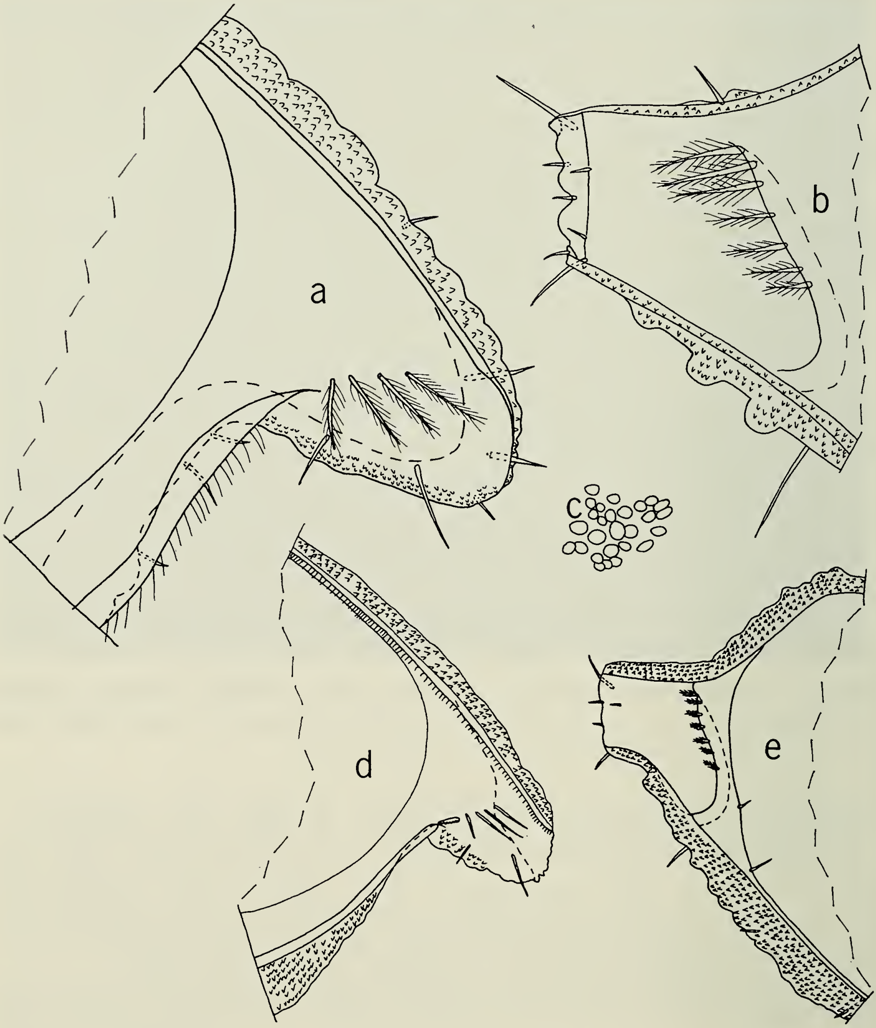

Fig. 2. *Dantya magnifica*, holotype, juv. ♀, USNM 157129: a, Rostrum, inside view; b, Caudal process, inside view; c, Left ends of central adductor muscles with left valve removed, anterior to left. Paratype, juv. ♀, USNM 157756: d, Rostrum, inside view (marginal spines not shown on 4 rostral bristles forming row); e, Caudal process, inside view.

corner of valve to lower edge of caudal process; ventral rib extending from middle of ventral margin of valve to point on lower lateral rib just anterior to caudal process; vertical rib connecting upper and lower ribs at point anterior to valve middle; oblique posterior rib extending from pointed

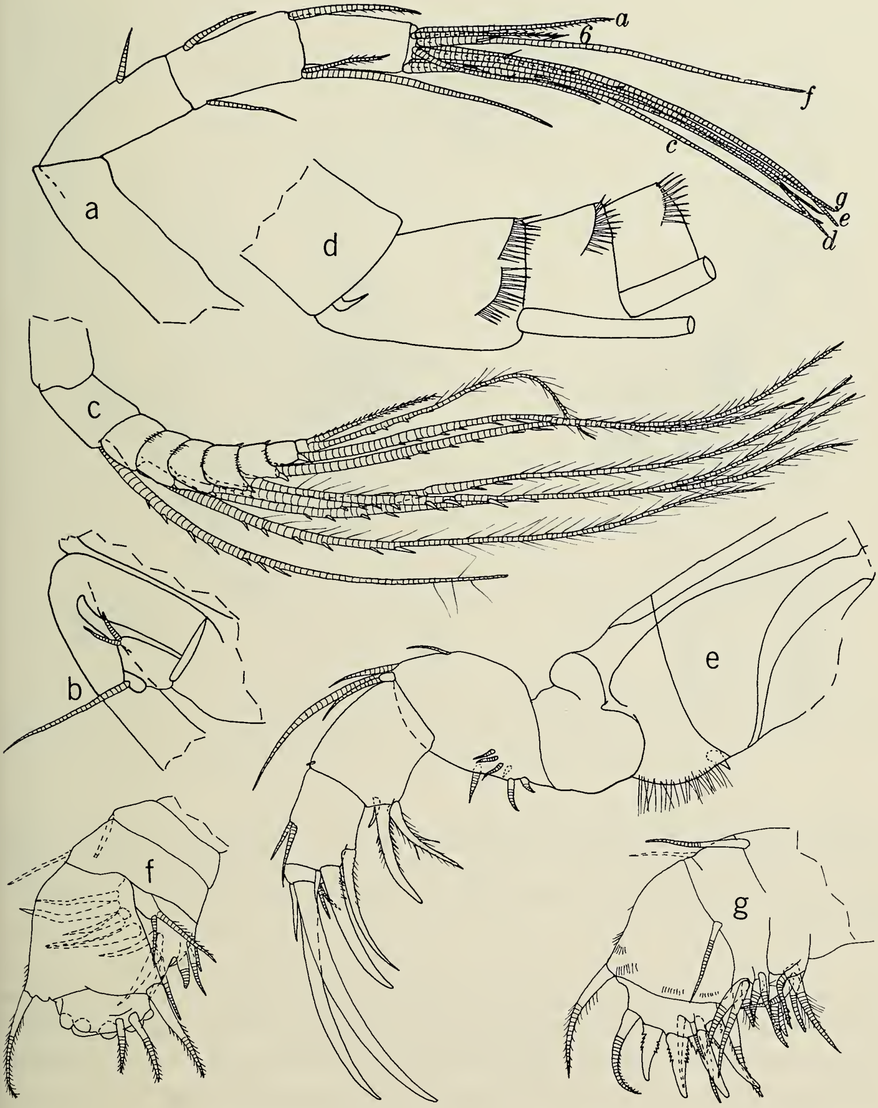

Fig. 3. *Dantya magnifica*, holotype, juv. ♀, USNM 157129: a, Left 1st antenna, medial view; b, Distal part of protopodite, proximal part of 1st joint of exopodite, and endopodite of right 2nd antenna, medial view; c, Exopodite of left 2nd antenna, lateral view; d, Distal part of 1st joint and joints 2–4 of exopodite of right 2nd antenna, medial view; e, Left mandible, lateral view; f, Left maxilla, lateral view; g, Right maxilla, medial view.

Fig. 4. *Dantya magnifica,* holotype, juv. ♀, USNM 157129; a, Left 5th limb, posterior view; b, Tip of right 5th limb, posterior view; c, distal end of 7th limb; d, Posterior of body showing Y-sclerite and right lamella of furca; e, Left lateral eye, medial eye and rod-shaped organ; f, Anterior of body showing spines along lower margin of upper lip.

process on posterodorsal corner of valve to upper edge of caudal process. Valves with numerous knoblike processes (Fig. 1, Pls. 1–5a); tip of each process with undulating structure (Pl. 3). Surface of valves minutely reticulate (Fig. 1, Pls. 1–3a, 4); area within reticulations with numerous pustules (Pl. 4b). Walls of reticulations as well as ribs with undulate margins (Pls. 1–3a, 4). Bristles scattered over valve surface and especially abundant along ventral margin (Pls. 1–4, 5b, c).

Infold: Rostral infold with 4 spinous bristles forming row along posterior part of rostrum, and 2 bare bristles near ventral margin of rostrum (Fig. 2a, d, Pls. 6a, b, f); infold of caudal process with 7 broad spinous bristles forming row near anterior part of process, and 2 small bare bristles near posterior

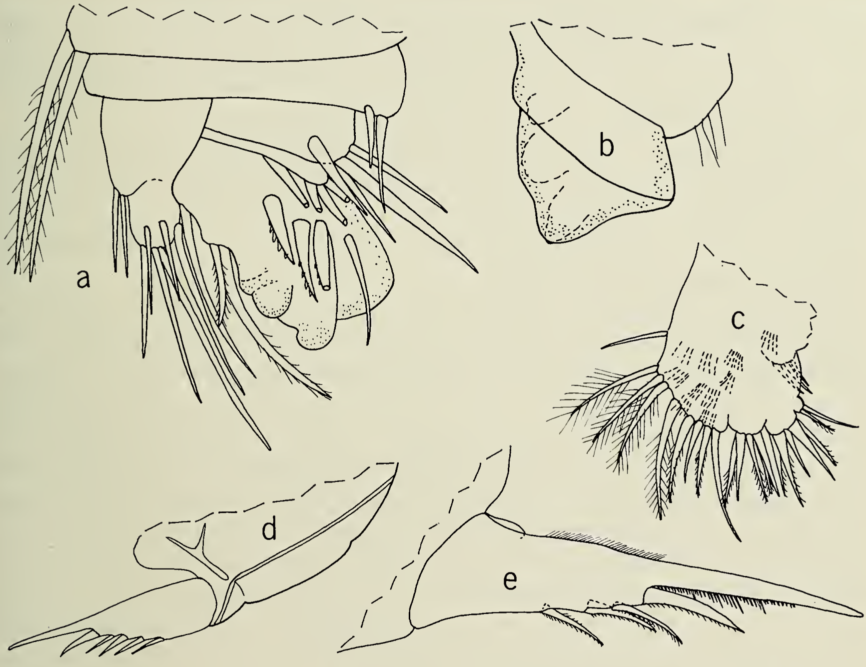

Fig. 5. *Dantya magnifica*, paratype, juv. ♀, USNM 157756: a, Tip of left 5th limb, posterior view; b, Tooth on 2nd exopodial joint of right 5th limb, anterior view; c, Right 6th limb, lateral view; d, Posterior of body showing left Y-sclerite and left lamella of furca (teeth and hairs on furca not shown); e, Right lamella of furca.

edge of process (Fig. 2b, e, Pls. 6a, 7b–d). Anteroventral infold with 3 small closely spaced bristles.

Selvage: Selvage along anteroventral and ventral margins with wide lamellar prolongation with fringed margin having long streamers (Pl. 6c–e); a similar lamellar prolongation present along anterodorsal valve margin; lamellar prolongation missing along anterior edge of rostrum, and selvage absent from ventral margin of rostrum; selvage appearing to be discontinuous in vicinity of rostrum with dorsal selvage terminating at anteroventral corner of rostrum, and ventral selvage terminating in vicinity of lowermost spinous bristle forming row on rostral infold (Fig. 2a, d, Pl. 6b).

Remarks concerning the rostrum: The rostrum (Pl. 6b, 7a) is unusual in not having a selvage along the ventral margin, and in that the 2 bristles near the ventral margin have proximal ridges (Pl. 7a) like the bristles that are usually found on the outer surface of the shell. From this it is tentatively concluded that the inner side of the rostrum is really part of the outer surface of the shell rather than part of the infold. The spinous bristles forming a row near the posterior end of the rostrum are of a type often found on the infold of the rostrum in other groups. This suggests that the edge of the valve might lie at the base of the bristles. Further work is necessary to elucidate the morphology of the rostrum.

Central adductor muscle attachments: Consisting of about 27 ovoid attachments (Fig. 2c); these appear to be reflected as small fossae on outer surface of each valve (Pls. 1a, 2a).

Size: USNM 157129, length 1.05 mm, height 0.57 mm; USNM 157756, length 1.02 mm, height 0.56 mm.

First antenna (Fig. 3a): 1st joint bare. Second joint with 1 midbristle on dorsal margin. Third joint short, not separated from 4th by suture, with 2 bristles, 1 ventral, 1 dorsal. Fourth joint elongate, with 3 bristles, 2 ventral, 1 dorsal. Fifth joint elongate; sensory bristle with 3 short marginal filaments and 1 minute filament at tip. Sixth joint minute; medial bristle longer than 5th joint and with faint marginal spines. Seventh joint: a-bristle about twice length of 5th joint, longer than bristle of 6th joint, with faint spines along dorsal margin; b-bristle about same length as a-bristle, with 1 minute filament near middle; c-bristle same length as sensory bristle of 5th joint, with 2 or 3 short marginal filaments and 1 minute filament at tip. Eighth joint; d- and e-bristles bare, about same length as c-bristle; f-bristle slightly shorter than c-bristle, with 3 short marginal filaments and 1 minute filament at tip; g-bristle same length as c-bristle, with 3 short marginal filaments and 1 minute filament at tip.

Second antenna (Fig. 3b–d): Prodopodite bare. Endopodite 2-jointed: 1st joint with 2 short proximal anterior bristles; 2nd joint small with 1 fairly long bristle. Exopodite with 9 joints: 1st joint elongate with minute distal medial bristle bent at right-angle in middle; joints 2–7 with slender minute spines forming row near distal margin; joints 4–8 with basal spines increasing in size on distal joints; basal spine of 8th joint longer than small ninth joint; bristle of 2nd joint with proximal ventral spines and a few distal natatory hairs; bristles of joints 3–8 with proximal ventral spines, proximal dorsal hairs, and distal natatory hairs on both margins; 9th joint with 2 bristles (1 long bristle with proximal ventral spines and distal natatory hairs, 1 short bristle with short, slender, marginal spines).

Mandible (Fig. 3e): Coxale: endite large for family, spinose, with pointed tip; ventral margin hirsute. Basale: dorsal margin with 1 short midbristle and 2 terminal bristles (1 long, 1 short); medial side with 2 small bristles near ventral margin; lateral side with 3 bristles near ventral margin; ventral margin with 2 small bristles. Exopodite minute, with 1 terminal bristle reaching past middle of dorsal margin of 1st endopodial joint. First endopodial joint: dorsal margin with 1 minute terminal spine; ventral margin with 1 small bristle and 2 long spinous claws. Second endopodial joint: dorsal margin with 2 subterminal bristles; ventral margin with 2 stout spinous claws; lateral side with 1 small bristle on terminal margin near base of distal ventral claw. Third endopodial joint with 2 long claws, 1 small dorsal claw, and 2 ventral bristles.

Maxilla (Fig. 3f, g): Three endites present: endite I with about 6 bristles; endite II with about 3 bristles; endite III with about 4 bristles. Coxale with 1 bare dorsal bristle. Basale with 1 slender medial bristle on distal margin and 1 slender, bare, terminal, dorsal bristle (bristle missing on USNM 157129). Exopodite consisting of small lobe with 2 bristles. Endopodite: 1st joint with distal medial spines and a spinous alpha- and beta-bristle (alpha-bristle almost one-half diameter of beta-bristle); end joint with 1 small spinous medial a-bristle, 2 small spinous lateral c-bristles, and 5 short stout terminal bristles (outer of these spinous, others pectinate).

Fifth limb (Figs. 4a, b, 5a, b): Three endites present: endite I with 2 or 3 short spinous bristles; endites II and III each with 4 spinous bristles. Epipodial appendage with 37 spinous bristles. Exopodite: 1st joint with main tooth consisting of 3 broad teeth; 2nd joint with large broadly triangular tooth and 7 anterior bristles (4 near inner edge, 3 near outer edge); 3rd joint with 2 short bristles on outer lobe and possibly 1 bristle on inner lobe; 4th joint with 5 or 6 bristles.

Sixth limb (Fig. 5c): Four endites present; bristles of endites either bare or with short marginal spines; endite I with 3 short bristles; endite II minute, with 2 bristles; endites III and IV about same size, slightly larger than endite I, each endite with 5 bristles; anterior half of margin of end joint with 4 bristles either bare or with short marginal spines, and posterior half of margin of end joint with 4 bristles with long marginal hairs; a single annulated bristle on posterior margin interpreted herein as being epipodial bristle; limb hirsute.

Seventh limb (Fig. 4c): Each limb with 4 tapering proximal bristles, 2 on each side, and 4 tapering terminal bristles, 2 on each side; each bristle with 2–5 bells, but no marginal spines. Terminus consisting of comb with about 5 teeth opposite small peg.

Furca (Figs. 4d, 5d, e): Each lamella with 5 or 6 claws; claw 4 stouter than claw 3; each claw with teeth along posterior margin; anterior of lamella proximal to claw hirsute; teeth along posterior margin of claw 1 consisting of 4 sets followed by smaller teeth (each set consisting of 8 or 9 teeth increasing in length distally).

Eyes (Fig. 4e): Lateral eyes small, unpigmented, each with 4 or 5 ommatidia. Medial eye with light amber pigment, slightly larger than lateral eye.

Rod-shaped organ (Fig. 4e): Elongate with about 8 proximal sutures; tip rounded.

Table 1. Plesiomorphic and apomorphic character states in the Philomedidae, Sarsiellidae, and Rutidermatidae.

	Plesiomorphic	Apomorphic
1. Prominent rostrum	present	absent
2. Bristles on rostral infold	present	absent
3. Large claw on 2nd endopodial joint of mandible	absent	present
4. 1st endopodial joint of maxilla	long	short
5. Number of endites on 5th limb	3	1
6. 1st exopodial joint of 5th limb	with teeth	without teeth
7. 2nd exopodial joint of 5th limb	without large tooth	with large tooth
8. Relationship of furcal claw 1 to lamella	separated by suture	fused
9. Glands in upper lip	present	absent

Upper lip (Fig. 4f): Consisting of simple lobe divided by shallow anterior midgroove; each half of lobe with rows of slender hairs or spines. No glandular opening observed when viewed with light microscope at ×200 magnification.

Y-Sclerite (Figs. 4d, 5d): Branching distally.

Discussion.—Dantya magnifica possesses some characters previously reported only on members of the Sarsiellidae and some characters previously reported only on members of the Rutidermatidae and Philomedidae. In order to ascertain the relationship between the species and the 3 families, we selected 9 morphological characters present in some but not all of the 3 families. The characters selected are those with character states whose polarity could be estimated with some confidence. The estimated polarity of the character states is shown in Table 1.

Comparing the character states of *Dantya magnifica* with those listed in Table 1, we find that the species shares only 1 apomorphic character state (character 7 in Table 1) with members of the Philomedidae, 4 (characters 3, 4, 7, 9 in Table 1) with members of the Rutidermatidae, and 4 (characters 3, 4, 8, 9 in Table 1) with members of the Sarsiellidae.

Clearly, *D. magnifica* is more closely related to the Sarsiellidae and the Rutidermatidae than to the Philomedidae. Because only in the Sarsiellidae, and on all its members, the 1st claw of the furca is fused to the lamella, we are inclined to give this apomorphic character state more weight than some of the others, and therefore, have concluded that the species is more closely related to the Sarsiellidae than to the Rutidermatidae.

D. magnifica has at least 2 claws on the 1st and 2nd endopodial joints of the mandible. This character state is clearly apomorphic, is not shared by other species of Myodocopina, and warrants proposal of the new subfamily Dantyinae, within the Sarsiellidae.

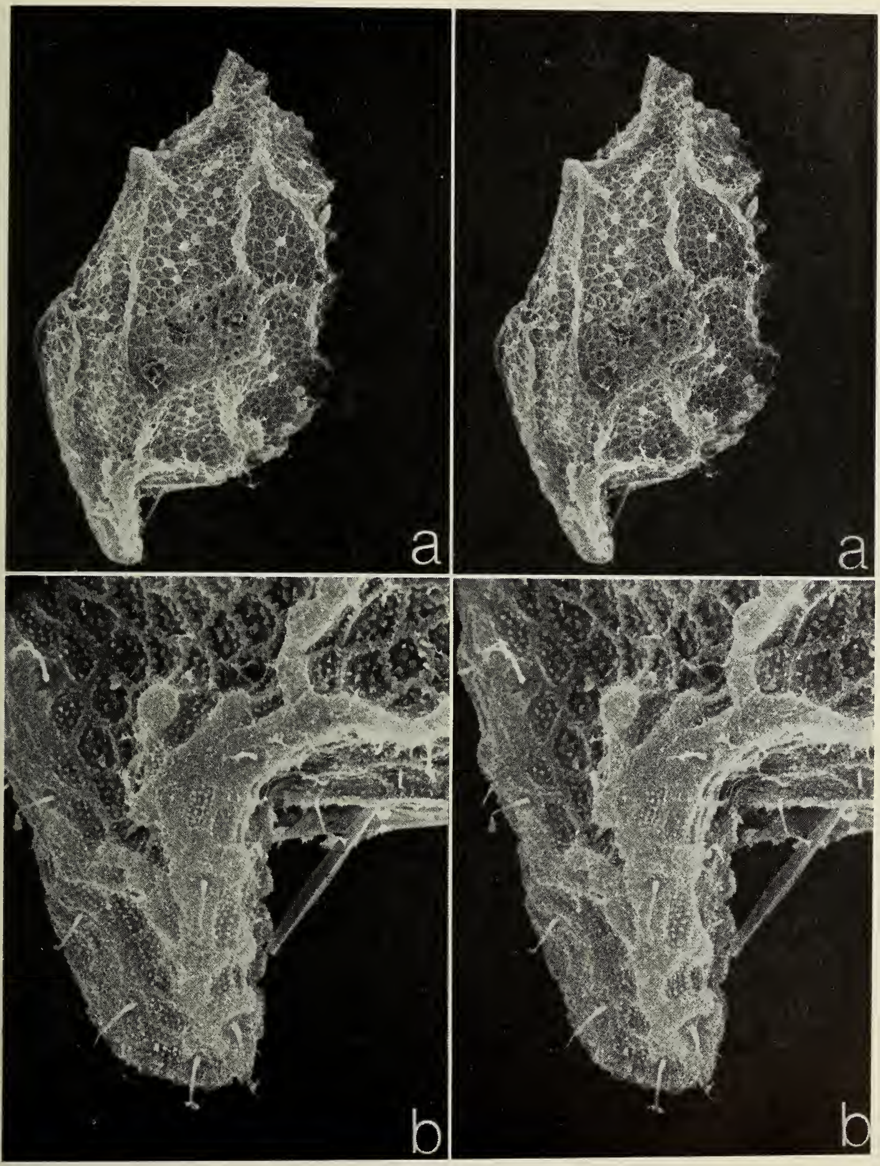

Plate 1. *Dantya magnifica,* holotype: a, Stereo-pair of left valve (posterior half of dorsal edge folded inwardly, for undistorted outline see Fig. 1), ×100; b, Stereo-pair of rostrum, note diatom spanning incisur, ×400. Magnifications given are those at which the micrographs were made on SEM; these have been reduced 26% for publication.

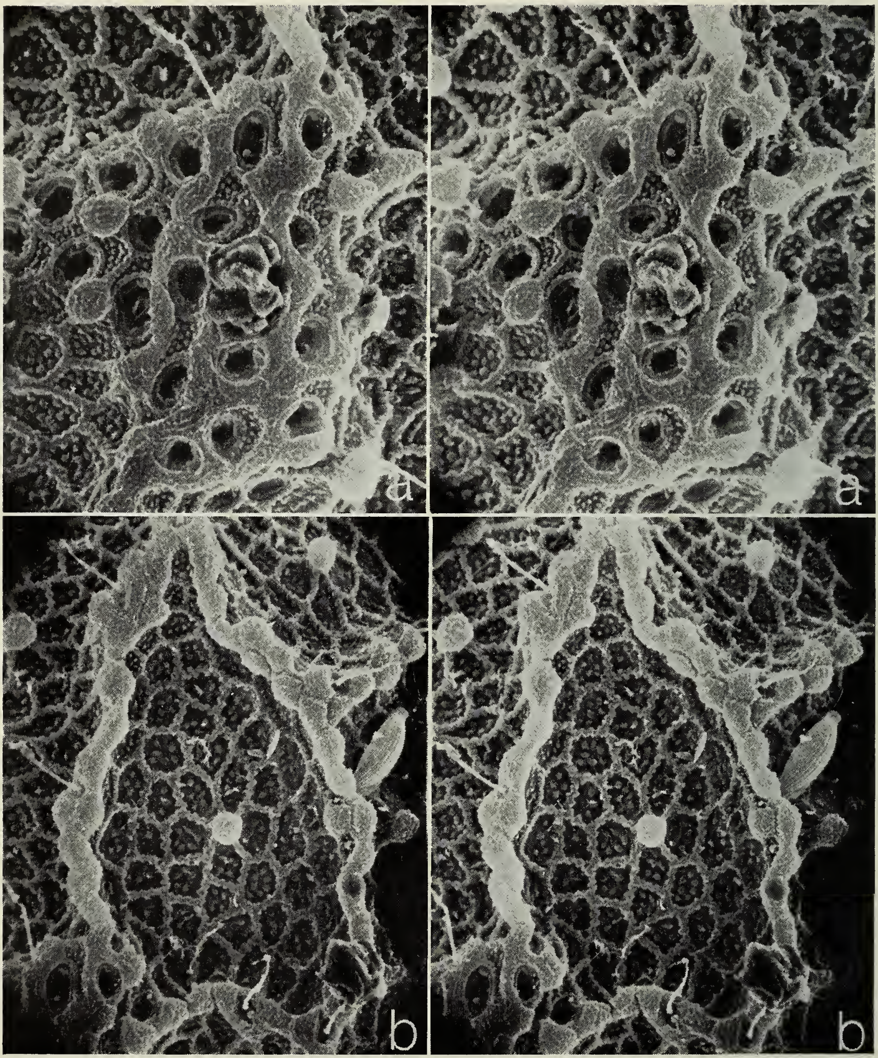

Plate 2. *Dantya magnifica,* holotype: a, Stereo-pair of valve in vicinity of central adductor muscle attachments, anterior towards bottom of micrograph, ×500; b, Stereo-pair of valve surface near ventral margin of valve posterior to middle, ×380. See Plate 1a for locations on valve of micrographs in Plate 2. Magnifications given are those at which the micrographs were made on SEM; these have been reduced 33% for publication.

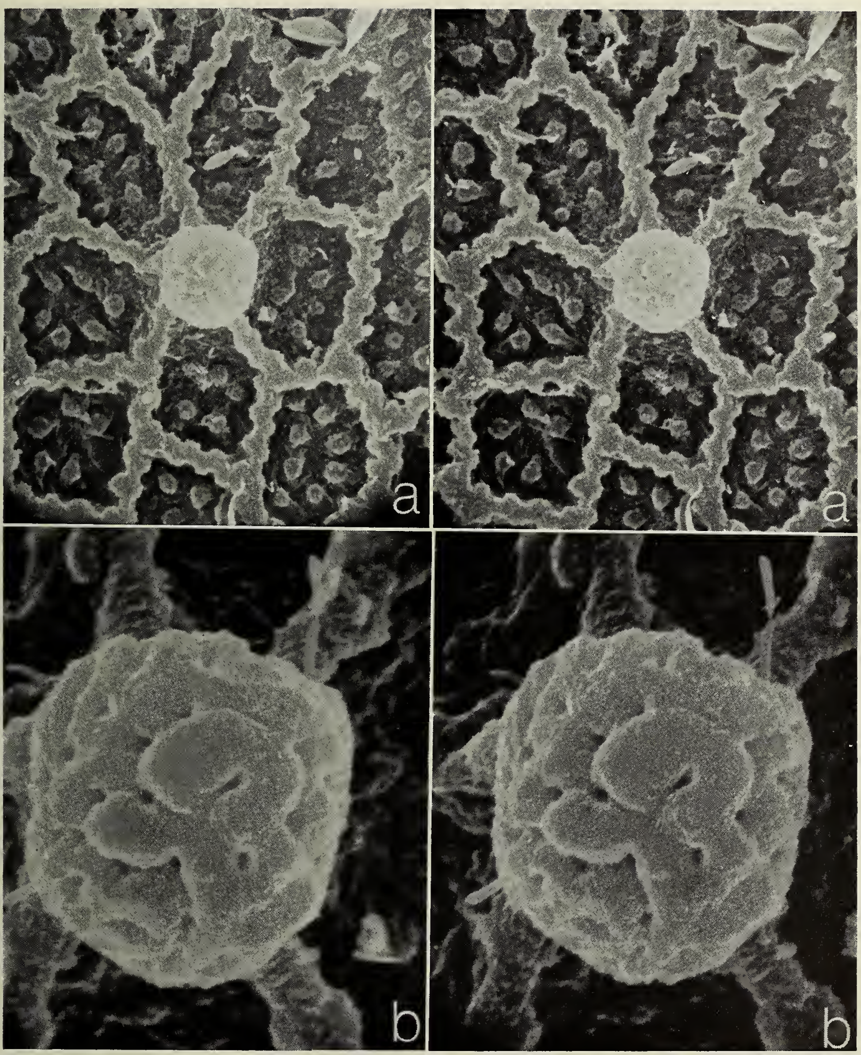

Plate 3. *Dantya magnifica,* holotype: a, Stereo-pair of surface reticulations and processes at middle of micrograph shown in Plate 2b, ×1,200; b, Stereo-pair of knob-like process in middle of a, ×4,000. Magnifications given are those at which the micrographs were made on SEM; these have been reduced 33% for publication.

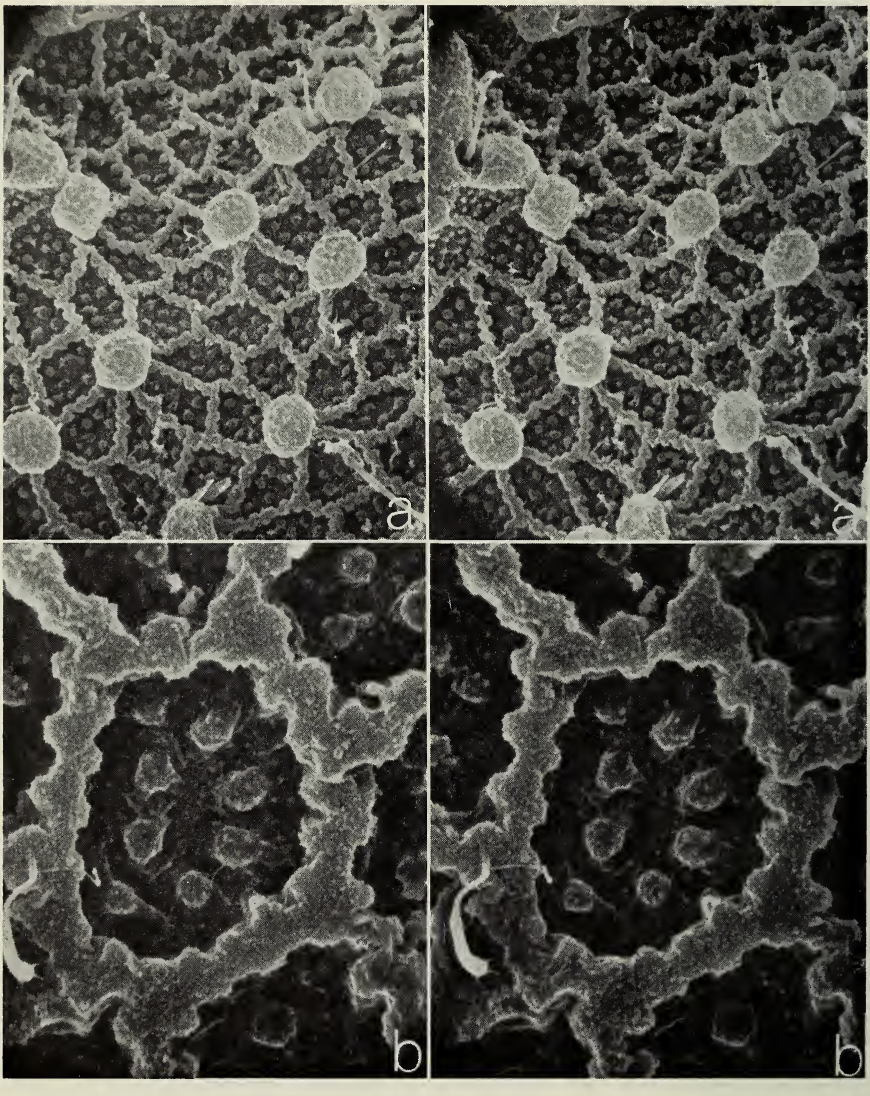

Plate 4. *Dantya magnifica*, holotype: a, Stereo-pair of reticulations and processes on valve just posterior and dorsal to central adductor muscle attachments, for location see Plate 1a, ×700; b, Stereo-pair of bristle, reticulations and pustules ×2,600. Magnifications given are those at which the micrographs were made on SEM; these have been reduced 30% for publication.

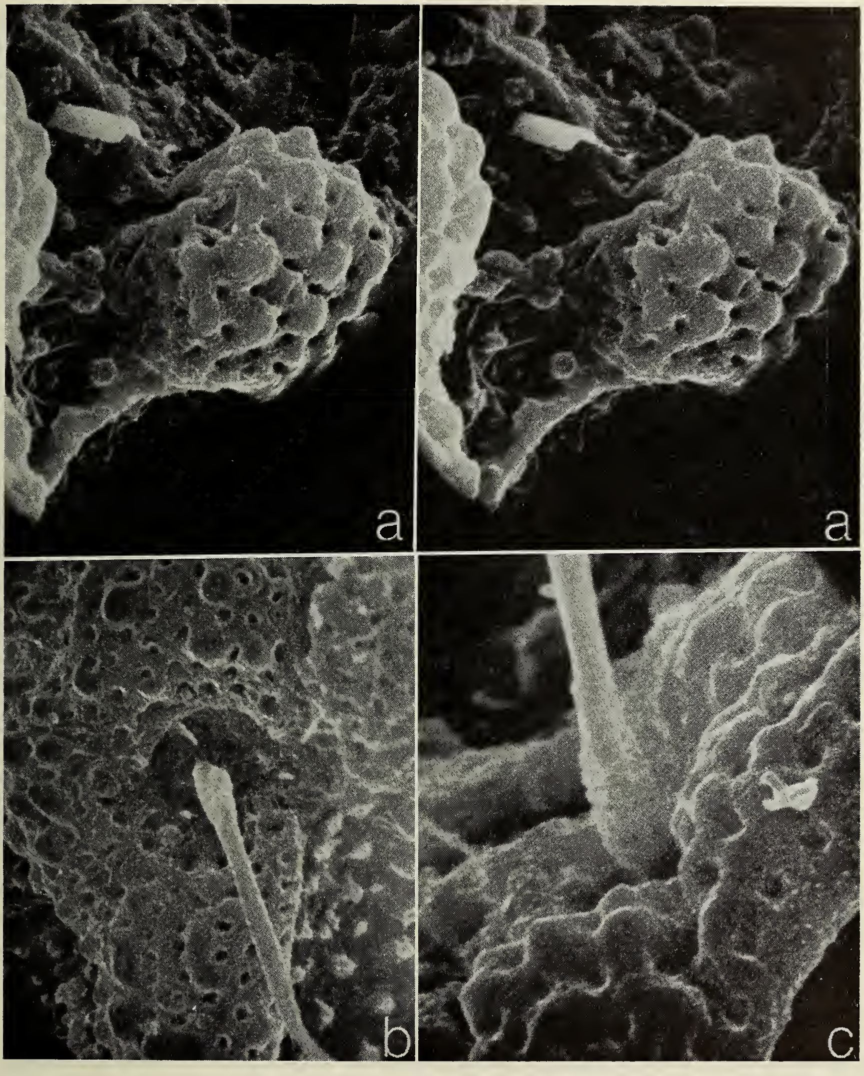

Plate 5. *Dantya magnifica*, holotype: a, Stereo-pair of knobby process, ×3,000; b, Bristle on rostrum, from Plate 1b, ×2,600; c, Base of bristle near central adductor muscle attachments, from Plate 2a, ×5,000. Magnifications given are those at which the micrographs were made on SEM; these have been reduced 33% for publication.

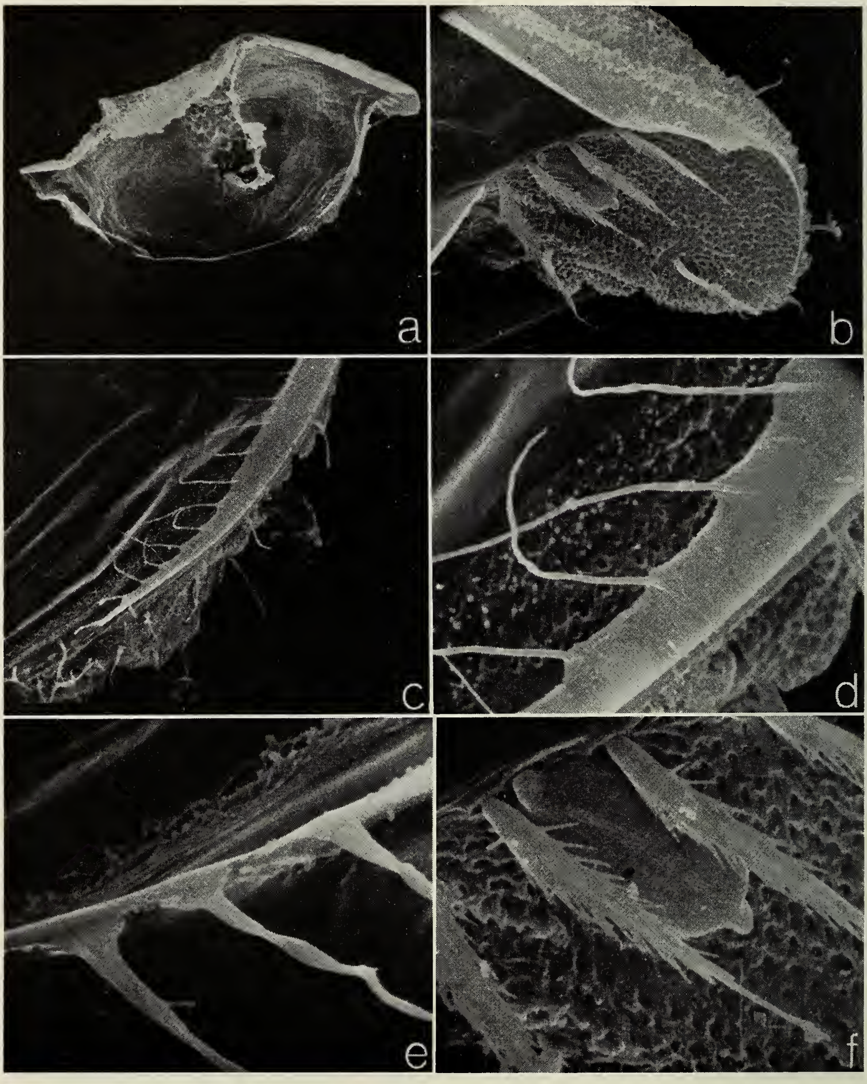

Plate 6. *Dantya magnifica*, holotype: a, Inside view of left valve, ×100; b, Inside view of rostrum, ×750; c, Anteroventral margin showing infold and lamellar prolongation of selvage, from a, ×500; d, Detail of lamellar prolongation of selvage shown in c, ×2,000; e, Ventral margin of valve anterior to middle showing infold and lamellar prolongation of selvage, from a, ×3,600; f, Detail from b showing bristles and diatom, ×2,200. Magnifications given are those at which micrographs were made on SEM; these have been reduced 43% for publication.

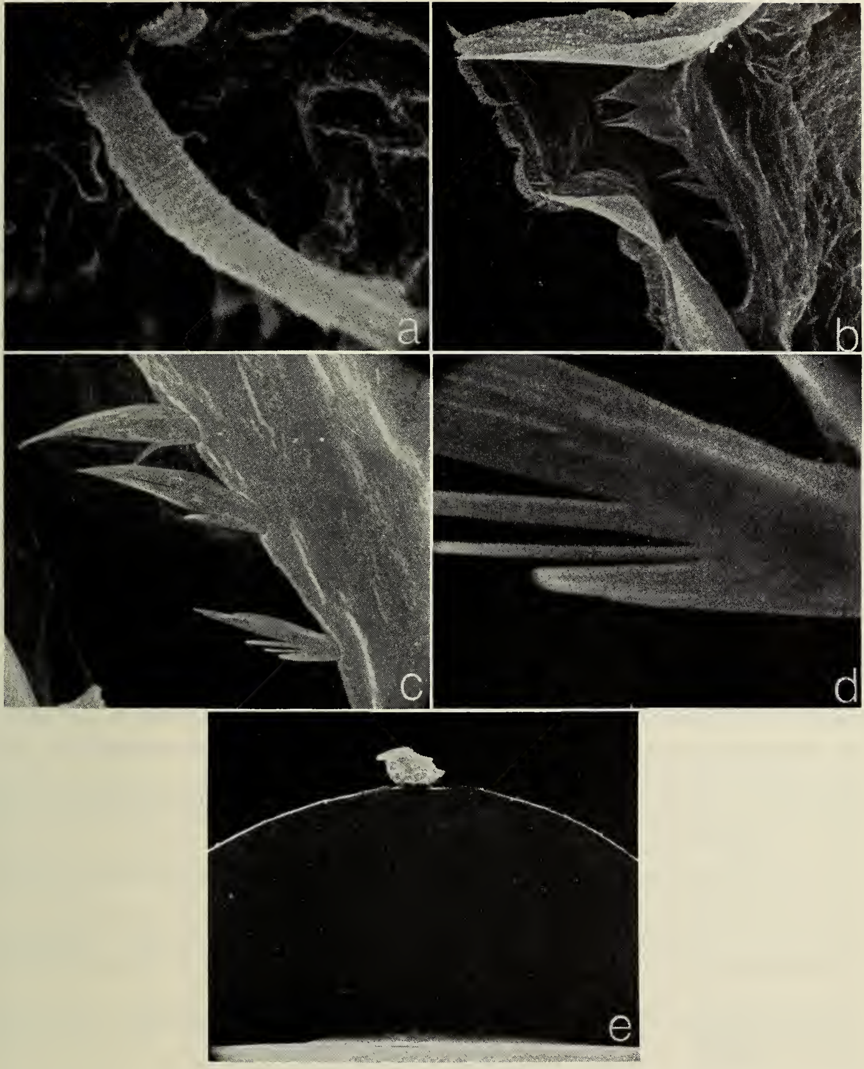

Plate 7. *Dantya magnifica*, holotype: a, Base of bristle on inside of rostrum near anterior edge, from Plate 6b, ×7,500; b, Inside view of caudal process, from Plate 6a, ×500; c, Detail from c showing bristles on list of caudal process, ×2,000; d, Detail of lower bristle in d, ×12,500; e, Outside view of left valve mounted on edge of cover slip, ×18. Magnifications given are those at which micrographs were made on SEM; these have been reduced 44% for publication.

Acknowledgments

Several people assisted in the preparation of this manuscript. The shaded rendering of the carapace was made by Mrs. Carolyn Bartlett Gast. Initial camera lucida drawings of most appendages were made by Mrs. Kathryn Brown, who also inked the final drawings. The assistance of Mr. Walter R. Brown and Miss Mary J. Mann, who operated the scanning-electron microscope, is acknowledged. Freeze-drying of the specimen for photography was done in the laboratory of Mr. Rolland O. Hower. We thank our colleagues for discussing nomenclatorial problems concerning the synonymy. This paper is contribution number 41 of the Smithsonian Institution Investigations of Marine Shallow-Water Ecosystems Project.

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SPERMATOPHORE PLACEMENT IN THE COPEPOD *EUCHAETA NORVEGICA* BOECK 1872 FROM DEEPWATER DUMPSITE 106

Frank Ferrari

Abstract.—Numbers and placement of spermatophores on females of *Euchaeta norvegica* from Deepwater Dumpsite 106 in the continental slope waters off Delaware are discussed and compared to those published from Loch Etive, Scotland. Numbers of single, double, and triple placements are comparable but numbers of spermatophores placed away from the ventral face of the genital prominence are higher in specimens from Deepwater Dumpsite 106. Changes in the spermatophore before and after attachment by the male are described. These include the addition of a long stalk, an attachment plate, and in some cases, a fertilization tube. An hypothesis is advanced to explain the imprecision in spermatophore placement.

Introduction

The separate phenomena of multiple spermatophore attachments and misplaced spermatophores, i.e., spermatophores attached away from the immediate area of the genital opening of the mature female, have received some attention in the literature on copepod reproductive behavior. Marshall & Orr (1955) briefly summarized reports for *Calanus finmarchicus*, noting that females occasionally carry more than one spermatophore and that as many as 15 have been reported by Gibbons (1936). Fleminger (1967) reported that females of *Labidocera diandra* had spermatophores attached in 2 positions; one spermatophore (in type 2 position) he considered nonfunctional due to a lack of a connection to the genital pore. Multiple spermatophores were also observed in *L. diandra* with the spermatophores in a variety of combinations in the 2 positions. Multiple spermatophores were reported for laboratory-reared *Eurytemora affinis* (Katona, 1975). Lucks (1937), cited by Katona (1975), noted that multiple spermatophores in *E. affinis* from the Baltic coast could be attached one upon the other or scattered over the ventral surface of the genital segment. Hammer (in press) reports multiple spermatophores on *Acartia tonsa*; these spermatophores are not misplaced but instead set one upon the other. Hopkins & Machin (1977) have reported multiple spermatophores with a variety of misplacements in *Euchaeta norvegica* from Loch Etive, Scotland.

Multiple spermatophores have most often been considered the result of an excess proportion of males to females (Fleminger, 1967; Katona, 1975). Misplaced spermatophores present a more complex question especially concerning their potential use by the females. Hopkins & Machin (1977) suggest that at least some misplaced spermatophores of *Euchaeta norvegica* are fully viable through a connection to the female genital opening, the fertilization tube. This paper presents data on spermatophore placement, including multiple and misplaced spermatophores, in *Euchaeta norvegica* from the continental slope waters off Delaware.

Materials and Methods

From 23 July to 2 August 1975, samples were collected from the pelagic environment of Deepwater Dumpsite 106 (DWDS), 72°00′–72°30′W and 38°40′–39°00′N, in waters of the continental slope off Delaware. A ten foot Issacs-Kidd Midwater Trawl with a meter plankton net (mesh width 1 mm) on the posterior part was equipped with a discrete-depth cod-end sampler. Further details of the sampling scheme and station positions can be found in Kruger et al. (1977). Although DWDS is usually occupied by slope water, the area is hydrographically quite dynamic (Warsh, 1975; Bisagni, 1976; Morgan & Bishop, 1977). During the sampling period, the hydrography of the area was complicated by the influence of a warm core eddy whose center was situated east of DWDS. In the following analysis no attempt has been made to determine if the observations of spermatophore placement in *E. norvegica* might be correlated with the horizontal and vertical distributions of the animals or affected by the complex hydrography of the area.

Copepods were sorted from 51 stations, each station having from 1–4 discrete depth samples. An analysis of the vertical and horizontal distributions of the copepod fauna is in progress. *Euchaeta norvegica* Boeck, 1872 was the most common and abundant copepod in the collection, occurring in 57 samples from 27 stations. Mature females and males of *E. norvegica* in these samples had begun spermatophore transfer. In addition to reporting the results of spermatophore placement in *E. norvegica* from DWDS 106, I compare this population with those from Loch Etive. It should be noted that Hopkins & Machin (1977) collected 1 sample every 10 days during 11 months of the year. Most of the values I have cited from their paper represent average values. The data in my paper are averages of all samples collected during the 11 day period. In terms of elapsed time, then, the values are comparable to a single sample from Loch Etive.

Figure 1 shows the left and right lateral views of the genital segment of a mature female. In the following description of this segment, I have used the terminology of Park (1975). The dominant feature is the large genital prominence with a genital flange on each side of the ventral face and a knob posteriorly and ventrally on the left lateral face. A small ridge extends across the ventral surface of the genital segment anterior to the prominence; it is slightly asymmetrical, being more pronounced on the

Fig. 1. Left (above) and right (below) lateral views of female genital segment. AR—anterior ridge; F—flange; GP—genital prominence; K—knob; PR—posterior ridge.

left side. Immediately posterior to the prominence is another large ridge with patches and rows of hairs on both sides. On the dorsal posterior region of the segment is another hirsute region.

I have recognized only 2 areas of spermatophore attachment. The first or 'correct' area is on or about the genital field, the ventral face of the genital prominence; this corresponds to grids A, D, F, and H of Hopkins & Machin (see their Fig. 1). The second or 'alternate' area is around, but generally in front of the small ridge anterior to the genital prominence, which corresponds to grids B, E, and G of Hopkins & Machin.

Results

At DWDS *E. norvegica* is found between 400–1,000 m during the day; at night its distribution may extend to within 100 m of the surface. Seven hundred and ninety-five mature females (stage VI copepodids), 46 mature males, 73 immature females (stage IV & V copepodids) and 285 immature males were collected and examined. Spermatophores were found attached only to the genital segment of mature females.

Spermatophore placement.—Information concerning the number of adult females with and without spermatophores and the position of the latter is summarized in Table 1. Of the 795 females, 436 (55%) had at least one spermatophore. The number of spermatophores per female carrying at least one spermatophore is 1.3. The mean number of spermatophores per female is .72. This approaches the value of .80 reported by Hopkins and Machin during the July–August period, a peak period of spermatophore attachment for the Loch Etive population.

The 317 females with a single attached spermatophore represent 41% of the total population of females and 73% of those with at least one spermatophore. One hundred and forty-eight females (46%) have the spermatophore attached in the correct area while 169 (54%) have it in the alternate area. These data contrast rather sharply with the Loch Etive population. Hopkins and Machin report that for females carrying a single spermatophore, about 80% were placed in areas I would consider as the correct area (in their Fig. 7A add columns A, D, F, and H).

The 93 females with 2 spermatophores, representing 12% of all females and 21% of those with at least one spermatophore, are divided into 3 categories. Those with both spermatophores attached in the correct area constitute 10% of the total for double attachments. The 33 females with both spermatophores in the alternate area comprise 35% of the total double attachments. The majority, 55%, have one each in the correct and alternate positions. Thus, only 37% of all spermatophores on females with double attachments are found in the correct area. This figure is distinctly lower than that reported for Loch Etive. More important however is the low percentage of double placements in the correct position. Generally, if a female possesses two spermatophores, at least one will be found in the alternate area.

Finally, 26 females have 3 or 4 spermatophores. These make up only 6% of the females with at least one spermatophore and only 3% of the total females. Several combinations are possible in each category, but not all are represented (see Table 1). For example, no female has 3 or 4

Table 1. Numbers of females of *Euchaeta norvegica* with various combinations of spermatophores. S = number of spermatophores per female; T = total number of females; C = spermatophore in correct area; A = spermatophore in alternate area.

		Combinations of spermatophores													
S	T	1C	1A	2C	1A/1C	2A	3C	2C/1A	1C/2A	3A	4C	3C/1A	2C/2A	1C/3A	4A
0	359														
1	317	148	169												
2	93			9	51	33									
3	19						0	2	10	7					
4	7										0	0	1	4	2

spermatophores in the correct area. In fact, only 3 of the 26 have more than one spermatophore in the correct area.

Fertilization tubes.—Hopkins and Machin have described fertilization tubes in *E. norvegica* from Loch Etive. Such structures are also found on specimens from DWDS. In 2 instances fertilization tubes are found with spermatophores placed in the correct area, yet more anteriorly on the ventral face of the genital prominence. These tubes run to the genital opening. In the majority of cases, fertilization tubes are found in conjunction with spermatophores placed in the alternate area and connect these to the genital opening (Fig. 2). Of a total of 351 spermatophores placed in the alternate area (Table 2), 14% (59) have an associated fertilization tube. In terms of numbers of females, 279 have at least one spermatophore in the alternate position; about 18% (48 females) of these have at least one fertilization tube. On a single specimen, all 3 spermatophores in the alternate position possess fertilization tubes.

Of the 59 spermatophores with a fertilization tube, the spermatophore is empty in 51 cases. In the remainder, the outer contents are absent leaving only a center core of material in the spermatophore. Of the 237 correctly placed spermatophores, 7 are empty; included in this group are the 2 which had fertilization tubes.

The length of the fertilization tube is .22–.24 mm if, as usual, it follows a path over the anterior ventral ridge and down the anterior face of the genital prominence (as in Fig. 2). The tube is slightly longer in the few cases in which more than one spermatophore, each with a tube, has been placed in the alternate area. These other tubes then do not pass over the ridge but run across the left lateral side of the genital segment and down the left lateral face of the prominence.

Since only 14% of the spermatophores placed in the alternate area have fertilization tubes, it is possible, as stated by Hopkins and Machin, that

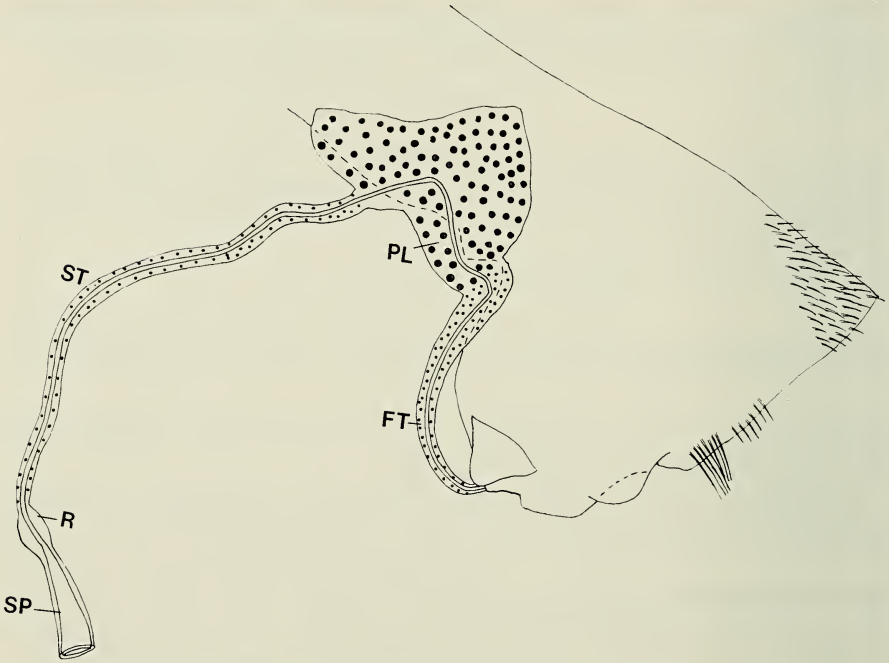

Fig. 2. Female genital segment, left lateral view, with stalk (ST) and plate (PL) complex and fertilization tubule (FT) of a spermatophore (SP) attached in alternate area. R—remnant of terminal spherical part of spermatophore.

few of the alternately placed spermatophores contribute to the fertilization of eggs. However, 88% (522) of all spermatophores (588) are full (Table 3). Seven in the correct area, including both with fertilization tubes are empty. All 51 in the alternate area which are empty have fertilization tubes associated. In the other 8 alternately placed spermatophores with fertilization tubes, the spermatophore is partly empty, lacking the matrix surrounding the central core in the spermatophore. Although alternately placed spermatophores with tubes represent only about 14% of that class, all are empty or partly empty, indicating that fertilization tubes are probably formed with all alternately placed spermatophores just before the contents of the spermatophore are emptied.

Males carrying spermatophores.—Forty-six males are found in the DWDS samples, about .06× the number of females. All are present in samples with females. All have spermatophores present in the bursa, or spermatophore sac, of the reproductive system (see Park, 1966, or Marshall & Orr, 1955, for a description of the anatomy of the male calanoid reproductive system).

Twenty-seven males, in addition to having one spermatophore in the

Table 2. Numbers of spermatophores in correct and alternate areas for single and multiple placements on females of *Euchaeta norvegica*.

	Correct	Alternate	Totals
Single placements	148	169	317
Double placements	69	117	186
Triple placements	14	43	57
Quadruple placements	6	22	28
Totals	237	351	588

reproductive system, hold a second spermatophore in the exopod of their left fifth leg (Fig. 3). It is possible to argue that these instances represent interrupted copulation during the time of sampling. However, if such is the case, it would seem improbable to find another spermatophore, virtually completely developed, in the bursa of these males. Instead, it appears that males of *E. norvegica*, like those of *Eurytemora affinis* (Katona, 1975) and *E. americana* (Williams, 1906), are able to secrete and carry one spermatophore with them before initiating direct physical contact with the female.

Changes in the spermatophore.—A comparison of the unattached spermatophore carried by the male fifth leg with those attached to the females shows interesting differences. A spermatophore removed from the fifth leg of the male is illustrated in Fig. 3. These range in size from .51–.55 mm (based on 10 examples). The spermatophore proper narrows to a short neck and then abruptly widens into a terminal spherical part, possibly the widened attachment disc plus a plug. The neck is enclosed by a short outer sleeve. The male grasps the spermatophore by the spherical part. It is held between the large claw of the serrated lamella and digitform process and is fronted by the third segment of the exopod of left fifth leg. By differential refraction of reflected light, the spermatophore proper can be seen to be divided into a central core and a surrounding matrix. The core is further differentiated at a point about ⅓ of its length from the neck. This may represent the dividing point between the proximal B-sper-

Table 3. Numbers of full, empty, and partly empty spermatophores on females of *Euchaeta norvegica*.

	Correct	Alternate	Totals
Full	230	292	522
Empty	7	51	58
Partly empty	0	8	8
Totals	237	351	588

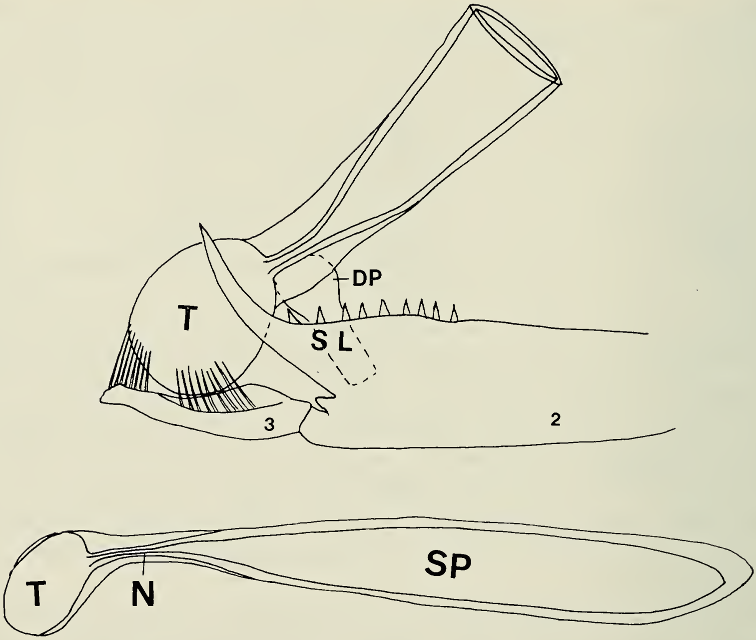

Fig. 3. (Above) Terminal spherical part (T) of spermatophore held in second (2) and third (3) exopodal segments of male left fifth leg. (Below) Spermatophore removed from grasp of exopod of male left fifth leg. DP—digitiform process; N—neck; SL—serrated lamella; SP—spermatophore proper.

matozoa and the distal Q-spermatozoa (Heberer, 1932), the latter involved in forcing the former from the spermatophore. The core narrows to a conducting tube in the neck region.

Spermatophores attached to the female differ from the preceding by: 1) a reduction of the spherical part, the remnant of which can still be seen at a point below the neck (Fig. 2); 2) the development of a long stalk usually ending in a small disc at the point of attachment to the female genital segment. The disc, however, may be enlarged to an irregular plate when the spermatophore is attached in the alternate area. For spermatophores placed in the correct position, the length of the stalk varies from .38–.44 mm; those placed in the alternate area range from .50–.54 mm (both based on 10 examples).

Judging from the relative occurrences of these data, major changes can occur in the spermatophore after it has been secreted from the male reproductive system and picked up by the exopod of the left fifth leg. First, the stalk and plate complex forms, probably immediately before attachment for the plate and immediately before or after for the stalk. Apparently after a relatively longer period of time, a fertilization tube forms if the spermatophore is placed away from the genital opening. Immediately after this, the spermatophore is emptied of its contents. The fertilization tube apparently forms after the male and female have separated and may develop as a phase change from sol to gel of the outer matrix of the spermatophore. Such a phase change has been observed in seminal fluids associated with copulation in *Centropages typicus* (Blades, 1977). The precise pathway of the fertilization tube may be determined by movement of the long hairs on the medial face of Th5 and the long seta on the basipodal segments of the fourth leg of the female.

Ratio of females to males.—The ratio of mature females to mature males is high (795:46) and does not reflect the number of spermatophores attached to females. One explanation is that by means of avoidance or loss through net meshes, males are collected less efficiently than females. The smaller size of the males (6.0–6.6 mm; females 7.4–8.6 mm) and their large, asymmetrical, hydrodynamically unstable fifth legs, however, would not seem to allow them to avoid a net more easily than the females. Loss through net mesh would be expected to differentially affect smaller specimens collected in a net. Although males of *E. norvegica* are smaller than females, they are still larger than most specimens collected in this study (unpublished data). Differential loss through the net mesh is probably not significant enough to explain differences between numbers of females and males.

A second explanation is suggested by the ratio of immature females to immature males (73:285). Here it would seem that there are enough future mature males to provide spermatophores for all future mature females. It is possible that males and females spend the same amount of time at each stage of development through copepodid V. As mature animals (copepodid VI), the males spend much less time than females, i.e. they have a much lower turnover time. This conclusion is supported by the fact that males do not feed as mature animals. The mandibular gnathobase and first lobe of the maxillule, well developed in copepodid V, are lost in copepodid VI. After mating once, or possibly several times, the males probably die. In the females the well developed mouthparts are retained in copepodid VI and feeding undoubtedly continues in this stage to provide energy for later egg development.

Discussion

The preceding observations of spermatophore placement in *E. norvegica* pose 4 important questions. Why are some spermatophores placed in the alternate area? What is the function of such alternately placed spermatophores? Why is more than one spermatophore attached? How can the evolution of such phenomena be explained within the context of a speciation process which places a high premium on precision and accuracy in all aspects of mating behavior (Fleminger, 1975)?

Concerning the function of alternately placed spermatophores, Hopkins and Machin state "the majority of imperfectly positioned spermatophores have no connexion between the attachment disc and the females (sic) seminal receptacles and cannot be thought of as viable for fertilization." Later they note that only those with fertilization tubes are fully viable. In samples from DWDS, as noted, the percentage of alternately placed spermatophores without tubes is very high, 86%. If these are not potentially viable, they would seem to represent quite a waste of energy. However, in all cases where fertilization tubes connect alternately placed spermatophores to the genital opening, the associated spermatophores are empty or partly empty. It is possible that all alternately placed spermatophores are capable of forming fertilization tubes and that tube formation occurs some time after spermatophore attachment and immediately before the spermatophore is emptied and subsequently removed by the female. This would explain why all specimens with fertilization tubes had empty or partly empty spermatophores. Because of delayed formation, fertilization tubes need not be associated with all such spermatophores at any one time.

Hopkins & Machin suggested tactile recognition of the female *E. norvegica* by the male using the ciliated area of the exopod of the left fifth leg. This idea is intuitively very appealing. Yet ciliated areas of the exopod of the male fifth leg are found in many calanoid families; besides Euchaetidae, for example the Pseudocalanidae, Aetideidae, Scolecithricidae, and Phaennidae. The primary function of this ciliated area seems to be to grasp the spermatophore while it is being transferred to the female. It may also be involved in a tactile interrogation of the female genital segment but this function would have to be carried out in *E. norvegica* while the male is holding the spermatophore since there is evidence that the male secretes and grasps the spermatophore before making direct contact with the female. Nevertheless, assuming that mating behavior involves the careful choice of position of attachment by the male and that most alternately placed spermatophores are viable via fertilization tubes, the question still arises, why place a second or third spermatophore in an alternate area? Why not, as has been observed in *Eurytemora affinis* (Katona, 1975) and *Acartia tonsa* (Hammer, in press), place those spermatophores in the correct area, that is just as close to the genital opening as the first?

I have assumed a different attachment behavior for *Euchaeta norvegica*. After mounting and positioning himself on the female, the male attempts to attach the spermatophore in the correct area with a quick stroke of the left fifth leg. Potential points of attachment then are restricted by the mechanical considerations of the length of the exopod of the left fifth leg and the flexion allowed by each segment of the exopod once the initial position with respect to the female has been determined. Then a spermatophore in the alternate area simply represents the result of a mechanical error, possibly caused by an attempt to attach it before the final correct position on the female was achieved. Hopkins & Machin suggested that until the female genital opening is sealed either by a spermatophore or a fertilization tube, the female may still be mated. Thus the position of the initial spermatophore very definitely affects the position of additional spermatophores since a female with an alternately placed spermatophore in which a fertilization tube has yet to form, can be mated again. Their suggestion would also explain the very low percentage, 10%, of 2 or more spermatophores in the correct area in multiple placements, since a correctly placed spermatophore would close the genital opening.

No matter which attachment behavior is choosen, the final question remains: how could a system of multiple spermatophores and misplaced attachments, either by choice or chance, have evolved within a speciation process which places a premium on precision in the morphology of structures associated with mating and accuracy in mating behavior? The systematic importance of the morphology of segments and appendages which function in mating behavior of copepods has been demonstrated for *Centropages* by Lee (1972). Steuer (1924) suggested that the morphological diversity in the female genital segment of *Acartia* acts as an obstacle to hybridization in closely related species. A complete study of these structures associated with prezygotic mating barriers in the genus *Labidocera* and an elegant statement of the process has been made by Fleminger (1975).

Mating behavior can be envisioned as a linear sequence of exact, time-ordered events. Each event has a very high probability, approaching unity, of occurring between sexes of the same species and a reduced probability between sexes of differing species. These probabilities are insured by precise morphological, physiological, and behavioral adaptions associated with each event. During incipient speciation, if prezygotic mating barriers have resulted in biological isolation then the sum total of all probabilities should approach zero for pairings with sexes of the different daughter populations. As the evolution of the daughter species continues, it is possible that biological isolation may be preempted by a particular subset of the initial set of events. Then the accuracy of events before or after that subset, but especially farther along the time sequence, might be relaxed. This, then, may explain how imprecision in spermatophore placement might have initially developed in *Euchaeta norvegica*.

Summary

The total number and relative numbers of single, double, triple, and quadruple placements of spermatophores on females of *Euchaeta norvegica* from samples collected in the Deepwater Dumpsite 106 agree with the data reported for Loch Etive, Scotland by Hopkins & Machin (1977). However, the Dumpsite population differs in having a higher number of spermatophores placed away from the ventral face of the genital prominence in an alternate area of attachment anterior to the genital prominence. The proportion of adult males was low; however, there were many more stage IV & V males than females. Some adult males were found clasping a spermatophore in the exopod of the left fifth leg. This spermatophore differs from those attached to the female by the addition of a long stalk, and attachment plate. A fertilization tube may be found associated with any spermatophore placed away from the female genital opening, but usually with those in the alternate area. Spermatophores attached in the alternate area with fertilization tubes were never completely full. The formation of the tube is believed to occur sometime after initial attachment but immediately before the spermatophore is emptied. Within the context of a speciation process which emphasizes morphological precision and behavioral accuracy, the variability in spermatophore placement is explained by hypothesizing the preemption of biological isolation by a subset of events in the initial time-ordered sequence of behavioral events involved in the isolation and a subsequent relaxation of events outside of the subset.

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A NEW MERGANSER FROM THE MIOCENE OF VIRGINIA (AVES: ANATIDAE)

Rafael Alvarez and Storrs L. Olson

Abstract.—A new species of merganser, *Mergus miscellus*, based on a pelvis with associated tibiotarsi and tarsometarsi from the Middle Miocene Calvert Formation of Virginia, provides the first Tertiary record for the genus and the earliest for the tribe Mergini. The species combines a specialized morphology of the tarsometatarsus, such as seen in Recent *Mergus* (*sensu stricto*) with a more primitive morphology of the pelvis similar to Recent *Mergellus*. Certain characters of the fossil support the presumed relationship between mergansers and goldeneyes (*Bucephala*). A fragmentary ulna representing an indeterminate genus and species of sheldrake (Tadornini) from the Calvert Formation in Maryland is also reported.

In recent years there has been a remarkable increase in the number of specimens of fossil birds known from Tertiary marine deposits of the eastern United States. Although there are several species of ducks represented among the thousands of seabird fossils from the early Pliocene Yorktown Formation in North Carolina (Olson and Wetmore, in press; Alvarez, in prep.), of almost 150 undescribed fossil bird specimens now in the National Museum of Natural History from earlier (Middle and Upper Miocene) deposits in Maryland and Virginia (Calvert, Choptank, St. Marys, and as yet unnamed beds) there are as yet but two specimens referable to the Anatidae. These consist of a pelvis associated with right and left tibiotarsi and tarsometatarsi (USNM 237150) belonging to a diving duck of the tribe Mergini, and the proximal end of a left ulna (USNM 25926), tentatively referred to the Tadornini (sheldrakes). Both specimens are from the Middle Miocene Calvert Formation, and were deposited in an offshore marine environment. Descriptive osteological terminology follows Howard (1929).

Order ANSERIFORMES
Family Anatidae
Subfamily Anatinae
Tribe Mergini

That the associated elements of USNM 237150 are those of a diving duck is shown by features of the tarsometatarsus, particularly the lateral compression of the shaft and trochleae and the elevation and lateral rotation of the inner trochlea. Only the tribes Aythyini, Somateriini, Mergini, and Oxyurini need therefore be considered further.

Comparisons at the tribal level.—The fossil differs from the Aythyini (pochards) in that the shaft of the tarsometatarsus is more slender and the inner trochlea more rotated; the distal third of the tibiotarsus is stouter; the proximal margin of the outer cnemial crest of the tibiotarsus is at a diagonal to the long axis of the shaft instead of nearly perpendicular; and the anterior margin of the inner cnemial crest is longer.

From the Somateriini (eiders) the fossil differs in the more compressed trochleae and much less medially expanded internal cotyla of the tarsometatarsus, and in having the postacetabular portion of the pelvis longer than the preacetabular portion, whereas these are of about equal length in eiders.

The Oxyurini (stiff-tailed ducks) are very different, with the tarsometatarsus much shorter and stouter, the trochleae less compressed, the tibiotarsus with its distal end bent farther medially, the prominence for the groove of M. peroneus profundus better developed, and the pelvis much narrower and more heavily ossified.

The fossil agrees with the Mergini (sea ducks) and differs from the other tribes of diving ducks in the very slender, laterally compressed shaft and more posteriorly directed inner trochlea of the tarsometatarsus, and in having the outer cnemial crest of the tibiotarsus relatively narrower and more posteriorly oriented.

Comparisons within the tribe Mergini.—Compared to the fossil, the tarsometatarsus in *Melanitta* has the trochleae much broader and more widely separated, the inner trochlea more anteriorly and medially directed, the external surface of the outer trochlea swollen anterior to the excavation on its lateral surface, the anterior opening of the distal foramen relatively wider, the posterior metatarsal groove narrower and less sharply defined, the distal expansion of the shaft greater to accommodate the wider trochleae, the anterolateral margin of the shaft more concave in lateral view, and the lateral surface of the shaft more curved in anterior view. In the tibiotarsus of *Melanitta*, the distal end is more expanded, the distal tendinal opening is larger, the external condyle in lateral view is less rounded, and the fibular crest is longer. The pelvis of *Melanitta* is narrower and longer, particularly anterior to the acetabulum, and the acetabulum is much larger in relation to the antitrochanter.

In the tarsometatarsus of *Histrionicus*, the tubercle for M. tibialis anticus is more swollen, the curvature of the lateral surface of the shaft is more pronounced in anterior view, the outer trochlea is more elevated in posterior view, the outer extensor groove is broader, the inner trochlea is more anteriorly directed, and the shaft is stouter and much flatter anteriorly. The proximal margin of the outer cnemial crest of the tibiotarsus of *Histrionicus* is nearly perpendicular to the shaft, as in *Aythya*, and the distal tendinal opening is much larger than in the fossil. The preacetabular portion of the pelvis is much shorter and broader in *Histrionicus* than in the fossil.

In *Clangula*, the tarsometatarsus is relatively shorter with the proximal and distal ends more expanded, the outline of the medial edge of the middle trochlea is rounder in medial view, the outer extensor groove is deeper, the tubercle for M. tibialis anticus is more swollen, and the anterolateral margin of the shaft is more concave in lateral view. The external condyle of the tibiotarsus of *Clangula* projects farther medially from the shaft and the pelvis is markedly broader and shallower than in the fossil.

The tarsometatarsus of *Bucephala* differs from that of the fossil in having the trochleae wider both individually and collectively, the shaft wider in anterior view and more deeply excavated proximally, the shaft not as deep in either lateral or medial views, the inner trochlea more anteriorly directed, and the outer extensor groove broader. The tibiotarsus of *Bucephala* differs from that of the fossil in having the inner cnemial crest extending farther proximally and being much more pointed at its proximal apex, with the proximal margin of the outer cnemial crest ascending much more vertically and being less rounded; the outer crest is smaller and less laterally expanded. Also, the anterior intercondylar fossa in distal view is broader in the fossil than in *Bucephala*. The pelvis of *Bucephala* is broader posteriorly, and narrower and much shorter anterior to the acetabulum than in the fossil.

The tarsometatarsus of *Lophodytes* differs from that of the fossil in being much shorter and relatively stouter, and in having the outer trochlea more elevated in posterior view, the anterior face of the shaft not as deeply excavated beneath the hypotarsus, and the anteromedial edge of the middle trochlea rounder in outline. The tibiotarsus of *Lophodytes* is much shorter, the inner cnemial crest is more pointed at its proximal apex, and the proximal margin of the outer cnemial crest forms a straight rather than a gently curving line. The fossil pelvis differs from *Lophodytes* in having the preacetabular portion relatively longer and the pectineal processes shorter.

The fossil tarsometatarsus differs from that of *Mergellus* in its much larger size and more slender proportions and in having the inner trochlea more compressed and posteriorly directed. The inner cnemial crest of the tibiotarsus of *Mergellus* is more pointed at its proximal apex, the internal ligamental attachment extends farther distally, and the outer cnemial crest is more anteriorly directed. The fossil pelvis is similar in proportions to that of *Mergellus*, but differs in having the ilioischiatic fenestrae relatively longer.

Shared and apparently derived characters which argue strongly for inclusion of the fossil form in the modern genus *Mergus* (*sensu stricto*) are the long slender proportions of the tarsometatarsus, the greater posterior rotation of the inner trochlea, the greatly elongate posterior articulating surface of the inner trochlea, the marked depth and narrowness of the middle and outer trochleae in posterior view, and the narrowness of the anterior opening of the distal foramen, which lies at an oblique angle to the shaft. The fossil tibiotarsus also shows a greater similarity to *Mergus* than to any of the other genera of Mergini. The fossil elements are referable to the genus *Mergus*, but they present sufficient differences from the living species of the genus to warrant recognition as a new species.

Mergus miscellus, new species
(Figs. 1, 2, 3a, b)

Holotype.—Pelvis with associated right and left tibiotarsi and right and left tarsometatarsi in varying states of imperfection. Vertebrate paleontological collections of the National Museum of Natural History, USNM 237150.

Locality and horizon.—Stratford Cliffs, 2 m above beach, 100 m west of east end of set of cliffs immediately east of Little Meadow Swamp, Westmoreland County, Virginia (.85 miles ESE of Maryland–Virginia boundary monument 25; 1.55 miles NNW of Stratford Plantation boundary marker A). Basal part of Zone 13, Calvert Formation, Middle Miocene. Collected by Robert Weems in the summer of 1966.

Measurements.—Left tarsometatarsus: length from intercotylar prominence to most distal point of middle trochlea, 43.6 mm; width through cotylae, 8.4; width of shaft at midpoint of overall length, 3.9; external depth at same point, 4.3; breadth through trochleae, 8.3; breadth through middle and outer trochleae combined, 7.2; depth of inner trochlea, 5.6; width of inner trochlea, 3.0; width of middle trochlea, 3.9; width of outer trochlea, 3.0. Right tibiotarsus: length from external articular surface to most distal point of external condyle, 77.7; greatest width through proximal articular surfaces, 8.5; width of shaft at distal end of fibular crest, 5.1; internal depth at same point, 3.6; width through condyles, 8.8. Pelvis: length of synsacrum, 76.9; width across antitrochanters, 29.2; diameter of acetabulum, 5.4; distance from midline of acetabulum to anteriormost and posteriormost portions of synsacrum, respectively, 32.3, 46.9.

Etymology.—L. *miscellus*, mixed, in allusion to the combination of primitive and derived characters shown by the species.

Diagnosis.—Comparable in size to Recent *Mergus serrator*. *M. miscellus* differs from Recent species of *Mergus* in having (1) the shaft of the tarsometatarsus relatively deeper, with the anterolateral edge elevated above the anteromedial edge for over half the total length of the bone, (2) the inner trochlea more compressed and posteriorly directed, (3) the wing of the inner trochlea with a distinct projection on its posteroproximal edge, and (4) the external margin of the distal foramen a straight ridge of bone lying nearly parallel to the long axis of the shaft. The tibiotarsus of *M. miscellus* closely resembles that of living species of *Mergus*, the

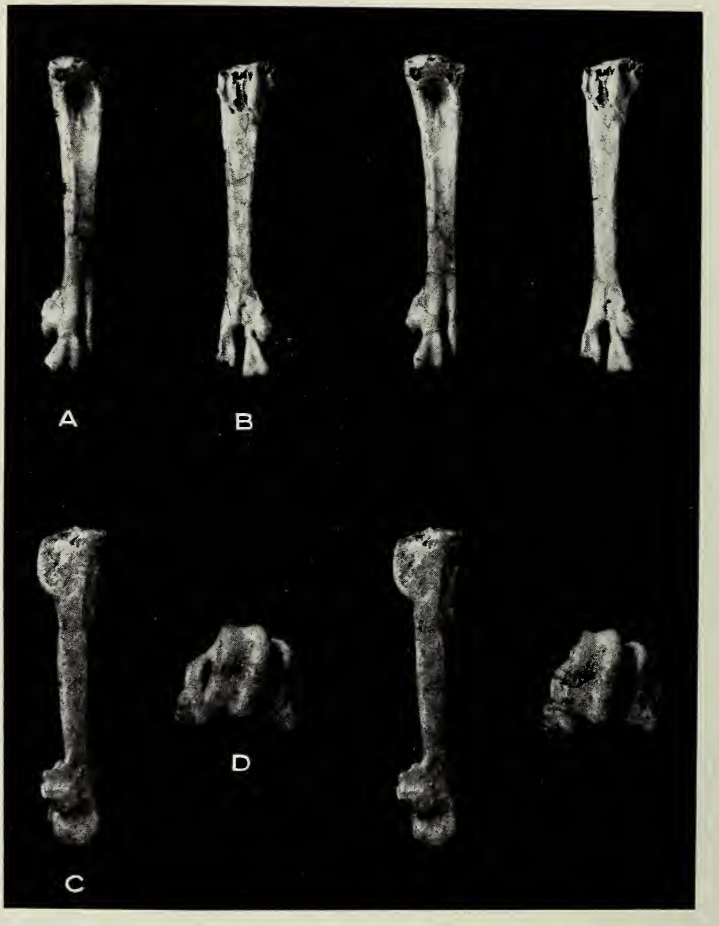

Fig. 1. Right tarsometatarsus of holotype of *Mergus miscellus* (USNM 237150). Stereo pairs: a, anterior view; b, posterior view; c, medial view; d, distal view. a–c, about natural size; d, 2×.

primary differences being the shorter inner cnemial crest and the more curved proximal margin of the outer cnemial crest of the fossil. The ilioischiatic fenestrae of the fossil pelvis are long, as in mergansers and not as in other Mergini. The pelvis of *M. miscellus*, however, is more similar in proportions to that of *Mergellus albellus*, and is not as long and narrow as in the larger, more specialized Recent species of *Mergus*. The combination of highly specialized features of the tarsometatarsus with an apparently primitive pelvic morphology distinguishes *M. miscellus* from any known mergansers of the genera *Mergus*, *Mergellus*, and *Lophodytes*.

Description.—Tarsometatarsus with medial and lateral surfaces of shaft

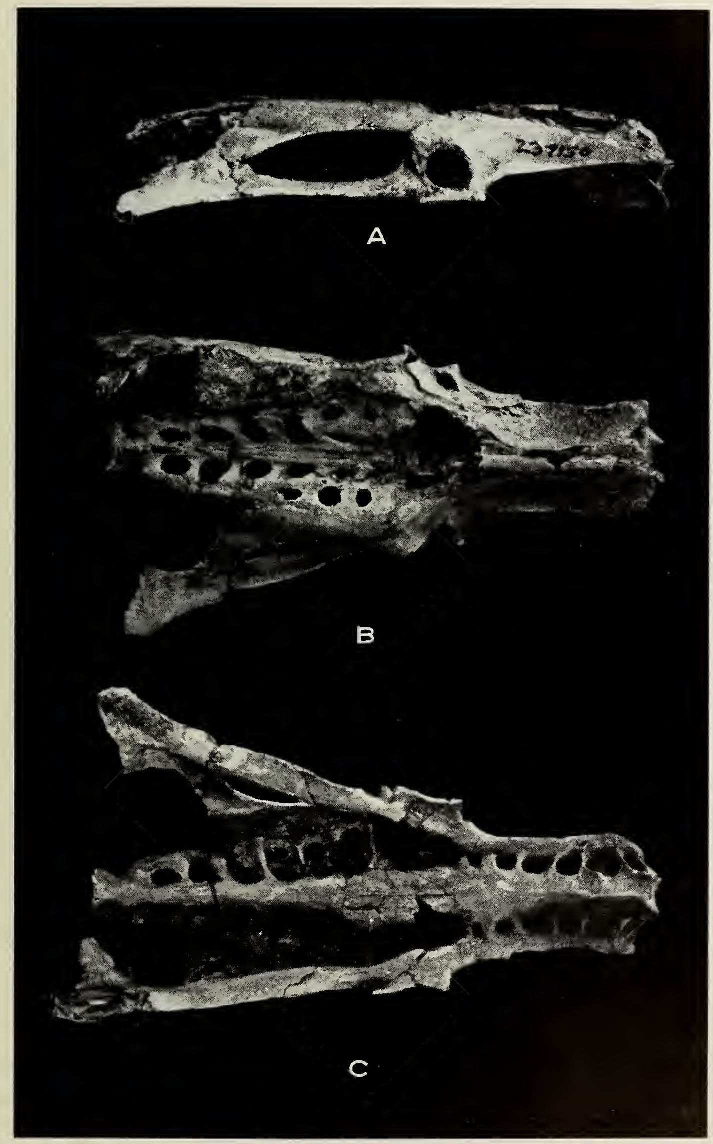

Fig. 2. Pelvis of holotype of *Mergus miscellus* (USNM 237150). a, right lateral view; b, dorsal view; c, ventral view. All figures about natural size.

flat and relatively straight in anterior view, showing little curvature proximally or distally; inner extensor groove shallow; posterior metatarsal groove broad; distal portion of shaft only slightly expanded; trochleae very narrow, giving the distal end of the bone a compressed appearance; outer

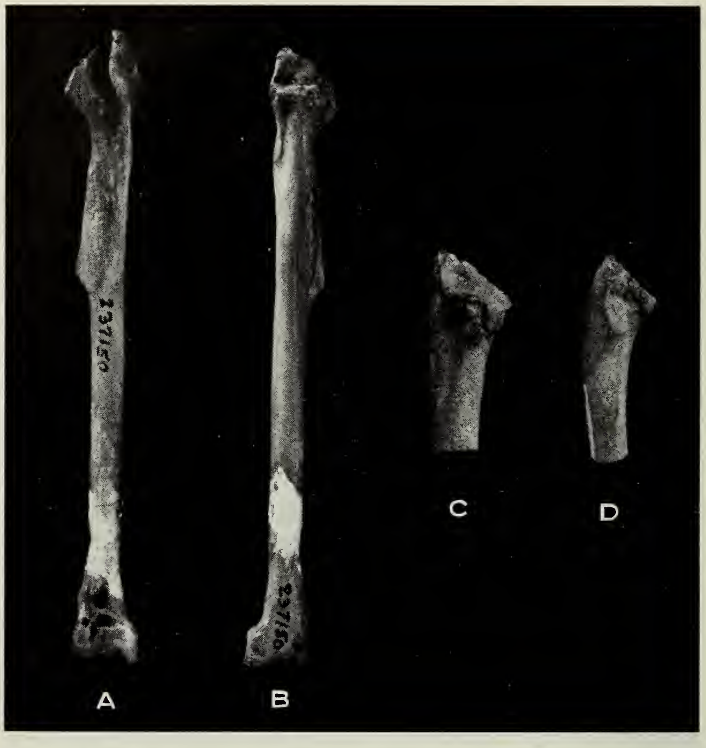

Fig. 3. a, right tibiotarsus of holotype of *Mergus miscellus* (USNM 237150), anterior view (inner cnemial crest warped laterally); b, same, posterior view; c, proximal end of left ulna of Tadornini gen. et sp. indet. (USNM 25926), internal view; d, same, anconal view. All figures about natural size.

extensor groove narrow and fairly deep; region anterior to excavation on lateral surface of outer trochlea flat; in lateral view the lateral edge of the middle trochlea extending farther anteriorly than the medial edge of the outer trochlea; and posterior surface of shaft depressed at base of middle trochlea.

Tibiotarsus in posterior view with the area beneath the internal articular surface deeply excavated; surface posterior to inner cnemial crest and directly anterior to internal articular surface with a deep, circular pit; internal ligamental attachment proximal to fibular crest; and posterior intercondylar sulcus flat.

Tibiotarsus in lateral view with outer cnemial crest laterally directed, its proximal edge nearly parallel to external edge of fibular crest; medial edge of shaft elevated above lateral edge toward distal end of bone; and external ligamental prominence moderately developed.

Tibiotarsus in anterior view with upper and lower margins of supratendinal bridge curved; groove for M. peroneus profundus very narrow, nearly obsolete; distal opening of tendinal groove oval; anterior intercondylar sulcus traversed by a conspicuous, narrow groove at the level of the apex of the internal ligamental prominence; and distal extensions of internal and external condyles equal.

Tibiotarsus in medial view with inner cnemial crest wide and bluntly flattened at its proximal apex; internal ligamental prominence moderately developed; and internal condyle extending farther anteriorly than external condyle.

Pelvis relatively wide; posterior iliac crest smoothly rounded directly above the ilioischiatic fenestra; and pectineal process short and sharply pointed.

Remarks.—Of the seven Recent species of mergansers, two are Holarctic in distribution (*Mergus serrator*, *M. merganser*), two Palearctic (*Mergellus albellus*, *Mergus squamatus*), one Nearctic (*Lophodytes cucullatus*), one has a limited distribution in southern Brazil and adajacent regions of Argentina and Paraguay (*Mergus octosetaceus*), and one extinct form (*Mergus australis*) is known historically from the Auckland Islands and from subfossil remains in New Zealand (Kear and Scarlett, 1970). *Mergus miscellus* provides the only Tertiary record of a merganser and the earliest record for the tribe Mergini.[1]

Although most authorities (Delacour, 1959; Johnsgard, 1960) now place the genera *Lophodytes* and *Mergellus* in *Mergus*, Woolfenden (1961) considered the differences in postcranial osteology of these forms sufficient to warrant the recognition of all three genera. Our observations confirm that these differences do indeed exist. We have continued to use the terms *Lophodytes* and *Mergellus* as a means of facilitating discussion and description; we reserve judgment on the actual generic value of these distinctions. The term *Mergus* is used in this paper only to refer to the five larger species of mergansers (i.e., *Mergus* in the strict sense of Woolfenden and many earlier authors).

Osteological specializations for diving in ducks and other birds include a progressive elongation and narrowing of the pelvis (Raikow, 1970), and lateral compression of the tarsometatarsus with narrowing of the trochleae and a more posterior rotation of the inner trochlea. With respect to the manner in which these characters are manifested in mergansers, *Lophodytes*, which has the broadest pelvis and the shortest and least compressed tarsometatarsus, appears to be the most primitive, while the species of *Mergus* are the most derived, with *Mergellus* being intermediate. The tarsometatarsus in *Mergus* is more compressed, with narrower trochleae and a more posteriorly rotated inner trochlea than in any of the Mergini, or, for that matter, than in any of the other diving ducks. The species *miscellus* shares with *Mergus* these same highly derived characters of the tarsometatarsus.

It is of interest, however, that the pelvis in *M. miscellus* is not as elongate and narrow as in the Recent species of *Mergus* but instead is most similar to that of *Mergellus*. This suggests that in *Mergus*, the diving specializations of the tarsometatarsus evolved before those of the pelvis. This in turn implies differential rates of evolution in the components of the pelvic assemblage and that the evolution of diving specializations of the foot is not linked to that of the pelvis as a single functional complex.

Woolfenden (1961:115) listed ten osteological characters that are shared between the mergansers and the goldeneyes (*Bucephala*) and which set this group apart from the other genera of Mergini. Of these, the straight external edge of the outer trochlea and the nearly straight diagonal line of the proximal edge of the outer cnemial crest are observable in *M. miscellus*, confirming its allocation to the merganser-*Bucephala* assemblage. We also found similarities between *M. miscellus* and *Bucephala* that are not shared by other mergansers. In the marked anterior extension of the anterolateral edge of the shaft of the tarsometatarsus, and the short rather than elongate pectineal process of the pelvis, *M. miscellus* agrees with *Bucephala* (and also with *Mergellus* in the case of the latter feature) and differs from *Lophodytes* and *Mergus*. These characters of *M. miscellus* tend to corroborate the relationship between the mergansers and *Bucephala* postulated by Delacour and Mayr (1945), Woolfenden (1961), and others, and which is supported as well by behavioral evidence (Johnsgard, 1960, 1961). Perhaps the most compelling evidence for such a relationship comes from the fact that *Bucephala clangula* has been known to hybridize with *Lophodytes cucullatus*, *Mergellus albellus*, and *Mergus merganser* (Johnsgard, 1960). This indicates a degree of genetic compatibility between *Bucephala* and the mergansers. *Mergus miscellus* shows that the divergence of mergansers from *Bucephala* had to have taken place prior to the Middle Miocene. Thus, the genetic compatibility between *Mergus* and *Bucephala* has persisted in excess of 14 million years, this being the approximate age of the Calvert Formation (Blackwelder and Ward, 1976).

Tribe Tadornini

Genus and Species Indeterminate

In order to complete the present record of the Anatidae in the Calvert Formation, we include mention of a specimen that is too imperfect to merit a name but that is still of interest. This is the proximal fourth of a left ulna (USNM 25926) collected by Albert C. Myrick on 22 June 1969 from Zone 14 in the Calvert Formation, 400 m south of Governor's Run Road, Calvert County, Maryland (Fig. 3c, d). The olecranon is somewhat abraded and the outer layer of bone on the shaft appears to have been etched away.

After examining a wide variety of anatid skeletons, we found this fragment to bear a decided resemblance to the Tadornini (sheldrakes), and particularly to *Tadorna.* It resembles *Tadorna* and differs from other tribes of Anatidae in the greater distal projection of the internal surface of the external cotyla and in the more elongate and more proximally situated prominence for the anterior articular ligament; a distinct ridge runs from this prominence to a transverse groove across the internal face of the olecranon. In size and proportions the fossil closely resembles the Recent species of *Tadorna.*

No members of the Tadornini occur in North America today, although the extinct genera *Anabernicula* Ross and *Brantadorna* Howard from the Pleistocene of western North America have been assigned to the Tadornini (Brodkorb, 1964). The significance of the present fossil lies mainly in adding another element to the Calvert avifauna.

Acknowledgments

We are particularly indebted to Robert Weems who discovered the type of *Mergus miscellus* and whose collecting has added considerably to our knowledge of birds in the Tertiary deposits of the Chesapeake Bay area. We are also grateful to Victor E. Krantz for taking the photographs and to Nancy Wu for her assistance with typing. Drafts of the manuscript were read and commented upon by Douglas A. Nelson, Gerald R. Smith, Robert W. Storer, John Farrand, Jr., Clayton E. Ray, and Helen F. James.

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Footnote

[1] A worn cervical vertebra from the Lower Pliocene of India was referred to as "*Mergus* (?) sp." by Lydekker (1890:142) but this assignment is too dubious to merit consideration as Lydekker had only a specimen of *M. serrator* with which to compare it and from this the fossil was said to differ in being "shorter and wider."

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A NEW CRAWFISH OF THE SUBGENUS *GIRARDIELLA*, GENUS *PROCAMBARUS* FROM NORTHWEST ARKANSAS (DECAPODA, CAMBARIDAE)

J. F. Fitzpatrick, Jr.

Abstract.—A new burrowing crawfish of the subgenus *Girardiella* of the genus *Procambarus* is described from Benton County, Arkansas. It is assigned to the Gracilis Group. The new species is distinguished by a linear areola, broad caudal process and other features of the male first pleopod.

Over the course of time, my family has been well trained to be alert for any unusual crawfishes to give to "Daddy." Thus, when the animals described below came to the attention of the children and their mother, they were careful to preserve them. On several occasions since 1964, I had attempted, unsuccessfully, to excavate burrows northwest of Rogers in Benton County, Arkansas, which were markedly similar to those of members of the subgenus *Girardiella* which I had been studying in Mississippi and Alabama—holes without chimneys, or nearly so, leading nearly straight down, and located in high meadows or pastures, removed from nearby watercourses.

In the summer of 1976, the cat of Mr. Harold May of Bentonville brought several crawfishes to him for "reward." When he mentioned this to my family, they determined that the crawfishes had been caught at night when they emerged from their burrows in his backyard, apparently to forage. Such behavior is common in *P.* (*G.*) *hagenianus* (Faxon) in Mississippi and Alabama. Subsequent "collections" by the cat were preserved and given to me in the late fall of that year. I discovered that they represented an undescribed species, and Dr. Horton H. Hobbs, Jr., compared them with materials at the National Museum of Natural History to confirm my opinion.

I am indebted to my children, Joseph, Kathleen, Eileen and Daniel; to their mother, Sarah E. Fitzpatrick; and to Mr. May and his cat for collecting the animals for me. I also thank Dr. Hobbs for examining the specimens and reading the manuscript. The Research Committee of the University of South Alabama provided partial support of incident expenses.

Procambarus (*Girardiella*) *liberorum* new species

Diagnosis.—Pigmented; eyes small, but well developed. Rostrum with gently converging margins, lacking marginal spines (Fig. 4); acumen nearly obsolete and poorly delineated from rostrum. Areola 39.3–41.5 (av.

40.2)% of entire length of carapace; areola linear. Carapace lacking cervical spines or tubercles. Suborbital angle broadly acute to obsolete. Postorbital ridges terminating cephalically without spines or tubercles. Cephalic part of epistome (Fig. 11) rounded trapezoid, lacking cephalomedian tubercle. Antennal scale 2.05–2.67 (av. 2.31) times longer than broad, widest distal to midlength, thickened lateral part terminating cephalically in short, stout, subconical spine. Mesial margin of palm with row of 6–7 strong, spinose tubercles decreasing in size distally, 2 additional irregular rows of 5–6 and 3–5 more squamous tubercles medial to it. Dactyl with 2–5 small tubercles on basal fourth of mesial margin. Opposable margin of immovable finger with large tubercle in basal fourth, tiny tubercle in proximal part of gently excavated next half, and distal fourth with crowded minute denticles interrupted by small tubercle proximally. Opposable margin of dactyl deeply excavate in basal third with 3 small tubercles, 2 more tubercles on margin proximal to midlength, and distal half with band of crowded, minute denticles, broken by small tubercle near base. Ischia of third pereiopods only bearing hooks in males; no conspicuous prominences or bosses on coxae of pereiopods (Fig. 13). Inner ramus of uropod lacking prominent spines projecting beyond distal margin (Fig. 10). First pleopods symmetrical, strong right-angled shoulder at base of central projection, pleopods reaching coxae of third pereiopods when abdomen flexed; distal extremity bearing (1) prominent, subacute, nearly setiform mesial process extending subparallel to main axis of pleopod and twice distance distally as other elements, and gently curved cephalad in distal half; (2) well developed central projection terminating distally in acute angle directed slightly caudolaterally; (3) conspicuous, subrectangular (in lateral aspect) caudal process laterally compressed distally, and extending distad just beyond central projection; and (4) prominent cephalic process placed cephalomesial to central projection, extending 90% of length of latter and running subparallel to main axis of pleopod. Annulus ventralis of female deeply excavate in cephalomedian half, flanking ridges ornamented with several prominent spines or tubercles, sinus originating in posteriodextral portion of trough, arching mediocaudad to midposterior margin; postannular sternite subtrapezoidal, excavated in center.

Holotypic male, Form I.—Body subovate, indistinctly compressed. Abdomen narrower than thorax (12.7 and 15.6 mm). Width of carapace at

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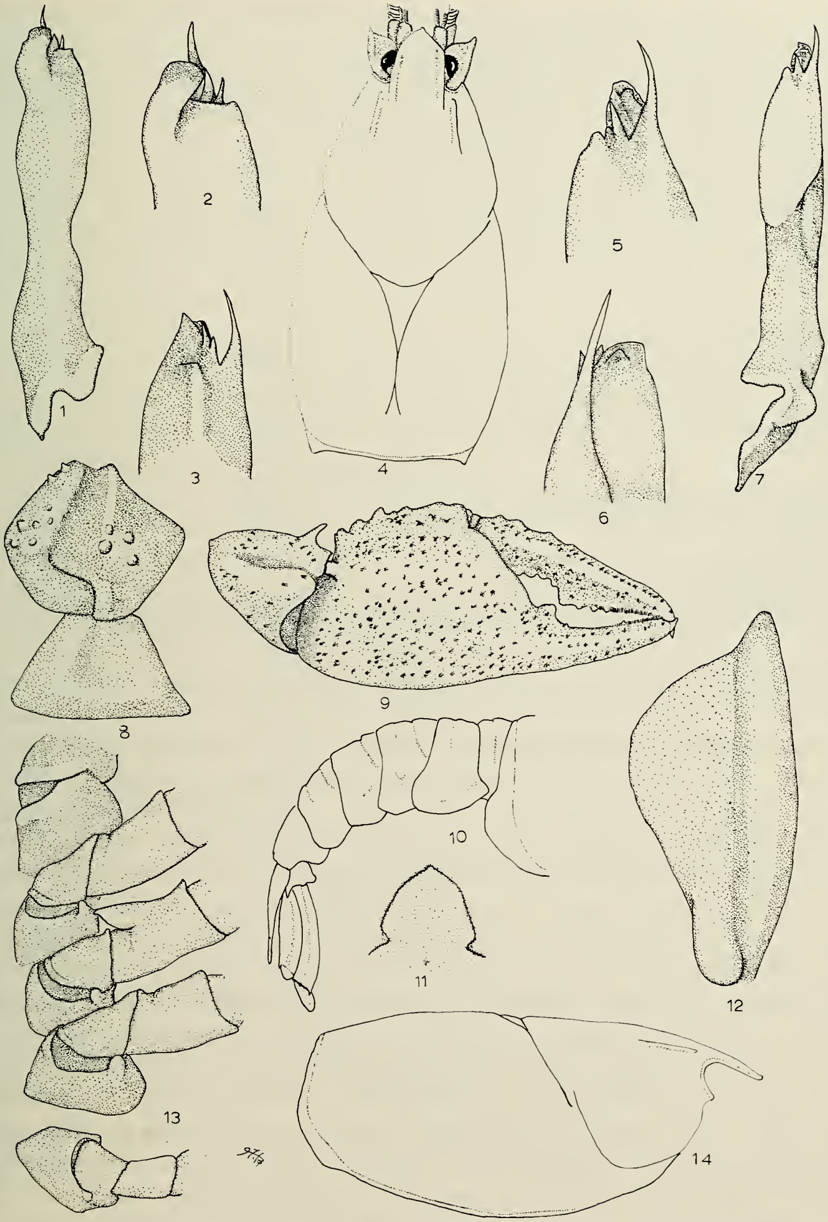
Figs. 1–14. *Procambarus* (*Girardiella*) *liberorum* (all figures of holotype, unless otherwise noted): 1, Lateral view of first pleopod; 2, Lateral view of terminal elements of first pleopod; 3, Cephalic view of terminal elements of first pleopod; 4, Dorsal view of carapace; 5, Mesial view of terminal elements of first pleopod; 6,



Caudal view of terminal elements of first pleopod; 7, Mesial view of first pleopod; 8, Annulus ventralis and fifth sternite of allotype; 9, Upper view of distal podomeres of cheliped; 10, Lateral view of abdomen; 11, Cephalic part of epistome; 12, Upper view of antennal scale; 13, Proximal podomeres of left pereiopods; 14, Lateral view of carapace.

Table 1. Measurements of type-specimens of *Procambarus* (*Girardiella*) *liberorum* (in mm).

	Holotype	Allotype
Carapace		
length	37.5	37.5
width	15.6	16.6
height	15.5	16.6
Areola		
length	15.0	15.2
Antennal scale		
length	4.5	5.1
width	2.0	2.1
Rostrum		
length	7.6	8.1
width	5.0	5.5
Chela		
length of inner margin of palm	11.6	9.3
width	14.8	11.3
total length	33.3	25.1
dactyl length	21.7	15.3

caudodorsal margin of cervical groove scarcely less than height (15.6, 15.9 mm). Areola 40.0% of total length of carapace, cephalic section of carapace 1.5 times length of areola. Rostrum depressed (Fig. 14), excavate dorsally, with slightly thickened gently converging margins, marginal spines lacking; acumen nearly tuberculate and poorly delimited; upper surface sparsely punctate, but with usual submarginal row of setiferous punctations. Subrostral ridges well developed to below suborbital angle and visible in dorsal aspect to about midlength of rostrum. Branchiostegal spine obsolete. Carapace punctate dorsally and laterally, grading to granulate cephalolaterally and with prominent squamous tubercles on cephalolateral surfaces. Cephalic section of telson with 2 spines in each caudolateral corner. Cephalic section of epistome as described in "Diagnosis." Antennules of usual form with well developed spine on ventral surface of basal segment slightly distal to midlength. Antennae broken; antennal scale (Fig. 12) 2.25 times longer than broad, widest distal to midlength.

Ischium of third maxilliped with dense, long, stiff setae arising from ventromesial surface and row along ventrolateral margin, setae of latter row shorter.

Right chela (Fig. 9) with palm inflated, moderately depressed; lateral margin entire and not keeled; palmar area covered with setiferous punctations above and below; mesial margin of palm with row of 7 spinose tubercles and irregular rows of 5 and 3 squamous tubercles medial to it.

Both fingers with submedian longitudinal ridge above and below, each flanked by setiferous punctations; mesial margin of movable finger with row of 4 small tubercles decreasing in size distally. Opposable margin of immovable finger with a single large tubercle in basal fourth, gently excavate with tiny tubercle proximodorsally in middle half, and distal fourth with crowded minute denticles, interrupted proximally by small tubercle. Opposable margin of dactyl with basal third deeply excised and bearing 3 small tubercles, 2 more small tubercles in basal half, and distal half with crowded minute denticles interrupted proximally by 2 small tubercles.

Carpus of right cheliped longer than broad; mesial surface with strong acute spine at base of distal third, 3–5 squamous tubercles proximal to it, and small, nearly tuberculiform spine at mesiodistal margin; punctate above and below with deep longitudinal furrow above; distal corners of ventral surface with stout acute spine.

Merus of right cheliped with single acute spine on distodorsal margin and row of 5 tiny tubercles proximal to it in distal half of podomere; ventromesial margin with row of 10 spines increasing in size distally; ventrolateral margin with row of 2 tiny, followed by 1 large, 1 tiny and 1 larger tubercle in distal two-thirds. Ischium without spines or tubercles.

Hooks on ischia of third pereiopods only, directed proximally to extend over distal fourth of basis. No bosses or eminences on pereiopodal coxae.

First pleopods (Figs. 1, 2, 3, 5, 6 and 7) as described in "Diagnosis"; tips of all elements except mesial process corneous.

Uropods as in "Diagnosis."

Sternites and extreme basal portions of coxae of pereiopods with long, dense setae partly concealing pleopods when latter held under thorax.

Male, Form II.—Unknown.

Allotypic female.—Differing from holotype in following respects: acumen more acute, but still quite reduced; mesial row of tubercles on palm flanked above and below by squamous tubercle at level of gap between 2 distalmost tubercles, next most medial row consisting of 6 tubercles. Sternites and pereiopodal coxae with only scant, short setae.

Annulus ventralis (Fig. 8) as described in "Diagnosis," with numerous tubercles on elevated (ventrally) cephalolateral parts; sinus arising in right third of annulus near midlength, soon turning sharply sinistrad to median line, then recurving to interrupt midcaudal margin; postannular sternite as described in "Diagnosis."

Types.—USNM 148353 and 148354 (holo- and allotype, respectively). Paratypes: all topoparatypic, all USNM (1♂I, 2♀♀).

Type-locality.—Bentonville, Benton County, Arkansas; yard at 206 SW Seventh Street.

Range.—Known only from the type-locality, but burrows located northwest of Rogers are probably inhabited by this species.

Variation.—All variations noted in this limited sample are covered in the descriptions and diagnosis sections above.

Relationships.—Procambarus (*Girardiella*) *liberorum*, because of the presence of the cephalic process on the first pleopod and of uropod morphology, is assigned to the Gracilis Group. Its pleopod is more nearly like that of *P.* (*G.*) *gracilis* (Bundy), but it can be distinguished from it by the wider caudal process originating more proximally, by the base of the mesial process being more or less straight, and by the cephalic process being directed less cephalically. It differs from the subspecies of *P.* (*G.*) *simulans* in possessing a broader central projection and caudal process and a dactyl which is deeply excised in its basal third; it likewise has a linear, rather than open, areola. The annulus of the female is more like that of *P.* (*G.*) *tulanei* Penn, particularly in the configuration of the postannular sternite. But in *P.* (*G.*) *tulanei* the cephalolateral eminences of the annulus overhang the adjacent sternal plate, and this is not so in *P.* (*G.*) *liberorum*. Further, *P.* (*G.*) *tulanei* has what is clearly the broadest areola in the subgenus and is unique in the Gracilis Group in having a bearded hand. *P.* (*G.*) *liberorum* is easily separable from *P.* (*G.*) *curdi* Reimer (1975) in that the terminal elements, except for the mesial process, of the latter are directed sharply cephalically, and the areola is clearly open.

Full bibliographic citations for most species are available in Hobbs (1974). Citation here would be redundant, and interested parties should consult Hobbs.

Etymology.—From the Latin, *liber*: children; in recognition of my family's efforts in bringing this species to my attention.

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STATUS OF THE GENUS *OCEANIDA* DEFOLIN (GASTROPODA: EULIMIDAE), WITH A DESCRIPTION OF A NEW SPECIES

William G. Lyons

Abstract.—Monotypic genera *Spiroclimax* Mörch, 1875, and *Athleenia* Bartsch, 1946, are later synonyms of *Oceanida* DeFolin, 1871; type-species of both genera are identical to *O. graduata*, the type-species of *Oceanida*. All were described from the tropical western Atlantic. *Oceandia inglei* n. sp. from Florida and North Carolina differs from *O. graduata* by lacking tabulate shoulders at posterior angles of spiral whorls. Differences between Eulimidae (preferred to Melanellidae) and Stiliferidae are unclear, indicating the latter should be combined with the former family.

Three originally monotypic genera have been erected to contain the single species most recently known as *Athleenia burryi* Bartsch, 1946. The earliest available name for the genus appears to be *Oceanida* DeFolin, 1871. Another species, presently known from Florida and North Carolina, is previously unnamed and is described herein.

Specimens were examined from collections of the Hourglass Cruises off west Florida, in samples taken during faunal studies near the Florida Power and Light nuclear facility at Hutchinson Island, Florida east coast, and in other programs conducted by the Florida Department of Natural Resources (FDNR) Marine Research Laboratory. Most specimens are housed in the FDNR invertebrate reference collection (catalogue prefix FSBC I) at St. Petersburg. Other specimens were examined from collections of the National Museum of Natural History (USNM), Washington, D.C., the Steger collection, now in the Delaware Museum of Natural History (DMNH), Greenville, Delaware, and additional material collected at Hutchinson Island by Applied Biology, Inc., Jensen Beach, Florida. Specimens were deposited in molluscan collections at the British Museum (Natural History) (BMNH), London, and the Museum of Comparative Zoology (MCZ), Harvard University, Cambridge, Massachusetts.

Genus *Oceanida* DeFolin, 1871

Oceanida DeFolin, 1871:264 (type-species *Oceanida graduata* DeFolin, 1871, by monotypy).—Kisch, 1959:107.

Spiroclimax Mörch, 1875:168 (type-species *Spiroclimax scalaris* Mörch, 1875, by monotypy).

Chrysallida (*Oceanida*): Thiele, 1929:232.

Odostomia (*Spiroclimax*): Thiele, 1929:235.

Athleenia Bartsch, 1946:30 (type-species *Athleenia burryi* Bartsch, 1946, by monotypy).—Abbott, 1974:130.

Diagnosis.—Shells small, with maximum lengths slightly less than 3.0 mm, glassy, smooth. Embryonic whorls tapered, rather slender, of about 3½–4 whorls, each bearing many very fine axial riblets. Postembryonic whorls broader than long, expanding rather rapidly, constricted at sutures, with about one weak growth interruption per whorl. Apertures tear-shaped, bordered by simple columella and outer lip.

Remarks.—*Oceanida* was introduced without formal description to contain *O. graduata*, a species described from Guadeloupe, West Indies, in the same paper by DeFolin (1871). No higher classification was suggested by DeFolin, but Thiele (1929) considered *Oceanida* a subgenus of the pyramidellid genus *Chrysallida* Carpenter, 1857. Kisch (1959) treated *Oceanida* as a genus of Chemnitzidae (= Pyramidellidae) in a review of DeFolin's taxa of that family. Both Thiele and Kisch recognized *O. graduata* as the type-species of *Oceanida*.

Four years after DeFolin introduced *Oceanida*, Mörch (1875) erected *Spiroclimax* for *S. scalaris*, described without illustration from a single specimen collected at St. Thomas, West Indies. Mörch considered *Spiroclimax* a genus of Pyramidellidae. Thiele (1929:235, fig. 240) subsequently illustrated *S. scalaris* as the type-species of *Spiroclimax*, which he considered a subgenus of *Odostomia* Fleming, 1817, another pyramidellid genus. Like *Oceanida*, *Spiroclimax* seems to have escaped further notice as a component of western Atlantic fauna.

More recently, Bartsch (1946) proposed *Athleenia* to contain *A. burryi*, which he thought to be a new species from deep water off south Florida. He assigned the genus to Stiliferidae.

At my request, Dr. Anders Waren examined the types of *Oceanida graduata* and *Spiroclimax scalaris* at the Muséum National d'Histoire Naturelle, Paris, and the Universitetets Zoologiske Museum, Copenhagen, respectively. We have both examined the holotype of *Athleenia burryi* (USNM 573616). According to Dr. Waren (personal communication), type-specimens of all three proposed names are identical and constitute a single species.

Assignment of *Oceanida* to Pyramidellidae by Mörch (as *Spiroclimax*), Thiele, and Kisch seems inappropriate as the shells bear no features relating them to that family. Abbott (1974) followed Bartsch in placing *Athleenia* in Stiliferidae, but also suggested that Rissoidae might be more appropriate, apparently noting the same "*forma Rissoae vitreae*" mentioned by Mörch in his description of *Spiroclimax*. I have found no genera of Rissoidae resembling *Oceanida*, but aperture and spire shape are suggestive of certain Rissoinidae, especially *Crepitacella* Guppy, 1867. The resemblance is superficial, however; species of *Crepitacella* bear marked axial sculpture, a broad anal fasciole, and a strong basal fold extending into the aperture, all lacking in *Oceanida.*

Shells of *Oceanida* seem similar to those of *Turveria* Berry, 1956, a monotypic genus erected in Stiliferidae to contain *T. encopendema*, a species parasitic on *Encope* echinoids in western Mexico. The species was illustrated in two line drawings by Berry (1956: fig. 2) and another, probably redrawn from Berry, in Keen (1971), but I have been unable to obtain shells or photographs for comparison.

Mörch, Thiele, Berry, and Abbott, in aforementioned papers, assigned synonyms of *Oceanida* and species in genera similar to that genus to Stiliferidae. Bartsch (1917) included *Stilifer* Broderip and Sowerby, 1832, and other customarily stiliferid genera in his monograph of east Pacific Melanellidae, but later assigned *Athleenia* to Stiliferidae. Keen (1971) continued to include east Pacific stiliferid genera in Melanellidae. Most members of both families are parasitic on echinoderms. Typical genera (e.g., *Stilifer*, *Melanella*) are obviously disparate, the first having thin, rotund shells with mucronate embryonic whorls, while the other has slender, elongate, relatively thick shells with glassy, polished surfaces and evenly tapered embryonic whorls. Genera differing more than slightly from the *Melanella* design (e.g., *Pelseneeria* Kohler and Vaney, 1908; *Mucronalia* A. Adams, 1860; "*Athleenia*" Bartsch, 1946) tend to be assigned to Stiliferidae. Berry (1956) seemed equally perplexed regarding familial assignment for his *Turveria*, opting for Stiliferidae because the shell possessed a "papilliform apex." The apex he figured, however, resembles those found on *Oceanida* species, which seem little more related to *Stilifer* than to some melanellids.

Problems have also arisen in selecting the proper name for the family containing *Melanella* Bowdich, 1822, primarily because of confusion regarding the supposed synonymous relationship between that genus and *Eulima* Risso, 1826, resulting in replacement of Eulimidae H. and A. Adams, 1853 (*fide* Golikov and Starobogatov, 1975) with Melanellidae Bartsch, 1917 (*fide* Abbott, 1974). Little would be accomplished by enumerating the many references maintaining this synonymy, but careful attention to differences separating genera in this family indicates that *Melanella* and *Eulima* are not synonymous (see Lyons, 1977, for examples of both genera). However, given that such synonymy could be demonstrated, Eulimidae remains the correct name for the family even though its type-genus was proposed later than that of Melanellidae (see International Code of Zoological Nomenclature, XV International Congress, 1964, Art. 64). Mayr (1969:356) argues effectively for retention of early familial appellations regardless of subsequent type-genus changes.

Because no well defined boundaries seem to exist between Eulimidae and

Stiliferidae, it would appear that they should be combined. Since Stiliferidae (originally Styliferidae) H. and A. Adams, 1853 (*fide* Abbott, 1974) and Eulimidae were described at the same time, subsequent selection is a matter of reviewer preference. The more diverse and abundant Eulimidae is herein preferred.

Oceanida graduata DeFolin, 1871
Figs. 1–3

Oceanida graduata DeFolin, 1871:264, pl. 24, fig. 6.—Kisch, 1959:107.
Spiroclimax scalaris Mörch, 1875:168.
Chrysallida (*Oceanida*) *graduata*: Thiele, 1929:232.
Odostomia (*Spiroclimax*) *scalaris*: Thiele, 1929:235, fig. 240.
Athleenia burryi Bartsch, 1946:30, fig. 1.—Abbott, 1974:131, fig. 1433.

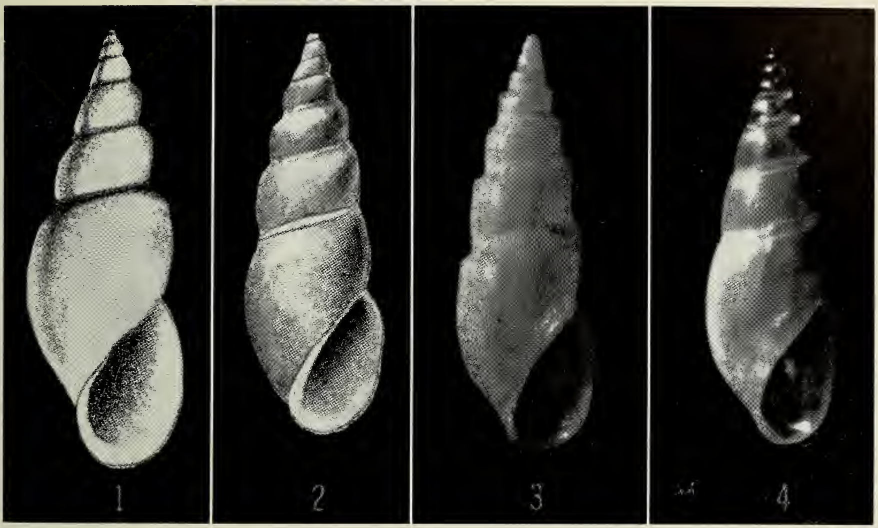
Description.—Shell small, to about 2.8 mm length, with approximately 3½ very finely ribbed embryonic whorls, followed by approximately 5½ smooth, translucent, posteriorly tabulated postembryonic whorls. Aperture extended and rounded anteriorly; outer lip slightly compressed, extending nearly parallel to longitudinal axis of shell.

Material examined.—FLORIDA: Holotype of *Athleenia burryi*, 2.1 mm; off Carysfort Reef Light, Monroe County, 400 ft (122 m); USNM 573616.—1, 2.8 mm; ¾ mi off Cape Florida Light, Dade County, 6 m; FSBC I 18166.—BAHAMAS: 1, 2.2 mm; Gibson Cay, Andros, beach drift; FSBC I 11748.—2, 2.1, 2.7 mm; South Bimini, beach drift; FSBC I 18164.—1, 2.3 mm; Fernandez Bay, Cat Island, beach drift; FSBC I 18165.

Remarks.—The holotype of *Athleenia burryi* is a dead shell described from a depth of 400 ft (122 m), but specimens I have seen from near Cape Florida and from beach drift at three Bahamian Islands indicate that the species probably dwells in shallows of the tropical western Atlantic. It is known to occur southward to St. Thomas, Virgin Islands (Mörch, 1875) and Guadeloupe (DeFolin, 1871).

Oceanida inglei, new species
Fig. 4

Description.—Shell small, to about 2.7 mm, glassy, transluscent, fading to white when dead. Protoconch of about 4 glassy, transparent, yellow whorls marked by many very fine axial riblets or lines. Postembryonic whorls 4½–5, expanding anteriorly, moderately rounded laterally, terminating abruptly posteriorly; anterior parts of spiral whorls seen through overlapping posterior portions of subsequent whorls as single, posterior spiral lines; each whorl marked by single axial growth line; penultimate whorl elongate, merging smoothly with base. Aperture tear-shaped, rounded, expanded anteriorly, constricted posteriorly; outer lip thin, simple, rounded; inner lip



Figs. 1–4. Western Atlantic *Oceanida.* 1, Original illustration of *Oceanida graduata,* after DeFolin (1871: fig. 6); 2, *Spiroclimax scalaris* [= *O. graduata*], after Thiele (1929: fig. 240); 3, *O. graduata,* 2.8 mm, from off Cape Florida, FSBC I 18166; 4, *Oceanida inglei,* n. sp., holotype, 2.7 mm, from off Hutchinson Island, Florida, USNM 771864. All 20×.

slightly elevated anteriorly, forming narrow pseudoumbilicus at intersection with base.

Holotype.—Length 2.7 mm; off Hutchinson Island, St. Lucie County, Florida, 9.7 m depth; USNM 771864.

Paratypes.—FLORIDA: 1, 1.9 mm; Florida Middle Ground in northeastern Gulf of Mexico, 28°38.1′N, 84°16.3′W, 28.6 m; FSBC I 18163.—3, 2.4, 2.6 mm, fragment; Hourglass Station A, 27°35′N, 82°50′W, off Egmont Key, Pinellas County, 6 m; FSBC I 11747.—1, 2.6 mm; off Hutchinson Island, 11.3 m; FSBC I 11746.—1, 2.7 mm; off Hutchinson Island, 11.0 m; FSBC I 11745.—1, 2.4 mm; off Hutchinson Island, 10.4 m; USNM 771865.—1, 2.7 mm; same data; MCZ 288503.—1, 2.6 mm; off Hutchinson Island, 10.7 m; BMNH 197813.—1, 2.2 mm; off St. Augustine, St. Johns County, 38 m; DMNH 121798.—NORTH CAROLINA: 1, 2.1 mm; 12 mi east of Frying Pan Shoal, 22 m; USNM 82989.

Etymology.—The species is named for Robert M. Ingle, former Director of the Florida Department of Natural Resources Marine Research Laboratory, who authorized and encouraged the Hutchinson Island faunal study.

Remarks.—*Oceanida inglei* resembles *O. graduata* in size, embryonic sculpture, shell surface texture, and general outline, but lacks the sharp, posterior shoulder angulations characteristic of the latter species. In addition, the aperture of *O. inglei* is slightly more constricted anteriorly than is that of its congener. The species are otherwise nearly identical.

Most specimens of the new species were collected from coastal areas of east and west Florida, and were accompanied by fauna of warm temperate, rather than tropical, affinity. The only apparently tropical association yet noted for the species is at the Florida Middle Ground, where Caribbean species predominate (Lyons, 1976; Turgeon and Lyons, 1978).

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Dr. Anders Waren, University of Göteborg, Sweden, graciously examined types at two European museums; without his assistance, this study would not have been possible. Drs. Joseph Rosewater (USNM), R. Tucker Abbott (DMNH), and Donald R. Moore, Rosenstiel School of Marine and Atmospheric Science, Miami, Florida, Mrs. Barbara Albert Steger, Tampa, Florida, and Robert M. Gallagher, Applied Biology, Inc., Jensen Beach, Florida, all loaned specimens for study. Dr. Moore also brought to my attention DeFolin's report. Mrs. Sally D. Kaicher, St. Petersburg, Florida, provided photographic assistance. All are gratefully thanked. The specimen from Andros, Bahamas, was collected during cruise G-7124 of the M/V *Gerda*, RSMAS research vessel.

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TRANSFER TO *PSEUDOMEDAEUS* OF THE XANTHID CRAB *MICROPANOPE DISTINCTUS* (RATHBUN)

Austin B. Williams

Abstract.—Generic placement of a xanthid crab living on offshore reefs in the southwestern North Atlantic is reconsidered in the light of a suite of characters (carapace, chelipeds, mouth field, sternum, male first pleopods). All three species now placed in *Pseudomedaeus* (*africanus* (Monod), *agassizii* (A. Milne Edwards), and *distinctus* (Rathbun)) agree with respect to the first four of these characters. However, first pleopods of the males, though constructed on the same general plan, clearly differ in details of setation, spination, and terminal curvature. Similarities and contrasts among these structures are pointed out in species of the genera *Pseudomedaeus*, *Paraxanthodes*, *Gaudichaudia*, *Lophopanopeus*, and *Micropanope*.

The xanthid crab treated by Menzies (1948) as *Micropanope distinctus* (Rathbun) ranges from off Cape Hatteras, N.C., through the Straits of Florida and the West Indies to Barbados. Originally identified as *M. sculptipes* Stimpson by A. Milne Edwards (1880a, 1880b–1881) but later described as a new species, *Lophopanopeus distinctus* Rathbun (1898, 1930), it was returned to *Micropanope* when Menzies revised *Lophopanopeus*. Menzies apparently based his decision on examination of a tiny male (USNM 20717 designated as a "homeotype," following a note in the specimen vial) which was mistakenly called a female, perhaps because of its immaturity (carapace length 3.1 mm, width 4.7 mm). Cerame-Vivas and Gray (1966) later listed the species from Carolinian waters as *Lophopanopeus distinctus*, the identification based on Rathbun's (1930) monograph.

The conflicting opinions of these authors concerning generic placement can be viewed in new light following preliminary revision of the family Xanthidae (Guinot, 1967, 1968, 1969, 1971) in which a number of genera have been restricted. Aided by Guinot's papers and by examination of new material in the crustacean collection of the Smithsonian Institution, I have concluded that the crab in question is allied to members of the genus *Pseudomedaeus* Guinot 1968, although there is room for doubt that this assemblage is a closely knit one. Reasons for this judgment are brought out below in comparisons among members of selected xanthid genera.

In the following discussion, station data are recorded in Rathbun (1930) for numbers succeeded by (R); numbers marked with an asterisk were determined as *Leptodius agassizii* by Rathbun (1930). Museum of Comparative Zoology catalog numbers = (MCZ), National Museum of Natural History = (USNM), University of North Carolina Institute of Marine Science = (UNC-IMS).

Pseudomedaeus Guinot

Guinot 1968:726.

Diagnosis.—Carapace rather broad, moderately inflated, dorsal regions clearly marked; 5 anterolateral teeth including outer orbital, second reduced and above subhepatic tubercle in granular zone, third conical, fourth stronger, fifth smaller. Front about ⅓ maximum width, anterior margin dorsally paralleled by line of granules and divided by median notch into oblique, rectilinear lobe on each side; supraorbital notch pitlike. Basal antennal article closing orbital hiatus. Epistome broad, respiratory channel (notch) reduced. Third maxilliped with merus of endopodite somewhat projecting anterolaterally; lacinia of first maxilliped moderately elongated transversely with bare suggestion of lobe mesially, anterior margin slightly concave. Low endostomian crest posteriorly. Chelipeds unequal, fingers a little excavated toward slightly crossed tips. Walking legs short and relatively stocky. Sternum broad, longitudinal groove anterior to abdomen; male abdomen relatively short, formed of 5 segments, sutures between 3–4 and 4–5 visible or not. First male pleopod rather short, with inclined apical lobe and subdistal clump of plumose hairs continued posteriorly by short hairs and pointed tubercles. (Translated and slightly modified after Guinot.)

Pseudomedaeus distinctus (Rathbun, 1898), new combination
Figs. 1, 2, 4*b*

Micropanope sculptipes: A. Milne Edwards 1880a:14.—1880b–1881:325, pl. 54, fig. 2–2c.
Lophopanopeus distinctus Rathbun 1898:272.—1930:331, pl. 155, figs. 1–2. —Cerame-Vivas and Gray 1966:263 (in faunal list).
Micropanope distinctus: Menzies 1948:24 (new combination).

Description.—Resembling species of the Atlantic *Pseudomedaeus* Guinot (1968:726). Integument granulated, especially on elevations and margins of carapace, granules especially crowded on chelipeds. Carapace broadly oval, slightly arched dorsally, regions distinctly marked and moderately raised, adult length-width ratio about 0.63 (.70 in juvenile holotype). Front with slightly deflexed and oblique lobes separated by broad median notch; double edged, each lobe with advanced inner angle, intermediate nearly straight section and less advanced outer angle almost paralleled dorsally by row of granules; antennal notch deep. Orbits rather small, lateral notch

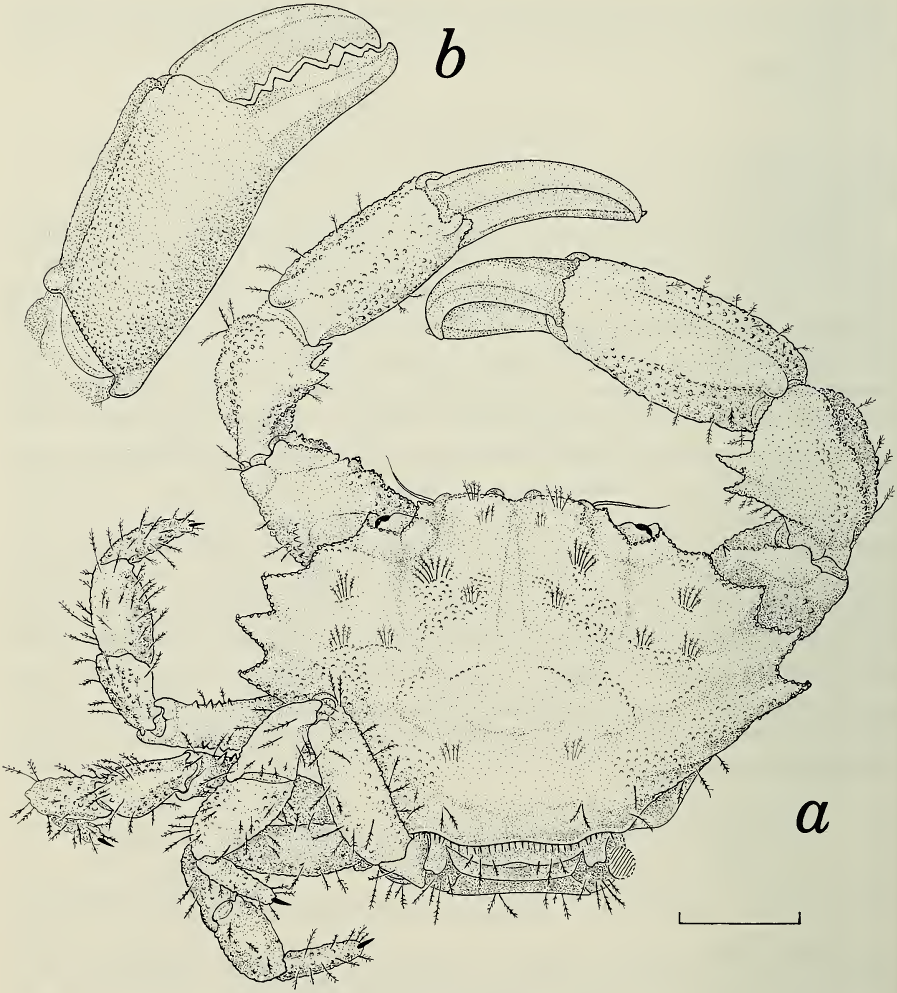


Fig. 1. *Pseudomedaeus distinctus*, USNM 101477 ♂. *a*, Dorsal view, walking legs of right side deleted; *b*, Major (rt.) chela, external view. Scale = 5 mm.

moderate, 2 dorsal fissures, infraorbital tooth obscured by inner orbital angle, outer suborbital tooth larger than rather acute outer orbital angle. Long anterolateral margin with 5 teeth; second tooth a low granular lobe, subhepatic eminence below and slightly in front of it barely visible in dorsal view; third to fifth teeth prominent, acute, slightly hooked forward at tip, last 2 nearly in line laterally in large adults. Posterolateral margins strongly converging. Antennules folding obliquely. Basal fixed article of antenna slightly inclined, meeting edge of front, tip of peduncle subequal to edge of outer frontal lobe. Buccal frame almost rectangular, merus of third maxilliped with anterolateral corner produced laterally. Lacinia of first maxilliped covering approximately 40% of endostome and reaching across ¾ of its width. Low endostomian ridge posteriorly. Sternum with median longitudinal groove anterior to abdominal tip.

Chelipeds strong, somewhat elongate, unequal; carpus spined internally; ungaping, longitudinally ridged fingers tapered to crossed tips, teeth on opposed edges sectorial and nearly uniform. Ambulatory legs strong and densely furred.

Male abdomen with telson rather triangular in young but broadly rounded distally in adults, segments 3–5 fused but distinguishable, their lateral margins converging distally.

Male first pleopods rather stout, terminating in elongate, flattened, membranous tip bent mesioventrally at approximately a right angle to axis of shaft; dorsal (sternal) surface with tract of scattered, elongate spinules proximal to tip; ventral (abdominal) surface with tract of much shorter, scattered spinules near base of tip; shaft with long tract of spinules proximal to these groups along dorsomesial border.

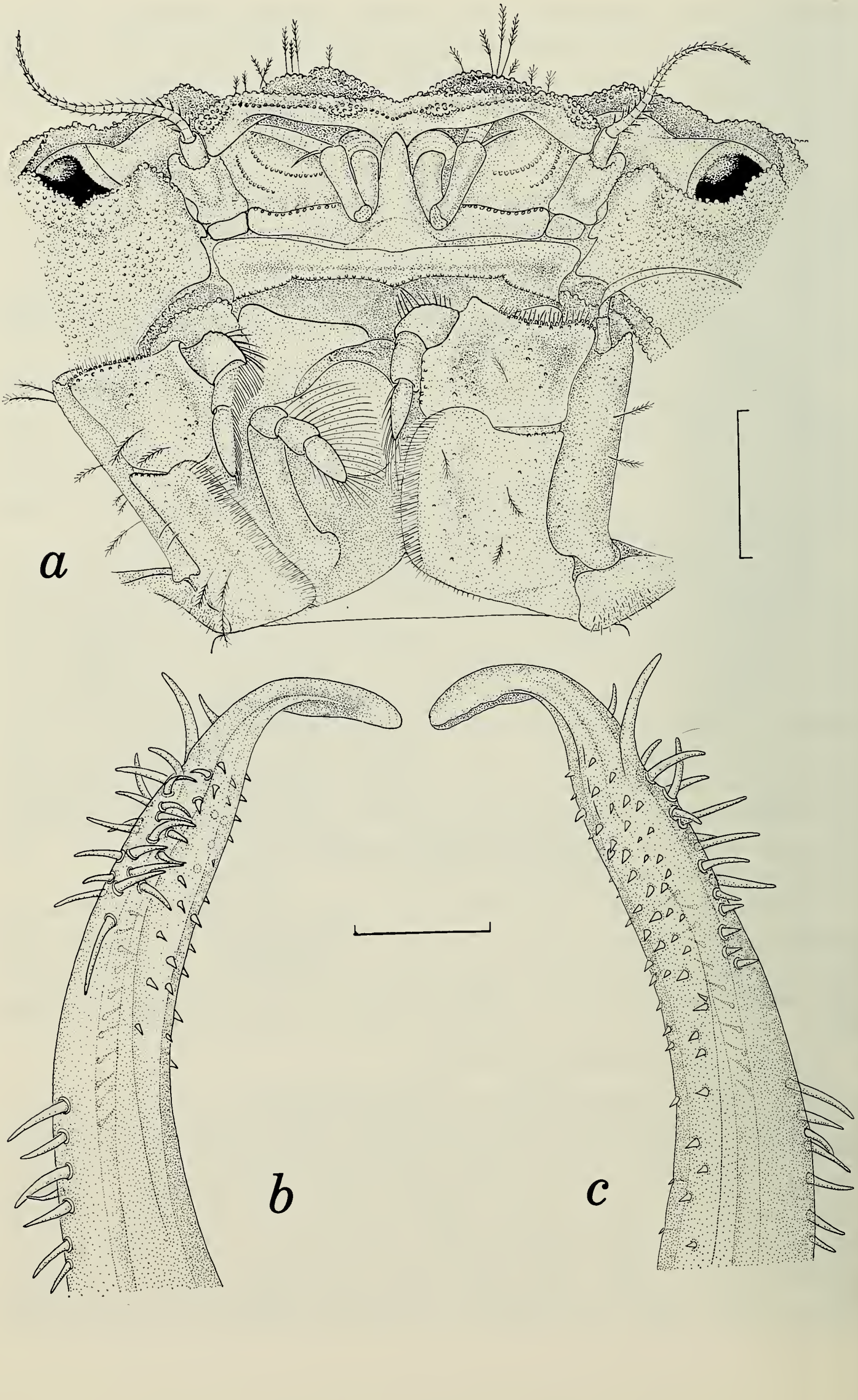
Holotype.—The holotype male is a juvenile (MCZ 2772, Gulf of Mexico, northwest of Dry Tortugas, 25°33′N, 84°21′W, 184.7 m (Rathbun, 1898:272; 1930:332); carapace length 4.1 mm, width 5.9 mm. Carapace with rather dense, sharp, subspinous granules on raised areas and along anterior and lateral margins. Even stronger, nearly spinelike granules on chelipeds, tending to form longitudinal rows on external surface of palms; strong internal carpal spine acute, another slightly smaller spine below it. The specimen is damaged, having the sternum and abdomen crushed inward, giving the impression that it may have been dried at one time. Only the chelipeds and left first and second walking legs are attached. The pleopods are not visible.

Color.—Large adult; body mottled gray and reddish gray or light brown, longitudinally elongate spot in anterior extension of mesogastric area darkest; fingers light brown. Small specimen; body more darkly blotched, legs banded with brownish speckled bands of same color as blotches on body.

Habitat.—Hard substrate; 47.5–185 m.

Known range.—Cape Hatteras, N.C., to Barbados.

Material examined.—Holotype. (USNM) 11403(R), 1♀. 20717(R), 1♂. 60884(R)*, 3♀. 61376(R)*, 1♂. 67852, N Puerto Rico, 18°31′N, 66°10′15″W, 38 fm, 3 Feb. 1933, 1♂, 1♀ (juv.), Johnson-Smithsonian Exped. 78267, S Tortugas, Florida, 40 fm, 4 Aug. 1931, 2♂, 5 juv., W. L. Schmitt. 101476, off Jacksonville, Florida, 30°11′N, 80°17′W, 32 fm, 31 Aug. 1956, 5♂ 6♀, *Combat* Sta. 72. 101477, SE Cape Canaveral, Florida, 28°52′N, 80°05′W, 65 fm, 3 Sept. 1956, 6♂ (measured ♂, carapace length 15.1 mm, width 24.4


a
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mm), 3♀, *Combat* Sta. 90. 170768, off Cape Canaveral, Florida, 28°17.5′N, 80°01.5′W, 41–34 fm, 25 Apr. 1960, 1♂, 1♀, *Silver Bay* Sta. 2010. 170769, Sapelo Is., Georgia, 11 mi SE sea buoy, 30°40′45″N, 80°06′07″W, 165 ft, 9 Dec. 1963, 1♂, M. Gray, Sta. 372. 170770, off Sapelo Is., Georgia, 30°48′47″N, 80°08′30″W, 143 ft, 9 Dec. 1963, 1♂, 1♀, M. Gray, Sta. 354.

(UNC-IMS) 1917, off Cape Hatteras, North Carolina, 34°57′N, 75°19′W, 90 fm, Mar. 1963, 1♀, M. Cerame-Vivas, Sta. H1S. 2292, off Cape Hatteras, North Carolina, 34°11′N, 76°10′W, 60 m, 4 May 1969, 1♂, *Eastward* Sta. 11943.

Pseudomedaeus agassizii (A. Milne Edwards)
Fig. 3

Leptodius agassizii A. Milne Edwards 1881:270, pl. 49, fig. 3.—Rathbun 1930:307, pl. 141, fig. 4–5.—Williams 1965:192, figs. 174, 183H.

Medaeus africanus: Monod 1956:309–310, figs. 381–382 (referred to as variety from east coast of North America).

Medaeus latifrons Chace 1942:83, pl. 25, figs. A–E.

Pseudomedaeus agassizii: Guinot 1968:726, figs. 25, 58 (new combination). —Felder 1973:67, pl. 9, fig. 11.

Male first pleopod.—Basically similar to that of *P. distinctus* but much more complex; terminating in thin, tubelike, laterally split process bent ventrally at almost a right angle to shaft and covered externally with an exceedingly fine pubescence; dorsal (sternal) surface with subterminal tuft of scattered, plumed setae followed by tract of elongate, pointed spinules; ventral (abdominal) surface with tract of crowded, shorter, blunt spinules at base of tubular terminal process. Spinules scattered along shaft preceding each of these groups increase in length distally.

Variation.—Small specimens from near Beaufort, N.C., have the last 3 anterolateral teeth on the carapace well developed, but a series of specimens from Pensacola, Fla., in the USNM show that these spines may be reduced to 2 in larger individuals. There is considerable variation in depth of sculpturing dorsally on the anterior carapace and chelipeds.

Habitat.—Primarily from rock and other hard substrates with fouling growth of sponges, bryozoans, etc., but also on sand; 7.3–82 m.

Type-locality.—Florida reefs, 21.9–32.9 m.

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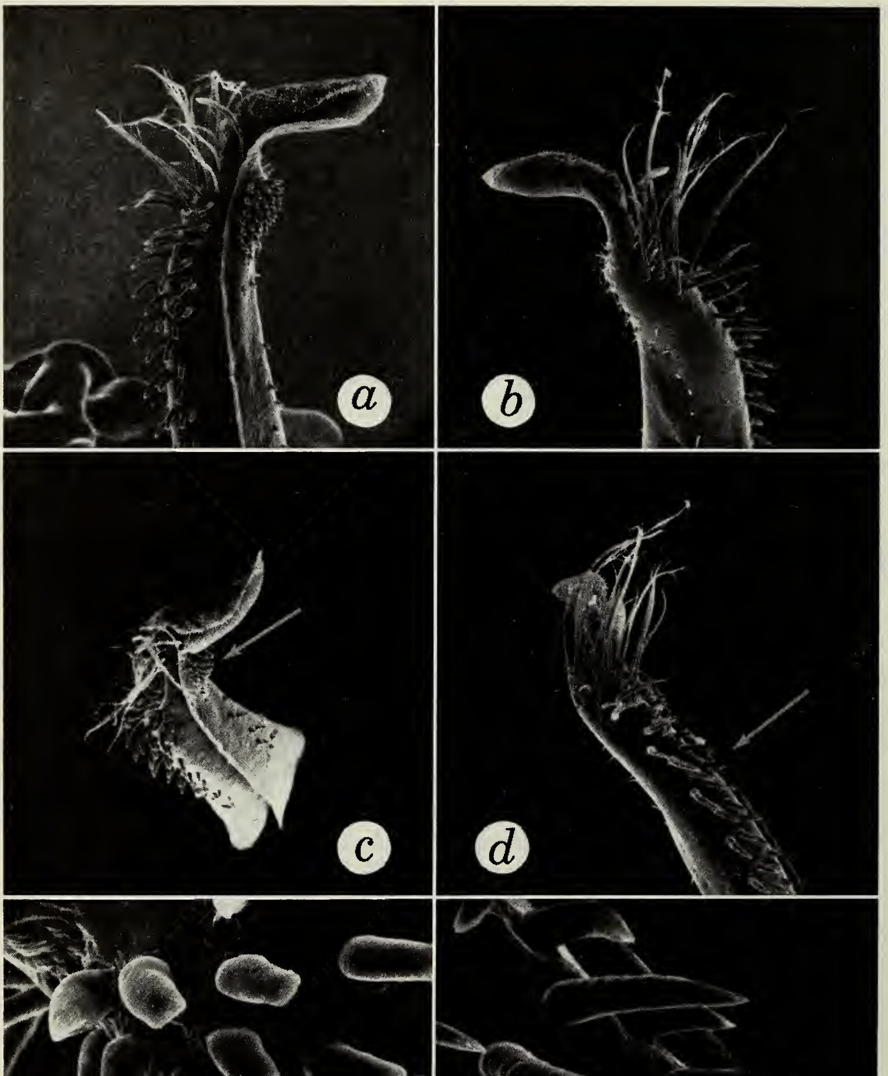
Fig. 2. *Pseudomedaeus distinctus*, USNM 101477 ♂. *a*, Part of frontal suborbital and mouth field region showing edge of front, antennules, antennae, eyes, epistome, third maxillipeds, lacinia of right first maxilliped in situ with overlying mouthparts turned aside, and outline of right mandible; *b*, Tip of right first pleopod, mesial view; *c*, Same, lateral view. Scales: *a* = 5 mm; *b*, *c* = .25 mm.


a
b
c
d
e
f

Known range.—Cape Hatteras, N.C., to southern Texas. The species is not known to occur in the Virgin Islands as previously reported (Williams, 1965). That record was based on specimens of *Cataleptodius* (= *Leptodius*) *floridanus* (Gibbes) in the USNM collection mistakenly identified as *L. agassizii.*

Material examined.—(MCZ) 8108, off Contoy, 12–18 fm, syntype male (carapace length 8.9 mm, width 13.8 mm), W. Stimpson, *Bache.* (USNM) 18008(R), 4♂, 2♀. 8851(R), 3♂, 3♀, 5 juv. 37858(R), 6♂, 17♀ (3 ov.), 28 juv. 51081(R), 1♂, 2♀. 53749(R), 2♂, 3♀ (1 ov.). 76082, Lake Worth Inlet, Florida, 1♂, 1 juv., 26 May 1936, T. B. Christiansen. 150089, Texas, 26°49′N, 97°19′W, 7.5 fm reef, 7 June 1970, 4♂, 1♀, 5 juv., D. Felder. 170771, off Sapelo Is., Georgia, 31°26′30″N, 80°48′30″W, 71–59 ft, 8 Apr. 1966, 2♂, 3♀ (ov.), M. Gray, Sta. 393.

Pseudomedaeus africanus (Monod, 1956)

Fig. 4*a*

Medaeus africanus Monod 1956:306, fig. 380.—Guinot and Ribero 1962: 58, figs. 25*a, b.*

Pseudomedaeus africanus: Guinot 1968:726, fig. 57 (new combination).

Male first pleopod.—Terminating in thin, tubelike spout more or less split open laterally, not abruptly bent ventrally at right angle to shaft as in *P. agassizii* but curved more gradually proximal to base of membranous tip; tract of long, plumed setae dorsally on curved part as well as proximal to it; tract of scattered, short spinules on ventral surface proximal to tip and a tract of scattered, longer spinules on dorsal surface.

Type-locality.—"Prob. env. de Dakar."

Known range.—Dakar to Angola; 20–200 m.

Material examined.—(USNM) 123222, Gulf of Guinea, Dahomey Coast, west Africa, 55 m. 170335, off Gabon, west Africa, 02°32′S, 09°05′E, 101 m, 5 Sept. 1963, 1♂, *Geronimo* Cruise 2, Sta. 211.

Gaudichaudia gaudichaudii (H. Milne Edwards)

Xantho gaudichaudii H. Milne Edwards 1834:396.

Gaudichaudia gaudichaudii: Rathbun 1930:278, pls. 126, 127.—Garth 1957:52.—Guinot 1968:714, figs. 39–41, 43, 44.

Male first pleopod.—Terminating in membranous, tubelike, laterally split tip bent at nearly right angle to shaft; lacking plumose setae but with tracts

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Fig. 3. *Pseudomedaeus agassizii*, USNM 53749, ♂ left first pleopod. *a,* Mesial view, distal part; *b,* Lateral view, distal part; *c,* Oblique view from distal end along mesial side; *d,* Dorsal (sternal) view, distal part; *e,* Spines indicated by arrow in *c;* *f,* Spines indicated by arrow in *d. a–d,* × ca. 60; *e,* × ca. 400; *f,* × ca. 300.

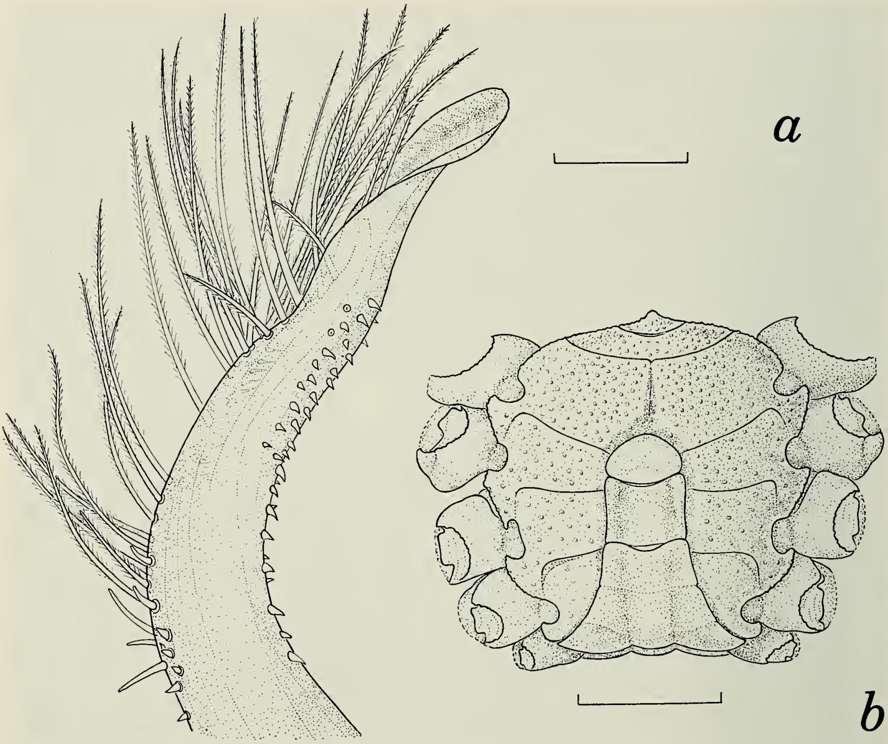

Fig. 4. *a*, *Pseudomedaeus africanus*, USNM 170335 ♂, distal part of first pleopod, mesial view; *b*, *Pseudomedaeus distinctus*, USNM 101477 ♂, sternum and abdomen. Scales: *a* = .25 mm; *b* = 5 mm.

of subterminal spines, short spines on ventral (abdominal) surface, longer ones dorsally (sternal surface).

Type-locality.—Chile.

Known range.—Bay of Sechura, Peru, to Port Otway [Puerto Barroso], Chile; Juan Fernandez Islands; 0–40 m.

Material examined.—(USNM) 60739(R), 1♂. 98304, Arica, Chile, Mar. 1955, 1♂.

Discussion

Pseudomedaeus distinctus obviously has presented a problem in generic placement; in fact, Rathbun (1898) included it only "doubtfully" in her genus *Lophopanopeus*. It is easy to see how small, sharply granular specimens such as the holotype could be mistaken for *Micropanope*. It is noteworthy that the dorsal aspect, sharply granular at this size, resembles that of other *Pseudomedaeus* species, but the carapace becomes relatively broader and smoother with age. The frontal margins of *P. distinctus* and *P. africanus* are much alike, but that of *P. agassizii* has a narrower median notch and less advanced inner and outer angles. *P. distinctus* has a pair of acute internal carpal spines on the chelipeds whereas *P. agassizii* has single or paired lobes or lobiform spines; *P. africanus* has chelipeds with tubercles more spiniform than in *P. distinctus*, and acute internal carpal spines. In *P. distinctus* the male abdominal fused segments 3–5 have much more convergent lateral margins and the telson is less triangular than in the other two species. The carapace of *P. distinctus* is also similar to that in species of *Paraxanthodes* Guinot (1968, Figs. 59–60), but chelipeds of the latter, as well as granules and granular tubercles of the palm and granular rugae of the carpus are less raised than in *Pseudomedaeus*.

Shape of the male first pleopod provides one of the most apparent distinctions between *P. distinctus* and similar species with which it has been or logically could be grouped. For convenience in comparing it we can set up three categories of male first pleopods: 1) pleopods of rather similar simple structure; 2) pleopods of basically similar but much more complex structure; 3) pleopods clearly different but representative of genera in which it was formerly included.

1) The male first pleopod of *P. distinctus*, described above, is relatively simple. Nearly as simple (as shown by Guinot, 1968, Fig. 51a, b) is the first pleopod of male *Paraxanthodes* which is relatively straight, ends in a simple thin lobe and slender process lying side by side, and bears two distal patches of small spinules which arise proximally on the shaft as single rows or narrow tracts.

2) *Pseudomedaeus agassizii* has male first pleopods basically similar to those of *P. distinctus*, but much more complex. *P. africanus*, the type-species of the genus, also has male first pleopods of the latter general type. At moderate magnification the pleopods of the three *Pseudomedaeus* species seem similar, but at higher magnification the setation, spination, and terminal curvature and opening are clearly different.

Specialized in another way at this level of complexity is the male first pleopod of *Gaudichaudia* (as shown by Guinot, 1968, Figs. 43, 44) which lacks plumose setae, but has tracts of spines subterminally, short spines on the ventral surface, longer ones dorsally, and, at least in *G. gaudichaudii*, ends in a tubelike, laterally split membranous tip bent at nearly a right angle to the shaft. The dorsal aspect of members of the genus, however, is quite different from that of *Pseudomedaeus*.

3) In contrast, members of the restricted genus *Lophopanopeus* Rathbun (Menzies, 1948) have male first pleopods with complex tip subdivided into a spinulose projection, narrow truncate hood, mesial spinulose lobe and other accessory spines and spinules, a general facies more or less

characteristic of several other panopeine genera grouped in the subfamily Panopeinae by Guinot (1967:349; 1969:249; 1971:1066) (*Panopeus* H. Milne Edwards, *Eurypanopeus* A. Milne Edwards, *Eurytium* Stimpson, *Hexapanopeus* Rathbun, *Neopanope* A. Milne Edwards, and *Rhithropanopeus* Rathbun). Finally, species of *Micropanope* Dana, sensu stricto (Guinot, 1967, Figs. 4a–c) have short male first pleopods with a thick tip folded at nearly a right angle to the shaft and a few small spines scattered along the shaft proximal to the tip.

Guinot thinks that probably the best systematic arrangement of the Xanthidae is based on the sexual apparatus. Male pleopod structure is unquestionably an aid in determining specific identity of these crabs, but we still do not know how much variation occurs at the generic level. Each case must be weighed individually. In the present case, distinction based on pleopod characters alone could easily split *Pseudomedaeus* into three monotypic genera. I am reluctant to take this course, for it is possible that as more material becomes available, perhaps including additional species, interpretation of generic limits can be more reliably accomplished.

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I thank H. W. Levi, Museum of Comparative Zoology, Harvard University, for the loan of type-material, and J. S. Garth, Allan Hancock Foundation, University of Southern California, R. B. Manning, Smithsonian Institution, and B. B. Collette, NMFS Systematics Laboratory, for critical review of the manuscript. The drawings were done by Maria Diéguez and the SEM photographs were made with the help of W. R. Brown.

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91(2), 1978, pp. 558–562

A NEW GENUS AND SPECIES OF ANTHURID ISOPOD FROM DEEP WATER OFF THE EAST COAST OF THE UNITED STATES

Brian Kensley

Abstract.—A new anthurid isopod genus and species, *Ocsanthura vimsae*, is described from deep water (350–460 m) off New Jersey and Virginia. The species is characterized by the possession of a 7-segmented maxilliped, the carpi of the posterior pereopods not underriding the propodi, free pleonites, and non-operculate first pleopods.

Amongst a small collection of anthurids submitted for identification to the author, by the Virginia Institute of Marine Science, were several specimens which were clearly an undescribed species. Difficulty was experienced in placing the species in an established genus, hence the present description.

The material was collected in deep water off New Jersey and Virginia during the Outer Continental Shelf Program (1977), sponsored by the Bureau of Land Management. Type-material has been deposited in the Smithsonian Institution (USNM) and the Virginian Institute of Marine Science (VIMS).

Ocsanthura new genus

Diagnosis.—Eyes absent. Antennular flagellum of 3 articles, antennal flagellum of 8 articles. Mouthparts of cutting type. Mandible with 3-segmented palp; lacina plate broad. Maxilliped bearing endite; palp 7-segmented. Pereopods 1–3 subchelate; pereopods 4–7 with rectangular carpus not underriding propodus. Pleonites 1–6 free. Pleopod 1 short, not operculate.

Etymology.—The 'Ocs' of the generic name is the acronym for Outer Continental Shelf (program); the 'anthura' is the commonly-used suffix for genera of the Anthuridea.

Type-species.—*Ocsanthura vimsae.*

Ocsanthura vimsae, new species

Figs. 1–2

Description.—Female: Integument of anterior body thin, becoming more indurate posteriorly; uropods and telson indurate. Triangular rostrum extending beyond anterolateral corners of cephalon. Body proportions: $C < 1 < 2 > 3 < 4 = 5 > 6 > 7$. Pereonites with dorsolateral grooves; pereonites 3–6 with single middorsal pit; pereonite 7 with 2 shallow depressions dorsally. Pleonites free; pleonite 1 equal to pleonite 5, slightly longer

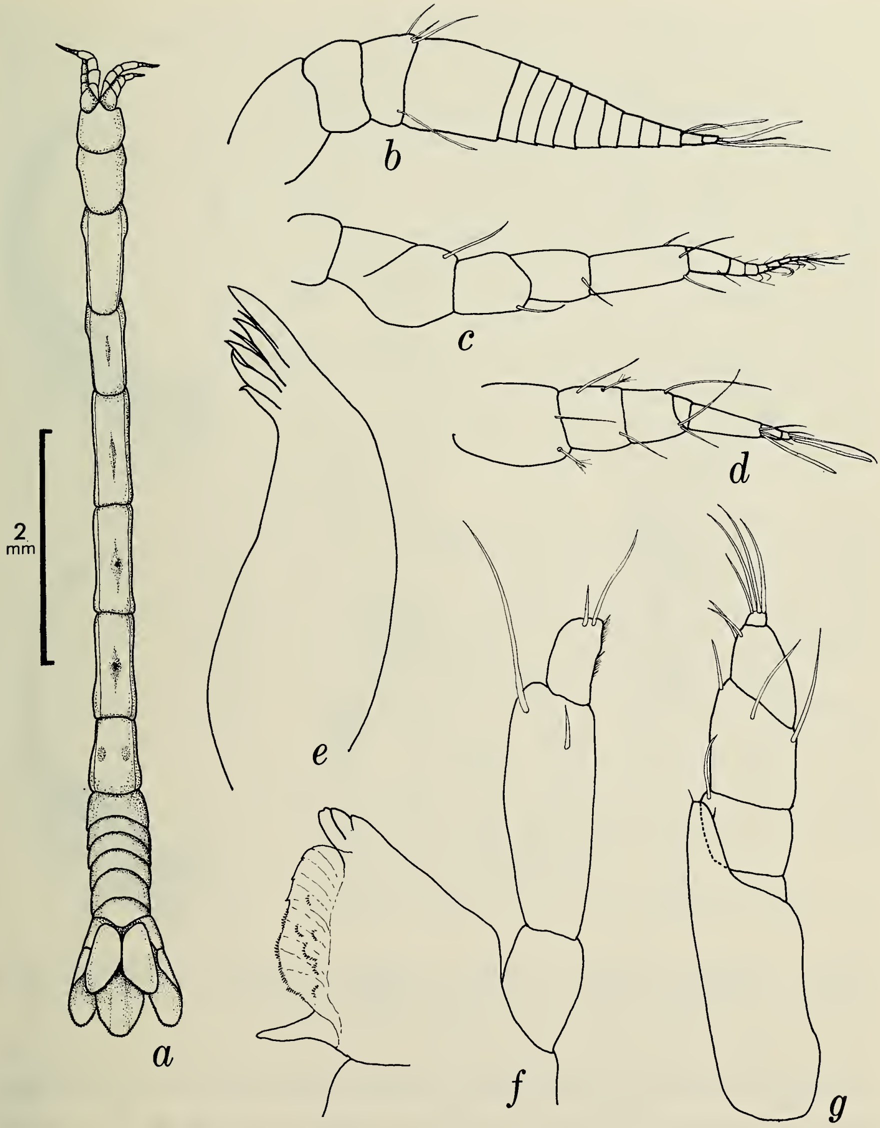

Fig. 1. *Ocsanthura vimsae*: a, Holotype ♀ in dorsal view; b, Antennule sub ♂; c, Antenna ♀; d, Antennule ♀; e, Maxilla; f, Mandible; g, Maxilliped.

than subequal pleonites 2–4. Pleonite 6 with convex posterodorsal margin. Telson with 2 basal statocysts, distally rounded, slightly wider distally than proximally, margin finely serrulate, with broad slightly raised mid-dorsal region; ventrally convex.

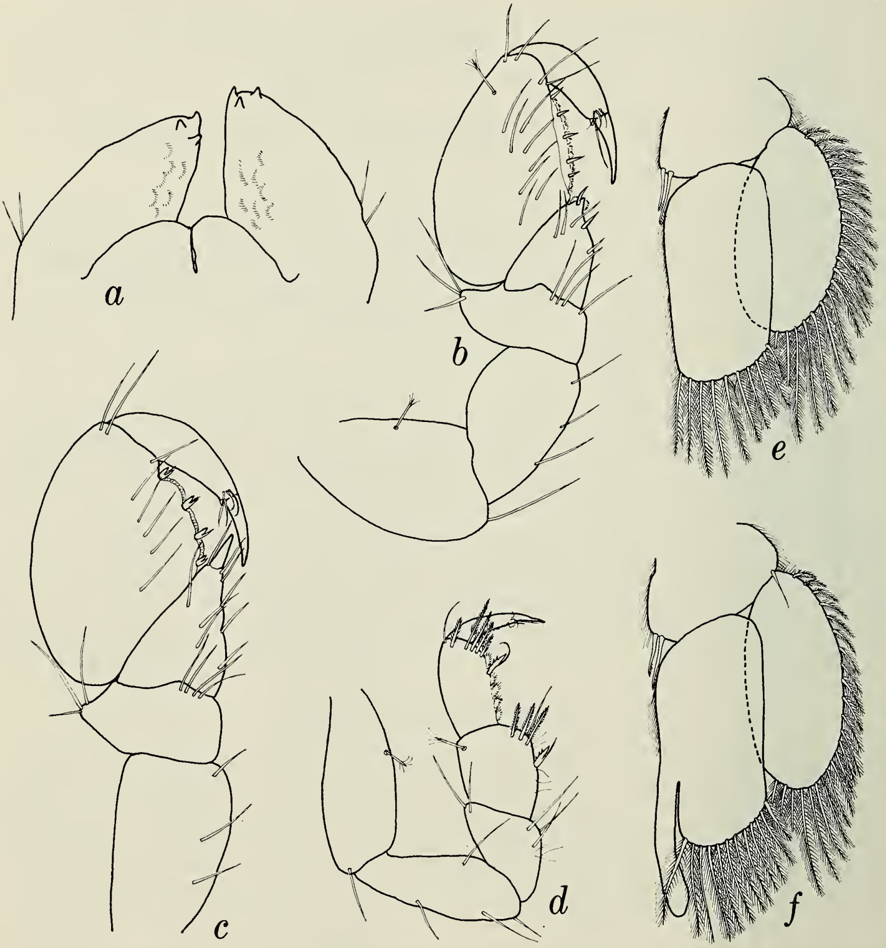

Fig. 2. *Ocsanthura vimsae*: a, Lower lip complex; b, Pereopod 1; c, Pereopod 2; d, Pereopod 7; e, Pleopod 1 sub ♂; f, Pleopod 2 sub ♂.

Antennular peduncle 4-segmented, fourth segment short, oblique; flagellum of 3 articles, basal article elongate. Antennal peduncle with second segment longest, segments 3 and 4 subequal, segment 5 slightly longer; flagellum of 8 articles. Mandibular palp 3-segmented, second segment twice length of basal segment, terminal segment one-third length of second; incisor of 3 cusps; molar slender, apically narrowed; lacinia broad, expanded, with 4 tiny marginal teeth distally, and finely serrulate proximal margin. Maxilla proximally relatively broad, with 7 distal teeth. Each lobe of lower lip bearing 3 short acute processes. Maxilliped 7-segmented, terminal segment tiny, setose; thin-walled endite reaching to distal margin of third segment. Pereopod 1 not as robust as pereopod 2, unguis somewhat more than one-third length of dactylus; propodal palm bearing 5 short spines with rounded and fringed scales between, carpus triangular, apically acute. Pereopod 2 unguis one-third length of dactylus, propodus broader than pereopod 1, palmar margin bearing 4 short bifid spines with blunt coalesced scales between; carpus triangular, with strong apical spine. Posterior pereopods with propodus bearing several distal fringed spines, strong dentate sensory spine, and several fringed scales on posterior margin; carpus broadly rectangular, with 3 fringed spines and single sensory spine on posterior margin, not underriding propodus. Pleopod 1 not operculate, similar to pleopods 2–5. Uropodal exopod indurate, reaching two-thirds length of telson, broadening distally, distal margin rounded, finely serrulate; endopod twice length of basis, equal in length to exopod, distally rounded, margin finely serrulate.

Submale.—Antennule swollen, elongate, only 3 peduncle segments discernible; flagellum of 12 articles, lacking whorls of aesthetascs. Pereopods as in female. Pleopod 1 not operculate; exopod oval, slightly shorter than more rectangular endopod; both rami bearing plumose setae; basis with 2 retinaculae. Pleopod 2 similar to pleopod 1 but with club-shaped stylet on mediodistal margin of endopod extending well beyond ramus.

Material.—Holotype: USNM 170859, ♀, 8.8 mm, VIMS sta. H1, 39°12′N, 72°23′W, 350–400 m. Paratypes: USNM 170860, sub ♂, 9.3 mm, VIMS Sta. L6, 37°04′N, 74°33′W, 350 m. USNM 170861, 2♀♀ (1 damaged) 9.0 mm, VIMS Sta. H1, 39°12′N, 72°23′W, 350–400 m. VIMS Acc. No. 821, ♀, 6.5 mm, VIMS sta. J1, 38°45′N, 73°01′W, 360–410 m. VIMS Acc. No. 822, ♀, 10.6 mm, VIMS Sta. I4, 39°06′N, 72°40′W, 460 m.

All specimens were recovered from a fine sandy substrate taken by a Smith-MacIntyre grab.

Etymology.—The specific name is derived from the acronym for the Virginia Institute of Marine Science.

Discussion.—Amongst the Anthuridae, only *Neohyssura* possesses a 7-segmented maxilliped, as in the present species. (See Amar, 1952; Kensley, 1978.) *Neohyssura* also has a non-operculate first pleopod, 6 free pleonites, and 7 or 8 articles in the flagellum of the antenna. The main differences between these two genera lie in the form of the telson, (acute and spine-like in *Neohyssura*) and in the carpus of the posterior pereopods (triangular and underriding the propodus in *Neohyssura*, rectangular and not underriding the propodus in *Ocsanthura*). The mandibles of both genera show a somewhat expanded lacinia, composed of several broad teeth in *Neohyssura* but forming a broad marginally serrulate plate in *Ocsanthura*.

Acknowledgments

My thanks are due to Ms. Marcia Bowen and Ms. Elizabeth Wilkins of the Virginia Institute of Marine Science for making the anthurid material available to me and for supplementary data; also to Dr. T. E. Bowman of the Smithsonian Institution for reading the manuscript and for making useful criticisms.

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A NEW *POLYSTEGANUS* (PISCES, SPARIDAE) FROM MAURITIUS

Margaret M. Smith

Abstract.—A new fish species, *Polysteganus baissaci*, is described from Mauritius, and a key to the species of *Polysteganus* from the western Indian Ocean is presented. The status of the genus *Polysteganus* Klunzinger is discussed.

Polysteganus baissaci, new species
Fig. 1

Common names in Mauritius: guingham; gueule pavée dorée

Polysteganus undulosus (*non* Regan) Baissac 1954:9.
Dentex sp. ou *Polysteganus* sp. Baissac 1956:354.
Polysteganus sp. Baissac 1976:211.

Material examined.—Holotype RUSI 29, total length (TL) 370 mm, standard length (SL) 287 mm. Caught on line in about 100 meters, N.W. of Gunner's Coin, Mauritius (19°56′30″S; 57°37′E).

Paratype RUSI 1350, 315 mm TL; 243 mm SL donated to the J. L. B. Smith Institute of Ichthyology from the Mauritius Museum's collection (some fins and symphyses of both jaws damaged).

Dorsal profile evenly convex, could become gibbous in large males as in *undulosus.* Body ovate. Posterior nostril slit-like, 4 mm in length in holotype, anterior nostril an oval pore, major diameter 1.8 mm in holotype, with a posterior flap capable of covering the orifice. Preopercle margin smooth; mouth fairly small; posterior end of maxilla, partly covered by preorbital when mouth closed, reaching to just beyond anterior margin of eye. Jaws subequal, upper 36.4 lower 40.6 percent in head length.

The following measurements (mm) are of the holotype, followed by paratype in parentheses. If different, the measurements of both sides are given, the left first: depth of body 124.5 (97.5); head length 104 (ca. 86.6), eye (horizontal diameter) 24.7 (24), eye (vertical diameter) 20.07, 21.5 (20.02, 20.09); snout 44.7, 45 (damaged), least depth of preorbital 25.5 (19.9); postorbital 44.7 (35, 37.5) and bony interorbital 29.95 (22.8), width of maxilla 12.35 (10.4).

Gill-rakers 7 + 1 + 11 (7 + 1 + 11), length of longest gill-filament 2.85 times length of longest raker and nearly 2% of head length.

Dorsal fin rays XII, 10. Dorsal fin originates above opercular flap, spines heteracanth, last ray double, 1st spine shortest 20.2 (paratype damaged), 2nd 30.5 (paratype damaged), 3rd 41.0 (36.2), 4th longest 44.5 (paratype damaged), reducing gradually to last 32.0 (26.0) millimeters. Rays

Fig. 1. *Polysteganus baissaci* n. sp., holotype RUSI 29, 287 mm SL.

(damaged in paratype) 1st longest, 32.3 2–4th subequal, 31.6, last shortest 20.5 millimeters.

Anal fin rays III, 8. Anal fin originating below last dorsal spine, spines heteracanth, last ray double. First spine 20.5 (19.5), 2nd 38.2 (37.5), 3rd 37.0 (36.1), 1st ray longest 33 (30), decreasing to last 27 (damaged in paratype) millimeters. Pectoral fin rays 16 reaching to above 3rd anal spine, 104.7, 107.5 (81, damaged). Pelvic fin rays I, 5: ca. 60, broken in holotype (57.5), length of spine 42.4 (40.08) mm. Pelvic axillary scale 22.8 (20.3). Origin of pelvic to anal origin 87.5 (77.5). Caudal with 9 + 8 principal rays. Caudal peduncle length 1.2 (1.4) times depth of peduncle which is 35.9 (29.0) mm. Vertebrae 9 + 15. Branchiostegals 6.

Teeth.—Typically denticine with four enlarged canines in each jaw; the inner pair smaller than the outer that flare slightly out and back. Pairs in upper jaw closer together than corresponding pairs in lower jaw. Along sides of jaws smaller subconical teeth form a cutting edge, the largest tooth being in the middle of this series. Those in upper jaw are slightly larger than those in lower jaw. Inside these lateral teeth in both jaws are bands of small granular teeth, slightly larger laterally and increasing in size anteriorly to form patches behind the enlarged canines. In the lower jaw two of these teeth, larger than the other lie between but behind the inner enlarged canines.

In *P. undulosus* and *P. caeruleopunctatus* these two teeth are larger and have moved forward into line with the enlarged canines giving six (instead of four in *P. baissaci*) such enlarged canines in the lower jaw.

Scales ctenoid, lateral line 50 + 3, 50 + 2 (48 + 2), lateral transverse 7/16. Seven rows across cheek, 4 rows on preopercle run obliquely down and back to angle, leaving edge of flange naked. Six–7 rows across opercle. About 40 predorsal scales extending into interorbital region where scales become very small and crowded, reaching to line joining upper edges of posterior nostrils. The margin of scaling is rounded leaving rim of eye naked. Preorbital, snout, about ⅓ of preopercle flange and entire chin to below vertical margin of preopercle naked.

Soft dorsal and anal naked until last ray but each fin fits into a scaly sheath 2 scales high that extend up onto the last ray.

Color in life.—Head rosy pink, nape and body pink with golden sheen on back, silvery below. The 6–7 sub-parallel narrow wavy blue bands along the body start behind the head with a few blue spots forward on area above eye. Membranes of dorsal and soft anal bluish. Eye rosy.

Coloration in preservative.—Whole fish pale buff color, bands darker.

Locality.—Known only from Mauritius, caught on lines mainly north of the main island in 80–100 meters.

Etymology.—It gives me very great pleasure to name the new Mauritius species *Polysteganus baissaci* after Jean de B. Baissac, not only because he recognized it as undescribed, but also to pay tribute to the many years he worked with Mauritian fishes. Through his energy, collecting and publications he has produced a comprehensive list of the fishes of that area, so useful to subsequent workers.

Relationships.—Closely related to *Polysteganus undulosus* with which it was originally confused, it differs in having fewer gill-rakers (11 on lower arch compared with 14–16 in *undulosus*) and only 4 enlarged canines in lower jaw (*undulosus* has 6). Dorsal fin originates over opercular flap instead of behind opercle (as in *undulosus*), pectoral fin reaches well beyond anal origin. The scales are larger: the lateral line has a maximum of 53 scales (*undulosus* has a minimum of 58 scales), lateral transverse 7/16 and 7 rows across cheek (*undulosus* 9–10/19–20 and 9–10 respectively).

The color also differs in that *baissaci* has fairly pale blue lines on a pink background while the body lines along *undulosus* are a brilliant peacock blue in a bright pink band, with body color in between being yellow. The most striking color difference which is obvious in preserved specimens as well is of course the absence in *baissaci* of the large black oval blotch that occurs in *undulosus* across the lateral line below the 5–6th dorsal spines.

Key to the Western Indian Ocean Species of *Polysteganus*

1. Eye 1.6–2.0 in preorbital depth (Algoa Bay to Beira) *praeorbitalis* Günther, 1859
– Eye about equal to preorbital depth 2
2. Each scale with a dot to form rows of dots along the body (Natal to Red Sea) *caeruleopunctatus* Klunzinger, 1870
– Every alternate row of scales with a narrow light line forming 8–9 wavy lines along body 3
3. A large dark (generally oval) blotch across lateral line beneath 5–6th dorsal spines, 14–16 gill-rakers on lower arch, 6 enlarged canines in lower jaw. Dorsal fin originates behind opercle (Cape to S. Mozambique) *undulosus* Regan, 1908
– No dark blotches on body, 11 gill-rakers on lower arch, 4 enlarged canines in lower jaw. Dorsal fin originates above opercular flap (Mauritius) *baissaci* new species

Discussion of the Genus *Polysteganus* Klunzinger, 1870

In 1870, Klunzinger described *Polysteganus* with its type-species being *P. caeruleopunctatus* from the Red Sea. After 1870, workers like Boulenger (1903), Gilchrist and Thompson (1908) and Barnard (1927) considered *Polysteganus* a junior synonym of the Atlantic *Dentex*. Fowler (1933) considered the subgeneric rank restricted to the type-species of *Polysteganus*.

Smith (1938) resurrected *Polysteganus* for four species found in South African waters, viz the type-species *caeruleopunctatus* and three endemics: *undulosus* Regan 1908, *argyrozona* Valenciennes, 1830 (which he placed in a new subgenus *Argyrozona*) and *praeorbitalis* Günther, 1859 (for which he erected the subgenus *Axineceps*). In 1949 Smith restricted *Polysteganus* to only three species, elevating *Argyrozona* to generic status. *Polysteganus* is here accepted as restricted by Smith (1949).

Denticine characteristics are: a moderate mouth with no true molars but four to six enlarged canines anteriorly in each jaw; scales ctenoid; and skull similar to Sparinae in having well-developed occipital and parietal crests but differing in having short premaxillary pedicels, much shorter than the relatively slender rami. The denticines also have no parapophyses on the first two precaudal vertebrae.

The following are common to all species of *Polysteganus*: A deep ovate body with depth greater than head length; blunt snout; moderate eye; lanceolate gill-rakers; Dorsal XII, 10; Anal III, 8–9; preopercle flange partly scaly; and predorsal scales extend to before anterior margin of eye. Dorsal and anal fins naked with scaly sheaths along bases of soft fins. Lateral line tubules, especially anteriorly, appear bifurcated due to two smaller tubes or pores behind the main tube. Color reddish with longitudinal bluish lines or spots. Predators of relatively deep water, only *P. praeorbitalis*, the species with the smallest eye, occasionally caught from the shore.

Acknowledgments

My grateful thanks go first to Jean de B. Baissac and David Ardill of Mauritius for catching the holotype more or less "to order" and for the donation of the paratype from the Museum collection; secondly, to John E. Randall (who dove and collected with me in Mauritius) for the photograph reproduced on Plate 1; and finally to Rhodes University and the South African Council for Scientific and Industrial Research for financial assistance.

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SIX NEW SPECIES OF SHALLOW-WATER MARINE DEMOSPONGES FROM CALIFORNIA

Donn A. Ristau

Abstract.—A compositional and distributional study of intertidal and shallow subtidal (to –31 meters), central and north-central California marine demosponges was conducted between 1972 and 1977. As a result of that study, six species are described as new: *Xestospongia trindanea, Adocia dubia, Toxadocia zumi, Leucophloeus actites, Axinomimus tuscarus,* and *Artemisina archegona.*

The study of California sponges has not generated a fervor of activity over the years, nor has the literature been saturated with information about this little-studied west coast phylum. Probably the greatest interest generated by sponges occurred recently, when several news agencies reported that giant, and presumably mutant, sponges were found growing on undersea nuclear waste storage containers (see Editor's Comment, San Francisco Chronicle, September 14, 1976). It has been rumored that the Japanese are now planning a motion picture in which a sleeze[1] of giant sponges rises from the depths of the Farallon Islands and phagocytizes the North Beach area of San Francisco. Undoubtedly, when this epic materializes, research and interest in California sponges will increase. Until that time, however, those interested in the sponge fauna of this area must be content with the paucity of scientific literature on this subject.

Ten references prior to 1932 deal with California's marine sponge fauna: Haeckel (1872), Lendenfeld (1889, 1910), Lambe (1894), Schulze (1899), Urban (1902, 1905) and de Laubenfels (1926, 1927, 1930). According to de Laubenfels (1932) some of this work is inadequate, incorrect or describes material from outside the California area.

De Laubenfels's (1932) monograph on marine and freshwater sponges is still one of the most complete guides to date for the identification of California sponges. In this work, 101 species from 3 classes (Hyalospongiae, Calcispongiae and Demospongiae) are discussed. Most specimens are from southern and central California, and most (76%) are members of the Demospongiae.

Major discussions of parts of the sponge fauna, after 1932, are given by Hartman and Smith (1954), Ricketts and Calvin (1968) and Hartman (1975). These authors predominantly discuss intertidal species of central and southern California. The species listed in Hartman and Smith (1954) and Ricketts and Calvin (1968) are, for the most part, those listed in de Laubenfels (1932). Hartman's (1975) key has been systematically updated and includes material previously unreported from California. The 1975 key is not complete in that some species, previously listed as occurring intertidally, are not mentioned (*Paresperella psila*, *Prianos problematicus*, *Myxilla parasitica*—see de Laubenfels (1932), Hartman and Smith (1954) and Bakus (1966) for systematic revision of 2 of these species).

North (1976) lists many subtidal California sponges, but some species identifications are questionable and the distributional data are sometimes incomplete.

The following works discuss material from outside California, yet they add pertinent information about the morphology and distribution of certain species that do occur in the state: Lambe (1893, 1894, 1895), Dickinson (1945), de Laubenfels (1935, 1961), Bakus (1966), Koltun (1959, 1966) and Kozloff (1974).

The majority of work done on California sponges has been concerned with intertidal species from the central and southern parts of the state. Very little research has been done on the sponge fauna of northern California, or on the subtidal fauna. Between 1972 and 1977, compositional and distributional data were collected by the author from three major areas in California (Ristau, 1977): southern California, central California (Carmel Bay area), and north-central California (Bodega Head, central Sonoma coast and north Sonoma coast) (Fig. 1). The identification and description of 6 new species has resulted from that investigation.

Materials and Methods

In situ collection and photography of all subtidal material was accomplished by SCUBA diving. Collected specimens were preserved in 95% ethyl alcohol (ETOH) or dried. Samples to be examined by scanning electron microscopy (SEM) were prepared in one of several ways: (1) preserved in ETOH and then air dried; (2) preserved in a 95:5 part mix of ETOH: glycerine and air dried; or (3) preserved in ETOH, oxidized 8–48 hours in 30% hydrogen peroxide and air dried. All SEM samples were triple coated with either gold or platinum. SEM photographs (Figs. 4–6) were taken with Polaroid Positive-Negative film (type 105) on a Cambridge Stereoscanner Electron Microscope at the Facility for Advanced Instrumentation, University of California, Davis.

Species identifications are based on spicular complement and skeletal arrangement. Spicule mounts were made by standard techniques. Spicule measurements are expressed in micrometers (μm) and average sizes are based on 25 randomly selected spicules. Maximum and minimum sizes were determined by searching for size extremes in an 18 mm^2 quadrant of a spicule preparation. Figures of the spicules were drawn freehand during their examination through a compound light microscope, or they were redrawn from SEM photographs.

The systematic scheme used herein is a combination of those used by

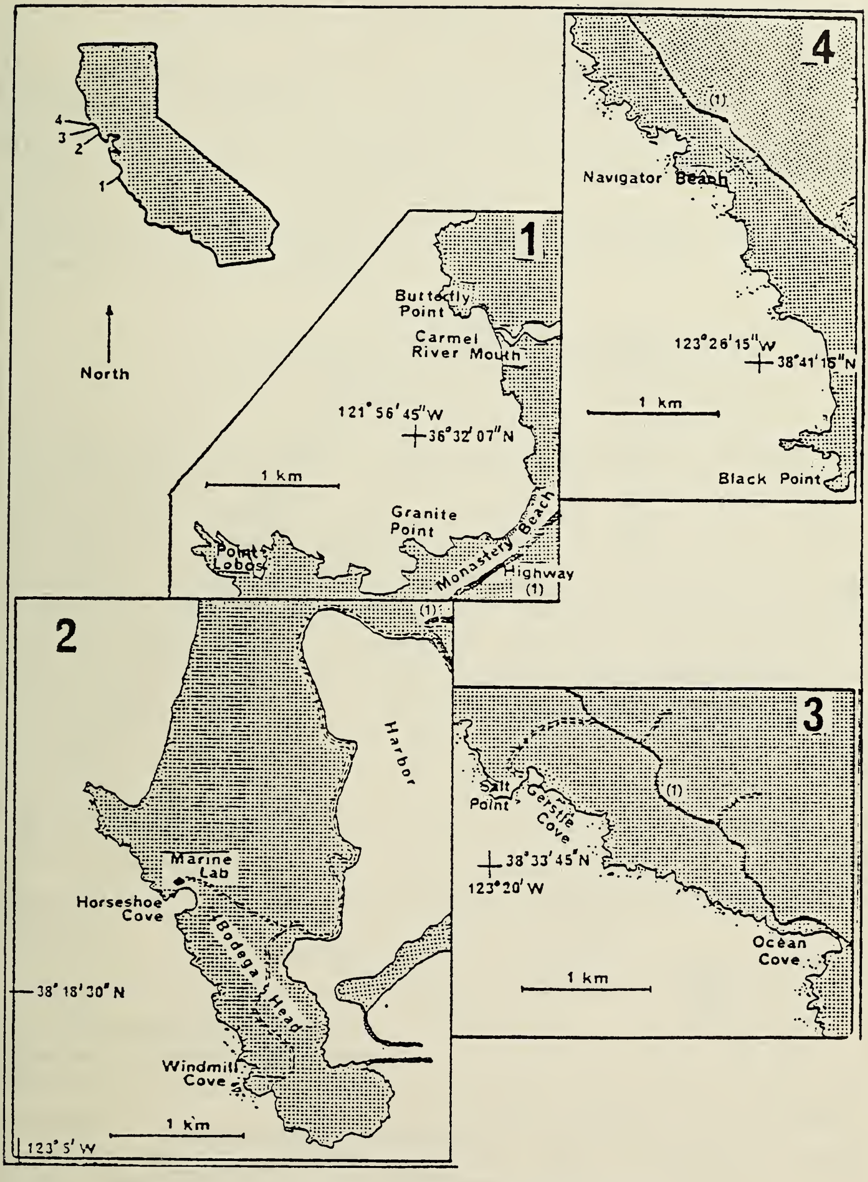

Fig. 1. Central and North-Central California collecting areas.

de Laubenfels (1936) and Levi (1960). Deviation from de Laubenfels's scheme is found in the diagnosis of *Artemisina archegona.*

Holotypes, along with spicule mounts and some paratypes, have been deposited in the National Museum of Natural History (USNM). Specimens

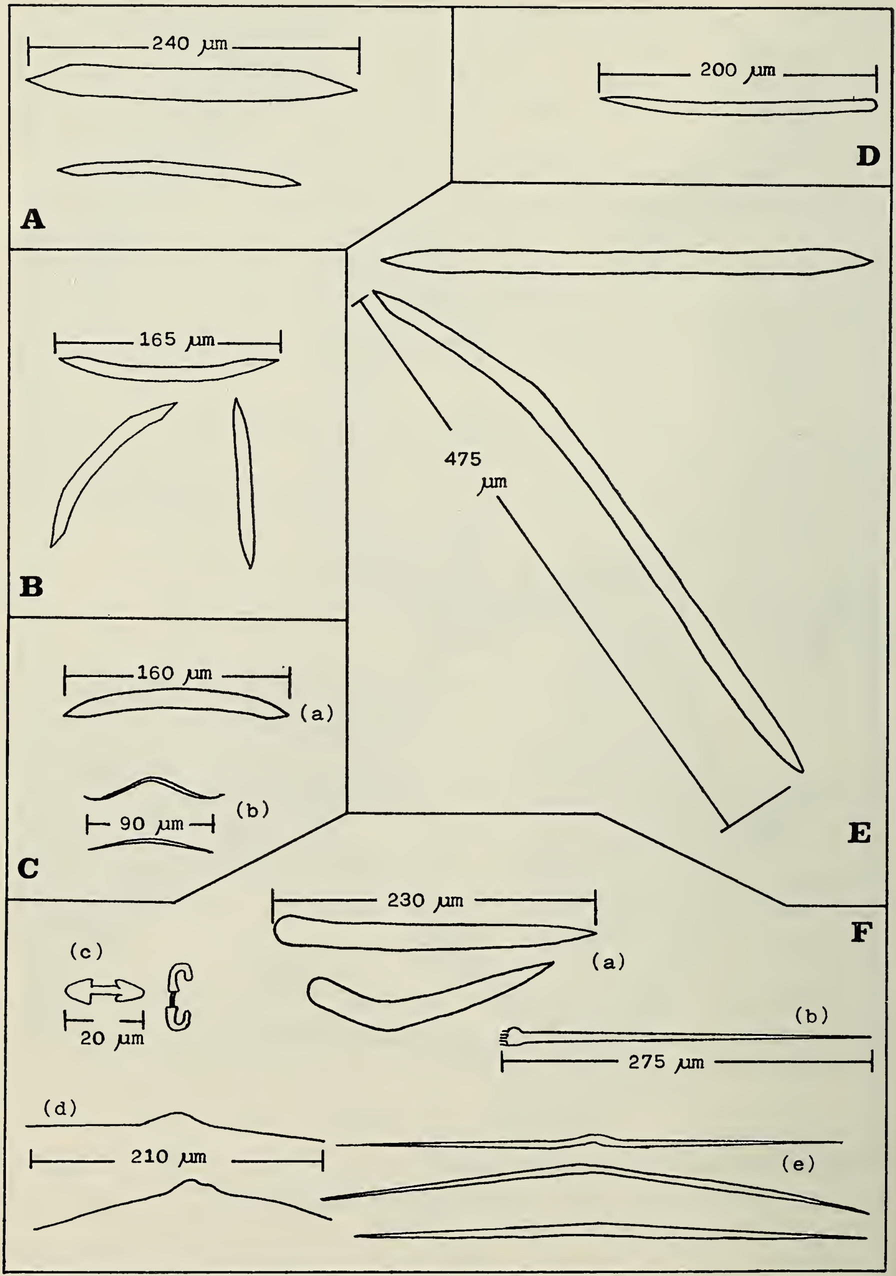

Fig. 2. A, *Xestospongia trindanea,* oxeas of both size ranges; B, *Adocia dubia,* oxeas; C, *Toxadocia zumi,* (a) oxea, (b) toxas; D, *Leucophloeus actites,* style; E, *Axinomimus tuscarus,* oxeas; F, *Artemisina archegona,* (a) styles, (b) subtylostyle with microspined head, (c) palmate isochelas, (d) toxas, (e) toxiform oxeas.

mounted on SEM plugs are included with some holotype material. Holotype spicule mounts and some paratypes will also be placed in the British Museum (Natural History). Holotype spicule mounts and paratypes have been included in the Bodega Marine Laboratory synoptic collection. Access to this material may be obtained by contacting the curator of the collection.

Unless otherwise stated, all holotypes are preserved in 95% ETOH. Paratypes may either be in ETOH or dried.

All intertidal and subtidal depths listed in "Localities" are measured from mean low water (MLW).

Haliclonidae

Xestospongia de Laubenfels, 1932

Xestospongia trindanea, new species

Figs. 2A, 3a, 4a, b

Holotype and type-locality.—USNM 24521, Carmel River Beach Point, Carmel, California.

Known range.—Pacific Coast of North America, from Carmel north to Sea Ranch, Sonoma County, California.

Localities.—Carmel River Beach Point, 2 specimens, –5 to –8 meters (m), 12 April 1973. Horseshoe Cove, Bodega Head, 18 specimens from wrack, between 1 August 1975 and 1 February 1977. Horseshoe Cove, Bodega Head, 2 specimens, –6 m, 6 September 1976. Horseshoe Cove, Bodega Head, 1 specimen intertidally, –0.15 m, 11 April 1976. Ocean Cove, Sonoma County, 1 specimen, –7 m, 28 November 1976. Sea Ranch, Sonoma County, 3 specimens, –2 to –8 m, 6 June 1974. This sponge occurs rarely in the intertidal and occasionally subtidally.

Description.—An encrusting or erectly lobate sponge that inhabits exposed, rocky substrates. Color, alive and dried, dark brown. In ETOH color may fade to light cinnamon. Color of interior lighter brown than that of exterior.

Consistency firm and hard, slightly compressible. Thicknesses of encrusting forms from 4–12 mm. Holotype, erect and laterally compressed, 8 × 3 × 5 cm high (Fig. 3a).

Surface slightly hispid with spicules projecting 60–80 μm above it. Ectosomal membrane raised slightly at point of contact with spicules, making surface conulose. Ectosome without special skeleton. Pores 10–20 μm in diameter. Oscula of holotype arranged in fairly well defined lineations. Oscula 1.5–5.0 mm in diameter, flush with surface. In other specimens, oscula spread irregularly over surface, 0.6–3.5 mm in diameter.

Interior appears solid and fleshy. Endosomal skeleton consists of rectangular reticulations of large, well defined multi-spicular tracts and of spicules strewn in confusion in-between (Fig. 4a). Major multi-spicular tracts, 100–160 μm wide, usually cored with 8–10 spicules. Rectangular meshwork variable in size, usually 200–800 × 100–400 μm (length × width). Oxeas of major spicule tracts uniform in size. Interstitial oxeas smaller and more variable (Fig 4b). Interior reticulate pattern more discernible in dried material than in alive or ETOH preserved specimens.

Reproductive bodies (similar to those described by de Laubenfels 1932: 84, 107; Bakus 1966:456, 473) found in Carmel specimens in April and in Horseshoe Cove specimens in March. Reproductive bodies light beige in color; about 210 μm in diameter; located throughout entire body of sponge.

Spicules consist of megascleres of oxeas, two fairly distinct sizes, 240–260 × 18–20 μm and 115–200 × 2–8 μm; (Fig. 2A).

Taxonomic discussion.—De Laubenfels (1932) erected the genus *Xestospongia*, which is characterized by "having only oxeas as spicules and these so abundant that any reticulate arrangement is obscured; there is no special dermal skeleton." Two species of *Xestospongia* (*X. diprosopia, X. vanilla*) have previously been described from California (de Laubenfels, 1932:115–116). Their general morphology and color are quite distinct from *X. trindanea*, and neither show the double size range of oxeas that is common in *X. trindanea.*

Lambe (1895:115) discussed a sponge from Middletown Island (Alaska/Canada area) which he identified as *Petrosia hispida* Ridley & Dendy, 1886. His brief description raises the possibility that it may be conspecific with *X. trindanea.* Lambe's specimen was a rich brownish-yellow in ETOH, had numerous oscula 1.5 mm in diameter and spicules from 242–327 × 16–26 μm. Lambe did not discuss the interior skeletal arrangement.

Ridley & Dendy's (1886, 1887) description of *Petrosia hispida* is of a lobate, yellowish-gray, papillate, brittle sponge with a hispid surface. The spicules were oxeas of one size only (370 × 21 μm). The sponge was collected at Royal Sound, Kerguelen Island (extreme South Indian Ocean) at –48 meters.

According to de Laubenfels (1932), Ridley & Dendy's (1887) definition of the genus *Petrosia* included two distinct generic types; sponges with a distinct dermal skeleton and strongyles and oxeas as spicules, and sponges without any dermal specialization and only oxeas as spicules. De Laubenfels erected the genus *Xestospongia* for this latter group. In discussing species of *Petrosia* that Ridley & Dendy described, but de Laubenfels felt should be placed in the genus *Xestospongia*, *P. hispida* was not mentioned as needing reassignment. However, based on the published description of this sponge, is seems justifiable to reallocate it. Due to the fact that *X. hispida* possesses only one size range of oxeas, and considering the general morphology, coloration and area of collection, I feel that *X. trindanea* is distinct from *X. hispida.*

The specific identity of Lambe's specimen is therefore somewhat problematical. I believe a reasonable doubt exists whether his specimen is conspecific with the Indian Ocean sponge. However, Lambe's description is not detailed enough to allow it to be identified with *X. trindanea* and at this time the identity will have to stand as *X. hispida.*

It is my pleasure to dedicate this species to my wife, Trinda, whose name has been used in the formation of the specific name.

Adociidae

Adocia Gray, 1867

Adocia dubia, new species

Figs. 2B, 3b, 4c, d

Holotype and type-locality.—USNM 24522, Horseshoe Cove, Bodega Head, Sonoma County, California.

Known range.—Pacific Coast of North America, from Bodega Head north to Sea Ranch, Sonoma County, California.

Localities.—Horseshoe Cove, Bodega Head, 1 specimen intertidally, –0.15 m, 11 April 1976. Horseshoe Cove, Bodega Head, 5 specimens from wrack, between 1 August 1975 and 1 February 1977. Sea Ranch (Navigator Beach), Sonoma County, 1 specimen, –3 m, 8 February 1974. Ocean Cove, Sonoma County, 1 specimen, –7 m, 22 August 1977. The sponge occurs occasionally in the subtidal and rarely in the intertidal.

Description.—An encrusting sponge found on exposed rock surfaces subtidally or cryptically in the intertidal. Color, alive, in ETOH and dried is white.

Consistency (wet and dry), very firm and non-compressible. Dry, the sponge is fairly friable. All specimens were laterally spreading encrustations, ranging in thickness from 4–8 mm. Holotype, about 3 cm in diameter, cut from a larger mass.

Surface smooth and level, except where volcano-like oscular rims project 0.5–1.5 mm (Fig. 3b). In other specimens, oscula flush with surface. In holotype, oscula spaced 3–5 mm apart over entire surface. In others, exhalent vents dispersed irregularly and have diameters from 0.8–1.3 mm. Pores, 10–30 μm in diameter. Pinacodermal membrane supported in a 50 μm thick tangential ectosomal layer. Tangential oxeas arranged in tracts (2–5 spicules wide) which form an irregular polygonal network with 120–140 μm meshes (Fig. 4c).

Pattern of circular areas often evident below surface. These areas represent beginnings of inhalent canal system. Diameters of areas usually 400–500 μm. Thickness of walls that outline the areas, 300–400 μm. Well defined subectosomal spaces in type; dermal layer supported by columns of erect oxeas (4–10 spicules wide). Subectosomal spaces not as evident in other specimens.

Interior varies from well defined reticulation of multi-spicular tracts to confused arrangement. Multi-spicular tracts usually 6–10 spicules wide. Thin, spiculiferous membranes often evident between reticulations. Some specimens exhibit growth lines (Fig. 4d), representing old ectosomal layers.

Specimen from Sea Ranch contains orange-brown (spongin?) fibers, cored with oxeas, in interior. Similar fibers noted in one wrack deposit specimen.

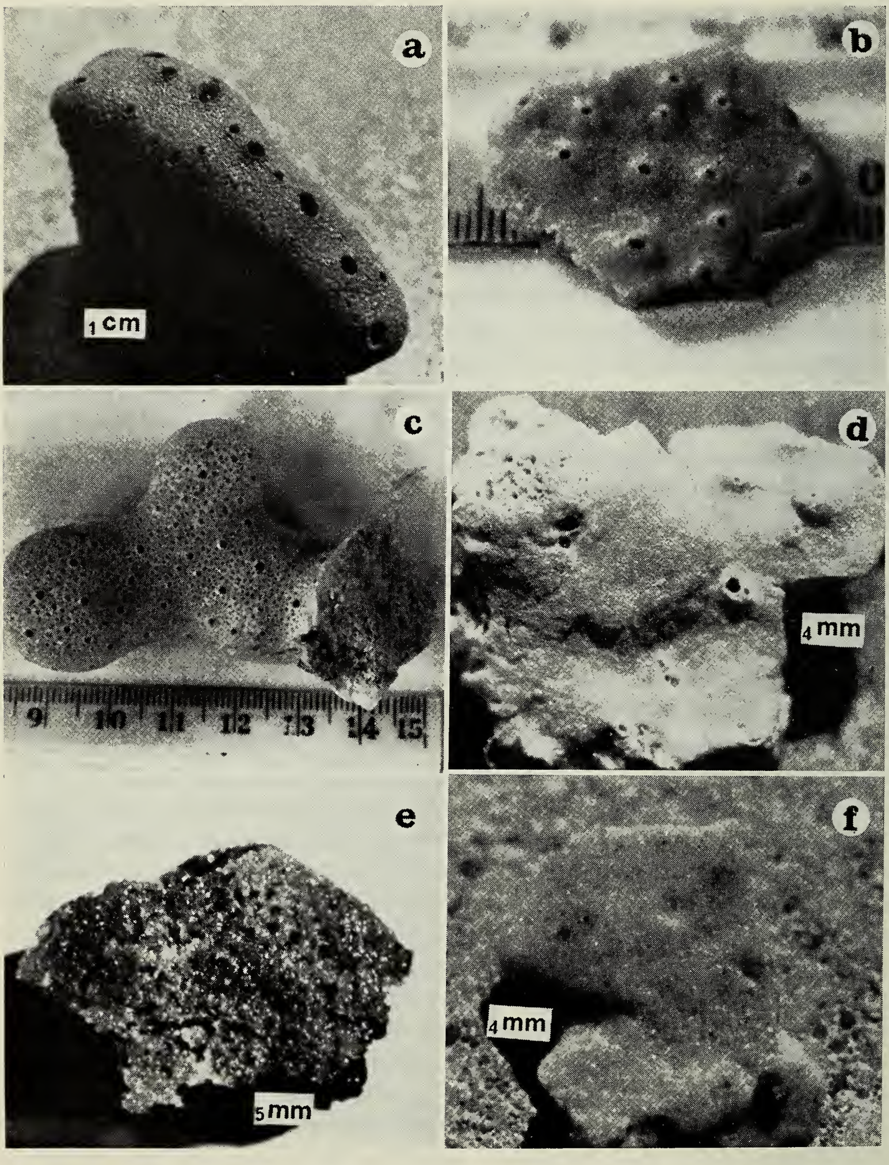

Fig. 3. a, *Xestospongia trindanea*, holotype; b, *Adocia dubia*, holotype; c, *Toxadocia zumi*, holotype; d, *Leucophloeus actites*, holotype; e, *Axinomimus tuscarus*, holotype; f, *Artemisina archegona*, holotype.

Specimens with fibers were not overgrown or attached to other organisms. Fiber origin, at this time, uncertain although they appear to be part of sponge.

Reproductive bodies, white in color, about 250 μm in diameter, noted in specimen collected in August; located throughout the interior.

Spicules consist of megascleres of oxeas, straight to slightly curved, some bent at 2 points, 140–180 × 10–16 μm (Fig. 2B).

Taxonomic discussion.—The characteristics of *Adocia dubia* (white, encrusting, hard, reticulate interior often obscured by spicules in confusion, and the shape of some spicules) are similar to those of *Xestospongia vanilla* (de Laubenfels, 1932; Hartman, 1975). The major distinction between these 2 species is the presence of a tangential ectosomal skeleton in *A. dubia.* De Laubenfels (1932, 1936) has often stressed that the genus *Xestospongia* does not possess a special dermal skeleton and it is for this reason that I believe the 2 species are distinct.

The only species of *Adocia* previously described from California is *A. gellindra* (de Laubenfels, 1932:114). This sponge was originally described as *Halichoclona gellindra,* a fragile, pale lavender, encrusting form from Carmel, California. Based on its published description it is quite distinct from *A. dubia,* and in fact Hartman (1975) has questioned the status of the species, claiming it may be identical to *Reniera* sp. A (which does not have a tangential ectosomal skeleton).

Dickinson (1945:10) described *Adocia ambrosia* as a ramose drab sponge from Mexico containing 2 size categories of oxeas. Its description indicates it is distinct from *A. dubia.*

I am rather dubious of the generic placement of *A. dubia* (hence the specific name) due to the fact that the reticulate interior may be obscured by spicules in confusion (as in *Xestospongia*) and that some specimens appear to develop fibers cored with oxeas (as in *Pachychalina*; see Hartman, 1975). I am tentatively placing this sponge in the genus *Adocia* because of the presence of a well defined tangential ectosomal skeleton, the simple spiculation and the presence of subpinacodermal cavities (de Laubenfels, 1936:39).

Toxadocia de Laubenfels, 1936

Toxadocia zumi, new species

Figs. 2C, 3c, 5a, b

Toxadocia sp. North, 1976:151.

Holotype and type-locality.—USNM 24524, Monastery Beach, Carmel, California.

Known range.—Pacific Coast of North America, from Carmel south to La Jolla, California.

Localities.—Monastery Beach, Carmel, 6 specimens, –12 to –18 m, between 1973 and 1976. Holotype collected 12 April 1973. Carmel River Beach Point, 2 specimens, –10 to –15 m, 6 June 1975. La Jolla, 1 specimen, –21 m, 4 June 1976 (collected by G. Zumwalt). This sponge is common at depths below –10 m at the type-locality.

Description.—An erectly branching sponge found on rock substrates in semi-cryptic environments (protected by overhanging ledges or in the interstices of boulder piles) or, occasionally, in exposed areas. Color, alive, in ETOH, and dried, white. Holotype dried, dichotomously branched, 6.5 cm high. Diameter of branches, about 2.0 cm. Branches may be cylindrical or compressed into lobes. Lobate forms often palmate or fan-shaped.

Consistency firm and rigid. Coral-like in appearance, due to ectosomal skeletal construction and regular disposition of oscula (Fig. 3d). Largest specimen noted, a palmate form, 17 × 5 × 18 cm (width × thickness × height).

Surface hispid. Spicule bundles erect on well defined tangential layer of oxeas (Fig. 5a). Tangential layer, 60–80 μm thick. Ectosomal membrane supported by erect spicule bundles 140–150 μm above tangential layer. Tips of spicule bundles project 10–20 μm above ectosomal membrane. Membrane thin, transparent, difficult to detach; contains oxeas and toxas. Pores, 10–30 μm in diameter. Oval inhalent areas, 240–400 μm in diameter, give tangential layer a honeycomb appearance. Thickness of walls defining each inhalent area from 200–500 μm. Oscula generally 1.0–1.5 mm in diameter, spaced 5–10 mm apart over entire surface. Vertical spicules surround each osculum, giving oscula elevated and fringed appearance.

Interior of multi-spicular tracts of oxeas running perpendicularly toward surface. Single spicules, united isodictyally, in confusion between spicule tracts. Tracts normally 6–10 spicules wide, spaced about 200 μm apart. Growth lines, representing old tangential layers, frequently found in interior. Former oscula discernible in these older layers. Growth lines disappear near centers of branches. Distance between successive lines has ranged from 1–4 mm. Maximum number of growth lines observed in a single branch, 5; initial indications that growth lines may be annual. However, sponge may be able to resorb or reorganize older layers, in which case accurate age determinations may not be possible. Reproductive bodies not noted in any specimens.

Spicules consist of megascleres of oxeas, 115–200 × 6–14 μm (most are 160–180 × 12 μm); microscleres of toxas, variable in shape, some with a high arch and recurved arms, others with low arches and straight arms, 50–96 × 0.5–1.0 μm (Fig. 2C).

Taxonomic discussion.—De Laubenfels (1936:69) erected the genus *Toxadocia* for sponges having the structure and megascleres of *Adocia* (special tangent dermal skeleton, isodictyal reticulate interior and oxeas as spicules) and only toxas as microscleres.

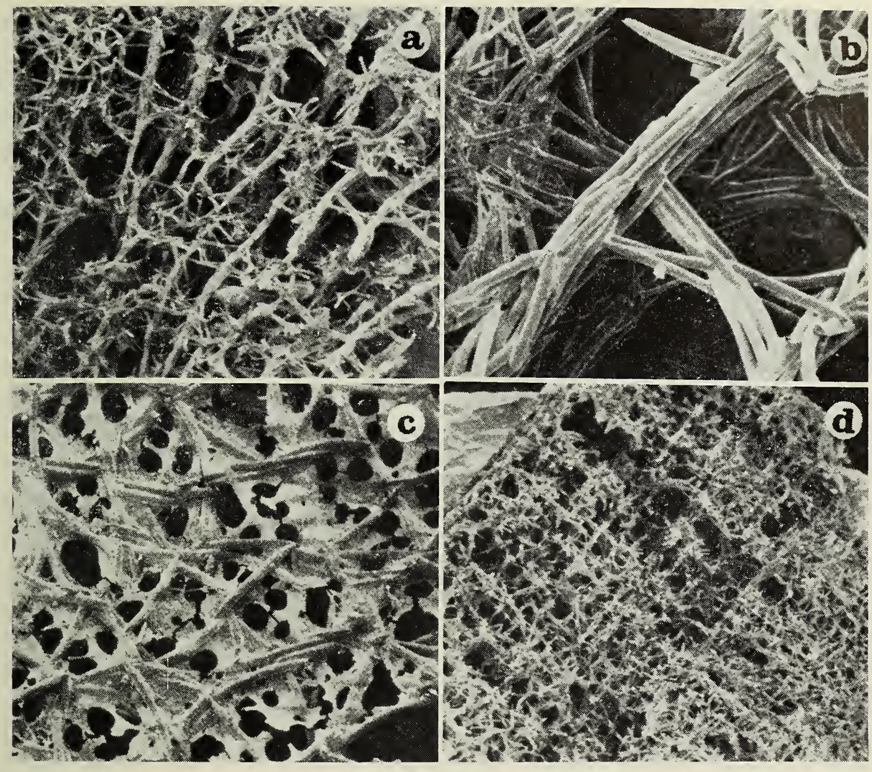

Fig. 4. a, *Xestospongia trindanea*: oxidized specimen showing reticulate pattern of multi-spicular tracts and confused arrangement of interstitial spicules (20×); b, *Xestospongia trindanea*: large oxeas of multi-spicular tracts and smaller interstitial oxeas (lower right) (100×); c, *Adocia dubia*: ectosomal tangential skeleton, ectosomal membrane and pores (125×); d, *Adocia dubia*: oxidized specimen showing reticulate pattern and several growth lines (running from upper right to lower left) (20).

Lambe (1895:115) described *Toxochalina borealis* from Kyska Harbor (Alaska), and based on his description this sponge should belong in the genus *Toxadocia*. The oxeas of the Alaskan sponge are comparable in size to those of *T. zumi*, however, Lambe's specimen has larger toxas and a markedly different morphology (encrusting, soft and spongy and yellow-brown in color) and is distinct from *T. zumi*.

Hartman (1975:60) listed *Toxadocia* sp. as occurring intertidally in central California, but claimed this sponge is uncommon and that more than one species may be present. The description of *Toxadocia* sp. (encrusting, olive-beige, pale gray-brown or deep chrome yellow in color, oxeas 120×7 μm and toxas 65 μm) is quite different from that of *T. zumi* and I believe the species are not conspecific. North (1976:151) pictured and listed a sponge (*Toxadocia* sp.) that is undoubtedly conspecific with *T. zumi*.

Although the surface of this sponge is hispid and the ectosomal membrane supported by erect spicules, and although the interior shows a combination of reticulate and confused structures, I have placed this species in the genus *Toxadocia.* There is a well defined subpinacodermal tangential skeleton and the spicule complement corresponds sufficiently well to de Laubenfels's generic description to allow placement in this genus.

It is my pleasure to dedicate this species to Gary S. Zumwalt, whose name has been partly used in the formation of the specific name.

Halichondriidae

Leucophloeus Carter, 1883

Leucophloeus actites, new species

Figs. 2D, 3d, 5c, d

Holotype and type-locality.—USNM 24526, Horseshoe Cove, Bodega Head, Sonoma County, California.

Known range.—Pacific Coast of North America, from Bodega Head north to Ocean Cove, Sonoma County, California.

Localities.—Horseshoe Cove, Bodega Head, 3 specimens, intertidally, –0.16 m, 6 January 1977. Horseshoe Cove, Bodega Head, 7 specimens from wrack, between 1 August 1975 and 1 February 1977. Ocean Cove, 1 specimen, –5 m, 22 August 1977. This sponge occurs occasionally in the intertidal and subtidal in north-central California.

Description.—An encrusting sponge found on exposed rock surfaces or semi-cryptically under ledges and in kelp holdfasts. Color, alive, bright yellow. Dried and in ETOH, a white exterior and a light yellow or white interior. Holotype is dried, 2.7 cm in diameter, 1 cm thick, amorphous in shape. Consistency, when alive, firm but flexible; dried, firm but easily friable. In situ, color, growth form and surficial characteristics very similar to *Halichondria panicea.*

Surface smooth, with irregular contour. Tangential ectosomal skeleton present, well defined, easily removed, 80–120 μm thick (Fig. 5c); consisting of several ill-defined layers (1–2) of horizontal styles. Ectosomal styles either formed into multi-spicular tracts (usually 2–5 spicules wide) and united into regular polygonal network, or matted together into smooth, solid surface (Fig. 5d). Semi-transparent ectosomal membrane evident in areas of polygonal meshwork; not as evident in matted areas. Pores 10–30 μm in diameter. Few oscula, 0.3–1.3 mm in diameter, scattered irregularly over surface; often situated on slightly raised mounds. Areas directly around oscula smoothly matted.

Interior fairly compact; appears fleshy. Subpinacodermal spaces generally well defined. Ectosomal skeleton supported by compact multispicular tracts although occasionally it rests directly on spiculation of

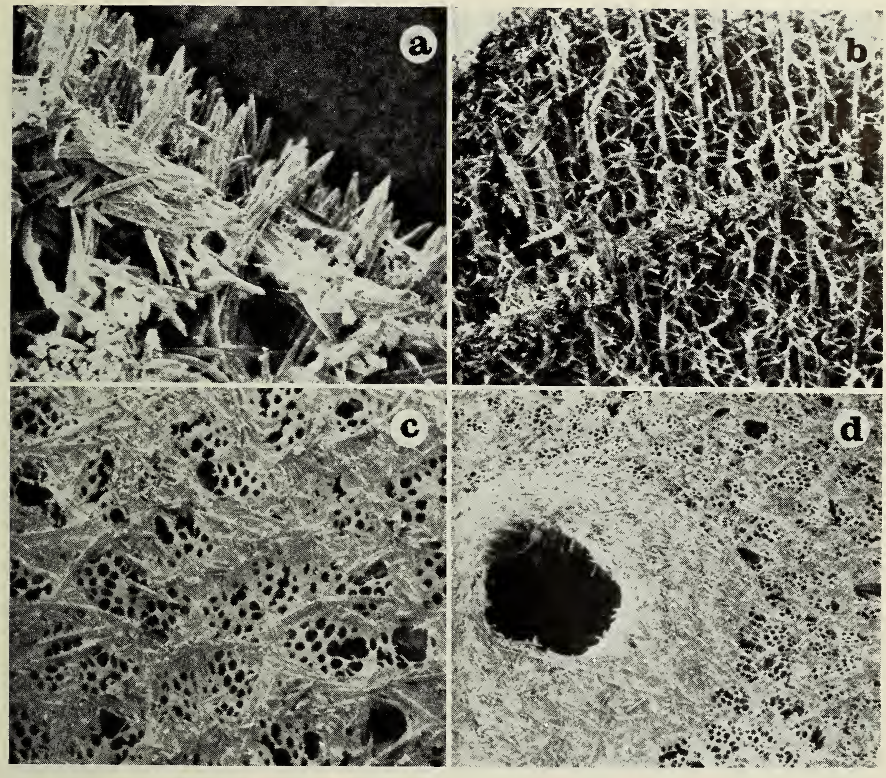

Fig. 5. a, *Toxadocia zumi*: surface cross-section showing erect spicules on tangential layer (100×); b, *Toxadocia zumi*: oxidized specimen showing reticulations and old tangential layer (concentration of spicules near center) (22×); c, *Leucophloeus actites*: ectosomal tangential skeleton, ectosomal membrane and pores (110×); d, *Leucophloeus actites*: osculum and smoothly matted area around osculum contrasted to polygonal arrangement of spicules (55×).

interior. Interior spiculation confused; styles pointing in all directions; rarely organized into fibers or tracts. Reproductive bodies not observed.

Megascleres of styles, smooth and gently curved, occasionally sinuous or irregularly bent, 165–220 × 4–8 μm (Fig. 2D).

Taxonomic discussion.—According to de Laubenfels (1936:135), the genus *Leucophloeus* belongs in the family Halichondriidae, whose members possess a special dermal skeleton, a confused interior and simple spiculation. De Laubenfels stated that *Leucophloeus* resembles *Ciocalypta*, which also has styles, but *Ciocalypta* has large subpinacodermal spaces, over which the dermal skeleton is supported by lengthy spicule columns. In *Leucophloeus*, the subpinacodermal structure is more compact. *Ciocalypta* also differs in that it has fistulous processes.

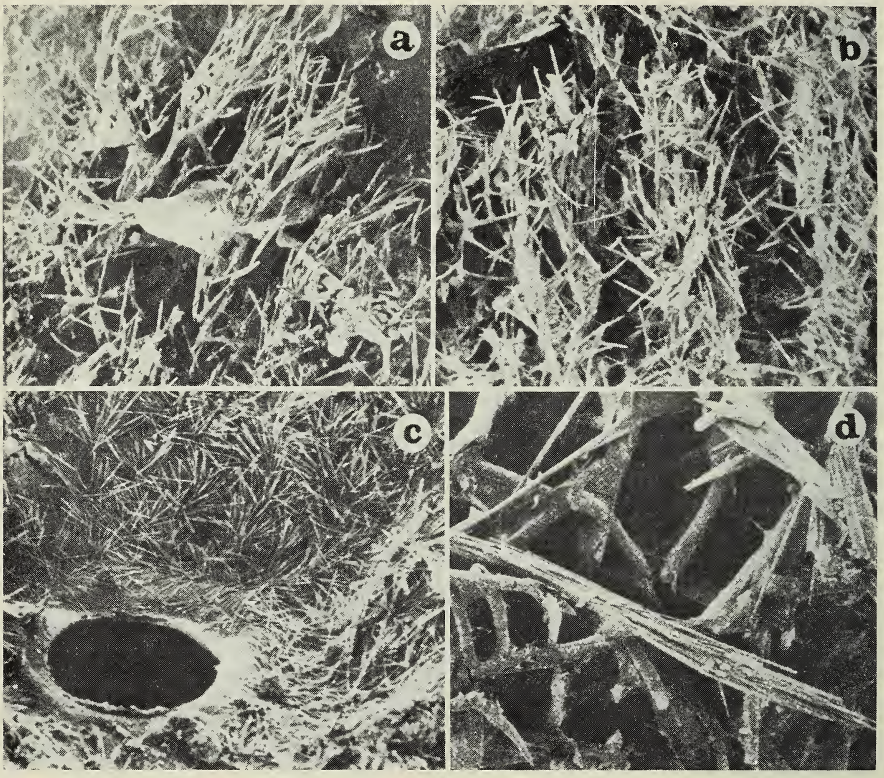

Fig. 6. a, *Axinomimus tuscarus*: spicule brushes shown projecting through fragment of ectosomal membrane (white area in center) (20×); b, *Axinomimus tuscarus*: vague spicule tracts and echinating spicules branching from tracts are shown (25×); c, *Artemisina archegona*: oscular area showing contractile membrane and radiating ectosomal spicules (50×); d, *Artemisina archegona*: fibrous bundles of toxiform oxeas in interior (130×).

No other species of *Leucophloeus* has ever been described from the west coast of North America. Thiele (1898:47–48) briefly described 2 species of *Leucophloeus* (*L. perforatus*, *L. incrustans*) from the Pacific area near Japan. Both forms had large tylostyles (1.0–1.6 mm length) and, based on their descriptions, are quite different from the California sponge. A third specimen, designated by Thiele as *Leucophloeus* sp. (p. 48), has styles from 250–500 × 6–20 μm. Another specimen, identified as *Leucophloeus* (?) sp. (p. 49), had styles from 160–180 × 10–12 μm. The spicule sizes of these latter forms approach those of *L. actites*, however nothing more of these Western Pacific sponges is known due to the brevity of Thiele's descriptions.

The genus *Hymeniacidon* shows some slight similarity to *Leucophloeus* and thus deserves mention. *Hymeniacidon* (Family Hymeniacidonidae, de Leubenfels 1936:136) is characterized by a fleshy ectosome, without a profusion of erect spicules. The dermis is always skin-like, contains few, if any spicules and those present are usually tangential. The interior is confused. A local species of this genus (*H. ungodon* de Laubenfels 1932:60) has spicules similar to those of *L. actites*, but, specimens of *H. ungodon* I have collected are very different in terms of coloration, growth form and disposition of the ectosomal skeleton.

I have chosen to place this new species in the genus *Leucophloeus* because it resembles members of the Halichondriidae more than those of the Hymeniacidonidae. The name "actites" is formed from the root word "actit," which means "dweller of the sea coast" (see Jaeger, 1963).

Sollasellidae

Axinomimus de Laubenfels, 1936

Axinomimus tuscarus, new species

Figs. 2E, 3e, 6a, b

Holotype and type-locality.—USNM 24527, Carmel River Beach Point, Carmel, California.

Known range.—Pacific Coast of North America, from Carmel north to Bodega Head, Sonoma County, California.

Localities.—Carmel River Beach Point, 1 specimen, –7 m, 10 April 1973. Horseshoe Cove, Bodega Head, 3 specimens, from wrack, between 1 August 1975 and 1 February 1977. This sponge occurs rarely at the type-locality. It has not been collected in situ at Bodega Head.

Description.—A thick encrusting sponge, found on exposed rock surfaces. Holotype formed an amorphous mass, intermixed with worm tubes; measures 3 × 2 × 1.5 cm thick; cut from larger mass. Color, alive and dried, light to medium dark brown exterior and dark chocolate brown interior. In ETOH colors fade slightly. Dried specimens from Horseshoe Cove, light tan in color; may represent surface area of sponge only. Consistency, alive and in ETOH, soft, slightly spongy, compressible; dried, brittle and very friable.

Surface very hispid. Single spicules or bundles (brushes) projecting 0.2–1.5 mm in various directions through ectosomal membrane (Fig. 6a). Projecting brushes often united with other brushes by cross-spicules connected in irregular and semi-isodictyal manner. No special ectosomal skeleton. Ectosomal membrane thin (10 μm), semi-transparent, difficult to detach. Membrane normally recessed below tips of spicule bundles, occasionally flush with spicule tips. Pores not evident. Oscula? appearing as irregular openings (0.4–1.0 mm in diameter) in membrane; dispersed irregularly over entire surface. Circular areas (usually 1 mm in diameter), and occasionally sinuous troughs, outlined by projecting spicule bundles; in places projecting spicules packed closely together, no circular areas or troughs evident. Dark colored pigment granules noted in lighter-colored surface area; quantity of granules may increase in older parts of sponge, causing noted color change.

Alive and in ETOH, interior gelatinous; skeletal construction not evident as only spicule tips seen projecting from gelatinous matrix. Dried, interior cellular material reduced in volume, granular in appearance; skeletal construction easily visible. Skeleton consisting of vertical multi-spicular tracts (vague to moderately well defined) plus confused arrangement of connecting spicules. Tracts normally 40–80 μm wide, containing 2–5 spicules; appear to branch and anastomose. Echinating cross-connecting spicules branch from tracts; unite isodictyally in confused arrangement (Fig. 6b). Presence of tracts often masked by confused echinating arrangement.

Megascleres of oxeas, slightly curved or irregularly bent, 380–530 × 10–22 μm, most 440–480 × 18 μm (Fig. 2E).

Taxonomic discussion.—The genus *Axinomimus* was erected by de Laubenfels (1936:163), with *Axinella paradoxa* Ridley & Dendy, 1886 (and 1887:187) being the genotype. The published description of *Axinomimus paradoxa* (massive, lobate, rubber-like, oxeas of 870 × 22 μm, from the South Atlantic Ocean) is sufficiently different to necessitate separation from *A. tuscarus.*

Brøndsted (1923:119) described *Halichondria intermedia* from the Auckland and Campbell Islands (New Zealand). He hesitatingly placed the sponge in this genus because the skeleton approached the Axinellid-type. Brøndsted's description stated the spicules were collected in indefinite fibers; the number of spicules in the fibers were from a few to 10 or more; and numerous spicules projected from the fibers in an Axinellid manner and lie scattered and disorderly. Brøndsted stated, "the sponge in hand is very interesting in taking up a median position between the Halichondriae and Axinellidae; other species do the same, e.g. *Axinella paradoxa* Ridley & Dendy." The spicules of *H. intermedia* were oxeas, 410–550 × 12–13 μm.

Bergquist (1970:34), in a review of the axinellids and halichondrids of New Zealand, stated that the type of *H. intermedia* was unavailable for study. Bergquist did not comment further on the systematic position of this species, although it seems that the sponge could be reallocated to the genus *Axinomimus.* However, considering that the type is unavailable, it should remain as *H. intermedia.* The question of conspecificity with *A. tuscarus* is not resolvable although certain similarities are evident.

Axinomimus tuscarus is the first sponge of this genus to be described from the Pacific Ocean. The specific name has been formed from the adjective root word "tuscar," meaning "in the Pacific Ocean" (see Jaegar, 1963).

Clathriidae

Artemisina Levi, 1960

Artemisina archegona, new species

Figs. 2F, 3f, 6c, d

Holotype and type-locality.—USNM 24528, Monastery Beach, Carmel, California.

Known range.—Pacific Coast of North America, in the Carmel Bay area.

Localities.—Monastery Beach, 1 specimen, –6 m, 8 April 1974. Carmel River Beach Point, 1 specimen, –5 m, 9 April 1974. This sponge occurs occasionally at the type-locality.

Description.—A thin encrusting sponge found on exposed rock substrates. Color, alive, bright orange; in ETOH, fades to white. Consistency, alive and in ETOH, firm yet slightly compressible; dried it is very friable. Holotype, 2.0 × 1.3 × 0.7 cm thick; cut from a laterally spreading mass 10 × 10 cm in area.

Surface minutely hispid. Projecting spicules appear to radiate in all directions, but SEM work shows only certain spicules (toxas, toxiform oxeas, subtylostyles) to radiate (Fig. 6c). Styles project vertically, 250–300 μm, through ectosomal membrane. Membrane, thin (10 μm), semi-transparent, difficult to detach. Few tangentially placed subtylostyles, toxas, and chelas in membrane but no special tangential skeleton. Pores, 30–40 μm in diameter; often localized in shallow, circular depressions (0.3–0.5 mm diameter). Oscula, about 0.6 mm in diameter, situated in larger (1.0–1.5 mm diameter) surficial depressions (Fig. 6c). Contractile membranes surround each osculum. Surficial depressions not as apparent in Carmel River Beach Point specimen.

Wet, interior appears fleshy and dense. Dried, endosomal material appears granular; interior cavernous, skeletal construction evident. Skeleton of vague tracts of styles (2–5 spicules wide) running more or less perpendicularly toward surface. Tracts connected by single or multiple-style tracts showing no well defined orientation. Vague reticulate network becomes confused as fibers (40–80 μm wide) of toxas and toxiform oxeas course randomly through interior (Fig. 6d); fibers often appear to branch and anastomose. Single toxiform oxeas and (rarely) subtylostyles dispersed in interior. Small toxas and palmate isochelas in interior membranes or attached to larger spicules. No echinating spicules.

Reproductive bodies, 400–500 μm in diameter; located near base of sponge.

Megascleres of styles, smooth, slightly curved or sharply bent, 185–240 × 7–20 μm; subtylostyles (occasionally styles), straight to slightly curved, often with microspined base, 120–340 × 2.5 μm. Microscleres of palmate isochelas (not very abundant), 18–21 μm; toxas, long, smooth, straight arms with low, compressed arch (which may be irregularly bent), 105–520 × 0.5–1.0 μm; toxiform oxeas, straight to irregularly bent, bend often resembles arches of the toxas, 450–800 × 3–6 μm (Fig. 2F). Toxas and toxiform oxeas may represent a gradational series, but are morphologically distinguishable. Toxiform oxeas included as microscleres following past convention (see Taxonomic discussion).

Taxonomic discussion.—The generic determination of this sponge has been problematical. There have been earlier records, from other parts of the world, of sponges showing affinities with the California sponge, but there has not been general agreement on their systematic position. For a review of these species see: Ridley & Dendy (1887:124–127, *Amphilectus apollinis*, *A. pilosus*); Hallman (1919:772–773, *Megaciella pilosus*, *Tenaciella canaliculata*); Babic (1922:259–261, *Artemisina*? *paradoxa*).

Tenaciella canaliculata (Whitelegge) possessed spicules of isochelas, and toxas (which form a series from small toxa up to large forms that resemble "rhapidiform oxea"). The spicule complement of *T. canaliculata* appears identical to *Artemisina archegona*, but the California sponge differs in the shape of the toxas, the skeletal construction and growth form.

Artemisina ? *paradoxa* Babic, possessed large "toxenartige Diactine" (toxen-resembling oxea) which were claimed to resemble those of *Amphilectus pilosus* [= *Megaciella pilosus* (Ridley & Dendy)].

Burton (1930:528), in an extensive definition of the genus *Artemisina*, claimed that *Amphilectus apollinis* Ridley & Dendy, really belonged in the genus *Artemisina* and that *Artemisina paradoxa* Babic, belonged in the genus *Clathria*. Burton listed many species that he felt belonged in the genus *Artemisina*, but did not mention the type-species of *Megaciella* or *Tenaciella*. Based on his definition however, they apparently could be classed as such.

Contrary to Burton, de Laubenfels (1936:117–118) placed the genus *Artemisina* into a new family, the Ophlitaspongiidae (which have enchinating spicules). De Laubenfels stated that *Artemisina* is characterized, in part, by spiny-ended toxas. De Laubenfels (p. 123) erected a new family, the Amphilectiidae (which do not have echinating spicules), and placed Hallman's genus, *Tenaciella*, in this family (p. 126).

Levi (1960) rejected de Laubenfel's division of the Clathriidae and thus rejected the family Ophlitaspongiidae. Levi (p. 83) discussed the genus *Artemisina*, and his diagnosis is essentially the same as Burton's. Levi did not mention sigmas as being part of the microscleres however and the forms he has assigned to this genus indicate that the toxas may or may not have spined ends. Levi did not discuss the genus *Tenaciella* or the family Amphilectiidae.

Apparently, a variety of sponges possess toxiform oxeote spicules, and the occurrence of such may not be indicative of a particular genus. The California sponge fits Levi's description of *Artemisina* and I have tentatively placed it here. It should be kept in mind that the genus *Tenaciella* has not been synonomized (to my knowledge) and conceivably may be valid. If further work proves it to be distinct from *Artemisina*, the generic placement of *A. archegona* possibly may have to be reviewed.

In California waters, *A. archegona* is easily recognized, for no other west coast species has toxiform oxeas or toxas of this particular shape. Inasmuch as this is the first record of an *Artemisina* from this area, the specific name has been formed from the root word "archegon," which means "first of a race" (see Jaeger, 1963).

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Footnote

[1] This word was coined to characterize aggregations of sponges. Its usage is comparable to other such nouns that define animal groups (i.e. gaggle, school, etc.). It was originally developed and defined by Ristau (1977).

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A REVISION OF THE NEW WORLD SPECIES OF *HEDYCHRIDIUM* (HYMENOPTERA, CHRYSIDIDAE)

R. M. Bohart and L. S. Kimsey

Abstract.—*Hedychridium* with its 36 New World species, 24 of which are described as new, is reviewed. The genus is in the subfamily Elampinae, and is the only one with a single median claw tooth. Most of the species are found in western United States and particularly the southwest. Biology of only one New World species is known, but Old World forms are parasitoids on sphecids and bees. Characters of special value are discussed, especially male genitalia, which are figured. Six species groups are defined and a key to species is presented. New species are *antennatum* Kimsey, *argenteum* Kimsey, *arietinum* Bohart, *azurellum* Bohart, *bilobatum* Bohart, *centrale* Bohart, *cornutum* Bohart, *coruscum* Bohart, *crassum* Bohart, *crebrum* Kimsey, *frontis* Kimsey, *frugale* Bohart, *gemmatum* Kimsey, *incisum* Bohart, *leucostigma* Bohart, *lividum* Bohart, *maricopae* Bohart, *menkei* Bohart, *milleri* Kimsey, *mirabile* Kimsey, *nevadae* Kimsey, *olene* Kimsey, *paulum* Bohart, *politum* Bohart, *purum* Kimsey, *rasile* Bohart. A lectotype is established for *Hedychrum discoidale* Buysson.

The genus *Hedychridium* Abeille de Perrin, 1878, includes about 150 named species of cuckoo wasps, occurring mostly in the Holarctic Region. Many of the species are small, often less than 4 mm long. The New World forms are commonly blue to purple, but a significant number from desert areas of southwestern United States exhibit metallic hues of copper, gold and red; thus rivalling the brilliant species of the Palearctic.

The genus falls in the subfamily Elampinae, characterized by having no female sting, abdominal venter mostly flat to concave, 3 well defined and exposed abdominal segments, tarsal claw with one or more subsidiary teeth, no transverse frontal carina, radial sector with its sclerotized basal part (RS stub) not extending apicad much beyond stigma, and outer veins of discoidal cell not fully sclerotized. Among the elampine genera, *Hedychridium* can be separated by a combination of characters: claw with a median tooth (Fig. 32), median cell of forewing setose, RS stub extending apicad at least as far as stigma, tergum III margin rounded or slightly indented apically (the closely related Ethiopian genus, *Acrotoma*, has a pair of apical teeth).

Geographic distribution.—Of the approximately 150 described species of *Hedychridium*, 32 are Nearctic (including the 24 described herein), 4 are neotropical, a few are Ethiopian or Oriental, and the rest are Palearctic. Considering the number of odd specimens which we were unable to readily identify, it is likely that 10 or 20 more species may be described eventually from the Nearctic fauna. Neotropical species are *guatemalense*, *centrale*, *carinulatum* and *argentinum*. Only the first two of these occur north of Panama, and *guatemalense* even reaches Texas. Unquestionably, additional species will be found in temperate parts of Argentina. Of the Nearctic species, only 4 are known to range east of the 100th meridian. These are *caeruleum*, *dimidiatum*, *crassum*, and *fletcheri*. Three factors may be responsible for this small number: (1) The New World fauna shows many similarities to that of the Palearctic Region. Ancestral forms may have arrived via the Bering Sea passage in fairly recent times and perhaps spread eastward slowly. (2) Desert areas seem to lend themselves to species proliferation, thus favoring the relatively dry west over the more humid east. (3) The large number of presumed hosts in the west, such as *Oxybelus* and *Tachysphex*, may have encouraged speciation in that part of the country.

Three cases of apparently extreme endemism in California may be modified by more intensive collecting. These are *milleri* from Borax Lake, Lake Co.; *coruscum* from the ocean beach near Goleta, Santa Barbara Co.; and *argenteum* from 18 mi W Blythe, Riverside Co. Species which favor the Sonoran deserts of southern and eastern California and Arizona are *arietinum*, *leucostigma* and *lividum*. A species known only from the Chihuahuan desert of New Mexico and eastern Arizona is *semirufum*. An apparent central Sierran endemic is *rasile*. Many of the distributional peculiarities might be explained if more host data were available.

Our ideas of distribution are based largely on the examination of about 4,500 *Hedychridium*.

Biology.—According to Móczár (1967), *Hedychridium* species have been reported to be parasitoids in nests of Sphecidae (*Tachysphex*, *Liris*, *Solierella*, *Oxybelus*, *Lindenius*, *Dinetus*, *Astata*, *Psen*) and Apoidea (Halictidae: *Halictus*, and Megachilidae: *Osmia*). These records refer to Palearctic species. Little has been published on New World forms except for the host-parasite records of Parker and Bohart (1968), and the fine work by Carrillo and Caltagirone (1970), both papers on *H. solierellae*.

Carrillo and Caltagirone reported *solierellae* females as entering nests of *Solierella packhami* (Ashmead) in twigs and almond hulls, and *Solierella blaisdelli* (Bridwell) in twigs. One egg per cell was deposited by the chrysidid, and its newly emerged larva usually killed the *Solierella* larva (or caused it to starve). Subsequently, the *Hedychridium* larva fed on the nest provisions, which were paralyzed immatures of lygaeids (*Nysius*). Cocooning took place after 6 days, the prepupal stage lasted 5–6 days, and the adult emerged 12–22 days later.

Parker and Bohart (1968) reared *H. solierellae* from trap nests utilized by *Solierella plenoculoides* (W. Fox) (misidentified as *S. blaisdelli* Bridwell) in 4 localities in Nevada, and 8 widely scattered areas in California. Some negative significance can be attributed to the fact that Parker and Bohart reported on nearly 7,000 twig nests collected over a 7-year period, but reared only *H. solierellae* among a total of 21 chrysidid species. This is a strong indication that *Hedychridium* attack primarily ground-nesting hosts.

Abbreviations and arbitrary measurements.—In the keys and descriptions certain characters are quite repetitive and for brevity as well as simplification, we have shortened flagellum to "F," abdominal tergum to "T," and abdominal sternum to "S." Thus, the basal flagellomere is F-I, third sternum is S-III, etc. Additionally, the diameter of a median ocellus is MOD, and the sclerotized basal part of the forewing radial sector is the RS stub. In male genitalia the length proportions of digitus to gonostyle are based on measurements as indicated in Fig. 33.

Characters of special value.—At first glance, *Hedychridium*, as in other chrysidids, seem to possess an abundance of systematic characters relating to color and punctation. More careful study tends to dissipate such taxonomic euphoria! However, color pattern and puncture distribution do have some significance. The extent of reddish coppery markings, spots on T-II and S-II-III, and color of stigma and wing membrane may all be useful. The sometimes fine punctation of the lower frons, usually associated with a dense mat of silvery pubescence, is a characteristic of several species. Length and width of antennal articles, particularly the pedicel and F-I, are important. Similarly, the lengths of the malar space, subantennal space (distance from antennal socket to clypeal apex), and RS stub must be taken into account. Finally, male genitalia have many intriguing structural features. In addition to length proportions, the shapes of the digitus, cuspis, and aedeagus may be quite distinctive. The aedeagus, especially, may have lateral bristles (Fig. 33), fingerlike lobes (Fig. 42), or a stout armlike projection (Fig. 48).

Species groups.—The following rather loose assemblages, except for the last heterogeneous one, seem to have group relationships and share characters as follows:

I (*dimidiatum* group), F-I more than twice as long as broad, pedicel considerably longer than broad, malar space about 0.5 MOD, basal vein strongly curved, lower frons not densely pubescent, posterior mesopleuron partly polished, wings brown stained. Included species: *bilobatum, crebrum, dimidiatum, menkei, olene, politum.*

II (*amabile* group), F-I more than twice as long as broad, pedicel considerably longer than broad, basal vein nearly straight, posterior mesopleuron completely microridged, tegula brown. Included species: *amabile, azurellum, cockerelli, coruscum, maricopae, rasile, solierellae.*

III (*crassum* group), F-I long to medium but pedicel nearly as broad as long, flagellomeres unusually cylindrical, basal vein distinctly curved, punctures of brow (swollen area below midocellus) and rather flat lower frons subequal, frons unusually broad, male genitalia weakly pigmented. Included species: *crassum, incisum, purum.*

IV (*fletcheri* group), F-I at most twice as long as broad, pedicel considerably longer than broad, basal vein gently curved, brow rather prominent, lower frons with dense pubescence in male at least, digitus relatively long and linear (male of *centrale* unknown). Included species: *centrale, fletcheri, mirabile.*

V (*frugale* group), F-I less than twice as long as broad, pedicel considerably longer than broad, basal vein nearly straight, contiguous microreticulation between punctures of head and thorax, body small (less than 3 mm long), digitus short and subquadrangular. Included species: *cornutum, frugale.*

VI (*gemmatum* group), F-I less than twice as long as broad (usually 1.5 times or less), pedicel considerably longer than broad, basal vein nearly straight, wings lightly smoky or clear, body small (less than 4 mm long), digitus subovate or clubbed. Included species: *antennatum, argenteum, arietinum, frontis, gemmatum, leucostigma, milleri, paulum.*

VII (Miscellaneous), Included species: *argentinum, caeruleum, carinulatum, guatemalense, lividum, nevadae, semirufum.*

Key to *Hedychridium* of the New World

1. F-I more than twice as long as pedicel (Fig. 29) and/or pronotal lobe polished in side view; S-III green or blue 2
– F-I never more than twice as long as pedicel (Figs. 25, 26), usually less than twice; pronotal lobe not extensively polished; S-III various 5
2. Pronotal lobe polished in side view; coarse punctures of brow (swollen area below midocellus) extending in a narrow strip down along eye margins, clypeus sparsely punctate; T-III indented apicomedially *guatemalense* Cameron
– Pronotal lobe punctate in side view; medium coarse punctures of brow extending in a broad band down along eye margins, clypeus closely punctate; T-III various 3
3. T-II much thickened toward apex (Fig. 21) *crassum* Bohart
– T-II not thickened toward apex 4
4. T-III margin rounded apically; F-I less than twice as long as broad; wings whitish *purum* Kimsey
– T-III margin a little incurved apically (Fig. 18); F-I more than twice as long as broad; wings smoky *incisum* Bohart
5. Forefemur rather sharply angled toward base (Fig. 31); S-III brown or with a median green spot *olene* Kimsey
– Forefemur rounded toward base; S-III various 6

6. Metanotum nearly triangular, pointed posteriorly; S-II densely punctate *caeruleum* (Norton)
– Metanotum rounded posteriorly; S-II with punctures well separated 7
7. F-I length more than twice breadth (Figs. 26, 28), head and thorax not closely microreticulate 8
– F-I length less than twice breadth (about twice in exceptional specimens, especially females), and/or head and thorax closely microreticulate (Fig. 11) 20
8. Forewing basal vein reaching MCu at a broadly obtuse angle (as in Fig. 5), mesopleural area above midcoxa completely microridged 9
– Forewing basal vein reaching MCu at a right angle or nearly so (as in Fig. 1), mesopleural area above midcoxa often with a polished spot 15
9. Malar space (shortest distance between eye and mandible socket) much shorter than pedicel (as in Fig. 9), T-II usually blackish medially, pubescence of lower face various 10
– Malar space subequal to length of pedicel (as in Fig. 6), T-II various, pubescence of lower frons dense (viewed from above) 12
10. Pubescence of lower frons dense, whitish *maricopae* Bohart
– Pubescence of lower frons sparse, often fulvous 11
11. T-II closely punctate toward middle and dull; S-II usually brown *solierellae* Bohart and Brumley
– T-II with punctures about a puncture diameter apart, shiny overall; S-III blue or green in male, usually with green or blue highlights in female *rasile* Bohart
12. T-II greenish to blue or purple, darkened medially 13
– T-II reddish coppery 14
13. Malar space about 2.0 MOD, lower frons more coarsely punctate along eye margins, S-II-III brown *cockerelli* Buysson
– Malar space 1.0–1.5 MOD, lower frons evenly and finely punctate to eye margins, S-II-III in male and S-II in female partly bluish to greenish *azurellum* Bohart
14. Basal vein of forewing as long as RS stub (as in Fig. 5) *amabile* Cockerell
– Basal vein of forewing longer than RS stub (about as in Fig. 2) *coruscum* Bohart
15. T-III rounded over and indented before apical membranous rim, rather pointed, especially in female (Fig. 19); forefemur plainly grooved and carinate ventrally (Fig. 30); male S-II-III green or blue; brow overhanging medially *dimidiatum* (Say)

– T-III not or hardly rounded over apically; forefemur at most weakly carinate, other characters various 16

16. Clypeus of female with a median tooth in side view; male with a longitudinal streak of fine appressed pubescence mediodistally on T-III (Fig. 15); S-II-III green or blue *carinulatum* (Spinola)

– Clypeus of female not dentate; no hair streak on male T-III 17

17. T-III margin somewhat drawn out posteromedially into a rounded point, especially in female (Fig. 16); punctures of pronotum moderate, close and even, only a little larger than those of T-II; S-II-III green or blue *crebrum* Kimsey

– T-III margin broadly rounded posteriorly (Fig. 20); punctures of pronotum coarse, uneven, much larger than those of T-II 18

18. T-II mediobasally with at most a small and indistinctly edged black area; tegula and male S-III green or blue; T-III margin broadly rounded *politum* Bohart

– T-II mediobasally with a large and diffuse, or medium and distinctly edged black area; male S-III brown or mostly so; other characters various 19

19. T-III somewhat pointed (as in Fig. 19), especially in female; tegula green; T-II with a definite basomedial black mark which may be triangular but more often is bilobate (Fig. 22); forefemur sometimes weakly grooved and keeled ventrally *bilobatum* Bohart

– T-III broadly rounded; tegula nearly always brown; T-II more than half covered with an indistinctly edged dark area; forefemur rounded ventrally *menkei* Bohart

20. Subantennal distance subequal to pedicel length (Figs. 10, 14) and/or interocellar area tuberculate 21

– Subantennal distance less than pedicel length (Figs. 11, 12), interocellar area simple 23

21. Vertical side of pronotum with coarse longitudinal ridging; lower frons in both sexes with inconspicuous pubescence; terga purplish and with dark pubescence *nevadae* Kimsey

– Vertical side of pronotum punctate; lower frons in male with dense fine pubescence arising from fine punctation; terga usually greenish to blue, tergal pubescence pale 22

22. Interocellar area tuberculate, T-II extensively black, tegula brown *centrale* Bohart

– Interocellar area simple, T-II not extensively black, tegula greenish *fletcheri* Bodenstein

23. Pronotal punctures separated by obvious microsculpture (shagreening or micropunctation, Fig. 11) 24

– Pronotal punctures not separated by obvious microsculpture 25

24\. Pronotum and tergum II with larger punctures sparse, microsculpture extensive and somewhat transverse; F-V of male longer than broad, flagellum moderately slender *frugale* Bohart

– Pronotum and tergum II with larger punctures separated by micropunctured areas of about a macropuncture diameter; F-V of male broader than long, flagellum broadened and flattened *cornutum* Bohart

25\. T-II extensively polished, many punctures 3 puncture diameters apart; T-III with fine, transversely oriented microridging; sterna brown *argentinum* (Buysson)

– T-II not extensively polished, most punctures less than 2 puncture diameters apart; T-III not transversely microridged; sterna various 26

26\. Forewing stigma pale yellow, flagellum reddish, wings water clear 27

– Forewing stigma brown to black, other characters various 28

27\. Mesopleuron densely silvery, obscuring punctation; most of frons densely silvery (Fig. 7) *argenteum* Kimsey

– Mesopleuron with obvious punctation; much of frons moderately silvery *leucostigma* Bohart

28\. Lower frons with punctation a little more coarse or irregular toward eye margins; pubescence of lower frons moderate to scanty, often pale fulvous 29

– Lower frons with zone of fine and even punctation extending to eye margins; pubescence of lower frons forming a dense silvery mat on either side 31

29\. Basal vein distinctly curved (Fig. 4), S-III brown in both sexes, tegula brown *lividum* Bohart

– Basal vein practically straight (as in Fig. 5), S-III usually bluish or with bluish highlights 30

30\. Brow rough overall, punctures practically contiguous; tegula partly bluish or greenish *paulum* Bohart

– Brow smooth overall, punctures separated by small smooth areas; tegula brown *milleri* Kimsey

31\. Abdomen, hindcoxa and hindfemur light red without greenish or bluish *semirufum* Cockerell

– Abdomen, hindcoxa and hindfemur marked with green to blue 32

32\. Punctures across brow much finer toward compound eyes, brow with a V-shaped median swelling (Fig. 12) *frontis* Kimsey

– Punctures across brow nearly even in size (Fig. 13) 33

33\. Brow well developed all across, overhanging scapal basin; tegula bright green or blue; RS stub shorter than basal vein *mirabile* Kimsey

– Brow not well developed; tegula and RS stub various 34

34. F-V about as long as broad or a little longer *gemmatum* Kimsey
- F-V distinctly broader than long (Figs. 23–25) 35

35. Tegula with bluish reflections, male F-V twice as broad as long (Figs. 24, 25), flagellum dark brown, RS stub as long as basal vein *arietinum* Bohart
- Tegula brown, male F-V less than twice as broad as long (Fig. 23), flagellum reddish, RS stub shorter than basal vein *antennatum* Kimsey

Hedychridium amabile Cockerell
(Figs. 6, 33)

Hedychridium amabile Cockerell, 1903:262. Female holotype, "Mesilla Park," Las Cruces, New Mexico, USNM, Washington.

Male (topotype).—Length 2.5 mm, forewing 1.8 mm; body green with extensive gold and coppery to coppery red; latter especially on vertex, pronotum, mesonotum and terga; tegula brown; abdominal venter brown with coppery highlights, particularly on S-II; wings almost clear. Pubescence pale, inconspicuous except on outer third of lower frons. Punctation fine on lower face, coarse and shallow on brow, medium and slightly separated on vertex and pronotum, mesopleural area above midcoxa microridged, punctures medium fine and 0.5 puncture diameter apart toward middle of T-II. Face (Fig. 6); malar space subequal to pedicel length; flagellum slender, F-I length 2.8 times breadth and 1.6 times pedicel length, F-V length 1.2 times breadth, F-XI 2.2 times; brow evenly rounded from midocellus to lower face; forewing basal vein nearly straight, as long as RS stub, meeting MCu at a strongly obtuse angle; genitalia (Fig. 33), digitus subovoid, three-sevenths as long as gonostyle, aedeagus with lateral bristle row.

Female (homotype and topotype).—Length 2.6 mm, F-I length 3 times breadth.

Distribution.—We have seen 50 males and 142 females from NEW MEXICO (Las Cruces, Loving, Carlsbad, Pie Town), COLORADO (Colorado Springs), ARIZONA (Portal, Willcox, Tombstone, Wickenburg, Yuma), WYOMING (Lander), IDAHO (Dietrich), CALIFORNIA (Borrego Springs, Glamis, Palo Verde, nr. Blythe, Needles, Vidal Junction, Thousand Palms, Huntington Park, Gorman, Foster Park in Ventura Co., Oso Flaco Lake and Dune Lakes in San Luis Obispo Co., Shafter, Salinas, Alviso, Isleton, Antioch, Davis, Sacramento, Carmichael, Dillon Beach in Marin Co., Lake Tahoe, Independence Lake in Sierra Co., Webber Lake in Nevada Co., Strawberry in Tuolumne Co. Mexican localities are: BAJA CALIFORNIA NORTE (Valle de Trinidad, 66 mi N San Felipe), TAMAULIPAS (Playa Altamira).

Systematics.—This gold and coppery red wasp rivals some of the most beautiful Old World chrysidids. Its group characters are the long F-I, nearly straight basal vein, microridged posterior mesopleuron, broadly rounded T-III, and brown tegula. The markings and long malar space separate this species from others in the group except for *coruscum*. The longer RS stub and presence of lateral bristles on the aedeagus distinguish the more broadly ranging *amabile*.

Hedychridium antennatum Kimsey, new species

(Figs. 23, 34)

Male holotype.—Length 2 mm, forewing 1.5 mm; head and thorax green except blue green on metanotum, tegula brown, terga green to purplish dorsomedially, S-II-III greenish blue, wings lightly smoky. Pubescence pale, short and dense on lower face, moderately dense on mesopleuron and T-III. Punctation medium coarse on brow, fine and dense on lower face, medium and separated by small polished areas on pronotum; mesopleural area above midcoxa microridged; punctures toward middle of T-II fine, shallow and about 0.5 puncture diameter apart. Malar space about half as long as pedicel; flagellum moderately stout (Fig. 23), F-I length a little less than breadth and shorter than pedicel, F-V length 0.66 times breadth, F-XI 1.5 times; brow a little prominent medially, forming a triangular swelling; forewing basal vein straight, longer than RS stub, meeting MCu at a strongly obtuse angle; T-III rounded but a little drawn out; genitalia (Fig. 34); digitus clubbed and slightly more than half as long as gonostyle; aedeagus without bristles.

Female.—Length 1.5–2 mm, F-I about as broad as long, sterna dark but S-II-III sometimes with blue-green highlights.

Holotype male (UCD), Tucson, Arizona, 27 May 1962 (F. D. Parker and L. A. Stange). Paratypes, 1 male, 2 females, same data as holotype; 1 male, 2 females, ARIZONA: Elfrida, 2 May 1956 (F. Werner, G. Butler, UA); 15 mi N The Gap, 21 September 1966 on *Cleomella* (P. Rust et al., UCD); 3 mi SW Wickenburg, 4 May 1964 (P. Torchio, G. Bohart, USU). An additional specimen has been seen from Nixon, Nevada, 22 June 1962 (R. Bohart, UCD).

Systematics.—*H. antennatum* belongs in the *gemmatum* group: F-I length subequal to pedicel and 1.5 times as long as broad, basal vein straight, and aedeagus without bristles. From *frontis* it can be separated by the reddish rather than brown flagellum with F-V definitely broader than long, tegula without green highlights, punctures similar in size all across brow instead of becoming much smaller toward ocular margins, and RS stub shorter than basal vein. The general coloration of *antennatum* is blue overall with green-blue highlights on S-II-III in both sexes. A distinct characteristic of this species is the broadly expanded and almost paddlelike cuspis (Fig. 34).

Hedychridium argenteum Kimsey, new species
(Figs. 2, 7, 35)

Male holotype.—Length 3 mm, forewing 2.5 mm; head blue green, flagellum light reddish, pronotum green, rest of thorax blue green to purple dorsomedially, terga and S-II-III green; tegula brown, wings water clear; stigma, basal vein and RS pale amber color. Pubescence dense, short, appressed and silvery on head, thorax, and abdomen; especially dense on mesopleuron, obscuring punctation; punctures fine and scattered on vertex, denser in scapal basin, fine and irregular on pronotum, mesopleural area above midcoxa polished, propodeal side polished, punctures toward middle of T-II fine and shallow, separated by 0.5–1.0 puncture diameter. Face (Fig. 7); malar space half as long as pedicel; flagellum slender, F-I length 1.8 times breadth and equal to pedicel length, F-V length 1.3 times breadth, F-XI 2.0 times; brow rounding evenly from micocellus to lower face; forewing basal vein weakly curved, longer than RS stub, meeting MCu at an obtuse angle (Fig. 2); T-III margin slightly obovate; genitalia (Fig. 35); digitus subovoid, a third as long as gonostyle; aedeagus without bristles.

Female.—Unknown.

Male holotype (UCB), 18 miles west of Blythe, Riverside Co., California, 29 April 1952, in nesting site of *Nomadopsis larreae* Timberlake (J. G. Rozen). Paratypes, 1 male (AMNH), same data as type, 1 male topotype, 11 October 1971 (C. Goodpasture, UCD).

Systematics.—*H. argenteum* belongs in the *gemmatum* group. It has F-I as long as the pedicel and less than 1.5 times as long as broad, basal vein straight, and no bristles on the aedeagus. It is distinguished by the presence of dense silvery setae covering most of the body, especially the face, mesopleuron and terga; pale red flagellum; and clear wings with yellow venation.

Hedychridium argentinum Buysson
(Fig. 36)

Hedychridium argentinum Buysson, 1909:195. Female holotype, "Mendoza," Argentina, MNHN, Paris.

Male.—Length 3.5 mm, forewing 3 mm, body blue green but with black infusion in ocellar area, mesonotum, tegula, extensive medial areas of terga; sterna brown, wings smoky. Pubescence pale, inconspicuous on face and elsewhere. Punctation on face coarse and shallow, grading into cross ridging medially; large, shallow and contiguous on pronotum, mesopleural area above midcoxa microridged, propodeal side microsculptured, punctures toward middle of T-II fine and separated by about 3 puncture diameters, sides of T-II and T-III with transverse microridging. Malar space 0.25 times as long as pedicel; flagellum slender, F-I length 1.5 times breadth and 1.2 times pedicel length, F-V length 1.1 times breadth, F-XI 1.8 times; brow rounding into somewhat angularly concave scapal basin; forewing basal vein curved, as long as RS stub, meeting MCu at a slightly obtuse angle, T-III margin broadly rounded, rim indistinct, genitalia (Fig. 36); digitus subovoid, two-fifths as long as gonostyle; aedeagus without bristles.

Female.—Similar to male.

Distribution.—We have seen only the female type (courtesy Ms. Simone Kelner-Pillault) and a male from Isla Choele Choel, Rio Negro, Argentina, 14 January 1968 (J. and L. Stange, UCD).

Systematics.—*H. argentinum* seems to have no close relatives. Essential characters are: F-I a little longer than pedicel, basal vein slightly curved, posterior mesopleuron completely microridged, coarse ridging but inconspicuous hair on lower face, sterna and tegula brown, fine and widely separated punctures on T-II, and transverse microsculpture on T-III.

Hedychridium arietinum Bohart, new species
(Figs. 24, 25, 37)

Male holotype.—Length 2.5 mm, forewing 1.6 mm; body greenish blue including S-II-III; tegula bluish, wings almost clear, stigma light brown. Pubescence pale, inconspicuous except for dense short pile on lower face and appressed hair on T-III. Punctation fine on lower face, grading into narrow median strip of cross ridging; medium on brow, vertex and pronotum but punctures separated by polished areas of about one puncture diameter; mesopleural area above midcoxa microridged; punctures toward middle of T-II fine, shallow, well separated by polished areas; propodeal side nearly impunctate, polished. Malar space as long as pedicel; flagellum broad and flattened (Fig. 24), F-I length 1.2 times breadth and a little shorter than pedicel; F-V length 0.5 times breadth, F-XI 1.3 times; brow smoothly and evenly rounded from midocellus to lower face, forewing basal vein nearly straight, as long as RS stub, meeting MCu at a strongly obtuse angle; genitalia (Fig. 37), digitus subovoid, three-sevenths as long as gonostyle; aedeagus without bristles.

Female.—Length 2–2.5 mm, tegula mostly brown, flagellum moderately stout (Fig. 25), F-I length 1.2 times breadth, F-V broader than long.

Holotype male (UCD), Thousand Palms, Riverside Co., California, 29 March 1977, on prostrate *Euphorbia* (R. M. Bohart). Paratypes, 11 males, 14 females, CALIFORNIA: Thousand Palms and nearby canyon (R. Bohart, E. Grissell, M. Irwin, P. Marsh, F. Parker, UCD, USNM), Borrego Valley in San Diego Co. (R. Bohart, E. Grissell, C. Goodpasture, M. and J. Wasbauer, P. Timberlake, M. Irwin, UCD, CDFA, UCR), Ogilby Road in

Imperial Co. (M. and J. Wasbauer, UCD, CDFA), 3 mi N Glamis (M. and J. Wasbauer, CDFA): NEVADA: Nixon (R. Bohart, UCD).

Systematics.—*H. arietinum* is one of the very small *Hedychridium* with F-I subequal in length to pedicel, tegula brown (but with blue highlights), basal vein nearly straight and as long as RS stub, and wings practically water clear. More specifically, S-II-III have blue highlights, the dorsum of the body is a luminous greenish blue, and the flagellum is unusually broad. In the male, F-V is twice as broad as long, and in the female it is broader than long.

Hedychridium azurellum Bohart, new species
(Figs. 26, 38)

Male holotype.—Length 2.8 mm, forewing 2.2 mm; body greenish blue including S-II and highlights on S-III, ocellar area faintly coppery, tegula brown, metanotum and propodeum purple, wings smoky. Pubescence pale on face to light fulvous elsewhere, inconspicuous except for dense short pile on lower face. Punctation fine on lower face, grading into cross ridging on middle third, coarse and close but shallow and irregular on brow, medium and nearly contiguous on pronotum, mesopleural area above midcoxa microridged, medium fine and slightly separated toward middle of T-II. Malar space subequal in length to pedicel; flagellum slender (Fig. 26), F-I length 2.5 times breadth and nearly twice pedicel length, F-V length 1.2 times breadth, F-XI 2.0 times; brow slightly swollen; forewing basal vein nearly straight and as long as RS stub, meeting MCu at a strongly obtuse angle; genitalia (Fig. 38); digitus subovoid, two-fifths as long as gonostyle; aedeagus with 3 lateral bristles (3–6 paratypes).

Female.—Length 2.0–2.8 mm; F-I length 3 times breadth.

Holotype male (UCD), Deep Springs, Inyo Co., California, 13 May 1974 (R. M. Bohart). Paratypes, 9 males, 9 females collected from May to September: CALIFORNIA: Deep Springs in Inyo Co. (R. Bohart, M. and J. Wasbauer, UCD, USNM, CDFA), Hallelujah Junction in Lassen Co. (R. Bohart, UCD); NEVADA: near Stillwater (F. Parker, UCD; M. Irwin, UCR), Carson Sink in Churchill Co. (R. Bohart, UCD), Mustang (R. Bohart, UCD). An additional 13 males and 9 female specimens have been seen from CALIFORNIA: Adel, Sagehen Creek in Nevada Co., Boca, Independence Lake in Sierra Co., Graegle, Brockway Summit in Placer Co., Carnelian Bay, Hope Valley and Carson Pass in Alpine Co., 11 mi N Bridgeport, Big Pine, Davis, Carmichael, and near Oceano; UTAH: Cornish; WYOMING: Shoshoni.

Systematics.—*H. azurellum* belongs in the *amabile* group which has F-I long, basal vein nearly straight, posterior mesopleuron microridged, tegula brown, and T-III broadly rounded. More particularly, *azurellum* has S-II and male S-III bluish, malar space moderate (1–1.5 MOD), and lower frons finely punctate to the eye margins. The deep blue to purplish metanotum contrasting with the lighter colored green to coppery and green mesonotum is a useful recognition character.

Hedychridium bilobatum Bohart, new species
(Figs. 22, 39)

Male holotype.—Length 4 mm, forewing 3 mm; body greenish blue, tegula green, a sharply defined and bilobed black spot basomedially on T-II (about as in Fig. 22), S-III brown, wings smoky. Pubescence pale, inconspicuous, scanty on lower frons. Punctation coarse on brow, continuing to clypeus in a narrow lateral band, median three-fifths of lower frons transversely microridged, pronotum with close but somewhat irregular moderate punctation, mesopleuron above midcoxa with a polished area, punctures toward middle of T-II fine and separated by 1–1.5 puncture diameters. Malar space half as long as pedicel; flagellum slender, F-I length 2.5 times breadth and 1.6 times pedicel length, F-V length 1.3 times breadth, F-XI 2.5 times; brow slightly overhanging cross ridged part of lower frons, forewing basal vein curved, a little longer than RS stub, meeting MCu at nearly a right angle; apical margin of T-III somewhat angled and drawn out; genitalia (Fig. 39); digitus subovoid, two-fifths as long as gonostyle; aedeagus with a lateral patch of strong bristles.

Female.—Length 3.8–5 mm; T-III a little more pointed than in male; T-II black markings usually as in Fig. 22, sometimes more triangular.

Holotype male (UCD), Sagehen Creek, Nevada Co., California, 29 June 1962 (R. M. Bohart). Paratypes, 21 males, 37 females, collected from June to September in CALIFORNIA: Sagehen Creek, Sattley, Boca, Carnelian Bay, Brockway, near Bridgeport, Fresno Meadow in Placer Co., Independence Lake and Sierra Valley in Sierra Co., Sierraville, Salie Keyes Lake in Fresno Co., Paradise Camp and Twin Lakes in Mono Co., Hallelujah Junction in Lassen Co., Grass Lake in El Dorado Co., Blairsden, Cedarville, Samoa, Santa Cruz Island, San Jose, Carmichael, and Davis. Other specimens determined as *bilobatum* are from Nevada (Mt. Rose, Reno), Oregon (Wallowa Co., Lake Co., Tillamock Co., Corvallis), Idaho (Payette National Forest, Lane), Utah (Ogden Peak in Weber Co.), Wyoming (15 mi S Green River), Colorado (Garden of the Gods), and New Mexico (12 mi N Las Cruces).

Systematics.—*H. bilobatum* is a relatively small member of the *dimidiatum* group with long F-I, short malar space, curved basal vein, partly polished posterior mesopleuron, and weak pubescence on the lower frons. It is distinguished from others of the group by the following combination: green tegulae, double line of coarse punctures along eye margins, slightly angled rather than broadly rounded T-III margin which is not rounded over, brown S-III and sometimes weakly grooved and carinate forefemur. However, most characteristic is the discrete black spot basomedially on T-II. This spot is usually bilobate (Fig. 22) but may be roughly triangular. In the latter case there are usually traces of green in the spot along the midline. As in *menkei* there is a patch of strong bristles laterally on the aedeagus.

Hedychridium caeruleum (Norton)
(Figs. 8, 40)

Hedychrum caeruleum Norton, 1879:239. Female holotype, "Dacota," ANSP, Philadelphia.

Male (specimen from North Dakota).—Length 3.5 mm, forewing 3 mm; body green with some bluish, including S-II-III; tegula mostly brown, wings smoky. Pubescence pale and inconspicuous on face and elsewhere. Punctation moderately coarse and close on head and thorax, merging with fine cross ridging in scapal basin; mesopleural area above midcoxa microridged; punctures toward middle of T-II moderate and slightly separated; those of sterna moderate and close; propodeal side completely sculptured. Face (Fig. 8); malar space a little longer than pedicel; F-I length 1.8 times breadth and 1.2 times pedicel length, F-V length 1.0 times breadth, F-XI 2.0 times; brow not unusually developed but overhanging sunken scapal basin; forewing basal vein slightly curved, longer than RS stub, meeting MCu at an obtuse angle; metanotum nearly triangular in dorsal view, sharply pointed posteriorly; propodeal projection obliquely truncate; S-II somewhat swollen on either side of middle; genitalia (Fig. 40); digitus subquadrangular, three-eighths as long as gonostyle; aedeagus without bristles.

Female.—Length 3.5 mm. F-I 1.9 times breadth, S-III brown.

Distribution.—In addition to the type we have seen 1 male and two females as follows: North Dakota: 11 mi W Walcott, 5 July 1962 (J. R. Powers, UCB); Indiana: Wells Co., 11 September 1971 (R. F. Wilkey, CDFA); Iowa: Ames, 24 June 1891 (UCD).

Systematics.—*H. caeruleum* does not seem to be closely related to any other species. Basic characters are the medium long F-I, malar space, and subantennal distance; basal vein slightly curved and longer than RS stub; and closely punctate sterna. Unique features are the pointed metanotum and obliquely truncate propodeal projection.

Hedychridium carinulatum (Spinola)
(Figs. 9, 15, 42)

Hedychrum carinulatum Spinola, 1851:411. Male holotype, "Chile," repository unknown.

Holopyga suturalis Mocsáry, 1889:140. Syntype females, Chile, HNHM, Hungary; new synonymy, types seen by R. Bohart.

Male (specimen from Olmué, Chile).—Length 6 mm, forewing 5 mm; body blue green to purple including tegula and S-II-III, wings brown stained. Pubescence light fulvous, inconspicuous on face and elsewhere except on T-III which has a narrow, longitudinal, medial stripe of fine hair (Fig. 15). Punctation moderate to coarse on head and thorax, punctures of lower face merging with cross ridging medially; pronotal punctures of two sizes, mostly contiguous; mesopleural area above midcoxa polished; punctures toward middle of T-II mostly 0.5 puncture diameter apart. Face (Fig. 9); malar space 0.33 times pedicel length; flagellum slender, F-I length 2.4 times breadth and twice as long as pedicel, F-V length 1.2 times breadth, F-XI 2.6 times; clypeus projecting a little medially; brow slightly swollen and scapal basin a little concave; forewing basal vein strongly curved, as long as RS stub, meeting MCu at almost a right angle; T-III margin rounded to a slight apicomedial concavity; genitalia (Fig. 42), digitus subovoid, three-eighths as long as gonostyle, aedeagus with an inner projection consisting of five or six stout setae.

Female.—Length 5–7 mm; F-I length 2.8 times breadth, S-I-III green, medial projection of clypeus dentiform in side view; no hair stripe on T-III.

Distribution.—This species is relatively abundant in Chile, where it occurs from Chiloé Province to Coquimbo Province. We have also seen specimens from across the Andean passes in Chubut and Neuquen Provinces of Argentina. We have seen 60 males and 88 females.

Systematics.—*H. carinulatum* does not seem to have any close relatives. This is indicated by the peculiar aedeagal tuft (Fig. 42) and the hair "pencil" on T-III of the male (Fig. 15). Other features are the long F-I, short malar space, strongly curved basal vein, and toothlike median clypeal lobe of the female.

Hedychrum discoidale Buysson (1909) from Mendoza, Argentina (UZMC, Copenhagen) was based on 4 males, one of which was labelled lectotype by R. M. Bohart and is here designated as such. This species is remarkably similar to *carinulatum*, even to the hair "pencil" on T-III. The split claws of *discoidale* place it in the genus *Hedychrum*. Other differences from *carinulatum* are rather subtle. In *discoidale* the ocelli are slightly lidded, the scapal basin is finely but not deeply cross ridged, overall punctation is more coarse, notal punctation is closer, and the clypeal apex is less protruding.

Hedychridium centrale Bohart, new species

Female holotype.—Length 3 mm, forewing 2.5 mm; body blue-green with black in interocellar area, middle third of scutum, scutellum mostly, large basomedian area on T-II, small median spot on T-III; tegula and sterna brown; wings lightly brown stained. Pubescence pale, fine and moderately dense on outer third of lower face, otherwise inconspicuous. Punctation fine and close on lower face, coarse and slightly separated on brow, moderate on pronotum but irregularly sized and nearly contiguous, mesopleural area above midcoxa microsculptured and weakly ridged, moderately fine and about a puncture diameter apart toward middle of T-II. Malar space 0.33 times as long as pedicel; interocellar area with a shiny and irregularly punctate tubercle between hindocelli and extending at a lower elevation between midocellus and each hindocellus; flagellum slender, F-I length 1.5 times breadth and 1.3 times pedicel length, F-V length 1.0 times breadth, F-XI 1.7 times; brow somewhat overhanging lower face; forewing basal vein evenly and weakly curved, longer than RS stub, meeting MCu at a slightly obtuse angle; T-III apical margin broadly rounded, a little rounded over.

Male.—Unknown.

Holotype female (UCD), Quezaltepeque, El Salvador, 16 July 1963 (D. Cavagnaro, M. Irwin). Paratypes, 6 females, same data as holotype but collected 6 August (UCD, USNM). Two additional females referable to *centrale* are from Mexico: 15 mi NE Guadalajara, Jalisco, 17 September 1970 (R. M. Bohart, UCD); and 23 mi N Manzanillo, Colima, in Malaise trap (M. and J. Wasbauer, CDFA).

Systematics.—The prominent brow, moderately long F-I, dense lower frontal pubescence, gently curved basal vein, and well developed subantennal area place *centrale* in the *fletcheri* group. There, the tuberculate interocellar area and black markings of the head, scutum and T-II are distinctive for *centrale*.

Hedychridium cockerelli Buysson

Hedychridium cockerelli Buysson, 1906:111. Male (not female) holotype, "South Boulder Canon, Colorado," MNHN, Paris.

Male holotype.—Length 2.5 mm, forewing 2 mm; body blue-green with coppery reflections; more bluish on prothorax, metathorax and propodeum; median third of T-II deep purple; tegula and abdominal venter brown; wings smoky. Pubescence pale, short and abundant on either side of lower frons, inconspicuous elsewhere. Punctation fine on outer third of lower frons except for a narrow zone of coarser punctures along eye margin; coarse and shallow on brow, medium and fairly close on pronotum, mesopleural area above midcoxa microridged, punctation fine and nearly contiguous toward middle of T-II. Face about as in Fig. 6; malar space longer than pedicel or F-II; flagellum slender, F-I length 3.5 times breadth and 1.5 times pedicel length, F-V length 1.2 times breadth, F-XI 2.2 times; brow rounded and slightly prominent; forewing basal vein nearly straight, as long as RS stub, meeting MCu at a strongly obtuse angle.

Female.—Unknown.

Distribution.—We have seen only the type specimen from Colorado, courtesy of Ms. S. Kelner-Pillault.

Systematics.—In the *amabile* group, *cockerelli* has F-I long, basal vein nearly straight, tegula brown, and posterior mesopleuron microridged. More particularly, the malar space is long, lower frons with punctures more coarse toward eye margins, S-III brown, and T-II greenish. *H. cockerelli* is similar to *amabile* and, except for the coarser lower frons punctation, might be considered an extreme bluish color form of it.

Hedychridium cornutum Bohart, new species
(Fig. 41)

Male holotype.—Length 2.5 mm, forewing 1.8 mm; body green with extensive coppery on ocellar area, terga and sterna; coppery to red on pronotum, scutum and apex of T-I; tegula green, wings smoky. Pubescence pale, present but not dense on outer third of lower face, inconspicuous elsewhere. Punctation fine to moderate on head and thorax but separated by dense microreticulation (about as in magnified part of Fig. 11); punctures of pronotum mostly 0.7–0.8 puncture diameter apart; mesopleural area above midcoxa microridged; punctures toward middle of T-II about 0.5 diameter apart; microridged area of lower frons limited to a small triangle above antennae. Malar space as long as pedicel; flagellum broadened and flattened (about as in Fig. 24), F-I length 1.2 times breadth and about as long as pedicel, F-V length 0.7 times breadth, F-XI 1.3 times; brow rounding evenly from midocellus to lower face; forewing basal vein nearly straight, as long as RS stub, meeting MCu at a strongly obtuse angle; genitalia (Fig. 41); digitus subquadrangular, two-fifths as long as gonostyle; aedeagus without bristles.

Female.—Length 2.5 mm, sterna brown, F-I 1.4–1.6 times breadth, F-V length equal to breadth, markings often extensively coppery to red.

Holotype male (UCB, on permanent loan to CAS), Dune Lakes, San Luis Obispo Co., California, 7 June 1973, on *Croton californicus* (J. Powell). Paratypes, 21 males, 12 females, collected from April to July. Records are all from the southern half of CALIFORNIA: Santa Cruz Island in Santa Barbara Co. (R. Brumley, UCD), 3 mi S Oceano on *Croton californicus* (J. Powell, R. Coville, UCB, UCD, USNM), Oso Flaco Lake in San Luis Obispo Co. (R. Bohart, UCD), Riverside on *Euphorbia albomarginata* (P. Timberlake, UCR, UCD, USNM); 7 mi E Sunnymead (M. Irwin, UCR); Vidal (J. MacSwain, UCB).

Systematics.—As discussed under *frugale*, that species and *cornutum* share a dense microreticulation between and within punctures of the head and thorax, as well as small size, coppery to coppery red markings, a nearly straight basal vein, short and quadrangular digitus, and no bristles on the aedeagus. *H. cornutum* differs in the closer and more distinct punctures of the body, particularly the pronotum and T-II. Also, F-I is shorter (1.2–1.6 times breadth), and F-V is much stouter in both sexes. All of the type series have at least some coppery to reddish coloration, especially on the scutum. Eight additional females with blue to green, but without coppery, are presumptive *cornutum*. They are from the California localities of Deep Springs and Owens Lake, Inyo Co.; Mira Loma, Riverside Co.; and Borrego Valley, San Diego Co.

Hedychridium coruscum Bohart, new species
(Fig. 43)

Male holotype.—Length 3.5 mm, forewing 2 mm; head and thorax green but marked on top of head, pronotum and mesonotum with extensive coppery to coppery red; terga mostly bright coppery red, S-II mostly greenish, S-III dark with coppery highlights; tegula brown, wings lightly smoky. Pubescence pale, inconspicuous except for short pile on lower face. Punctation fine on lower face, merging with fine cross ridges in middle third; medium and fairly close on brow; medium and contiguous on vertex and pronotum, mesopleural area above midcoxa microridged, fine and slightly separated toward middle of T-II. Face about as in Fig. 6; malar space 1.2 times pedicel length; flagellum slender, F-I length 2.4 times breadth and 1.8 times pedicel length, F-XI 2.5 times; brow rather sharply rounded above scapal basin but not obviously swollen; forewing basal vein nearly straight, longer than RS stub, meeting MCu at a strongly obtuse angle; genitalia (Fig. 43), digitus long ovoid, two-thirds as long as gonostyle; aedeagus without bristles.

Female.—Length 2.5–3 mm; F-I length 3 times breadth.

Holotype male (UCD), Goleta, Santa Barbara Co., California, 6 July 1959, in nesting site of *Oxybelus sericeus* Robertson (R. M. Bohart). Paratypes, 10 males, 11 females, same data as holotype but collected from 22 June to 15 July (UCD, UCB, USNM). Additional collectors were C. A. Campbell, F. D. Parker, and P. M. Marsh.

Systematics.—This beautifully marked, small chrysidid is quite similar to *amabile*, including the long F-I and long malar space. The only discernible external difference is the short RS stub of *coruscum*. Otherwise, the absence of bristles on the aedeagus, and the differently shaped digitus (Fig. 43) can be used for separation. Although *amabile* is widespread, *coruscum* is known only from the sand beach locality on the University of California, Santa Barbara campus.

Hedychridium crassum Bohart, new species
(Figs. 21, 44)

Male holotype.—Length 5.5 mm, forewing 5 mm; body blue-green, scutum and metanotum partly purple, S-II-III green, tegula brown, wings brown stained. Pubescence pale, inconspicuous in scapal basin. Punctures moderately coarse, dense on clypeus, practically contiguous and similar in size on head, pronotum and T-II; lower frons transversely microridged in middle third; mesopleural area above midcoxa punctate. Malar space a little less than unusually short pedicel; flagellum slender, tapering, each article cylindrical, F-I length 2.2 times breadth and 3 times pedicel length, F-V length 1.6 times breadth, F-XI 4 times; brow starting rather abruptly above scapal basin but not obviously swollen, face unusually flat, forewing basal vein curved, as long as RS stub, meeting MCu at a right angle; T-II strongly swollen across apex (Fig. 21); T-III broadly rounded over apically, somewhat blunt and ending in a darkened membranous rim; T-II-III with traces of a median longitudinal carina; genitalia (Fig. 44) weakly pigmented; digitus slender, two-fifths as long as gonostyle which is unusually slender; aedeagus without bristles.

Female.—Length 4–6 mm; body green to purple, face usually green, tegula sometimes a little blue. S-I-III marked with green to blue.

Holotype male (UCD), Hallelujah Junction, Lassen Co., California, 2 July 1968 (R. M. Bohart). Paratypes, 44 males, 30 females from the following localities: CALIFORNIA: Tule Lake, Artois, Williams, Westgard Pass in Inyo Co., Mt. Diablo, Davis, Miami Ranger Station in Mariposa Co., Stockton, Santa Cruz Island, Woodlake, Foster Park in Ventura Co.; NEVADA: Orovada, near Eastgate, Spring Valley, Paradise Valley, Minden, 7 mi E Oreana; OREGON: Summer Lake, Medford, Warner Pass in Lake Co., Corvallis; WASHINGTON: Pullman, Benton Co., Prosser; IDAHO: near Malta, Salyer Cow Camp and Roy Summit in Oneida Co., Sublett Reservation in Cassia Co., 14 mi NE Mountain Home, 12 mi SE Oakley; UTAH: near Snowville, Cedar Hill, Curlew River, Grantsville, Leeds Canyon in Washington Co.; ARIZONA: 10 mi W Jacob Lake, near Portal, Sabino Canyon, Oak Creek Canyon; COLORADO: Moffat Co.; MONTANA: Dixon; NEBRASKA: North Platt, Neligh, 7 mi N Harrison; SOUTH DAKOTA: Vasta; IOWA: Ankeny; MEXICO (GUERRERO): Acapulco. Months of collection are June to September.

Systematics.—Among the *Hedychridium* with long F-I, *crassum* can be recognized at once by the swollen margin of T-II (Fig. 21). Otherwise it seems related to *purum* and *incisum*, which are smaller species, by a combination of characters: pedicel two-fifths to one-third as long as F-I; flagellum unusually cylindrical; basal vein curved; clypeus rather densely punctate, brow punctation moderate, close, and similar to that on lower frons; S-III blue; and male genitalia weakly pigmented. Female *crassum* in collections frequently have the ovipositor exserted and as long as the abdomen.

Hedychridium crebrum Kimsey, new species
(Figs. 16, 45)

Male holotype.—Length 3.5 mm, forewing 3 mm; body blue green, a dark spot basomedially on T-II, tegula and S-II-III blue, wings smoky. Pubescence pale, inconspicuous on face and elsewhere. Punctation moderately coarse and close on head and thorax, a little finer and nearly contiguous on terga; mesopleuron above midcoxa and propodeal side completely ridged. Malar space 0.3 times as long as pedicel; flagellum slender, F-I length 2.8 times breadth and 1.8 times pedicel length, F-V length 1.2 times breadth, F-XI 2.5 times; brow rather sharply rounded but not strongly projecting; forewing basal vein curved, as long as RS stub, meeting MCu at a slightly obtuse angle; T-III margin angulate, posterior apex rounded but drawn out (Fig. 16); genitalia (Fig. 45); digitus long ovoid, five-ninths as long as gonostyle; aedeagus without bristles.

Female.—Length 3–4 mm, body green to blue or purple, S-II blue or green, S-III partly blue or green.

Holotype male (UCD), Mariposa Canyon, Mariposa Co., California, 18 June 1968 (R. M. Bohart). Paratypes, 7 males, 16 females, OREGON: Medford (A. McClay, UCD); CALIFORNIA: Hornbrook station in Siskiyou Co. (D. Douglas, CDFA), Susanville (T. Haig, CDFA), Davis (S. Miyagawa, M. Irwin, A. McClay, F. Parker, C. Kovacic, R. Bohart, UCD, USNM), Farnham Ridge in El Dorado Co. (J. Leevers, UCD), Clarksburg (R. Bohart, UCD), Tassajara (G. Bohart, UCD), Mariposa (R. Bohart, UCD), 5 mi NE Santa Margarita (R. Thorp, UCD), Thousand Palms (P. Marsh, UCD), Riverside (J. Hall, UCR), Borrego Valley in San Diego Co. (E. Schlinger, UCD), Fish Creek Mts. in Imperial Co. (W. Mason, Canadian National Collection); UTAH: 14 mi E Moab (P. Torchio, USU), Leeds Canyon in Washington Co. (W. Hanson, USU). Dates of collection are April to May in southern California desert areas and June to October in more northerly localities.

Systematics.—*H. crebrum* belongs to the *dimidiatum* group which has the malar space less than 0.5 MOD, F-I more than twice as long as broad, pedicel over half as long as F-I, lower frons not densely pubescent and basal vein strongly curved. It is distinguished by having the margin of T-III drawn out posteromedially into a rounded point, especially in females

(Fig. 16), and the pronotal punctures rather even and not much coarser than those of T-II.

Hedychridium dimidiatum (Say)
(Figs. 19, 30, 32, 46)

Hedychrum dimidiatum Say, 1824:330. Holotype female, "Pennsylvania," destroyed.

Chrysis mexicana Cameron, 1888:460. Holotype female, "Mexico, Zacatecas City," BMNH, London; new synonymy, type seen by R. Bohart.

Holopyga mexicana Mocsáry, 1911:448. Holotype male, "Mexico," HNHM, Hungary, nec Cameron, 1888; new synonymy, type seen by R. Bohart.

Male (specimen from New York).—Length 6.5 mm, forewing 5 mm; body green to blue, ocellar area dark, tegula brown, a dark spot mediobasally on T-II, S-II-III mostly green, wings brown stained. Pubescence pale, inconspicuous on face and elsewhere. Punctation moderate to coarse, coarse on lower face merging with cross ridging on middle third, coarse and contiguous on pronotum, moderate and slightly separated toward middle of T-II; mesopleural area above midcoxa punctate and partly polished. Malar space 0.25 times as long as pedicel; flagellum slender, F-I length 2.5 times breadth and 2.0 times pedicel length, F-V length 1.1 times breadth, F-XI 2.8 times; brow prominent, overhanging somewhat sunken scapal basin; forefemur creased and carinate along lower outer edge (Fig. 30); forewing basal vein strongly curved, longer than RS stub, meeting MCu at a right angle; T-III distinctly rounded over and indented before apical membranous margin; genitalia (Fig. 46); digitus sublinear, half as long as gonostyle; aedeagus without bristles.

Female.—Length 4.5–7.5 mm, F-I length 3 times breadth, S-III brown.

Distribution.—We have seen 287 males and 334 females from most of the United States as well as from Canada (Alberta, British Columbia) and Mexico (Jalisco, San Luis Potosí, Morelos, Distrito Federal, Baja California Norte).

Systematics.—Group features are the long F-I, short malar space, curved basal vein, partly polished posterior mesopleuron, and weak pubescence on the lower frons. Considering the broad range of *dimidiatum*, it is not surprising that size and markings are variable. In most specimens the punctures of T-II are moderate sized, deep, and separated by about 0.5 puncture diameter. The tegulae are usually brown but in about 10 percent of the specimens there is at least some green. More distinctive characters are the angled and rounded over T-III (Fig. 19), grooved and carinate forefemur (Fig. 30), and usually unmarked base of T-II. The character of the forefemur is otherwise found only in *olene* and *bilobatum* (weakly) among nearctic species. However, it occurs in several European species, such as *ardens* (Coquebert), *incrassatum* (Dahlbom), and *moricei* Buysson.

Hedychridium fletcheri Bodenstein
(Figs. 10, 27, 47)

Hedychrum viride Cresson, 1865:306. Lectotype female, "Colorado Territory," ANSP, Philadelphia; nec Guérin, 1842.

Hedychridium fletcheri Bodenstein, 1951:720; new name for *Hedychrum viride* Cresson.

Male (specimen from Montrose County, Colorado).—Length 7 mm, forewing 5 mm; head, thorax and terga bluish green, tegula and S-II green, S-III brown, wings smoky. Pubescence pale and short, dense on lower face. Punctation coarse and dense on brow, fine and dense on lower face; dense and both coarse and fine on pronotum; mesopleural area above midcoxa punctate to slightly ridged and partly polished; punctures fine toward middle of T-II, one to two puncture diameters apart; face (Fig. 10), ocelloclypeal distance as long as least interocular distance, subantennal distance unusually long, malar space about 0.6 times pedicel length; flagellum moderately stout (Fig. 27), F-I length 1.8 times breadth and 1.2 times pedicel length, F-V length subequal to breadth, F-XI 2.5 times; brow a little swollen; forewing basal vein curved, longer than RS stub, meeting MCu at a slightly obtuse angle; T-III margin somewhat drawn out; genitalia (Fig. 47); digitus elongate and linear, three-fourths as long as gonostyle; aedeagus without bristles.

Female.—About as in male, lower frons not as pubescent.

Distribution.—We have seen about 550 males and 1,040 females of this relatively common species. Most of these came from west of the 100th meridian, as far north as Saskatchewan and as far south as Chihuahua and Baja California Norte in Mexico. Some were also collected in Nebraska, Kansas, Minnesota, Texas, Iowa, Indiana, Illinois, Manitoba, and Florida. We have seen no specimens from northeastern U.S.

Systematics.—*H. fletcheri* is the most commonly collected species of the genus in America north of Mexico. It is also rather variable, as might be expected. Large specimens, such as the male described above, are easily recognized by the moderately long F-I (1.7–1.9 times breadth), moderately curved basal vein which meets MCu at an obtuse angle, somewhat prominent brow which overhangs a lower frontal zone of fine punctation bearing silvery pile in the male, and an unusually long face including a subantennal distance subequal to the pedicel length. In small specimens, some only 3 mm long, the above characters may be less pronounced. Especially, F-I may be only 1.5 times breadth. Male genitalia mounts of variant specimens have not indicated the presence of more than one species. Unfortunately, there are no host data for this species. It is possible that different host size or species might account for variation. Most *fletcheri* occur in shades of green to blue. Occasionally a specimen may be purplish or rarely may have considerable coppery markings. Several European species resemble *fletcheri* in the long and pubescent face of the male. Especially close in other respects also is *jucundum* (Mocsáry) which differs primarily by its extensive reddish markings and mostly dark sterna.

Hedychridium frontis Kimsey, new species

(Figs. 5, 12, 48)

Male holotype.—Length 2 mm, forewing 1.5 mm; head and thorax blue green, tegula brown and a little blue, terga blue green to black dorsomedially, S-II greenish blue, S-III brown, wings clear. Pubescence pale; short and dense on lower face; moderate in postocular area, mesopleuron and propodeum. Punctation medium to coarse and dense toward middle of brow, fine and dense on lower face and sides of brow, medium and separated by polished areas on pronotum; mesopleural area above midcoxa rather irregularly punctate; punctures toward middle of T-II fine, shallow and about one puncture diameter apart; T-III with fine, shallow punctures. Face (Fig. 12), malar space 0.3 as long as pedicel; flagellum moderately slender, F-I length 1.3 times breadth, a little shorter than pedicel, F-V length slightly less than breadth, F-XI 1.6 times; brow forming a V-shaped median swelling (Fig. 12); forewing basal vein straight, as long as RS stub, meeting MCu at a strongly obtuse angle (Fig. 5), T-III margin broadly rounded; genitalia (Fig. 48); digitus subovate, four-sevenths as long as gonostyle; aedeagus without bristles but with lateral projection.

Female.—Length 1.5–2.0 mm; F-I length equal to that of pedicel; terga usually somewhat violet; coppery tints frequent, especially in ocellar area.

Holotype male (UCD), 18 mi W Blythe, Riverside Co., California, 2 April 1963 (R. M. Bohart). Paratypes, 10 males, 10 females (UCD, USNM, CDFA, CAS, UCR, AMNH, UCB) same data as holotype but some collected by M. Irwin, F. Parker and D. Horning. Other paratype dates are 3 April and 14–16 October. Three male and 4 female paratypes are from Cronise Valley (San Bernardino Co.), Borrego, and Thousand Palms, California. Additional specimens have been seen from Tucson, Arizona; and 36 mi N El Golfo, Sonora, Mexico.

Systematics.—Since F-I is subequal in length to the pedicel and 1.5 times as long as broad, and the basal vein is nearly straight, *frontis* is placed in the *gemmatum* group. It is similar to *antennatum* but can be distinguished by the punctures on the brow, which are coarse medially but become fine near the ocular margins. Also, the RS stub is as long as the basal vein. This species is generally greenish to a little coppery and violet in females. S-III is greenish in the male and brown in the female, and the tegulae have greenish highlights. The aedeagus has an elongate lateral arm (Fig. 48), which is quite unlike the situation in any other *Hedychridium* studied.

Hedychridium frugale Bohart, new species
(Figs. 11, 49)

Male holotype.—Length 2 mm, forewing 1.6 mm; head and thorax green but marked on top of head, pronotum and mesonotum with coppery to coppery red; terga greenish to violet, T-II mostly violet, tegula and S-II-III brown; wings nearly clear. Pubescence pale, moderate and short on lower face, inconspicuous elsewhere. Punctation fine on lower face, merging with broad median cross ridging; medium and shallow on brow; fine and sparse on vertex, pronotum and terga but separated by dense microreticulation; that on pronotum and T-II giving a transverse effect; mesopleural area above midcoxa microridged; face (Fig. 11); malar space 0.6 as long as pedicel; flagellum slender, F-I length 2.1 times breadth and 1.2 times pedicel length, F-V length 1.2 times breadth, F-XI 2.7 times; brow rounding evenly from midocellus to lower face; forewing basal vein almost straight, as long as RS stub, meeting MCu at a strongly obtuse angle; genitalia (Fig. 49), digitus subquadrangular, two-fifths as long as gonostyle; aedeagus without bristles.

Female.—Length 2–2.5 mm, F-I length 2.2–2.5 times breadth.

Holotype male (UCD), Glamis, Imperial Co., California, 8 April 1964 (R. M. Bohart). Paratypes, 32 males, 44 females: CALIFORNIA: near Glamis, Palo Verde, 18 mi W Blythe, Thousand Palms, Borrego Valley, Baker, near Indio, 7 mi SW Kelso, Santiago Canyon in Orange Co., Deep Springs in Inyo Co., 19 mi W Shafter, Sacramento; ARIZONA: 32 mi S Quartzite, 21 mi N Yuma, 3 mi SW Wickenburg. Collection dates range from 22 March to 8 April in southern California deserts, May in Sacramento Valley, April to May in Arizona, and September at Deep Springs. Collection depositories: UCD, USNM, CAS, USU, CDFA, LACM, UCB, UCR.

Systematics.—A few species of *Hedychridium* have a pronounced microsculpture or reticulation separating the punctures of the head (Fig. 11) and thorax. Two of these, *frugale* and *cornutum*, are recognized here. They share the following additional characters: small size; basal vein almost straight and as long as RS stub, markings extensively coppery to coppery red, short and subquadrangular digitus (Fig. 41, 49), and no bristles on the aedeagus. From *cornutum* the differentiating characters of *frugale* are the more slender flagellum in both sexes, longer F-I (2.1–2.5 times breadth), much more widely spaced punctures, and a strong tendency for reticulation of thorax and abdomen to give a transverse effect. Some primarily green to blue *Hedychridium* show microreticulation and may be *frugale*, but the concept is here restricted to the forms marked with extensive coppery and coppery red.

Hedychridium gemmatum Kimsey, new species
(Fig. 50)

Male holotype.—Length 2 mm, forewing 1.5 mm; head and thorax green, metanotum blue green, terga green grading to purplish medially, S-II-III green, tegula brown, wings clear. Pubescence pale, short and dense on lower frons, obvious on tergum III. Punctation coarse and sparse on brow, fine and dense on lower frons without medial cross ridging, punctures large and medium-sized on pronotum but with polished interspaces, mesopleural area above midcoxa microridged, punctures toward middle of T-II separated by 1–2 puncture diameters. Malar space 0.7 times as long as pedicel; flagellum slender, F-I length 1.4 times breadth and 1.2 times pedicel length, F-V as long as broad, F-XI 1.6 times, brow rounding evenly to lower frons; basal vein straight, longer than RS stub, and meeting MCu at a strongly obtuse angle; T-III margin broadly rounded; genitalia (Fig. 50); digitus subovoid, four-ninths as long as gonostyle; aedeagus without bristles.

Female.—Similar to male, ocellar area and notum often a little coppery.

Holotype male (UCD), 18 mi W Blythe, Riverside Co., California, 9 October 1971 (R. M. Bohart). Paratypes, 6 males, 2 females, same data as holotype except for F. Parker and E. Grissell as additional collectors and 16 October 1965 as an additional date (UCD, USNM); 1 female, Borrego Valley in San Diego Co., 19 April 1957 (R. Bohart, UCD), 2 males, Wilcox, Arizona on *Euphorbia* (P. Hurd, UCB). An additional specimen has been seen from Las Cruces, New Mexico.

Systematics.—*H. gemmatum, frontis* and *antennatum* are in the same group and share the straight basal vein, F-I about 1.5 times as long as broad and subequal in length to the pedicel, and small size. It is distinguished by a combination of characters: antenna dark, tegula brown, F-V at least as long as broad, punctures coarse all across the rather smoothly rounded brow, and the RS stub shorter than the basal vein.

Hedychridium guatemalense (Cameron)
(Fig. 17)

Hedychridium guatemalense Cameron, 1888:459. Holotype female, "Guatemala, Zapote, Panzos," BMNH, London.

Holopyga kohli Buysson, 1901:100. Holotype female, "Bresil," Brazil, MNHN, Paris, new synonymy, type seen by R. Bohart.

? *Holopyga pallolimbata* Ducke, 1903:133. Holotype female, "Itaituba am Tapajós," Pará, Brazil, Mus. Belém (?), tentative new synonymy.

Female (specimen from Guatalón, Guatemala).—Length 8.5 mm, forewing 6.5 mm; body green with purple along sulci and basally on T-II-III; tegula purple, S-II-III green, wings brown stained. Pubescence pale fulvous, inconspicuous on face, scattered on dorsum of body, abundant and mostly appressed on sterna. Punctation coarse and close on brow, almost defining an irregular cross carina; coarse on lower face, merging with a broad, median, cross ridged area; coarse and contiguous on pronotum, lateral lobe polished in side view; mesopleural area above midcoxa and propodeal side extensively polished; moderate, slightly separated and somewhat transverse on T-II-III; S-II moderately punctate, S-III rather closely so. Malar space 0.4 times as long as pedicel; flagellum slender, F-I length 2.9 times breadth and 2.1 times pedicel length, F-V length 1.3 times breadth, F-XI 5 times; brow moderately prominent, lower face slightly concave, ocelli lidded, pronotal lobe carinate dorsally, forewing basal vein strongly curved, as long as RS stub, meeting MCu at a right angle; propodeal projection unusually stout, approaching a right angle; T-III slightly depressed subapically, indented at posterior middle of margin (Fig. 17).

Male.—Unknown.

Distribution.—We have seen 14 females of this widespread tropical species, including the types of *guatemalense* and *kohlii.* New locality records are: GUATEMALA: Mocá, Guatalón (J. Bequaert, UCD); PANAMA: Barro Colorado Island (C. and M. Rettenmeyer, Kansas State University, UCD; L. Kimsey, UCD); VENEZUELA: Paraitepuy, Bolivar (P. Anduze, UCD); BRAZIL: Belém, Pará (Oliveira and Wygodzinsky, AMNH); ARGENTINA: Oran, Salta (R. Golbach, Tucumán, UCD), Horco Molle (L. Stange, UCD).

Systematics.—*H. guatemalense* seems to have no close relatives. Basic characters are the long F-I, strongly curved basal vein, short malar space, and green S-III. Specific characters are the extensively polished lateral pronotum, posterior mesopleuron, and lateral propodeum; lidded ocelli; and apicomedially indented T-III. It is the largest of our *Hedychridium*, slightly surpassing *dimidiatum* and *nevadae*.

Hedychridium incisum Bohart, new species
(Figs. 18, 51)

Male holotype.—Length 3.3 mm, forewing 2.5 mm; body blue-green including S-II-III, an ill-defined purple spot basomedially on T-II, wings light smoky. Punctures moderately coarse, dense on clypeus, practically contiguous and similar in size on head, pronotum, and T-II, lower frons microridged above antennal sockets, mesopleural area above midcoxa punctate and narrowly polished. Malar space a little less than unusually short pedicel; flagellum slender, tapering, each article cylindrical, F-I length 2.3 times breadth and 2.2 times pedicel length, F-V length 1.3 times breadth, F-XI 2.5 times; brow rounded, face unusually flat; forewing basal vein strongly curved, as long as RS stub, meeting MCu at a right angle; T-III margin broadly rounded except for a posteromedial indentation; genitalia (Fig. 51) weakly pigmented; digitus slender, three-fifths as long as gonostyle; aedeagus without bristles.

Female.—Length 3.3–4.0 mm, T-III somewhat more drawn out before apical indentation, flagellum reddish toward base.

Holotype male (UCD), Sierra Valley, Sierra Co., California, 24 July 1971 (R. M. Bohart). Paratypes, 3 females, same data as holotype but collected 7 and 11 July 1970. A female which appears to be this species was taken on *Eriogonum fasciculatum*, 9 mi S Warner Springs, San Diego Co., California (R. C. Bechtel, UCD). It is purplish overall.

Systematics.—*H. incisum* shares with *crassum* and *purum* the short pedicel, cylindrical flagellomeres, uniform punctation of brow and lower frons, curved basal vein, and weakly pigmented male genitalia with linear digitus. It differs from *crassum* by smaller size and unswollen T-II, from *purum* by longer F-I and smoky wings. From both of the above the indented posterior margin of T-III is distinctive.

Hedychridium leucostigma Bohart, new species
(Fig. 52)

Male holotype.—Length 2 mm, forewing 1.6 mm; body bluish green with some coppery reflections on dorsum of head and thorax; terga partly violet, especially on T-II. S-II-III with coppery and faint bluish reflections; flagellum entirely, tibiae mostly pale reddish; forewing stigma, basal vein and RS translucent yellow, tegula brown, wing membrane water clear. Pubescence slivery white, short and dense on lower face except narrow, median, cross ridged strip; fine silver pubescence easily visible on other body parts, especially terga. Punctation fine and close on lower face, moderate on brow, fine and separated by about a puncture diameter on pronotum and T-II, mesopleural area above midcoxa punctate and a little polished, propodeal side with a large polished area. Malar space half as long as pedicel; flagellum slender, F-I length 1.5 times breadth and a little shorter than pedicel, F-V a little wider than long, F-XI length 2.2 times breadth; brow rounding evenly from midocellus to lower face; forewing basal vein almost straight, slightly longer than RS stub, meeting MCu at an obtuse angle; RS stub extending well beyond distal end of stigma; genitalia (paratype) (Fig. 52), digitus stoutly clubbed, nearly half as long as gonostyle; aedeagus without bristles.

Female.—Length 2 to 2.5 mm, S-I-II brown.

Holotype male (UCD), Borrego Valley, San Diego Co., California, 11 April 1969, on *Croton californicus* (R. M. Bohart). Paratypes, 3 males, 8 females, CALIFORNIA: Needles (R. Schuster, R. Brumley, P. Torchio et al., UCD, USU), Borrego Valley in San Diego Co. (R. Bohart, UCD, USNM), Palo Verde (M. Wasbauer, CSDA), 18 mi W Blythe (R. Bohart, UCD), 6.2 mi N Glamis (M. Irwin, UCD); BAJA CALIFORNIA NORTE: 23 mi N San Luis (M. Irwin, UCR, UCD). Collecting dates of paratypes are in March, April, May and October. An additional female specimen was collected 27 mi SE Tucson, Arizona in May (M. Irwin, UCD).

Systematics.—Among the small species of *Hedychridium* with nearly straight basal vein, brown tegula, reddish flagellum, extensively silvered lower frons, and non-bristled aedeagus, *leucostigma* agrees with *argenteum* in having the wings water clear. Also the veins and stigma are pale yellow rather than brown. From *argenteum* it differs in the less heavily silvered mesopleuron, F-I equal to or a little shorter than pedicel instead of a little longer, flagellum considerably stouter and shorter, and RS stub proportionately longer.

Hedychridium lividum Bohart, new species
(Figs. 4, 53)

Male holotype.—Length 3 mm, forewing 2 mm; body deep greenish blue, thorax more greenish, face a little purplish; T-II with a large mediobasal black spot covering nearly a third of tergum, S-II with a little blue, S-III dark; tegula brown, wings faintly smoky. Pubescence pale, inconspicuous on face and elsewhere. Punctation rather coarse on lower face, grading into transverse rugae medially, coarse and slightly separated but shallow and irregular on brow, medium and practically contiguous on pronotum, fine and separated by one to two puncture diameters toward middle of T-II, mesopleural area above midcoxa irregularly punctate and partly polished. Malar space half as long as pedicel; flagellum slender, F-I length 1.5 times breadth and 1.4 times pedicel length, F-V length about as long as breadth, F-XI 2 times; brow rounded evenly from midocellus to scapal basin; forewing basal vein curved, as long as RS stub, meeting MCu at nearly a right angle (Fig. 4); genitalia (Fig. 53); digitus subovoid, two-fifths as long as gonostyle; aedeagus with a lateral row of bristles.

Female.—Length 2.5–3.5 mm; F-I length 1.5 times breadth.

Holotype male (UCD), Thousand Palms, Riverside Co., California, 29 March 1977, on prostrate *Euphorbia* (R. M. Bohart). Paratypes, 11 males, 5 females, same data as holotype but collected also 2–11 April. Other paratypes, CALIFORNIA: 4 males, 19 mi W Blythe, 11–14 October (R. Bohart, C. Goodpasture, N. Smith, D. Horning, UCD); 3 males, 1 female, Borrego Valley, March to April (E. Grissell, UCD, CAS; M. Wasbauer, CDFA); 3 females, Glamis, April (R. Bohart, P. Marsh, UCD, USNM); 2 males, Deep Springs, Inyo Co., May and September (M. and J. Wasbauer, UCD, CDFA); 1 female, Riverside (P. Timberlake, UCR).

Systematics.—Except for the moderate length of F-I (1.5–1.7 times breadth) and the lightly smoky wings *lividum* could be a member of the *dimidiatum* group. It has a short malar space, strongly curved basal vein, partly polished posterior mesopleuron and weakly pubescent lower frons. T-II has a well developed black area (hence *lividum*: black and blue), and S-III is brown, both of which are features of *bilobatum* and *menkei*. The brown tegula and broadly rounded T-III increase the resemblance to *menkei*. However, the shorter F-I and much more restricted facial cross ridging of *lividum* are separation points.

Hedychridium maricopae Bohart, new species
(Fig. 54)

Male holotype.—Length 2.7 mm, forewing 2.0 mm; body greenish blue including S-II-III; T-II with a large, diffusely edged, dark, basomedian area; tegula brown, wings smoky. Pubescence pale, short and dense on lateral third of lower frons, inconspicuous elsewhere. Punctation fine and close in pubescent area of lower frons, blending with cross ridging in middle third, medium and close on brow and pronotum, mesopleural area above midcoxa microridged, punctures toward middle of T-II fine and slightly separated. Malar space 0.3 as long as pedicel; flagellum slender, F-I length 2.5 times breadth and 1.3 times pedicel length, F-V length 1.2 times breadth, F-XI 2.4 times; brow rounded but slightly prominent; forewing basal vein practically straight, as long as RS stub, meeting MCu at a strongly obtuse angle; genitalia (Fig. 54); digitus half as long as gonostyle, subovoid; aedeagus apparently without bristles (two small lateral ones present in paratype from Santa Ynez, California).

Female.—Length 2.5–3.0 mm, F-I length 3 times breadth, S-III brown but usually with faint green highlights toward base.

Holotype male (USU), 3 mi SW Wickenburg, Maricopa Co., Arizona, 5 May 1964 (P. Torchio, G. Bohart). Paratypes, 13 males, 15 females, ARIZONA: near Wickenburg (P. Torchio, G. Bohart, USU, UCD), 32 mi S Quartzite (D. Miller, UCD), near Portal (M. Cazier et al., AMNH); IDAHO: Malta (R. Westcott, UIDA); NEVADA: 7 mi E Oreana (T. Haig, CSDA), Nixon (R. Westcott, LACM); CALIFORNIA: Arbuckle on *Portulaca* (J. Carrillo, UCD, USNM), Sacramento (F. Parker, UCD), Davis (M. Irwin, UCD), Turlock (R. Snelling, LACM), Yosemite National Park (M. Irwin, UCR), Santa Ynez (M. Irwin, UCD), Foster Park in Ventura Co. (R. Bohart, UCD), Wyman Canyon in White Mts. of Mono Co. (J. Powell, UCD), Deep Springs in Inyo Co. (M. and J. Wasbauer, R. Bohart, CSDA, UCD), 12 mi SE Ivanpah (P. Hurd, UCB), 7 mi SW Kelso (M. and J. Wasbauer, CSDA), Ogilby Road in Imperial Co. (M. Wasbauer, CDFA). Paratypes were collected in every month from March to November. One additional male which appears to be *maricopae* bears the data: Guanajuato, Mexico, 6,000 feet, 21 December 1963 (M. Tauber, C. Toschi, UCB).

Systematics.—The long F-I, nearly straight basal vein, microridged posterior mesopleuron, brown tegula, and broadly rounded margin of T-III place this species in the *amabile* group. The abundant silvery pile of the lower frons and blue male S-III relate it to *azurellum.* From that species *maricopae* differs by its shorter malar space and longer digitus (Fig. 54). A few lateral bristles may be present on the aedeagus but these are weaker than in *azurellum.*

Hedychridium menkei Bohart, new species
(Figs. 13, 55)

Male holotype.—Length 3.2 mm, forewing 2.5 mm; body green; a little coppery on face, vertex, and scutum; T-II with a large, diffusely edged, dark, medial area; S-II greenish; S-III and tegula brown; wings smoky. Pubescence pale, inconspicuous, sparse on lower frons. Punctation coarse and shallow on brow, extending downward along eye margins, merging with cross ridging which extends to eyes near clypeus; punctures close and moderate to fine on pronotum; mesopleural area above midcoxa largely polished; punctures toward middle of T-II fine and separated by a puncture diameter. Face (Fig. 13); malar space 0.3 as long as pedicel; flagellum slender, F-I length 2.4 times breadth and 1.4 times pedicel length, F-V length 1.2 times breadth, F-XI 2.3 times; brow evenly rounded, forewing basal vein curved, as long as RS stub, meeting MCu at nearly a right angle; genitalia (Fig. 55); digitus stout linear, three-fourths as long as gonostyle; aedeagus with a lateral patch of strong bristles.

Female.—Length 3–4 mm, F-I length 2.3–2.5 times breadth.

Holotype male (UCD), Leland Meadow, Tuolumne Co., California, 5 August 1960 (A. S. Menke). Paratypes, 10 males, 29 females, June to September, CALIFORNIA: Coffee Creek in Trinity Co., Lake Almanor in Plumas Co., Hallelujah Junction in Lassen Co., Yuba Pass in Sierra Co., Sierraville, Sagehen Creek in Nevada Co., Truckee, Carnelian Bay, South Lake Tahoe, Grass Lake in El Dorado Co., Hope Valley and Independence Lake in Alpine Co., Carson Pass in Alpine Co., Leland Meadow and Soda Springs in Tuolumne Co., Cottonwood Creek (9,000 feet) and White Mountains (10,000 feet) in Mono Co., Big Bear Lake in San Bernardino Co. Other records: CALIFORNIA: Davis, Carmichael, Goleta; OREGON: Benton Co., Wallowa Co.; IDAHO: Franklin Co.; BRITISH COLUMBIA: Frazier River, Princeton; UTAH: Iron Co.; WYOMING: Fremont Co.; COLORADO: Denver Co.; ARIZONA: Coconino Co.

Systematics.—*H. menkei* is a medium small species in the *dimidiatum* group with long F-I, short malar space, curved basal vein, partly polished posterior mesopleuron, and weak pubescence on the lower frons. Along with the brown S-III and usually brown tegulae, *menkei* has the lower frons with an extensive cross ridged area which practically reaches the compound eye just above the clypeus (Fig. 13). Another feature of *menkei* is the extensive but indistinctly limited dark area of T-II. As in *politum* and *bilobatum*, the aedeagus has a patch of lateral bristles.

Hedychridium milleri Kimsey, new species
(Fig. 63)

Male holotype.—Length 3 mm, forewing 2.6 mm; body greenish blue including S-II-III, tegula brown, wings faintly stained. Pubescence pale, short and moderate on lower face, inconspicuous elsewhere. Punctation on brow coarse, shallow and a little separated; becoming abruptly fine and dense on lower face, merging with medial cross ridging; punctures moderate on pronotum with some punctures separated by polished areas; mesopleural area above midcoxa irregularly microsculptured; punctures toward middle of T-II fine and 1–2 puncture diameters apart. Malar space half as long as pedicel; flagellum slender, F-I length 1.9 times breadth and 1.2 times pedicel length; F-V length 1.3 times breadth, F-XI 2 times; brow rounding evenly from midocellus to lower face. Forewing basal vein almost straight, as long as RS stub, meeting MCu at a strongly obtuse angle; T-III margin evenly rounded; genitalia (Fig. 63); digitus stoutly sausage shaped, four-ninths as long as gonostyle; aedeagus with three small bristles near apex on outer side.

Female.—Length 3 mm, F-I length 1.9 times breadth, S-II-III with faint blue highlights.

Holotype male (UCD), Borax Lake, Lake Co., California, June, 1963 (D. R. Miller). Paratypes, 48 males, 3 females, same data as holotype.

Systematics.—*H. milleri* is similar to *paulum* and shares with it the medium length F-I, short malar and subantennal space, nearly straight basal vein, slightly smoky wings, posterior mesopleuron completely microsculptured, medium small size (3–4 mm long), and partly bluish S-II-III. Differentiating characters of *milleri* are the slightly separated brow punctures, slightly finer lower frons punctation, and brown tegula. In addition the punctures of T-II are finer, shallower and more widely spaced. These features by themselves might indicate only a local variety of *paulum* but to them must be added the curved digitus (Fig. 63) rather than a clubbed one (Fig. 59).

Hedychridium mirabile Kimsey, new species
(Fig. 56)

Male holotype.—Length 4 mm, forewing 2.5 mm; head and thorax green to blue, tinged with coppery on ocellar area and pronotum; terga bright coppery red, becoming greenish on T-I; venter brown; tegula green, wings lightly smoky, pubescence pale, short but abundant on outer third of lower face. Punctation fine on lower face, grading into medial cross ridging; medium coarse and contiguous on brow and pronotum; mesopleural area above midcoxa irregularly punctate and a little polished; punctures toward middle of T-II medium-sized, deep, separated by about 0.5 puncture diameter. Face similar to that of *fletcheri* (Fig. 10) but subantennal distance shorter and frons a little wider; malar space half as long as pedicel; flagellum slender, F-I length 1.7 times breadth and 1.4 times pedicel length, F-V length 1.2 times breadth, F-XI 2 times, brow roundly overhanging scapal basin; forewing basal vein nearly straight, longer than RS stub, meeting MCu at an obtuse angle; T-III margin rounded but a little drawn out, strongly rimmed; genitalia (Fig. 56); digitus slender, five-sevenths as long as gonostyle, aedeagus without bristles.

Female.—Length 3–4 mm, head and thorax green to blue, usually with a strong infusion of coppery red, terga usually coppery red; F-I length 1.8 times breadth.

Holotype male (UCD), Rumsey, Yolo Co., California, 26 April 1966 (R. M. Bohart). Paratypes, 37 males, 28 females, CALIFORNIA: 3–4 mi N Rumsey (M. Irwin, C. Moore, R. Bohart, UCD, USNM), Putah Canyon in Yolo Co. (F. Parker, UCD), Sacramento (F. Parker, R. Bohart, M. Wasbauer, F. Andrews, UCD, CDFA), Davis (F. Parker, R. Bohart, C. Moore, M. Irwin, A. Grigarick, UCD, UCB, LACM, CAS, USU), Grand Island in Sacramento Co. (M. Wasbauer, CDFA, UCD, CSU). Paratypes were collected in April, May and September. This species is found throughout California at low to moderate elevations. A total of 79 males and 78 females have been seen in addition to paratypes, some of them from British Columbia and most of the western states as far east as Wyoming and New Mexico.

Systematics.—This is a member of the *fletcheri* group based on a rather prominent brow, dense pubescence on the lower face, F-I less than twice as long as broad and basal vein curved. It is distinguished by having the subantennal distance shorter than the pedicel, RS stub shorter than the basal vein, S-II brown, and T-II-III coarsely punctate. The type series was chosen from individuals having obvious coppery red or reddish purple on at least T-II. However, over half of the specimens seen are green and blue with no reddish markings on the terga. A series collected by J. Powell near Mt. Shasta City included both color forms and intermediates.

Hedychridium nevadae Kimsey, new species
(Figs. 14, 57)

Male holotype.—Length 7 mm, forewing 5.5 mm; body, including tegula and S-II-III purple with some blue to green, wings brown stained. Pubescence fulvous to brown, inconspicuous in scapal basin. Punctation mostly coarse, irregular and transverse in scapal basin, coarse and contiguous on pronotum, a little finer and slightly separated on T-II; vertical side of pronotum with longitudinal ridges in front of lobe, punctate anteriorly; mesopleural area above midcoxa punctate and polished; side of propodeum polished anteriorly, becoming punctate and longitudinally ridged posteriorly. Face (Fig. 14); malar space 0.6 as long as pedicel; mandible nearly simple, F-I length 1.9 times breadth and 1.4 times pedicel length, F-V length 1.1 times breadth, F-XI 1.5 times, brow swollen medially, pronotum with neck area elevated so that horizontal surface extends forward to a median carina and is nearly twice as long in midline as scutellum; forewing basal vein slightly curved, longer than RS stub, reaching MCu at an obtuse angle; T-III apical margin a little blunt medially, membranous rim somewhat uneven; genitalia (Fig. 57), digitus sublinear, half as long as gonostyle; aedeagus without bristles.

Female.—Body length 6–7 mm, S-II mostly purple, S-III partly so.

Holotype male (UCD), 2 mi E Lone Pine, Inyo Co.; California, 12 October 1971 (R. M. Bohart). Paratypes: 1 pair, same data as type (except E. E. Grissell an additional collector); 1 male, 3 females, 5–6 mi NE Sparks, Nevada on *Chysothamnus* (R. C. Bechtel, UCD, USNM); 1 pair, Vya, Nevada (F. D. Parker, UCD); 1 male, Great Sand Dunes National Monument, Alamosa Co., Colorado (D. Gwynne, CSU); 1 male, Adel, Oregon, (R. F. Denno, E. E. Grissell, UCD). Paratype dates were from 10 August to 12 October.

Systematics.—*H. nevadae* is a distinctive species and seems unlike any other *Hedychridium* in the western hemisphere. Characters that distinguish it are: subantennal distance greater than 2 MOD; facial and other pubescence sparse, erect and dark; mandibles long and slender, without distinct teeth; and F-I less than twice as long as broad. This is also a large species for the genus, ranging between 6 and 8 mm in length. The color varies from deep green to purple.

Hedychridium olene Kimsey, new species
(Figs. 1, 31, 58)

Male holotype.—Length 4 mm, forewing 3.5 mm; body blue green, S-II with a medial green spot, S-III brown, tegula brown and a little green, wings brown stained. Pubescence pale, inconspicuous on face and elsewhere. Punctation moderately coarse on head and thorax, merging with medial cross ridging on lower face, contiguous on pronotum; mesopleural area above midcoxa punctate and polished; punctures toward middle of T-II moderately fine and slightly separated. Malar space a fifth as long as pedicel; flagellum slender, F-I length 2.1 times breadth and 1.4 times pedicel length, F-V length 1.2 times breadth, F-XI 2.5 times; brow rounding evenly from midocellus to lower face; forefemur enlarged and sharply angled basally, creased along lower margin (Fig. 31); forewing basal vein curved, longer than RS stub, meeting MCu at a right angle (Fig. 1); T-III apical margin evenly rounded; genitalia (Fig. 58); digitus rhomboid, half as long as gonostyle which is unusually broad and bears large sensilla along inner wall, aedeagus with a patch of lateral setae.

Female.—Length 4–5 mm, F-I length 2.2 times breadth, S-I-III brown.

Holotype male (UCD), Boca, Nevada Co., California, 16 August 1963 (R. M. Bohart). Paratypes, 10 males and 11 females: CALIFORNIA: Sierraville, Sierra Valley (Sierra Co.), Sagehen Creek (Nevada Co.), Boca, Leland Meadow (Tuolumne Co.), Strawberry and Dodge Ridge (Tuolumne Co.), Antelope Springs (Inyo Co.), Davis, Camatti Canyon (San Luis Obispo Co.), 6 mi S Cottonwood Springs (Riverside Co.); Borrego Valley (San Diego Co.), ARIZONA: Gila Bend; OREGON: 6 mi E Warner Pass (Lake Co.); IDAHO: Leslie. Dates of collection are from 19 April in Borrego Valley to 29 August at Strawberry. Paratypes are in collection of UCD, USNM, UCR, UCB, and WSU.

Systematics.—*H. olene* belongs to the *dimidiatum* group. It has F-I more than twice as long as broad, pedicel over half as long as F-I, malar space about half an MOD, basal vein strongly curved, lower frons weakly pubescent, and posterior mesopleuron partly polished. *H. olene* is readily distinguished from related species by the strong subbasal angle of the forefemur with associated crease and ridge (Fig. 31), and the presence of a cluster of bristles on the aedeagus (Fig. 58). Is is the only species of *Hedychridium* with an angled forefemur, but this condition occurs commonly in *Holopyga* and in at least one species of *Hedychrum*.

Hedychridium paulum Bohart, new species
(Fig. 59)

Male holotype.—Length 3 mm, forewing 2 mm; body bluish green including tegula and S-II-III; wings smoky. Pubescence pale, inconspicuous on face and elsewhere. Punctation moderate and contiguous on head and thorax, fine and nearly contiguous toward middle of T-II; mesopleural area above midcoxa microridged; malar space 0.7 as long as pedicel; face below brow unusually flat; flagellum moderately slender, F-I length 1.4 times breadth and a little more than pedicel length, F-V slightly broader than long, F-XI length 2 times breadth; brow rounding evenly from midocellus to lower face; forewing basal vein nearly straight, as long as RS stub, meeting MCu at a strongly obtuse angle; genitalia (Fig. 59); digitus stoutly clubbed, four-ninths as long as gonostyle which is broadly rounded apically; aedeagus without bristles.

Female.—Length 2.5–3 mm, S-III mostly green.

Holotype male (UCD), Sagehen Creek, Nevada Co., California, 5 July

1966 (R. M. Bohart). Paratypes, 32 males, 130 females collected June to August in the central Sierran localities: Sagehen Creek in Nevada Co., Independence Lake in Sierra Co., and Carnelian Bay in Placer Co. Collectors were R. Bohart, M. Irwin, L. Stange, J. Powell, J. Wasbauer, R. Giblin, and B. Villegas. Several of the Sagehen Creek females were caught as they emerged from burrows of *Pulverro monticola* Eighme (Sphecidae). A series of females were also taken in a nesting site of *Dufourea trochantera* G. Bohart (Halictidae) at Independence Lake.

This relatively abundant species occurs in many other California localities, particularly in the Sacramento-San Joaquin Valley and in the Sierra from Inyo Co. north. It is found along the Sacramento River in the Lower Sonoran Zone and at 10,000 feet elevation in the Hudsonian Zone of White Mountains, Mono Co. Coastal collections have been made at Foster Park, Ventura Co. and Point Arena, Humboldt Co. Out-of-state records are: NEVADA: Mt. Rose, Verdi, Pyramid Lake; OREGON: Mt. Hood, Lake of the Woods; WASHINGTON: Walla Walla; UTAH: Willard Peak in Weber Co.

Systematics.—This medium small species seems to have no close relatives. Its basic features are: F-I about 1.5 times breadth, basal vein nearly straight, malar space short, brow closely punctured, face flat with little pubescence, tegula and S-II-III greenish, aedeagus without bristles, and digitus clubbed (Fig. 59). Unlike the other small sympatric species, *menkei*, *bilobatum*, and *rasile*, T-II is not black basomedially, but usually green with a faint coppery discoloration. From the above three the short F-I of *paulum* also provides ready separation. Occasionally, the coppery tint is more extended and intensified, as in a series of rather highly colored specimens collected by J. Powell near Oceano, San Luis Obispo Co.

Hedychridium politum Bohart, new species
(Figs. 20, 28, 60)

Male holotype.—Length 4.5 mm, forewing 4 mm; body greenish blue including tegula and S-II-III, wings brown stained. Pubescence whitish to fulvous, inconspicuous on lower frons. Punctation fine to moderate, lower face with moderate punctures grading into transverse microridging in middle third; brow with coarse and close but shallow punctures; pronotum with moderate and fine punctures closely intermixed; mesopleural area above midcoxa punctate and partly polished; T-II with fine punctures separated mostly by one puncture diameter, polished overall. Malar space 0.2 as long as pedicel; flagellum slender (Fig. 28), F-I length 2.2 times breadth and nearly twice pedicel length, F-V length 1.3 times breadth, F-XI 2.5 times; brow rounding evenly from midocellus to lower face; forewing basal vein curved, longer than RS stub, meeting MCu at a right angle; apical margin of

T-III broadly rounded; genitalia (Fig. 60); digitus subtriangular, two-fifths as long as gonostyle which is broadly rounded apically; aedeagus with a lateral patch of bristles.

Female.—Length 4–6 mm; S-II blue-green; S-III brown, sometimes tinged with blue-green; T-III margin rather broadly rounded (Fig. 20).

Holotype male (UCD), Sagehen Creek, Nevada Co., California, 13 July 1968 (R. M. Bohart). Paratypes, 22 males, 35 females, same locality as holotype but collected from 23 June to 30 July by R. Bohart, R. Giblin, and M. Irwin. In addition about 125 specimens have been seen from many localities in the California Sierra and from Mt. Pinos in Kern Co.; and out-of-state localities: NEVADA: Mt. Rose; OREGON: Milton, Cornucopia, Crater Lake, Aneroid Lake, Parkdale, Lake of the Woods, Hat Point in Wallowa Co.; IDAHO: Valley Co., Kootenai Co., Butte Co., UTAH: Weber Co., Box Elder Co.; WYOMING: Centennial, 20 mi W Farson, Jenny Lake; COLORADO: Fort Collins.

Systematics.—*H. politum* roughly resembles *dimidiatum* and shares with it the long F-I, short malar space, curved basal vein, partly polished posterior mesopleuron, and weak pubescence on the lower frons. Distinguishing features of *politum* are as follows: green tegulae, lower frons mostly punctate, broadly rounded T-III margin which is not rounded over, blue male S-III, simple forefemur, and base of T-II without a black area or with a small and indefinite one. The digitus is uniquely short and broad (Fig. 60), and the aedeagus has a lateral patch of bristles. In most specimens of *politum*, T-II presents an overall polished appearance, hence the name.

Hedychridium purum Kimsey, new species
(Figs. 3, 29, 61)

Male holotype.—Length 3.5 mm, forewing 3 mm; head and thorax blue, terga purple, tegula and S-II-III blue, wings somewhat whitish. Pubescence pale, inconspicuous on lower face and elsewhere. Punctation moderately coarse; close on brow; same on lower face but a little finer; slightly separated on pronotum; mesopleural area above midcoxa punctate and a little polished; punctures toward middle of T-II nearly as large as on pronotum, deep, and about 0.5 puncture diameter apart. Face unusually flat; malar space subequal in length to pedicel; flagellum slender, articles cylindrical, F-I length 1.7 times breadth and 2.6 times pedicel length, F-V length 1.4 times breadth, F-XI 3 times (Fig. 29); brow rounding evenly from midocellus to lower face; forewing stigma ending abruptly opposite RS stub, basal vein curved, longer than RS stub, meeting MCu at a right angle (Fig. 3); T-III margin evenly rounded; genitalia (Fig. 61) weakly pigmented, digitus subovoid, four-ninths as long as gonostyle; aedeagus without bristles.

Female.—Length 3–4 mm, body color ranging from all green to all purple, F-I about 1.8 times breadth, S-II-III blue.

Holotype male (UCD), Kelton, Box Elder Co., Utah, 15 August 1969 (G. F. Knowlton). Paratypes, 1 male, 7 females collected from 17 April to 15 August as follows: UTAH: near Kelton (G. Knowlton, UCD); ARIZONA: Florence Junction in Pinal Co. (W. Barr, UIDA), Tucson (R. and E. Painter, UA; NEVADA: near Eastgate (E. Linsley, G. Gaumer, R. Bohart, UCD, USNM), 12 mi NE Stillwater (F. Parker, UCD).

Systematics.—*H. purum* belongs in the *crassum* group, the characters of which are listed under that species. The shorter F-I and simple T-II are immediate points of separation, the first character from both *crassum* and *incisum*, the second from *crassum*. Other features are the yellowish-white wings, rather small size (3–4 mm long) and short RS stub which ends abruptly opposite the end of the stigma. There may be several species involved, considering observed variations in size and wing color. Therefore, the concept of *purum* is here limited to specimens with white to yellowish-white wings, a range of 3–4.5 mm in length, blue or green tegula, T-III coarsely punctate and broadly rounded apically, female flagellum with some red or yellow and F-I at least twice as long as pedicel. This group from which the type series was chosen is found in Upper Sonoran areas in Nevada, Utah, California and Arizona. Two other groups (species?) are found only in Lower Sonoran desert areas in California and Arizona.

Hedychridium rasile Bohart, new species
(Fig. 62)

Male holotype.—Length 3 mm, forewing 2.4 mm; body greenish blue, mesonotum green; T-II with a large, diffusely edged, dark, basomedial area; S-II-III bluish green; tegula brown, wings smoky. Pubescence pale, sparse on sides of lower frons, inconspicuous elsewhere. Punctation moderate and close on brow, a little finer below and blending with median cross ridging, moderate and contiguous on pronotum, mesopleural area above midcoxa microridged, punctures toward middle of T-II fine and slightly separated. Malar space half as long as pedicel; flagellum slender, F-I length 2.3 times breadth and 1.5 times pedicel length, F-V length 1.2 times breadth, F-XI 2.3 times; brow evenly rounded, forewing basal vein slightly curved, as long as RS stub, meeting MCu at a strongly obtuse angle; genitalia (Fig. 62); digitus three-fifths as long as gonostyle, curvilinear; aedeagus without bristles.

Female.—Length 3–3.5 mm, F-I length 2.2–2.5 times breadth, S-II brown or more often with a greenish tint.

Holotype male (UCD), Sagehen Creek, Nevada Co., California, 19 June 1974 (R. M. Bohart). Paratypes, 29 males, 24 females collected from June to August in the following central Sierran localities: CALIFORNIA: Sagehen Creek in Nevada Co., Independence Lake in Sierra Co., Carnelian Bay in Placer Co., Boca and Russell Valley in Nevada Co., Winnemucca Lake and Highland Lake in Alpine Co., Carson Pass in Alpine Co.; NEVADA: Mt. Rose, 8,000 ft meadow in Washoe Co. Collectors were R. Bohart, P. Marsh, D. Poirier, N. Smith, and B. Villegas.

Systematics.—*H. rasile* is in the *amabile* group with F-I long, basal vein nearly straight, tegula brown, and posterior mesopleuron microridged. Characters in combination which distinguish *rasile* are: lower frons weakly pubescent, malar space short, male S-III blue, and T-II punctures well separated. The last two features are useful in separating *rasile* from *solierellae*. Although running to different parts of the key on the basis of F-I length, *rasile* and *paulum* are similar and may be collected together in the central Sierra Nevada. The brown tegula of *rasile* is an additional distinguishing feature as well as the unclubbed digitus.

Hadychridium semirufum (Cockerell)

Holopyga semirufa Cockerell, 1896:17. Holotype female, "Las Cruces," New Mexico, USNM, Washington.

Female (specimen from 19 miles north of Rodeo, New Mexico).—Length 3.5 mm, forewing 2.5 mm, face green, genal and cervical areas bluish purple, thorax dorsally green except metanotum purple, legs red, terga and sterna non-metallic red, tegula brown, wings nearly clear. Pubescence pale, short and dense on lower face. Punctation coarse and shallow on brow separated by polished areas, becoming fine and dense on lower face, medium and separated by polished areas on pronotum, mesopleural area above midcoxa with a small polished spot among microridges, punctures small and separated by one to two puncture diameters toward middle of T-II. Face unusually flat, malar space half as long as pedicel; flagellum slender, F-I 1.7 times as long as broad, as long as pedicel, F-V as long as broad, F-XI 1.7 times; brow rounding evenly to lower face; forewing basal vein almost straight, longer than RS stub, meeting MCu at a strongly obtuse angle; forewing stigma ending before apex of RS stub; T-III margin evenly rounded.

Male.—Unknown.

Distribution.—We have seen 13 specimens, including the type. These were collected from 14 August to 23 September. Localities are: ARIZONA: 4 mi NW Geronimo on Gila River (R. Dickson, UCR), 16 mi NE Douglas (J. Rozen et al., AMNH, UCD), Wilcox (UCB); NEW MEXICO: 18 mi N Rodeo (C. Moore, P. Hurd, R. Bohart, UCD, UCB), Mesilla (G. Bohart, USU).

Systematics.—This is a very distinctive species, unlike any other in the Western Hemisphere. It is distinguished principally by the nonmetallic red abdomen and legs, as well as by having a straight basal vein that is longer than the RS stub, and a flat face. Red abdominal coloration is found in several European species, including: *lampadum* Linsenmaier and *roseum* (Rossi). However, these have metallic violet hues associated with the red, and otherwise appear quite unrelated to *semirufum.*

Hedychridium solierellae Bohart and Brumley
(Fig. 64)

Hedychridium solierellae Bohart and Brumley, 1967:234. Male holotype, "Arbuckle, Colusa County, California," UCD, Davis.

Male (topotype reared from almond hull nest of Solierella peckhami).—Length 2.5 mm, forewing 2.0 mm; body green to greenish blue, tegula brown, a large black spot on T-II extending to base; S-III brown; wings lightly smoky. Pubescence fulvous, scanty on face, inconspicuous elsewhere. Punctation coarse and close on brow; moderate on face, merging medially with cross ridging, moderately coarse and close on pronotum, moderate and practically contiguous on T-II; mesopleural area above midcoxa microridged. Malar space half as long as pedicel; flagellum slender, F-I length 2.5 times breadth and 1.4 times pedicel length, F-V length 1.2 times breadth, F-XI 2 times, brow slightly swollen above shallow scapal basin; forewing basal vein almost straight, as long as RS stub, meeting MCu at a strongly obtuse angle; genitalia (Fig. 64); digitus subovoid, three-sevenths as long as gonostyle; aedeagus without bristles.

Female.—Length 2.5–3 mm, F-I length 2.8–3.0 times breadth.

Distribution.—We have seen about 60 males and 85 females, collected in every month from March to October. The species is widespread in California, where it occurs in the Sacramento-San Joaquin Valley from Colusa Co. (Arbuckle) to Kern Co. (McKittrick); in southern California from San Diego Co. (Borrego Valley) to Orange Co. (Laguna Beach) and San Bernardino Co. (Vidal Junction); in coastal mountains of Monterey Co. (Arroyo Seco); in the central Sierra of Placer Co. (Carnelian Bay) and Nevada Co. (Boca); and in the eastern desert of Inyo Co. (Deep Springs). Out-of-state localities are: NEVADA: Nixon, Patrick, Reno; ARIZONA: Continental, Wickenburg, 32 mi S Quartzite, Santa Catalina Mts., Gila Bend, near Tombstone; UTAH: Wellsville Mts., Delta.

Systematics.—As in others of the *amabile* group, this species has F-I long, basal vein nearly straight, tegula brown, and posterior mesopleuron microridged. The short malar space and weakly pubescent lower frons are shared with *rasile.* However, the nearly contiguous punctures of T-II and brown male S-III are distinguishing for *solierellae.* We have in our collection a single male from the island of Cyprus determined by W. Linsenmaier as *monochroum* Buysson. This European species is parasitic on *Solierella* according to Móczár (1967). It is quite similar to *solierellae,* but slight observed differences are the shorter but broader head, and longer subantennal distance of *monochroum.*

Biology.—A parasitoid of three species of *Solierella* (Sphecidae), as discussed in the Introduction.

Acknowledgments

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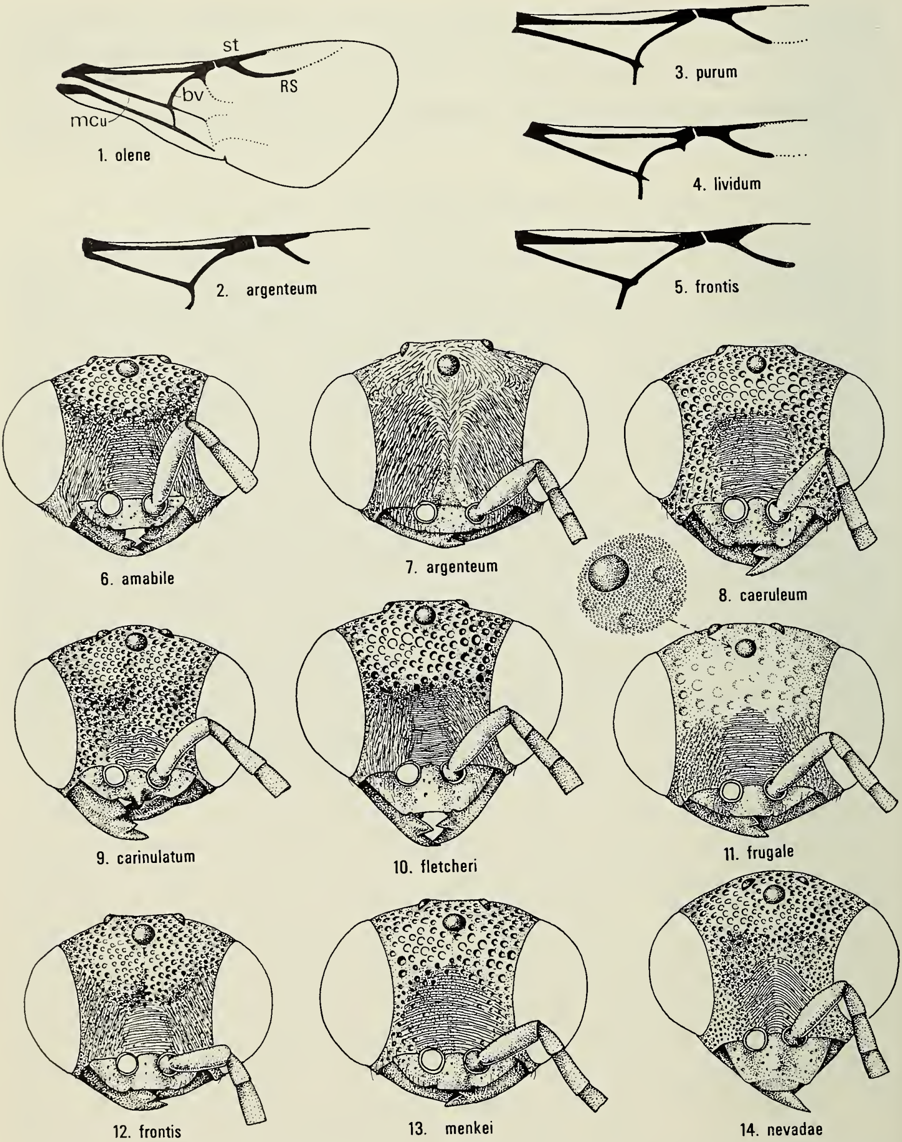
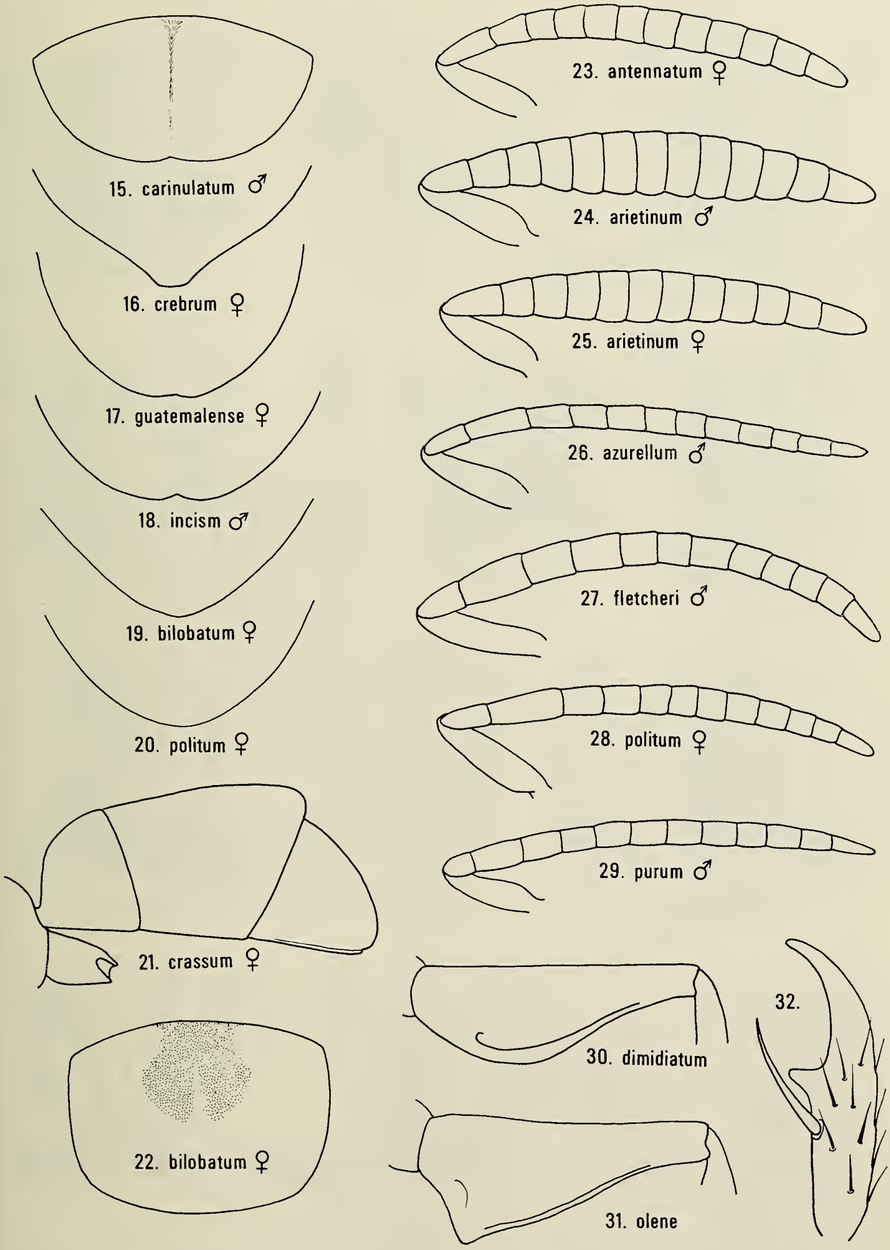
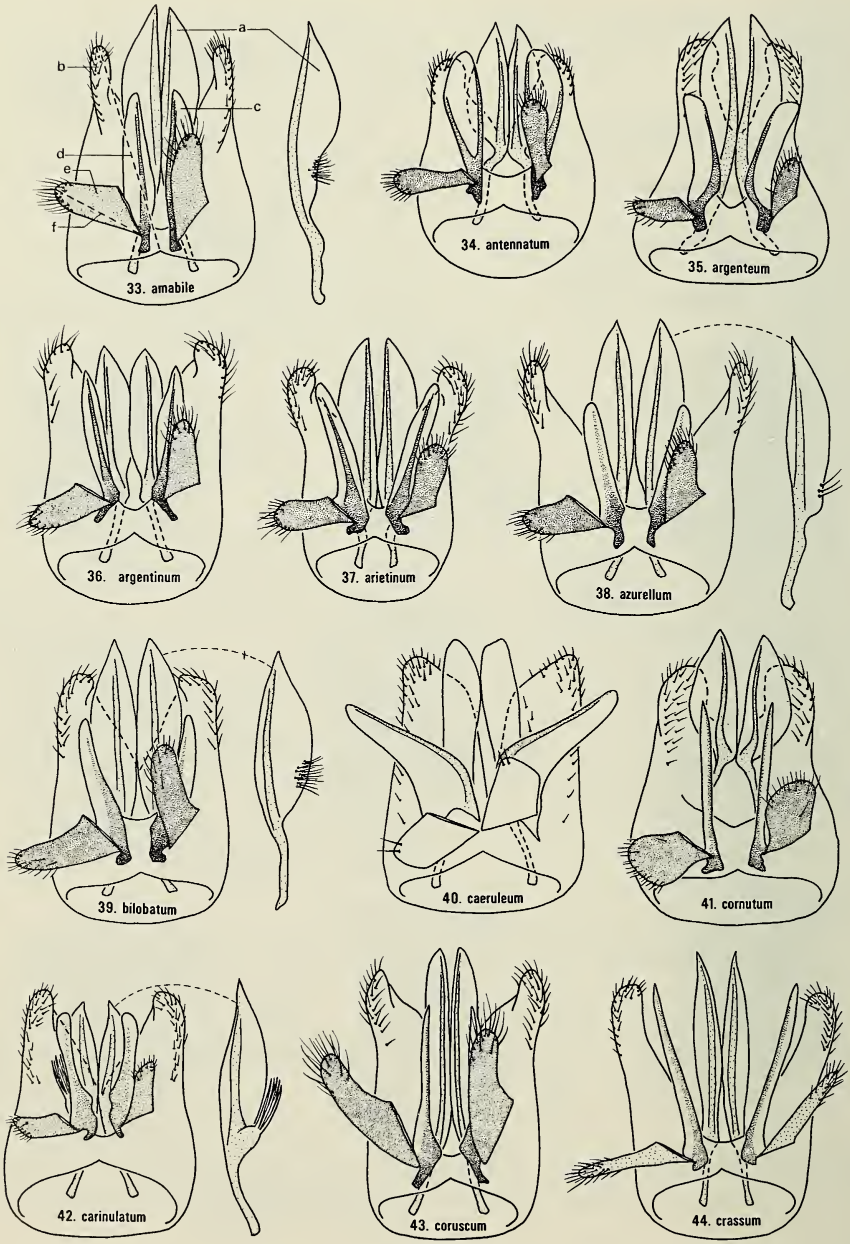


Figs. 1–5. Forewing venation; MCu: mediocubital vein, bv: basal vein, st: stigma, RS: radial sector stub. Figs. 6–14. Front view of head, males except Fig. 9.

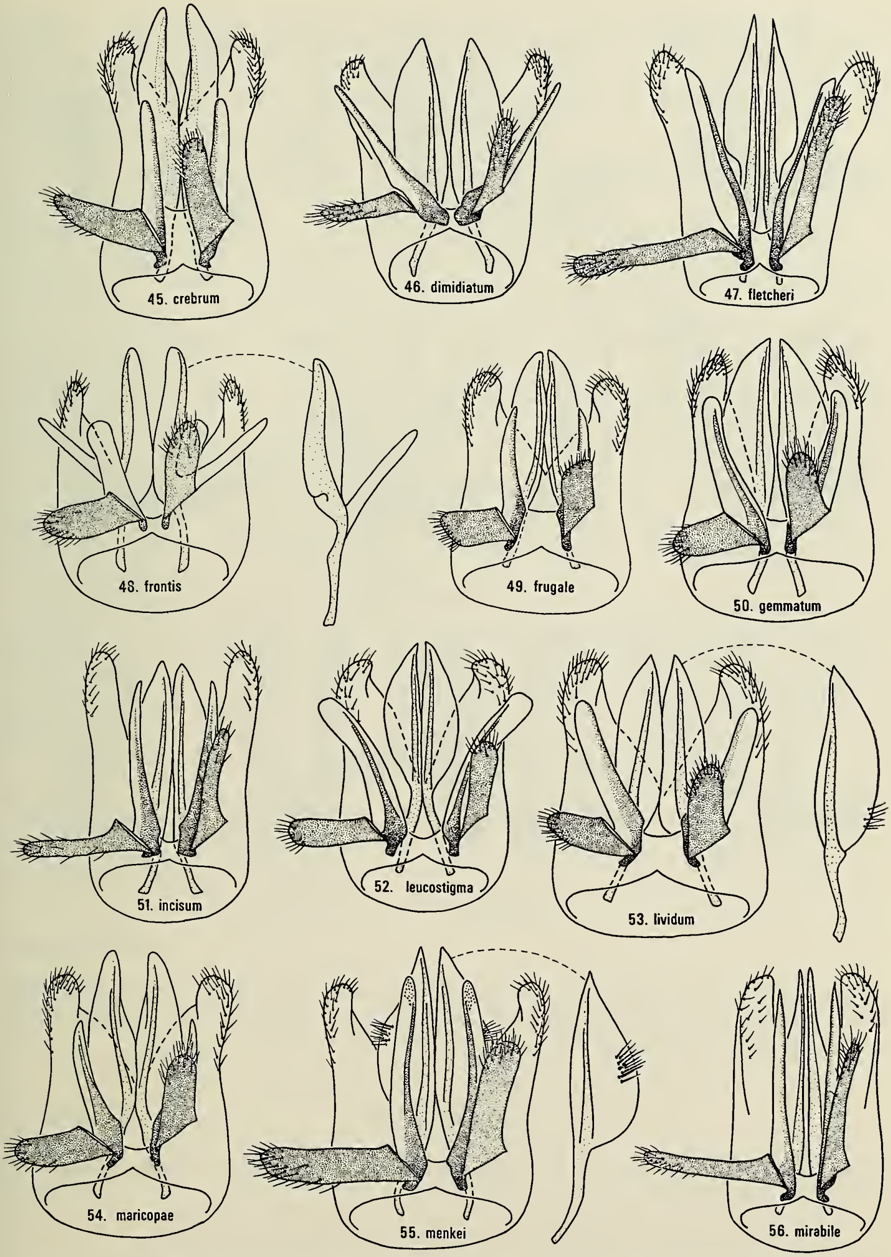


Figs. 15–20. Outline of tergum III. Fig. 21. Lateral view of abdomen. Fig. 22. Pattern of black spot on tergum II. Figs. 23–29. Inner view of antennae. Figs. 30, 31. Outer view of forefemur. Fig. 32. *Hedychridium dimidiatum,* claw, lateral.

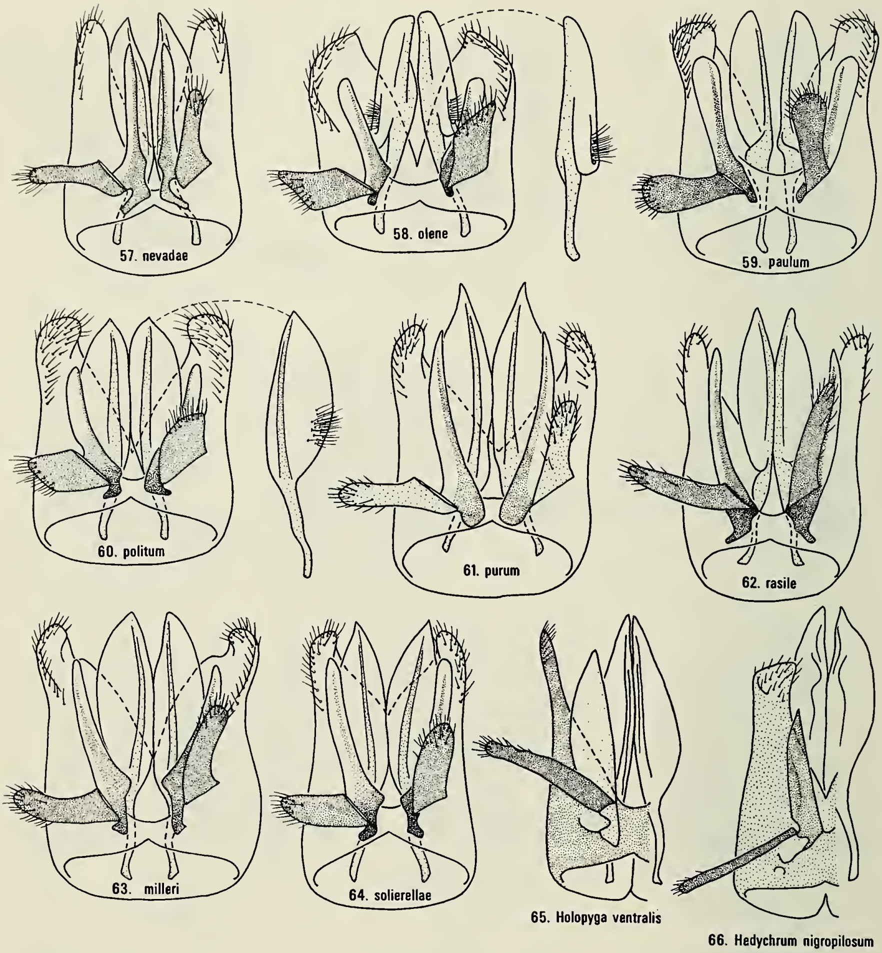


33. amabile
34. antennatum
35. argenteum
36. argentinum
37. arietinum
38. azurellum
39. bilobatum
40. caeruleum
41. cornutum
42. carinulatum
43. coruscum
44. crassum

Figs. 33–44. Male genitalia, ventral (34, 35, 37–39, 41, 43, 44 are drawn from holotypes): a, aedeagus; b, gonostyle; c, cuspis; d, gonostyle length; e, digitus; f, digitus length.



Figs. 45–56. Male genitalia, ventral (45, 48–56 are drawn from holotypes).



Figs. 57–64. Male genitalia of *Hedychridium*, ventral (57–63 are drawn from holotypes). Figs. 65–66. Male genitalia, left ventral: 65, *Holopyga ventralis* (Say); 66, *Hedychrum nigropilosum* Mocsáry.

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A SUPPLEMENTARY DESCRIPTION OF *PINNIXA TOMENTOSA* AND COMPARISON WITH THE GEOGRAPHICALLY ADJACENT *PINNIXA TUBICOLA* (BRACHYURA, PINNOTHERIDAE)[1]

Thomas B. Scanland and Thomas S. Hopkins

Abstract.—Two species of morphologically similar pinnotherid crabs, *Pinnixa tomentosa* and *P. tubicola* are commensal with the same host where their ranges overlap in Southern California. This paper presents the first description of the male of *P. tomentosa*, elaborates on the existing description of the female, and clarifies differences between the two species of crabs. *P. tomentosa* males have a smooth palm on the chelae; *P. tubicola* males have tuberculate palms. In *P. tomentosa* the propodus of the third walking leg terminates in 3–5 spines; this article is smooth in *P. tubicola*. The interorbital margin of the carapace in female *P. tomentosa* is produced beyond the upper anterolateral margin; it is recessed in female *P. tubicola*.

The genus *Pinnixa* has at least 11 species which are known to inhabit the West Coast of North America. These species are usually quite host specific (Rathbun, 1918; Schmitt, 1921; Wells, 1928; Schmitt et al., 1973). The two species dealt with in this paper inhabit the tubes of annelid worms. The polychaete *Chaetopterus variopedatus*, onuphids, and terebellids are their hosts in Southern California and Baja California. *Pinnixa tomentosa* has been reported to range from San Felipe, Gulf of California, south to Cape San Lucas, and north along the west coast to Monterey, although we have seen no specimens from north of San Diego; *P. tubicola* has been reported to range from San Diego northward to Puget Sound, Washington. According to Rathbun (1918), neither of these species has Atlantic coast or Southern Hemispheric analogues.

Although *P. tubicola* was fairly well defined by both Rathbun (1918) and Wells (1928), *P. tomentosa* has not been well described. Rathbun based her description of *P. tomentosa* on data from Holmes (1894), and on the examination of a single female specimen, lacking chelipeds, taken at San Clemente. We are not aware that the male *P. tomentosa* has been described, and we believe that the paucity of specimens of *P. tomentosa* has led to some important oversights in the description of the external features of this species, and in the differences between this and the similar species, *P. tubicola*. The dichotomous keys supplied by both Rathbun (1918) and Schmitt (1921) are not adequate for the separation of these two species inasmuch as the keys are based upon measurements we have found to be unreliable.

The purpose of this paper is to enlarge upon the diagnostic external morphology of both male and female *P. tomentosa* in comparison with *P. tubicola.*

Material Examined

The principal material used in this study was more than 500 fresh specimens of male and female *P. tomentosa* and female *P. tubicola*, taken from *Chaetopterus* tubes collected at the entrance channel to Mission Bay at San Diego. In addition, we have examined the following material from the collections of the National Museum of Natural History and the Allan Hancock Foundation collections:

P. tomentosa: USNM 68331, 1♂, 1♀, San Felipe, Mexico.

P. tubicola: USNM 24752, 1♀, Pt. Conception, California; USNM 60110, 1♂, Pacific Grove, California; AHF 1464-42, 3♂, 1♀, Oregon; USNM 53308, 1♂, 1♀, Nanaimo, British Columbia.

We are grateful for the loan of this material.

Pinnixa tomentosa Lockington
Figs. 1A–C; 2A–C

Pinnixa tomentosa Lockington, 1876:156 (type-locality, Angeles Bay, Gulf of California). Holmes, 1894:568.—Rathbun, 1918:141.—Schmitt, 1921: 258.

Supplementary description.—Female: Carapace between 2 and 2½ times as wide as long, appearing hexagonal due to protrusion of interorbital margin and curvature of upper anterolateral margins; upper anterolateral margin with 5–9 well defined spines near juncture with posterolateral margin; posterolateral margin minutely tuberculated; interorbital margin produced so that front and orbits protrude beyond lower, or true, anterolateral margin as viewed from above. Gastric and cardiac regions on single plane with carapace sloping downward from that plane in all directions producing a rounded appearance; cardiac ridge not prominent though distinctly set off by deep cervical groove. Front with short bristles, lateral edges near and beyond slope of carapace heavily bristled. Chelae robust; dactylus with tooth in proximal half; fixed finger with variable number of teeth together in single group. Lower margin of palm smooth, concave below intersection of propodus and dactylus giving fixed finger appearance of being slightly bent downward. Tip of dactylus curved downward, closing inside upcurving tip of propodus; 3–4 small tubercles on outside of upturned distal extremity of fixed finger. Short bristles cover entire dorsal surface of palm, dactylus, and ventral and outer surfaces of fixed finger; thick bristles line opposing surfaces of both fingers distal to group of teeth on

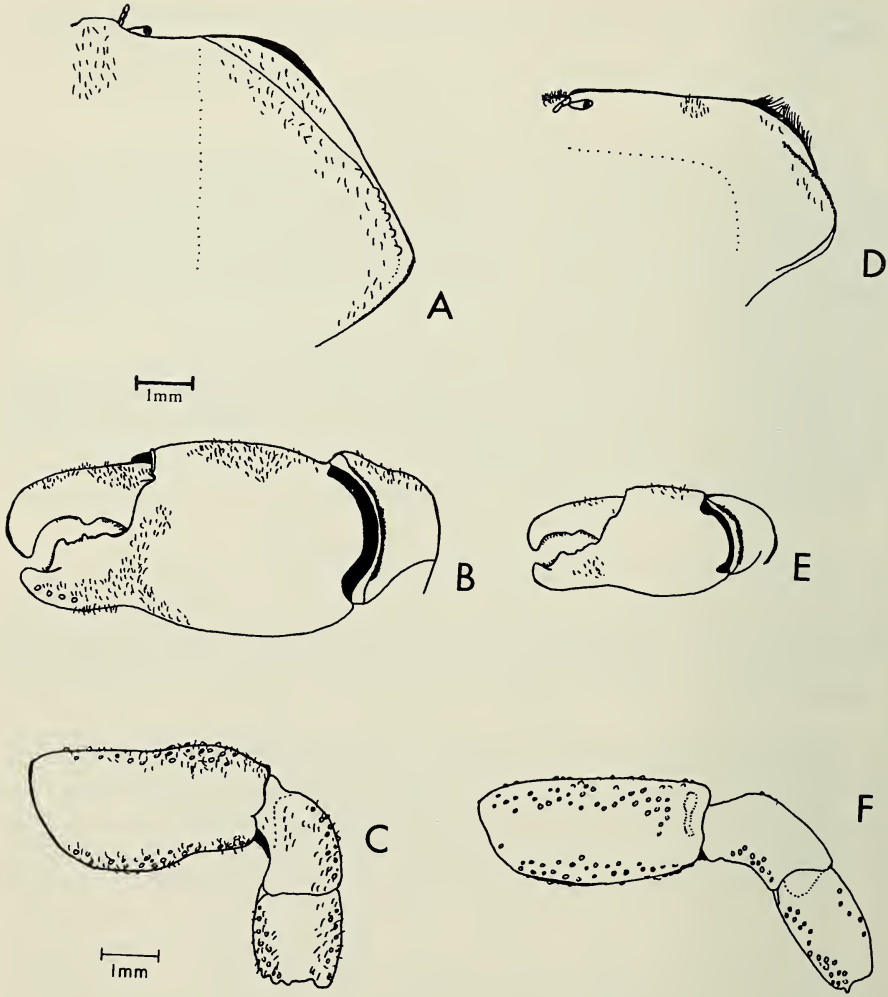

Fig. 1. *Pinnixa tomentosa* (left) and *P. tubicola* (right) females: A, D, Right dorsal carapace; B, E, Left cheliped; C, F, 3rd walking leg, merus, carpus and propodus.

propodus; proximal half of inner surface dactylus with bristles; opposing surface of fixed finger without bristles.

Third walking leg largest, followed in order of size by second, first and fourth. Third as follows: dactylus with corneous tip, heavily tubercled and bristled, tubercles tending to become spiniform; propodus squarish, heavily tubercled on lower surface and terminating in 3–5 spines, bristles thick on upper and lower surfaces; carpus with a few tubercles on heavily bristled

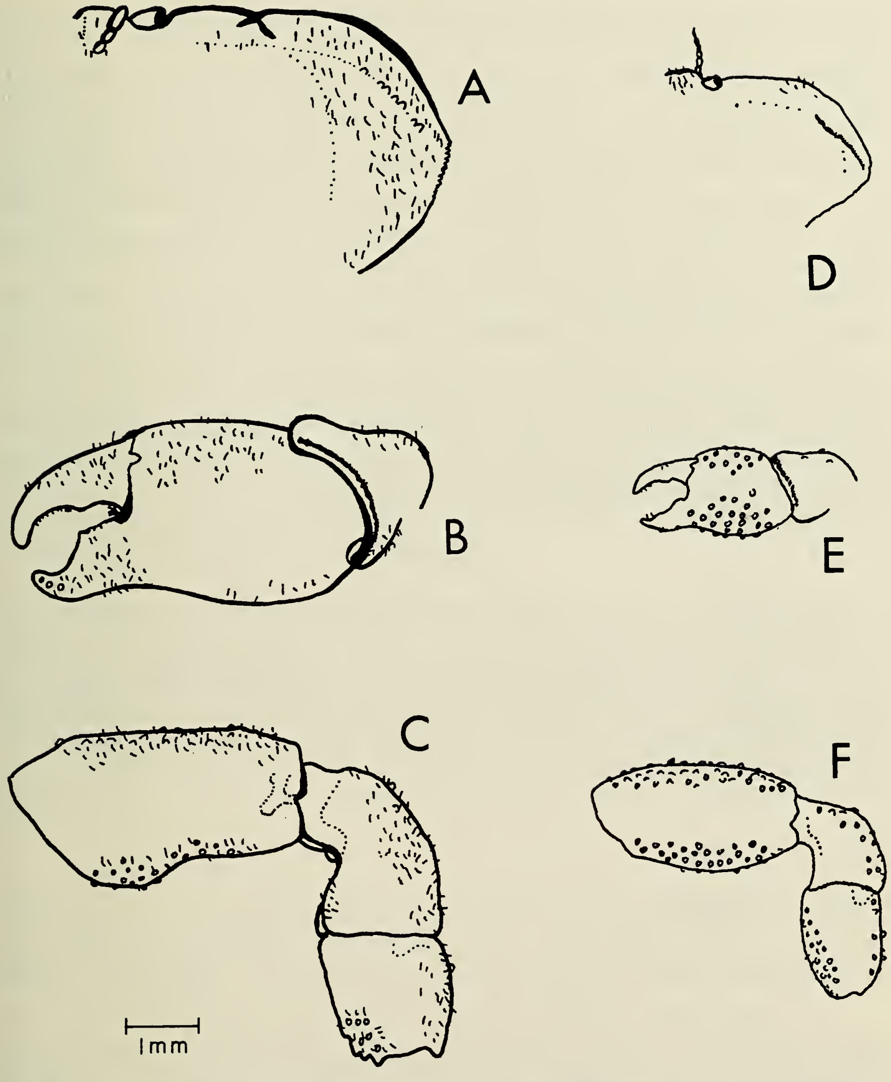

Fig. 2. *P. tomentosa* (left) and *P. tubicola* (right) males: A, D, Right dorsal carapace; B, E, Left cheliped; C, F, 3rd walking leg, merus, carpus and propodus.

dorsal surface; merus heavily tubercled, with bristles above and below; raised areas dorsally at distal end and ventrally at proximal end.

Male: Carapace 1½–2 times as wide as long, similar to female except front more pronounced, upper anterolateral margin less curved, and lower anterolateral margin extending farther laterally before curving posteriorly.

Chelae as in female, but distal extreme or dactylus less hooked. Walking legs similar to female.

Color: Sexes similar, carapace being mottled brown and cream, appendages light tan.

Size: Females, as a rule, are larger (and more abundant). Mature females have a width varying from 7.4–14.9 mm, and males from 3.0–11.8 mm in a total sampling of 343 females and 133 males. The females varied from 1.9–2.5 times as wide as long in a sample of 104. The males varied from 1.6–2.2 times as wide as long in a sample of 77.

Range.—San Felipe (USNM 68331) south to Cape San Lucas and then north on the West Coast to Monterey (Schmitt et al., 1973).

Habitat.—Commensal with chaetopterid, onuphid, and terebellid polychaete worms from intertidal to subtidal depths.

Notes.—This species has been found to be ovigerous in the spring in the San Diego area. It has also been found to be a host for several ectocommensals such as ectoprocts and foraminiferans.

Discussion

At the region of contiguity and overlap of the ranges of *P. tomentosa* and *P. tubicola*, the identities of these two species may be confused by their generally similar appearance and by the lack of clear separating characters in the existing literature. To separate them in Schmitt's dichotomous key to the California species of *Pinnixa* (1921:256), the following can be applied (see Figs. 1 and 2, A–C for *P. tomentosa*, D–F for *P. tubicola*):

II. . . .
  B. . . .
    1. . . .
      a. Interorbital margin in females beyond upper anterolateral margin when viewed from above; propodus of third walking leg terminating in 3–5 spines; palm of chelae in males smooth. *tomentosa*, p. 258.
      b. Interorbital margin in females recessed, orbits lying in plane of slope of carapace between upper and lower anterolateral margins when viewed from above; propodus of third walking leg without spines; palm of chelae of males tuberculate. *tubicola*, p. 265.

The females are most easily distinguished by the carapace character, *Pinnixa tubicola* appearing nearly rectangular in shape, and *P. tomentosa* more nearly hexagonal. Because of the protruding rostrum of males this character is less evident than in the females, but the males can be separated on the basis of the tuberculature of the palm of the chelae of *P. tubicola* as opposed to the smooth palm of *P. tomentosa*.

The difficulty in using the bristles as an identifying character arises from these commensals' habitat. Fresh specimens of both specimens are generally covered with detritus, and in this condition both species seem to be very "tomentose." Application of a bottle brush will remove most of this, but the degree of coverage by what appear to be bristles depends entirely upon the amount of brushing. A thoroughly cleaned specimen of *P. tomentosa* will show bristles only after close scrutiny under magnification. Bristles are definitely a distinguishing character, but the usefulness of the character is entirely dependent upon preparation of the specimen.

The ambulatory legs of both species are heavily tubercled both above and below, those on the dactylus sometimes tending to become spiniform. However, the terminal edge of the propodus is smooth in *P. tubicola*, spinous in *P. tomentosa*.

The chelae of *P. tomentosa* are more robust than in *P. tubicola* and the teeth of the fixed finger occur in a single group rather than in two separate groups. The tooth of the dactylus of *P. tomentosa* is in the proximal half, while in *P. tubicola* it is medial or in the distal half. The lower margin of the palm is more nearly straight in *P. tubicola*, having a shallower concavity beneath the base of the fingers.

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Footnote

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REASSIGNMENT OF *BATILLARIA SORDIDA* (GMELIN) FROM THE CERITHIIDAE TO THE POTAMIDIDAE (GASTROPODA: PROSOBRANCHIA)

Richard S. Houbrick

Abstract.—Batillaria sordida, formerly known as *Cerithium carbonarium, C. bornii* or *C. tourannense,* is shown to be a potamidid snail that is convergent in shell characters with some *Cerithium* and *Clypeomorus* species. A synonymy and redescription are presented and the geographic range is given.

While revising the Indo-Pacific Cerithiidae, I examined several lots of a little-known potamidid species from the continental coasts of China and Vietnam that has often been considered a cerithid in older monographic papers and known as *Cerithium carbonarium* Philippi, 1848 or *Cerithium bornii* Sowerby, 1855. It is not frequently mentioned in the modern literature, and most museums have only a few lots of poorly preserved or badly eroded specimens. Shells of this species are stocky, proportionately heavy, have a distinctive sculpture of two spiral rows of black nodes on each whorl, and short but distinct anterior canals (Fig. 1a, b, e). Although previously placed in the genus *Cerithium* Bruguière, 1789 by most authors, I regard this species as a member of the family Potamididae H. and A. Adams, 1854 in the genus *Batillaria* Benson, 1842. I will refer to it as *Batillaria sordida* (Gmelin, 1791), employing the earliest available name. The reasons for this taxonomic reassignment are herein discussed and a synonymy and redescription presented.

Family Potamididae H. and A. Adams, 1854

Batillaria Benson, 1842

Batillaria sordida (Gmelin, 1791)

Fig. 1

Strombus tuberculatus Born, 1778:284 (no locality given; refers to Martini, Conch. Cab., 4, pl. 157, fig. 1490; *non* Linnaeus, 1767).—Born, 1780:284, pl. 10, figs. 16–17.

Murex sordidus Gmelin, 1791:3561 (no locality given; refers to Martini, Conch. Cab., 4, pl. 157, fig. 1490, herein selected to represent lectotype).

Cerithium morus Bruguière, 1792:500–501 [in part], ("mer Méditerranée"; refers to figures of Lister, Synopsis Method. Conch., tab. 1024, fig. 89; Seba, Locup. rerum naturo . . . etc., pl. 55, fig. 21; Born, Test. Mus. Caes. Vindo.; pl. 10, figs. 16–17; Martini, Conch. Cab., pl. 157, fig. 1490; *non* Lamarck, 1822).

Murex varicosus Röding, 1798:99, no. 1278 (no locality given; refers to Martini, Conch. Cab., 4, pl. 157, fig. 1490).

Cerithium carbonarium Philippi, 1848:142–143 (China; no figure; type not found; *non* Reeve, 1865).—Watson, 1886:531 (*in* Thompson and Murray, 1886).—Tryon, 1887:133, pl. 24, fig. 24 (not fig. 34).—Kobelt, 1898: 276–277, pl. 47, figs. 3–4 (*in* Martini-Chemnitz, 1898).—Adal, 1958:126.—Dance, 1974:66.

Cerithium tourannense Souleyet, 1852:601, pl. 39, figs. 3–5 (*in* Vaillant, 1852; Touranne [= DaNang, Vietnam]; lectotype, MHNP, no reg. no., here selected and figured.)

Cerithium bornii Sowerby, 1855:869–870, pl. 182, fig. 175 (Seychelles; type not found).—Reeve, 1865: no. 26, pl. 4, fig. 26.

Batillaria bornii (Sowerby). Kuroda, 1941:89, pl. 15, fig. 5.—Chen, 1960:4.

Description.—Adult shell turrited, stocky consisting of 7–9 inflated whorls and having an apical angle of 40 degrees. Shell ranges in length from 34.2–16.5 mm and 17.0–8.0 mm in width. Each whorl sculptured with 2 prominent spiral cords and numerous fine spiral striae. Spiral cords each with 9–12 black, laterally expanded nodes per whorl. Body whorl greatly inflated and with 5 spiral rows of black nodes. Penultimate and body whorls with distinct sutural ramp. Protoconch unknown and early whorls usually badly eroded. Suture moderately incised. Aperture circular-ovate, a little less than ⅓ length of shell. Columella deeply concave and with weak callous. Outer lip thick, slightly crenulate, extending posteriorly ½ length of penultimate whorl. Anal canal deeply incised and with prominent flattened anal callous. Anterior siphonal canal well-developed, but short and sharply curved to left. Shell color gray with spiral rows of dark brown to black nodes. Operculum thin, corneous, tan, circular and multispiral with central nucleus.

Radular ribbon taenioglossate, about ⅛ the length of shell and consisting of 70 rows of teeth. Face (basal plate) of rachidian tooth rectangular, slightly concave at top. Upper part with large, central pointed cusp flanked by 2 smaller denticles on each side. Base of rachidian with 2 pairs of mid-basal cusps, short, slight central bulge, and thin, elongate lateral extensions. Rachidian formula 2–1–2/2–2. Lateral tooth rhomboidal, serrated at top with 2 small entocones, a large wide mesocone and 2–3 small ectocones, respectively. Base of lateral tooth with wide, deeply extending central process and long, twisted lateral extension. Marginal teeth long, spatulate, serrated at tips with 4 smooth inner cusps. Internal anatomy, eggs and larvae unknown.

Synonymic History

A survey of the monographic literature reveals an interesting and complex synonymic history. *Batillaria sordida* (Gmelin) was first described by Born

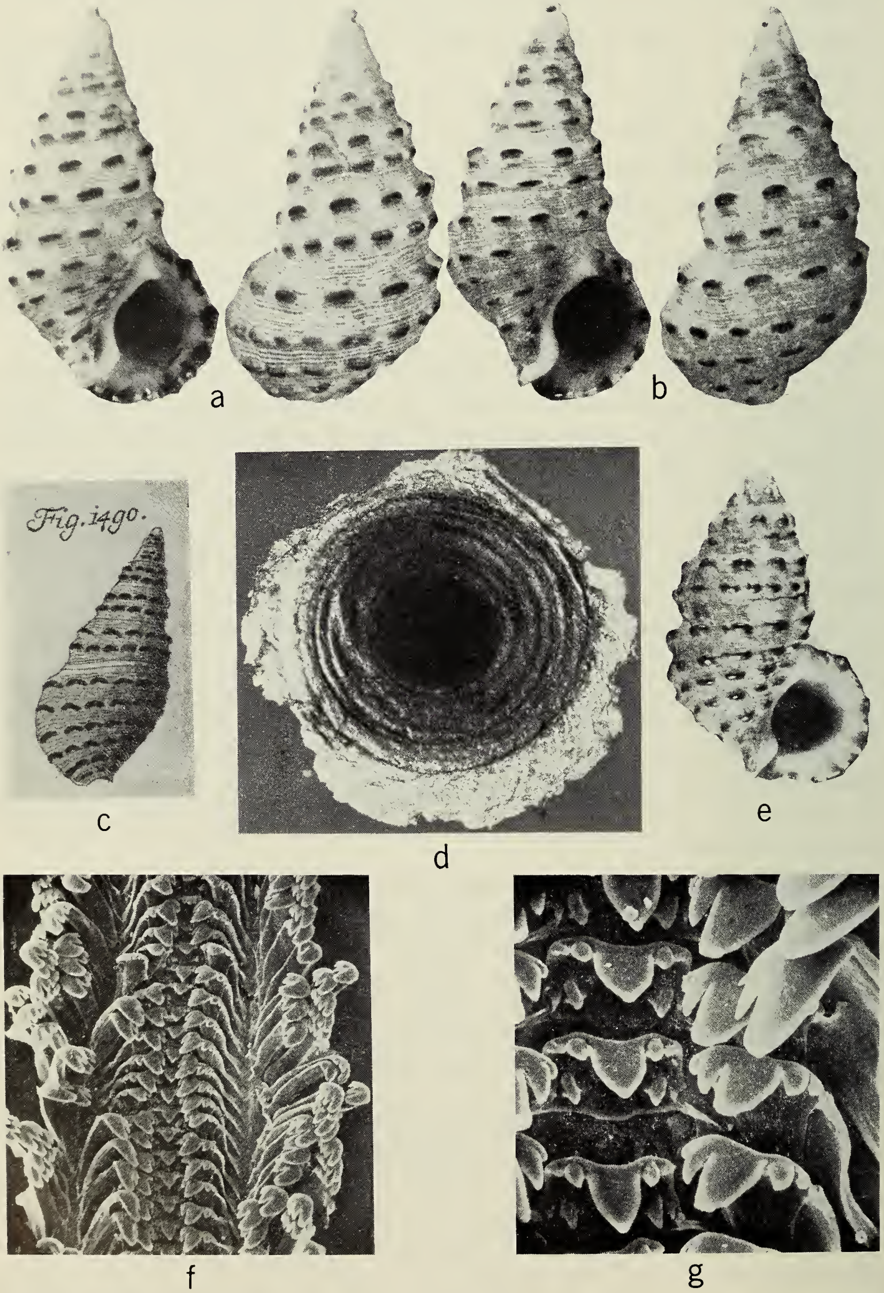
a
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Fig. 1490.
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(1778) as *Strombus tuberculatus*, but this name is preoccupied by that of Linnaeus, 1767. Although Born (1778) initially referred to a figure in Martini (1780, pl. 157, fig. 1490), he later illustrated this species in 1780 (pl. 10, figs. 16–17). Both the Martini and Born figures are excellent representations of *Batillaria sordida* and not easily confused with other similar species. Martini (1780) correctly cited "Chinese waters" as the locality for this species but Born's (1780) citation, "Mari Mediterraneano" should be considered erroneous. Sowerby (1855:865–866), noting that *tuberculatus* was preoccupied, proposed the name *bornii* for this species, but an earlier available name is *Murex sordidus* Gmelin, 1791. It is interesting to note that Gmelin (1791:3561) considered *sordidus* to be a variety of *tuberculatus* Born. Although Gmelin gave no locality, he referred to Martini's (1780) figure (pl. 157, fig. 1490). Röding (1798) named this species *Murex varicosus*, citing *Murex sordidus* Gmelin in the synonymy, and referred to the same Martini figure as did Born (1780). *Cerithium morus* Bruguière, 1792, is undoubtedly a synonym of *sordida*, at least in part. Bruguière (1792) cited four figure references considering the best to be those of Born (1780, pl. 10, figs. 16–17) and Seba (1758, pl. 50, fig. 21, upper right hand corner). With the exception of fig. 89 of Lister (1770), all of Bruguière's figure references for *C. morus* clearly represent *sordida*. Lister's (1770) figure, although poor and not clearly attributable to any species, is definitely not *sordida*. *Batillaria sordida* has also been confused with *Strombus tuberculatus* Linnaeus, 1767. The latter species has a complex synonymic history (see Dodge, 1956) and is considered a *nomen dubium*. Since all of the above authors cited the identical Martini figure (see Fig. 1c, this paper) and Gmelin's type-material has not been found, I herein designate the figure in Martini (1780, Conch. Cab., 4, pl. 157, fig. 1490) to represent the lectotype of *Murex sordidus* Gmelin, 1791 (see Fig. 1c). Philippi (1848), who called this species *Cerithium carbonarium*, did not illustrate it, but in his description noted the two distinctive spiral rows of black nodes on each whorl and cited China as the type-locality. *Cerithium carbonarium* Philippi was synonymized by Sowerby (1855:870) and Reeve (1865, pl. 4, fig. 21, a,b) with *Cerithium tuberculatum* Linneaus, 1767. Both Sowerby and Reeve confused Philippi's

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Fig. 1. *Batillaria sordida* a, b, Specimens from Shanghai, China showing distinctive spiral rows of black nodes and apertural characters (a, 32 mm long; b, 35.5 mm long); c, Figure of Martini (1780: pl. 157, fig. 1490), herein selected to represent lectotype of *Murex sordidus* Gmelin, 1791; d, Operculum of specimen from Long Hai, Vietnam (6.0 mm diameter); e, Lectotype of *Cerithium tourannense* Souleyet, 1852, from DaNang, Vietnam (28.7 mm long); f, Scanning electron micrograph of radula of *Batillaria sordida* from Long Hai, Vietnam (125×); g, Details of rachidian and lateral teeth (500×).

species, *carbonarium*, which has only two rows of spiral nodules, with *tuberculatus* Linneaus, which has three spiral rows. This error was first pointed out by E. A. Smith (1884:65) and later noted by Tryon (1887:133), Watson (1886:531), and Kobelt (1898:276–277), who correctly identified *carbonarium* Philippi with *tuberculatum* Born (*non* Linnaeus, 1767) and *Cerithium bornii* Sowerby. *Cerithium tourannense* Souleyet, 1852 is also a synonym of *Batillaria sordida*. The figures of *tourannense* (Souleyet, 1852, pl. 39, figs. 3–5) are excellent and depict the operculum as multi-spiral and round, an indication that this species is not a cerithid.

The earliest available name for this species is *sordidus* Gmelin, 1791. The use of this name eliminates the nomenclatural confusion surrounding the two more frequently used names for this species, *carbonarium* Philippi and *bornii* Sowerby.

Remarks

Although nearly all authors have referred this species to the genus *Cerithium* Bruguière 1789, I questioned this when I first noticed the potamidid operculum depicted by Souleyet (1852, pl. 39, fig. 5). Several specimens from Long Hai, Vietnam had dried soft parts from which I was able to extract opercula and radulae. The operculum (Fig. 1d) is round, multispiral and has a centrally-placed nucleus that is typical of animals in the family Potamididae; to my knowledge, there are no species in the family Cerithiidae with such an operculum. A radula 4.2 mm long consisting of 75 rows of teeth was dissected from a specimen with a shell length 31 mm long and 13.8 mm wide. The radula (Fig. 1f, g) is typically taenioglossate (2 + 1 + 1 + 1 + 2). The face (basal plate) of the rachidian tooth (Fig. 1g) is rectangular and has 2 cusps arising from each side of its mid-lateral surface. The rachidian formula is 2–1–2/2–2. This pattern is not seen in the rachidian tooth of *Cerithium* species, which lack the mid-basal cusps. No other anatomical observations were made due to poor preservation of the animals.

Both Kuroda (1941) and Chen (1960) correctly referred this snail to the genus *Batillaria* but did not give any reasons for the generic reassignment. I also consider this species to be a member of the genus *Batillaria*. The leftward directed anterior canal, ovate aperture with strongly concave columella and the adjacent, flattened anal callous are typical of *Batillaria* as are the opercular and radular characters. *Batillaria sordida* resembles some cerithids in the genera *Clypeomorus* Jousseaume, 1888, and *Cerithium* Bruguière. Its shell is convergent with those of *Clypeomorus* and *Cerithium* species that occur in high intertidal or high energy environments. Convergence of shell characters is not an uncommon phenomenon between members of the Potamididae and Cerithiidae [e.g. *Cerithium lutosum*

Menke, 1828 and *Batillaria minima* (Gmelin, 1791); *Cerithium coralium* Kiener, 1842, and *Velacumanthus australis* (Quoy and Gaimard, 1834)].

Batillaria sordida lives on rocks in the lower intertidal but may also extend to the midlittoral region (Yen, 1933; Adal, 1958). Although there is no other ecological information available, I suspect that it is primarily an estuarine species, as are most potamidids.

The known geographical distribution of *Batillaria sordida* is limited to the continental coastline of eastern Asia from Chekiang Province, China (Ping, Chi and Teng-Chien Yen, 1932) to Vietnam and to the island of Taiwan. I have examined museum specimens from these localities. In the earlier literature this species was incorrectly recorded from the Seychelles (Sowerby, 1855; Reeve, 1865; Tryon, 1887) and although Kobelt (1898) questioned this locality he cited China and Japan. I believe Japan is an erroneous locality. There is also a questionable record from the Philippines (Watson, 1886).

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APPENDIX

Specimens Examined

China.—Shanghai (MCZ). Bay N of Ngaam Kok, Port Shelter, Hong Kong (ANSP). Hong Kong Harbor (AMNH: ANSP). Cape D'Aquilar, Hong Kong (NMNH). Nan-ta-wu, Amoy (NMNH).

Taiwan.—Kao Hsiung (ANSP). Tanshui Beach (AMNH: ANSP). NW coast of Tam-Sui (NMNH).

Pescadores.—Tung Lian Beach, Makung Id. (AMNH).

Vietnam.—Long Hai, near Vung Tan (AMNH). Chu Lai Bay (NMNH). Touranne (DaNang) (MHNP).

Abbreviations

AMNH American Museum of Natural History. ANSP Academy of Natural Sciences, Philadelphia. NMNH National Museum of Natural History, Smithsonian Institution. MCZ Museum of Comparative Zoology, Harvard. MHNP Museum d'Histoire Naturelle, Paris.

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SPADELLA GAETANOI, A NEW BENTHIC CHAETOGNATH FROM HAWAII

Angeles Alvariño

Abstract.—The new *Spadella* is described and compared with the related species *S. cephaloptera*, *S. angulata* and *S. bradshawi*, with which it agrees in the lack of adhesive digital organs. The diagnostic characteristics of *S. gaetanoi* and the three closely related species of *Spadella* are compiled (Table 1). Information on the habitat and the food of *S. gaetanoi* is also included.

The genus *Spadella* Langerhans was discussed by Alvariño (1970), who compiled the diagnostic characteristics and world distribution of the species. Since that time, another species of *Spadella*, *S. bradshawi* Bieri, 1974, has been described from California. The new species described herein is related to *S. cephaloptera*, *S. angulata* and *S. bradshawi*, with which it agrees in several characteristics, such as lack of adhesive digital organs. However, *S. cephaloptera* and *S. angulata* have intestinal diverticula, which are absent in *S. bradshawi* and *Spadella* new species.

Spadella gaetanoi, new species
Figs. 1–2

Material.—Holotype (USNM 55361) and 6 paratypes (USNM 55362) collected at Kure Atoll (Hawaii) in August 1977.

Diagnosis.—The body is opaque, flattened dorso-ventrally and with well developed muscles (Fig. 1A, B). Total length when mature, 2–3 mm, tail fin not included. The body is widest at the posterior part of the trunk. The head is large, roundish, almost twice as wide as the neck. Neck is distinct, and covered by a thick collarette (Fig. 2A). The caudal segment constitutes 53–55% of the total length. The eyes are large, round; the pigmented region is large, and the pigment is in an H shape, leaving 4 clear spaces filled by lenses. The hooks are slender, rather strongly curved, usually 8 or 9 (up to 10) at each side of the head. The anterior teeth are 4 per set at each side of the head. They are long, thin and curved. The teeth at the middle of each set are the longest. The posterior teeth are 4 or 5 at each side of the head. They are thin and small, when present. The corona ciliata is a perfect oval, not as thick as in *S. bradshawi*, with the longest axis transverse to the longitudinal axis of the body. It covers the neck, extending into the collarette region of the neck. The collarette is thick, well developed, extending from the head to the level of the posterior septum and

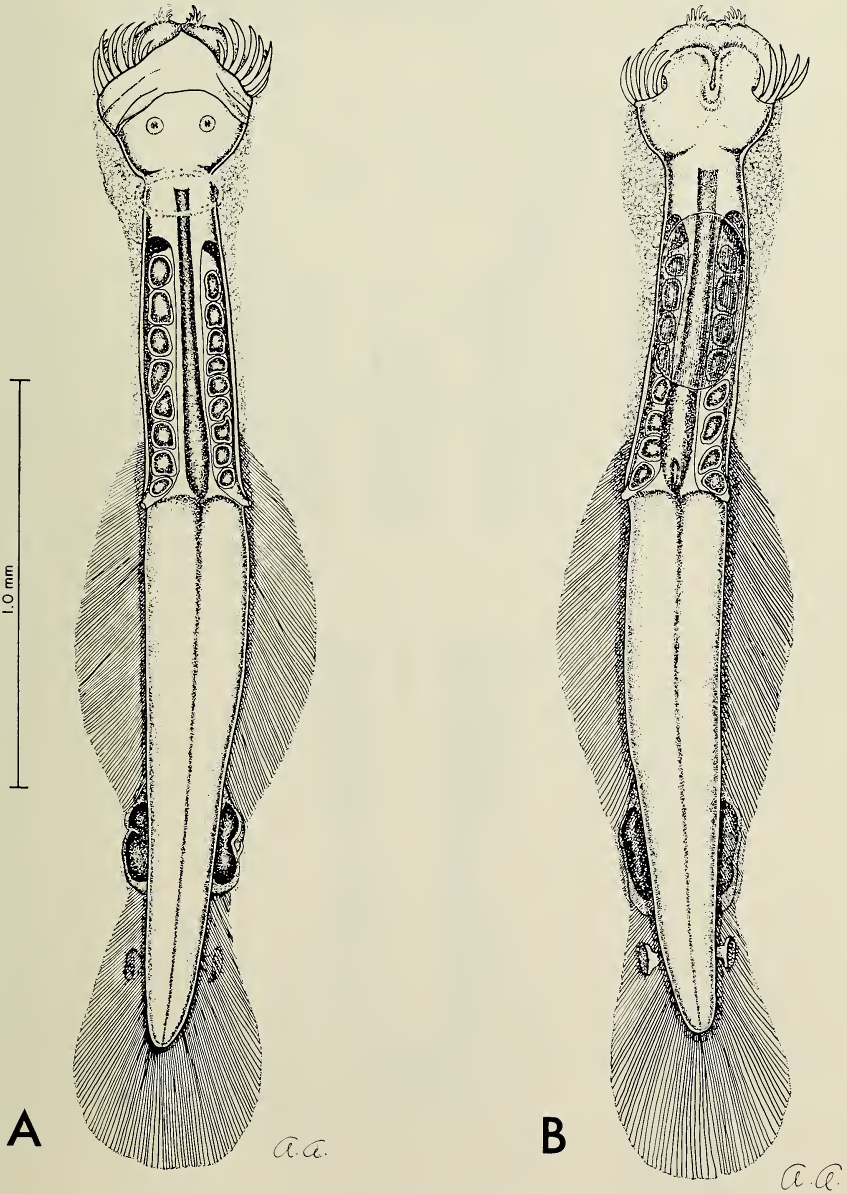

Fig. 1. *Spadella gaetanoi.* A, Dorsal view; B, Ventral view.

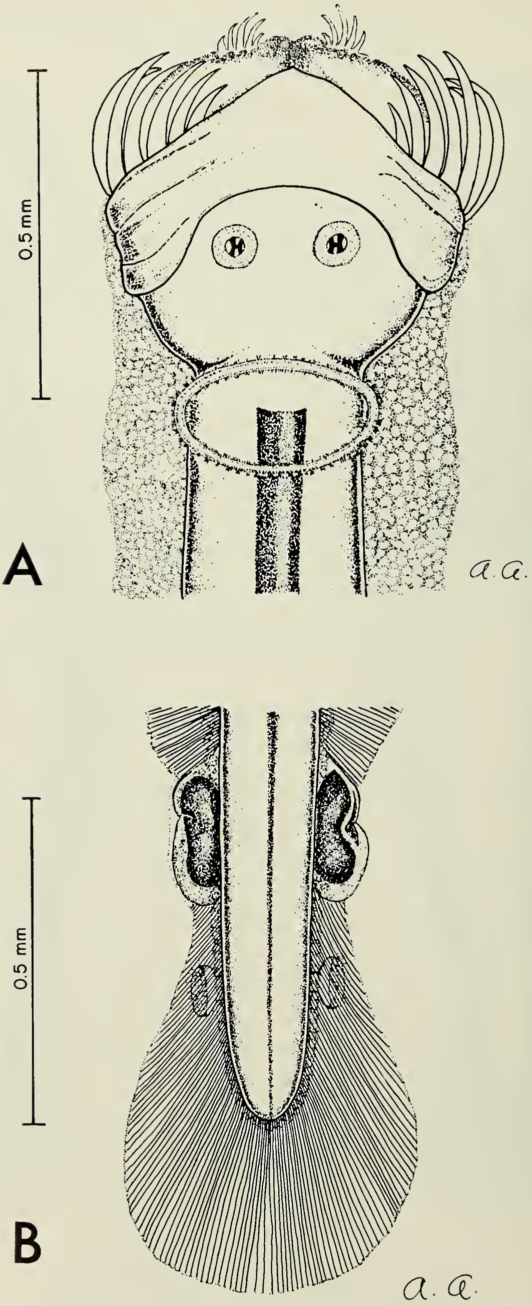

Fig. 2. *Spadella gaetanoi.* A, Dorsal view of head, with detail of hooks, teeth, eyes, corona ciliata, neck, collarette, and anterior part of intestine; B, Dorsal view of posterior part of tail segment, with detail of seminal vesicles and tail fin.

progressing along the tail segment to the tail fin. It is widest at the neck region. Intestinal diverticula absent. The ventral ganglion is large, thick, occupying totally the width and almost half the length of the trunk. It is located at midlength of the trunk, closer to the neck than to the posterior septum.

There is a pair of lateral fins, which are long, narrow, broadest at midlength. They extend from the posterior part of the trunk, from a level anterior to the opening of the oviducts, to the seminal vesicles. They are completely rayed. The caudal fin is long, rounded along the tip of the tail, with a shape as in *Krohnitta pacifica* (Aida) and *K. mutabbii* Alvariño. It is continuous with the lateral fins, by a membranous rayless band which covers the ventral part of the seminal vesicles.

Adhesive digital organs are absent. However, on the ventral side, midway from tip of tail to seminal vesicles, there is on each side a cup-like structure which could have an adhesive function (Fig. 1A, B; Fig. 2B).

The ovaries extend to the neck region, reaching the level of the posterior end of the corona ciliata. The ova are large, in one row, and less than 10 per ovary. The seminal vesicles touch the posterior end of the lateral fins and the tail fin. They are small, reniform. They open at the dorsal side by a latero-dorsal slit at the anterior half of the vesicle. This opening is notch shaped. The ventral extension of the lateral and caudal fins, which cover the ventral part of the seminal vesicles, may function as a soft protecting membranous shield, preventing damage to the vesicles when the animal crawls, and also acting as a device to ensure copulation. During copulation the fins may press against the vesicle to force the release of the gametes, ensuring their entrance to the oviducts (Fig. 2B).

The sensory spots appear distributed at the edges of the ventral and dorsal sides. These structures disappear in part or totally, due to the effect of preservative substances used. Groups of reddish spots observed in other species of *Spadella* were not present in the specimens of *S. gaetanoi*. The animals were fixed in formaldehyde and later transferred to alcohol, which may have destroyed some of the sensory tufts. However, Bieri's specimens of *S. bradshawi* had been maintained in a weak solution of formaldehyde for nearly 20 years, and after that time the orange spots and sensorial papillae could be clearly detected on the animals. The specimens of *S. gaetanoi* had been in preservation only for a few weeks, and the color spots were not evident on the animals.

Remarks.—Spadella gaetanoi differs from *S. cephaloptera* and *S. angulata* in every anatomical characteristic, especially in the absence of the intestinal diverticula, which are present in the two latter species (Table 1). *Spadella gaetanoi* and *S. bradshawi* do not have intestinal diverticula. They differ conspicuously in other anatomical features, including body size, dimensions of ventral ganglion in relation to the length of the trunk, shape of the seminal vesicles and their position in relation to the lateral and

Table 1. Differential characteristics of species of *Spadella* with no digital adhesive organs.

Charact.	*S. cephaloptera* Bush, 1851	*S. angulata* Tokioka, 1951	*S. bradshawi* Bieri, 1974	*S. gaetanoi*, n. sp.
Body length, mm	2–10, firm, broad, wider at posterior septum. Yellow-brownish.	2.5–4–18, including tail fin. Slender, broadest at posterior septum	5.5 to 6.5	2.00 to 3.00
Head	Medium size, neck distinct	Faint orange spots on head		Large, twice as broad as neck.
% tail segment	20–38	51.2–57.9 including tail fin	53–54	53–55
Lateral fins	One pair, long, narrow, from posterior septum to seminal vesicles. Broadest at mid-length	One pair, from posterior part trunk to anterior end seminal vesicles. Broadest at mid-length. No rayless zone. Separated from tail fin	One pair, from level anterior to transverse septum to near seminal vesicles, but not reaching them. No rayless zone.	One pair, from posterior part of trunk to seminal vesicles, joining tail fin over ventral side of seminal vesicles. No rayless zone.
Caudal fin	Long, spatulate starts as posterior end of seminal vesicles	Spatulate	Square spatulate	Roundish-spatulate joining lateral fins at ventral side
Eyes	Pigmented region crescent shape	Pigmented region roundish		Round, prominent. Pigmented region in X shape.
Hooks	7–11, slender, slightly saginated, points sharp, curved	8–10	7–12	8–9 or 10, slender, strongly curved.

Table 1. Continued.

Charact.	*S. cephaloptera* Bush, 1851	*S. angulata* Tokioka, 1951	*S. bradshawi* Bieri, 1974	*S. gaetanoi*, n. sp.
Anterior teeth	2–5, long, thin, innermost longer	2–4	3–5	4–5, long, thin, strongly curved, mid ones on each side are longest.
Posterior teeth	0–4, short, thick	None	None	None, or 4–5, thin, small.
Corona ciliata	Elliptical, rectangular, crescent shape, slightly waved at posterior part, longest axis transverse	Transversely elongated oval, protruding undulation at anterior part.	Oval, massive	Perfect ellipse, extending slightly over collarette
Ventral ganglion		Large, ⅓ of length of trunk	Covers middle ⅓ of trunk	Large, at midlength of trunk, closer to neck than to posterior septum. About half of trunk length
Sensory spots		Evenly spaced, 5 on midline of dorsal side tail segment	4 on midline of dorsal side of tail segment, 2 anterior more spaced than 2 posterior	Along edges of ventral and dorsal sides
Ovaries	Reach neck or anterior end of ventral ganglion. Ova large, close together.	Reach posterior end ventral ganglion. Ova roundish, of regular size.	Reach neck	Reach neck. Ova large, in one row.

Table 1. Continued.

Charact.	S. *cephaloptera* Bush, 1851	S. *angulata* Tokioka, 1951	S. *bradshawi* Bieri, 1974	S. *gaetanoi*, n. sp.
Seminal vesicles	Small, spherical or reniform, touching lateral and tail fins.	Elongated ellipse, breaking at lateral anterior half.	Do not touch tail fin or lateral fins. U shape tube projects to anterior lateral side.	Reniform, breaking by slit of flute point shape, at latero-dorsal side of anterior half.
Intestinal diverticula	Present	Short, distinct.	Absent	Absent.
Adhesive digital organs	None. Adhesive cylindrical cell groups and small glandular lobes on ventral side, mainly on caudal septum.	None	None	None. Adhesive cylindrical disks at ventral side of tail at mid-distance from tip of tail to seminal vesicles.
Collarette	Wide at neck, diminishing in thickness towards tail segment.	Well developed at neck, diminishing thickness towards seminal vesicles.	From head to trunk and tail fin.	Head to tail fin. Thickest at neck region.

tail fins. In S. *gaetanoi* the seminal vesicles touch both lateral fins and tail fin (with a prolongation of those fins covering the ventral side of the seminal vesicles), whereas in S. *bradshawi* the seminal vesicles are separated from both lateral fins and tail fin (Table 1).

Food of Spadella gaetanoi.—The specimens analyzed had been feeding on Copepoda and invertebrate larvae, as those items appeared in the digestive tract in various stages of digestion.

Distribution.—The specimens studied were collected at night at the Kure Atoll (Hawaii) on the western side of the atoll inside the lagoon, on sandy rubble substrata at about 6 m depth. The collections were obtained with an emergence trap attached to the bottom during a survey program by NMFS Honolulu Laboratory on benthic marine communities. With this program Dr. Edmund Hobson and James R. Chess are comparing various marine communities of the leeward islands and the main Hawaiian Islands. Collections were also obtained from Midway Atoll, but S. *gaetanoi* was not found there.

Etymology.—Named after the navigator Juan Gaetano, discoverer of the Hawaiian Islands in 1555. The Hawiian Islands were first named Isles of Volcanoes. They appear in the world map by Juan Martinez (1587), and the map of the Pacific Ocean by Juan Riero Oliva (1591). Cook in his diary and memoirs explains that he was not the first European to visit these islands, and that he knew of the information regarding the discovery of the islands.

Acknowledgments

I would like to express my appreciation to James R. Chess, from NOAA, NMFS Laboratory at Tiburon, California, for his kindness in sending me the material of *Spadella* for identification.

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CLEANTIOIDES, A NEW IDOTEID ISOPOD GENUS FROM BAJA CALIFORNIA AND PANAMA

Brian Kensley and Herbert W. Kaufman

Abstract.—*Cleantis occidentalis*, described from a single specimen by Richardson (1899*a*) and not seen since, is now recorded from the Bay of Panama. The species is redescribed and figured, and placed in the new genus *Cleantioides*. The differences between this new genus and the closely-related *Cleantis* and *Zenobiana*, which lie mainly in maxillipedal, antennal, and uropodal structure, are summarized. Ecological observations indicate that the species lives in warm water (22–30°C) of about 1 meter depth, in an overlying silt/clay sediment layer.

The idoteid isopod *Cleantis occidentalis* was described by Richardson in 1899 from a single specimen collected in Baja California. In her 1905 monograph on the marine isopods of North America, Richardson noted that this specimen had been lost. The type has still not reappeared. In the course of sampling the benthic fauna of Culebra Island, Pacific Panama, by the second author, several idoteids were collected, which at the outset were tentatively identified as *C. occidentalis*. Subsequent examination, however, revealed discrepancies in generic diagnoses of *Cleantis* and related genera. The present paper attempts to resolve only part of the problems revealed in the generic designation of species of *Cleantis* and *Zenobiana*.

Cleantioides, new genus

Diagnosis.—Body parallel-sided. Coxae visible on pereonites 2–7. Pleon composed of 3 complete and 1 incomplete pleonites, plus pleotelson. Antennal flagellum consisting of single large article. Maxillipedal palp 4-segmented. Pereopod 4 somewhat reduced. Uropod lacking endopodal ramus on inner face.

Type-species.—*Cleantioides occidentalis* (Richardson, 1899*a*).

Etymology.—The generic name is derived from *Cleantis* plus '*oides*' the Greek suffix meaning 'resembling or having the form of.'

Remarks.—The genera *Cleantis* and *Zenobiana*, which together contain about 20 species, have not been examined carefully enough to produce clearcut diagnoses. As a result, several species have been moved from one genus to the other without the removal of an element of uncertainty (e.g. *C. phryganea*: Hale, 1946:165). The features on which generic position is determined include the number of complete/incomplete pleonites, number of articles in the antennal flagellum, number of segments

Table 1. Comparison of 3 Genera of Idoteidae.

	Cleantioides n. gen.	*Cleantis* Dana, 1849	*Zenobiana* Stebbing, 1895
Type-Species	*C. occidentalis* (Richardson, 1899*a*)	*C. linearis* Dana, 1849	*Z. prismatica* Risso, 1826
Antennal Flagellar Articles	1	1	3
Maxillipedal Palp Segments	4	5	4 (5) (segments 2 & 3 fused)
Uropodal Endopod	Absent	Present	Present

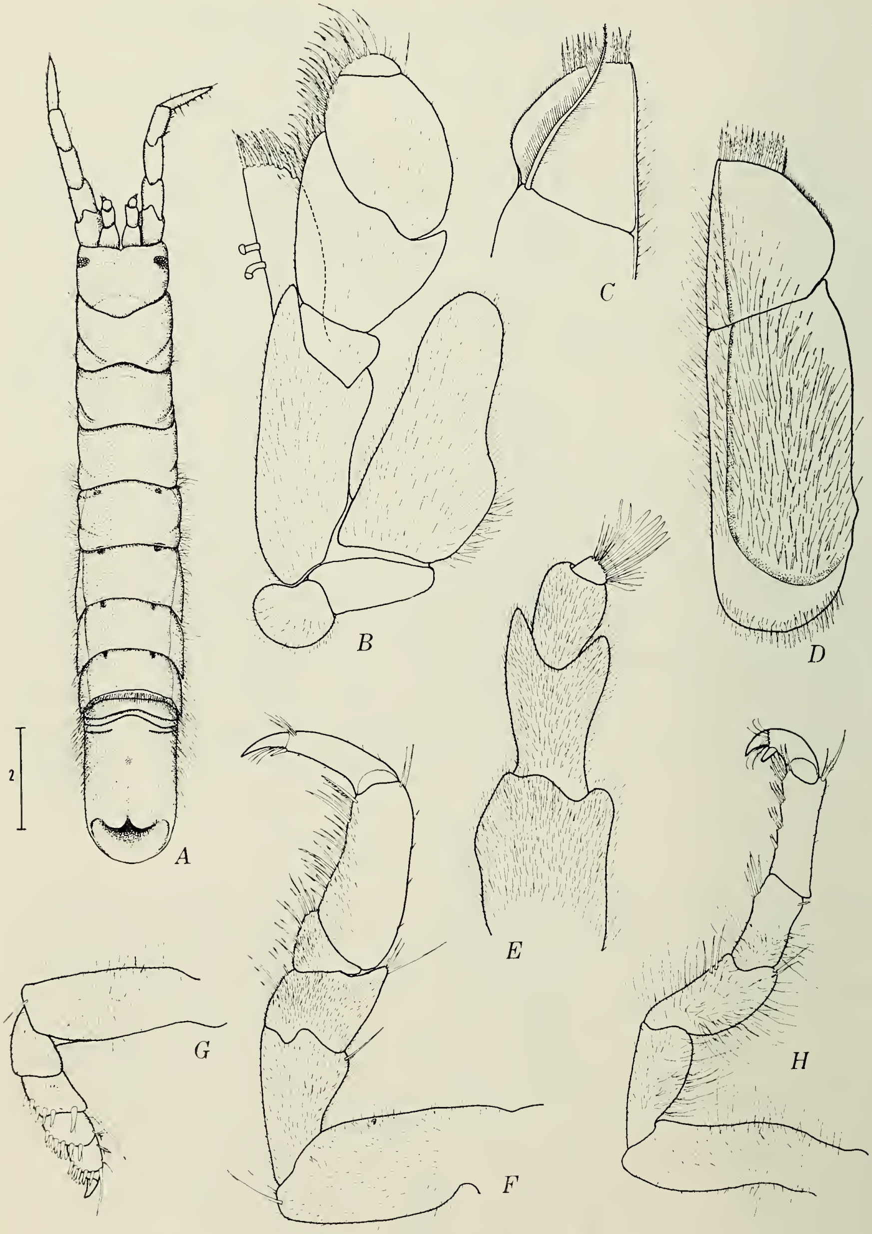

Fig. 1. *Cleantioides occidentalis.* A, Ovigerous ♀; B, Maxilliped; C, Inner view of uropodal exopod; D, Outer view of uropod; E, Antennule; F, Pereopod 3; G, Pereopod 4; H, Pereopod 7.

in the maxillipedal palp, and the presence or absence of a uropodal endopod.

Nordenstam (1933) redefined *Cleantis* after examining the type-species (*C. linearis* Dana). The key characters of his definition include a 5-segmented maxillipedal palp, a single large antennal flagellum article with or without further vestigial articles, and the presence of a small 'secondary' uropodal ramus (i.e. endopod) bearing plumose setae. This restricted diagnosis admits only *C. linearis* Dana, *C. granulosa* Heller, *C. chilensis* Menzies, and *C. phryganea* (Hale).

Examination of British Museum material of *Zenobiana prismatica* (see Fig. 2) (the type-species of *Zenobiana*) shows a species possessing 1 incomplete and 3 complete pleonites, in common with *Cleantis* and *Cleantioides.* Separation of these 3 closely-related genera is now provisionally based on a combination of 3 features. A comparison based on their type-species is given in Table 1.

Regarding the two remaining North American species of *Cleantis*, it would seem that *C. planicauda* Benedict, 1899, also belongs to *Cleantioides.* This species possesses a single antennal flagellar article, and lacks a uropodal endopod, but does have a 5-segmented maxillipedal palp. *C. heathii* Richardson, 1899*a*, possessing 1 incomplete and 2 complete pleonites, an antennal flagellum of 3 or 4 relatively large articles, and lacking a uropodal endopod, is regarded as the juvenile of *Idothea urotoma* (Menzies, 1950).

Cleantioides occidentalis (Richardson, 1899*a*)

Fig. 1

Cleantis occidentalis Richardson, 1899*a*:850, figs. 23, 24; 1899*b*:270, figs. 23, 24; 1909:406, figs. 455, 456.—Tattersall, 1921:426.—Nierstrasz, 1941: 31.—Schultz, 1969:83, fig. 107. (Menzies, (1962:95) referring to Menzies (1950) states erroneously that *Cleantis occidentalis* is the young of *Idothea urotoma.* In fact, Menzies (1950:166) places *C. heathii* in the synonymy of *I. urotoma*).

Previous record.—Magdalena Bay, Lower California, 22 meters.

Description.—Female: Body almost 6 times longer than wide, parallel-sided. Posterolateral areas provided with fine dense plumose setae. Anterior margin of cephalon sinuous, with tiny median notch; posterior margin convex; distinct arc-shaped impressed line posterodorsally. Eyes dorsolateral. Pereonites 1–4 with dorsolateral groove in posterior part; coxae small, distinct. Coxae of pereonites 5–7 large, posteroventrally acute. Pleon consisting of 1 incomplete and 3 complete pleonites plus pleotelson. Anterior pleonite with marked fringe of setae. Pleotelson with evenly rounded distal margin; dorsally with 2 submedian sharp-edged lobes separated by very faint furrow. Antennular peduncle 3-segmented; flagellum of single

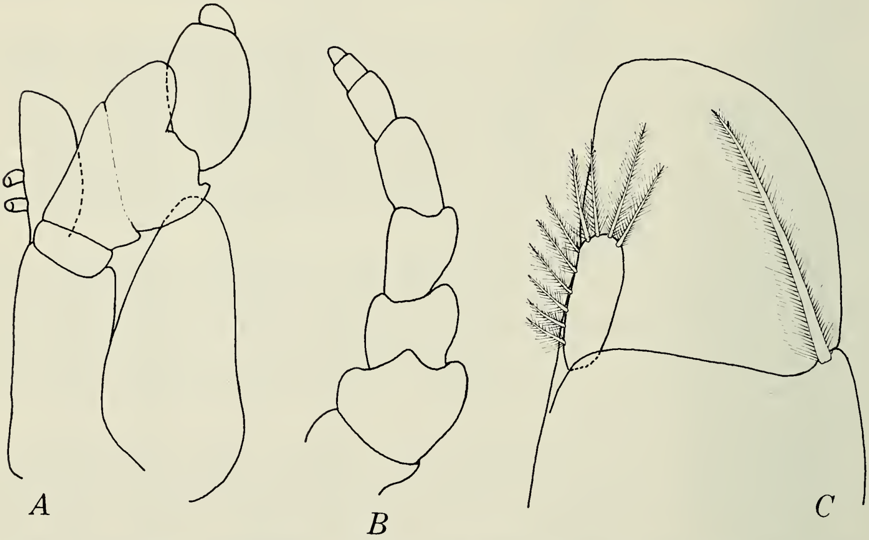

Fig. 2. *Zenobiana prismatica.* A, Maxilliped; B, Antenna; C, Inner view of uropodal endopod and exopod.

short article bearing several aesthetascs and setae. Antennal peduncle of 5 robust segments; flagellum of single tapering article bearing clusters of setae. Maxillipedal palp 4-segmented, terminal segment and basal segment short, segments 2 and 3 expanded; 3 distal segments with slender spines on medial margin; endite reaching nearly to end of second palp segment, with several fringed spines on outer distal margin; 2 retinaculae on median margin. Pereopods 1–3 increasing in length posteriorly, with numerous short setules and slender spines on posterior margin of propodus, carpus, and merus; unguis about one-third length of slender dactylus. Pereopod 4 reduced, about one-third length of preceding pereopod, basal segment equal in length to 5 distal segments together; dactylus a short squat spine; propodus, carpus, and merus each slightly longer than preceding segment, armed with several short sensory spines. Pereopods 5–7 increasing in length posteriorly; dactylus biunguiculate, strongly curved; propodus and carpus with small clusters of finely serrate spines on posterior margin; carpus, merus, ischium, and basis bearing numerous fine elongate setae. Brood pouch containing about 25 eggs, formed by 5 pairs of oostegites on pereonites 1–5. Uropods with dense plumose setae on outer surface, with curved ridge on proximal part of basis, extending distally along median margin onto exopod; latter roughly triangular, with distal row of about 12 fringed spines; endopod absent; basis with single elongate plumose seta extending beyond apex of exopod.

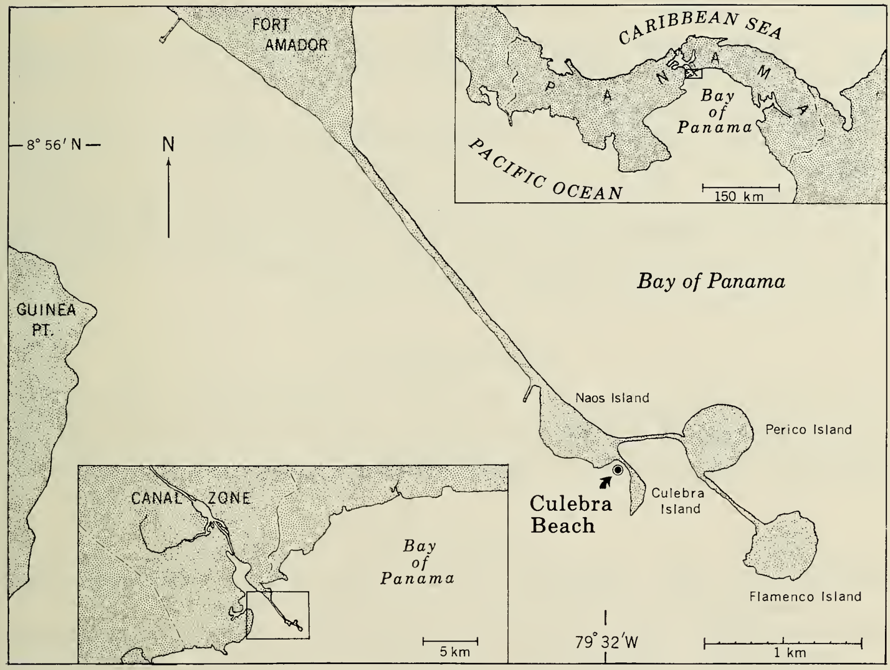

Fig. 3. Locality map for *Cleantioides occidentalis.*

Color.—Animal dorsally red-brown mottled, with 2 spots on anterior part of 4 posterior pereonites.

Material.—3 ovigerous ♀♀, total length 11.0–12.5 mm; 5 immature ♀♀, total length 4.5–10.0 mm. Culebra Island, Bay of Panama, 8°55′N, 79°32′W. USNM 171153 collected Aug.–Oct. 1977.

Ecological notes.—The specimens of *C. occidentalis* were collected on Culebra Island sand beach (see Fig. 3) located in the Bay of Panama and connected to the southern extremity of Fort Amador by a man-made causeway approximately 2 km in length. The isopods were found in the intertidal zone near mean low water level, about 300 ft from shore. In this area of the beach, the sediment is composed of approximately 75% sand, 19% silt/clay, and 6% wood and shell fragments. The sand is such that species making permanent burrows can live in it (e.g. *Callianassa, Acanthosquilla digueti*, and *Nanosquilla decemspinosa*). There is no apparent reduced layer and the sediment appears to be well oxygenated. Salinity measurements obtained at low water while collecting specimens ranged from 26–30‰ in the wet season (June to November) and from 29–33‰ in the dry season (January to April). The water temperature ranged from 24–30°C (wet season) and 22–29° (dry season). The tides in the Bay of Panama are semi-diurnal with a range of about 6 m.

The majority of the specimens were collected by dragging a small dredge across the muddy sand sediment at depths of about 1 m of water. The samples were collected during a flooding tide and sieved through a screen with 0.5 mm apertures.

Cleantioides occidentalis lives under warm-water conditions during the wet season and is subject to somewhat cooler conditions in the dry season, at which time upwelling occurs in the Bay of Panama. Observations of the living animals were not made, but from the ease with which they were collected by dredging, it would seem that *C. occidentalis* lives and forages in the overlying silt/clay fraction of the sediment.

Acknowledgments

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ILYOCRYPTUS GOULDENI, A NEW SPECIES OF WATER FLEA, AND THE FIRST AMERICAN RECORD OF *I. AGILIS* KURZ (CRUSTACEA: CLADOCERA: MACROTHRICIDAE)

Judith L. Williams

Abstract.—*Ilyocryptus agilis* Kurz, 1878, is reported from the Potomac River, Maryland, the first record in the New World. Specimens were compared with *I. agilis* from the Lilljeborg collection, Zoological Museum, Uppsala, Sweden, for verification. A detailed description of the trunk limbs and feeding habits of *I. agilis* are presented here for the first time. A new species, *Ilyocryptus gouldeni* (type-locality: Anacostia River, near Washington, D.C.) is also described here along with observations of live animals.

Ilyocryptus agilis Kurz, 1878, once thought to be strictly a European form, has actually developed a substantial-sized population in the eastern United States, unknown until 1974.

Kurz (1878) first described this species from samples taken in a mill pond in Bohemia. The first British record was by Scourfield (1894) from the Victoria Regia tank in Regent's Park, London, England. Other recordings followed shortly from the Byre River in east Norfolk, Great Britain (Gurney, 1907), and from Sweden (Lilljeborg, 1900).

More recent records indicate that *I. agilis* is distributed extensively in European countries, including Scotland, France, Italy, Czechoslovakia, Hungary, Poland, Romania, Denmark, Finland, China, and Russia (Flossner, 1972; Smirnov, 1976). The discovery of *I. agilis* on the eastern coast of the North American continent was unexpected as for quite some time it was considered rare even in Europe (Kurz, 1878).

The first specimens recorded in the U.S. were from the stomach contents of juvenile white perch (*Morone americanus*). The fish were collected in the lower Potomac River estuary from river mile 60 (Sta. 18 area) to river mile 99 (12 miles north of Sta. 24) (Fig. 1), during the summer of 1974 (Sage, Summerfield and Olson, 1976).

The number of *I. agilis* found per gut ranged from 1–10 with a total of 32 found in 3 fish guts combined from station 18 (Fig. 1). The cosmopolitan macrothricid, *I. sordidus*, was consistently found in association with *I. agilis* in the fish guts. The 2 species were routinely found inhabiting the same locations, though *I. sordidus* has a consistently higher number of individuals, with a maximum of 191 specimens found at station 22. This finding corresponds nicely to those of Chirkova (1972) who stated that *I. sordidus* has a tendency to "nest" so that the young, when leaving the brood

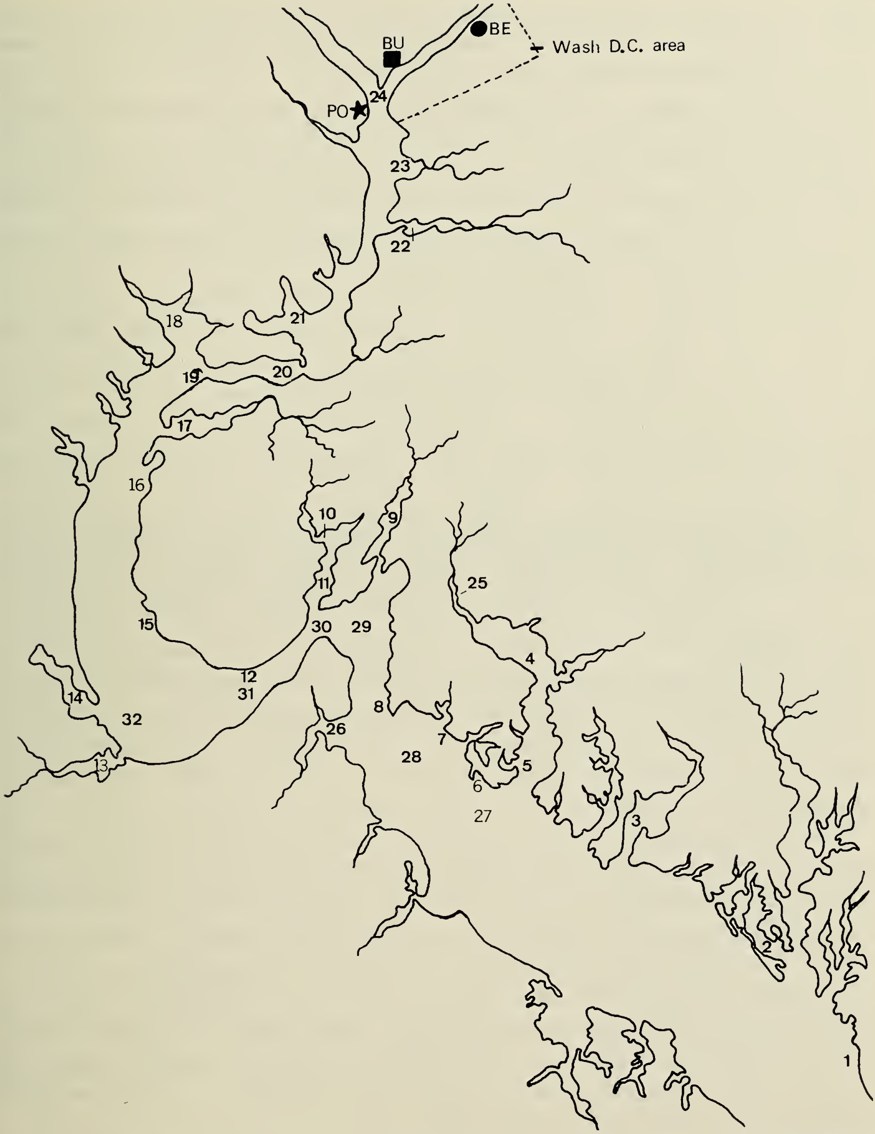

Fig. 1. Lower Potomac River, showing field stations and locations of the 3 electric generating stations: BE, Benning Road; BU, Buzzard Point; PO, Potomac.

pouch in the mud, do not swim away, but remain in the same area, producing as many as 11,000 individuals per cubic meter, whereas the surrounding area may not be populated. Comparative studies on the nesting tendency of *I. agilis* have not yet been attempted.

Both animals constituted a significant part of the stomach contents of the juvenile white perch, which suggests that they are an important food item for this, and perhaps other, benthic feeders.

During the summer of 1975, plankton samples were taken in the vicinity of 3 electric generating stations in the Washington, D.C., area. *I. agilis* was found at all 3 locations. The Buzzard Point Plant location (Fig. 1) had the highest densities (500/m^3 in one replicate of one sample); *I. agilis* was found, unexpectedly, in *surface*, as well as mid-depth and bottom plankton samples during both the day and night.

Washington, D.C., presents one of the most fascinating examples of coexistence of these macrothricids encountered in our studies. For example, at the Benning Road site, there were 4 species of *Ilyocryptus* present and occasionally all 4 were found in the same sample! The 4 species were the American *I. spinifer*, the cosmopolitan *I. sordidus*, the European (and now U.S.) *I. agilis*, and a new species *I. gouldeni*, described herein.

The waters at this site are quite turbid and have an extremely high nutrient content. This probably lessens interspecific competition because the tolerant *Ilyocryptus* species can surivive in fairly polluted waters which do not permit the survival of most benthic animals. Healthy specimens of *I. sordidus* have been found in oxygen-poor mud and foul organic matter. A physiological adaptation of sufficient hemoglobin in their blood enables them to survive these conditions and gives them their characteristic red body color (Fryer, 1974). Hemoglobin is also present in *I. gouldeni*, which has been found living in an environment similar to that preferred by *I. sordidus*.

Complete shedding of the old carapace when molting enables *I. agilis* and *I. spinifer* to swim and feed in the water column despite the excessive amounts of detritus because they are not burdened by "old clothes" of incompletely molted shells, as is *I. sordidus*. This directly reduces competition with their benthic relatives, *I. sordidus* and *I. gouldeni*.

According to Kurz (1878), *I. agilis* uses its antennae in rapid, unsynchronized strokes, enabling it to swim feebly in the water. The presence of *I. agilis* in surface as well as in mid-depth and bottom samples, suggests, however, that this animal is a more active swimmer than previously thought (Scourfield, 1894; Fryer, 1974).

I. agilis young swim almost continuously, rarely attaching themselves to the bottom, and are most often found at the surface (air)–water interface, exhibiting almost copepod-like behavior. The older, larger individuals swim occasionally, then settle on their backs (as in *I. sordidus*) and filter water through their food chambers. Apparently because there is less detritus on the shell, there is less antenna action sweeping across the shell opening to keep it clean. *I. agilis* appears to seek food more actively than *I. sordidus*, a passive filter feeder (Fryer, 1974). Animals observed exhibited a unique method of feeding compared with other macrothricids (Sergeev, 1973). The *I. agilis* swim until they come into contact with a suitable detritus deposit; they then use their antennae to bury themselves head first just under the surface of the detritus, where they remain without moving their antennae, simply filtering water and food particles through their food chamber. This resting, filtering activity generally lasts only a few minutes; then *I. agilis* begins swimming again. This frontal approach differs greatly from that of *I. sordidus* which continuously drags itself along on its back and occasionally with what seems to be great effort, rolls over and buries itself deeper in the detritus.

Ilyocryptus agilis Kurz, 1878
Figs. 2–3

Ilyocryptus agilis Kurz, 1878:406.—Scourfield, 1884:429.—Sars, 1890:45.—Lilljeborg, 1900:332.—Stingeline, 1908:82.—Kielhack, 1909a:62.—Arevalo, 1916:50 (var. *longisetus*).—Romijn, 1919:536.—Wagler, 1937:44.—Behning, 1941:204.—Herbst, 1962:72.—Sramek-Husek, 1962:289.—Manujlova, 1964:204.—Flossner, 1972:238.—Smirnov, 1976:50.

Material examined.—Potomac River, Maryland, near Washington, D.C., USNM 170540. James River, Virginia, near Williamsburg, USNM 170541. Walloxen, Sweden, Lilljeborg collection #1053, 1054. Malma, Sweden, Lilljeborg collection #1055.

Diagnosis.—The size range of the *I. agilis* found in the eastern U.S. is .5–1.2 mm, about .2 mm larger than the maximum size reported from Europe. This size range includes females only, as no males from this continent have yet been found. The color is often a pale horn yellow (Kurz, 1878), but they also have a tendency to be pale and almost translucent as in Scourfield's (1894) specimens from England. The head is small in comparison with that of *I. sordidus.* The complex eye is close to the forehead, the ocellus positioned near the rostrum. The sensory antennules (first antennae) are long, slender and equal in length, the length equal to the distance from their bases to the forehead. They are two-segmented, and bear numerous apical sensory setae which are unequal in length.

The second antennae are longer and slimmer than those of *I. sordidus,* and not quite so long as those of *I. spinifer.* There are 3 long and 1 short setae on each end segment, and a single seta, slightly feathered, on the second and first segments. The coxa is strong and well developed. There are single short spines on the anterior side of both the proximal and the distal segments as in the Russian forms described by Smirnov (1976).

The shell molt is complete in this species. Due to the complete shedding of the old shell, there is only one row of setae on the rim of the shell. The

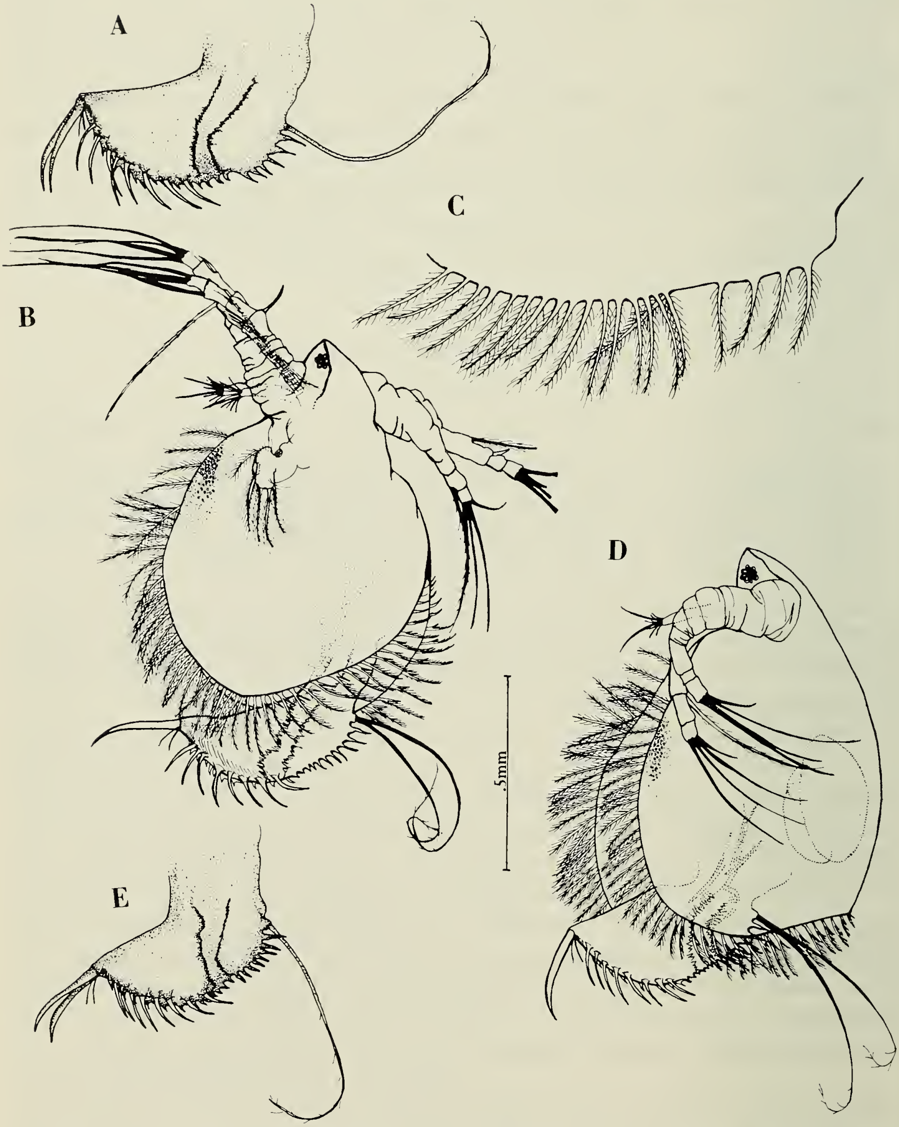

Fig. 2. *Ilyocryptus agilis*, female. A, Postabdomen, Potomac River, Maryland; B, Adult, Potomac River, Md.; C, Medial view, anterior rim of shell, (4,000×) showing placement of fifth seta; D, Adult, Walloxen, Sweden; E, Postabdomen, Walloxen, Sweden.

setae on the anterior part of the shell (near the antennae) are finely feathered, while those on the posterior margin are pectinate, though simply (Fig. 2B).

Kurz (1878) states that one of the distinguishing features for separating *I. agilis* from other members of the genus is the fifth seta on the anterior margin of the shell. The seta is always directed posteriorly and laterally toward the back and out, crossing over the following setae. A medial view of the shell indicating placement of this seta is shown in Fig. 2C. Examination of European specimens from the Lilljeborg collection (Sweden) showed the European form to be identical in this feature (Fig. 2D).

The postabdomen is large and quite broad. The claws are quite long and slightly curved, with a fine row of minute setae on the underside. There are 2 fine sense hairs at the base of each claw. Between the claw base and the first marginal spine are 4–5 minute setae placed on the lateral edge of the postabdomen. The anal opening is placed more toward the posterior of the postabdomen, the distal curve being much greater than the curve of the proximal part (Fig. 2A).

On the distal curve are 8 long spines, slightly curving toward the rear of the postabdomen. These spines decrease in length as they near the anal opening. Along the anal furrow is a row of about 14 small marginal teeth between the longer curved spines. This row of marginal teeth begins near the base of the claws and continues across the anal opening to the beginning of the proximal curve of the postabdomen. The proximal curve bears a series of 6–8 spines graduating in length (and breadth), from the anal opening to the base of the anal sensory setae. These spines can be simply curved or leaf-shaped, as described by Kurz (1878) and reiterated by Scourfield (1894) who indicated he had seen both types in his collections. Specimens from the United States are of both types as well. The reason for the variation is unknown.

In comparing the European and American forms of *I. agilis*, there seems to be a consistent difference in the number of spines on the proximal part of the postabdomen. The American form (Fig. 2A) tends to have 6–7 preanal spines, while the European form (Fig. 2E) tends to have 7 or 8 spines. The spines are otherwise identical in placement and shape

There is a long, lateral sense hair located on the male's antennule approximately three-fourths of the way up from the base (Fig. 3, A1). This feature has been used to differentiate males from females in *I. agilis* and other members of the genus. The length and placement of this seta varies from species to species, making this a useful key characteristic.

Although to date no males of *I. agilis* have been found in the U.S., a European specimen from the Lilljeborg collection (1900) in Sweden was examined. The postabdomen of the male seems somewhat longer, as does the body, and there are 6 small median teeth across the anal opening, in

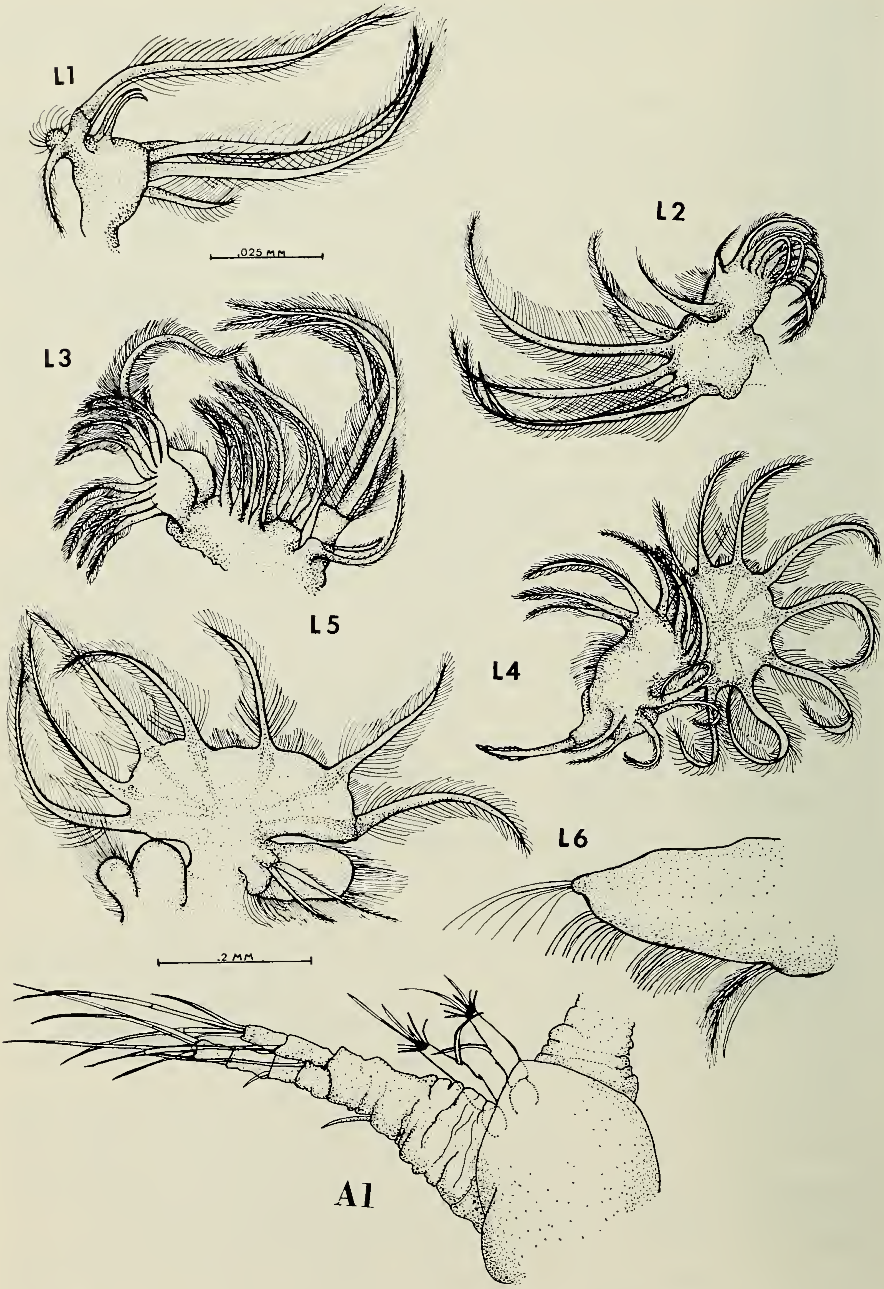

Fig. 3. *Ilyocryptus agilis*. L1–L6, Thoracic limbs, female, adult, Potomac River, Md.; A1, Antennule of male *I. agilis* from Sweden, showing placement of lateral seta.

Fig. 4. World map showing known distribution of *Ilyocryptus agilis*.

contrast to the females examined which have only 4 of these teeth. This may not be a consistent male characteristic as only one male specimen was examined.

The trunk limbs of *I. agilis* are virtually identical to those of the other members of the genus. During the time that these individuals are resting on the bottom filtering for food, their limbs act in the same manner as those of *I. sordidus* (Fryer, 1974, Sergeev, 1973). Detailed camera lucida drawings of the trunk limbs are given in Fig. 3. A thorough description of the function and purpose of each limb is given in Fryer's (1974) monograph on the evolution and adaptive radiation of the Macrothricidae.

Ilyocryptus gouldeni, new species

Fig. 5

Material examined.—Holotype, female (USNM 170599). Type-locality: Anacostia River, Maryland, near Washington, D.C., 38°50′N, 76°57′W, collected from bottom, near shore, in shallow freshwater area with detrital mud benthos, by Judith L. Williams, and Scott Zeger, August 1977. Paratypes: 4 females (USNM 170602) from type-locality, collected by J. L. Williams, August 1975; 3 females (USNM 170601) from a pond in Orange, Texas, collected by Clyde E. Goulden, April 1975; 5 females (USNM 170600) from Tidemill Marsh, James River, Virginia, collected by Katie Munson, August 1977.

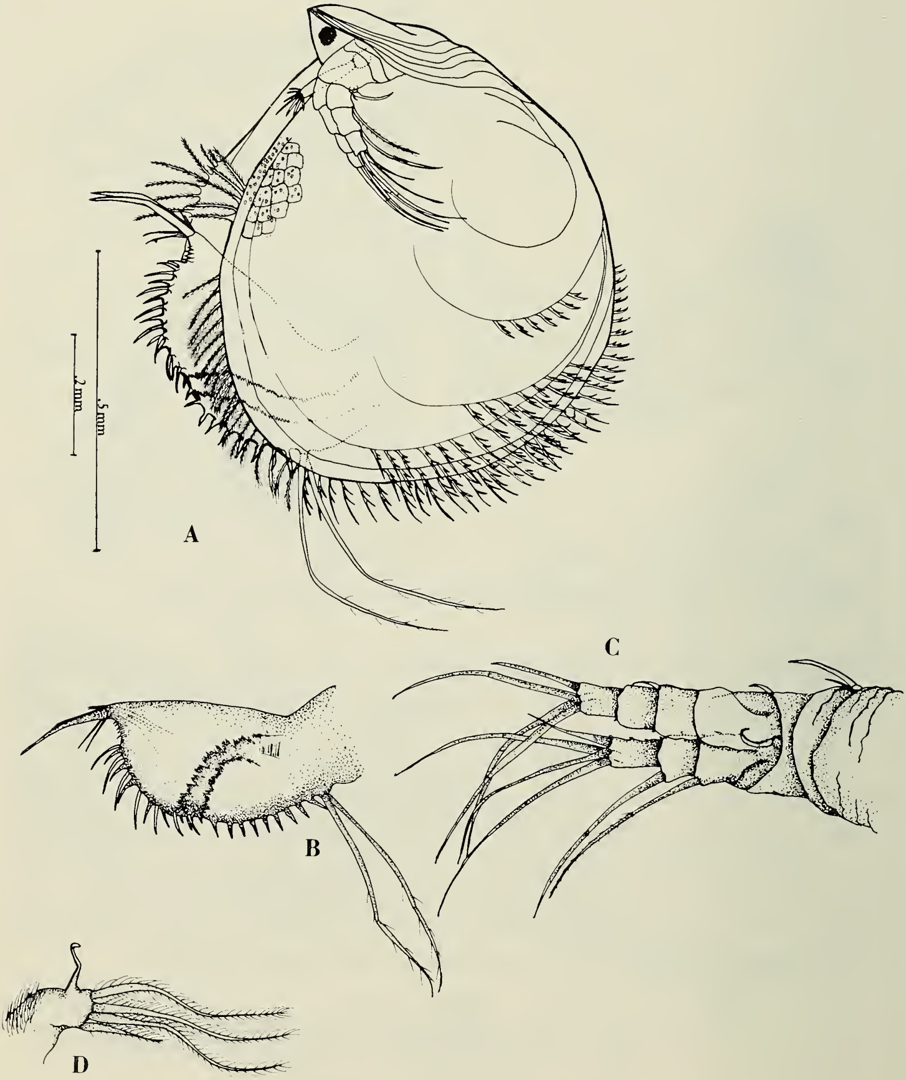

Fig. 5. *Ilyocryptus gouldeni.* A, Adult female, James River, Va.; B, Postabdomen, female; C, Antenna (second), female; D, Ejector hook of first thoracic limb.

Diagnosis.—Female: The lateral view is generally oval. The ventral edge of the shell is slightly convex and the body appears wedge-shaped, as the angle from the dorsal to the ventral edge of the shell decreases greatly. The head region tapers anteroventrally to form a triangle. The shell molts are incomplete, causing a buildup of 2–5 old carapaces, each bearing the heavily barbed protective setae found on the posteroventral rim of the shell, as in *I. sordidus* (Fryer, 1974). The valve is reticulated in a hexagonal pattern, in combination with numerous minute dots covering the surface. The dorsal region of the headshield shows 3–5 heavily cuticular layers fused together. The eye is located in the anteroventral part of the head, along with the large ocellus, situated above the eye. The antennae are short, the basal segment very strong, and well developed for rowing through detritus. There is a heavy spine used for burrowing on the dorsal part of the annulated base of the antennae.

The distal part of the antenna has 2 branches with setae (0-0-0-3/1-1-3) and spines (0-1-0-1/0-0-1) and a series of small barbs located on the ventral part of the 3-segmented branch. The antennules are long, 2-segmented, with numerous (7–10) apical sensory setae, unequal in length. The postabdomen is large, twice as long as wide, with a slight sinuation in the midventral part at the anal opening. The proximal part is slightly convex, and bears 8–9 spines, decreasing in length slightly as they near the anal opening. There are 2–4 small spines across the anal opening. The distal part of the postabdomen is convex, and heavily spined. There are 6–7 large marginal denticles, beginning at the anal opening and ending just before the last lateral spine near the base of the claw. There are 7 long lateral spines decreasing slightly in length proximally. Located between the base of the claws and the first lateral spine are 4–5 minute spinules, decreasing in length distally. The claws are long, and bent at a slight angle at midlength. There are 2 small basal spines located on the dorsal part of the claws and 2 long, fine basal setae on the underside of each claw. The natatory setae consist of a long basal segment and a shorter distal segment armed with a long, fine seta.

The 6 trunk limbs are similar to those of other species in this genus, and are relatively stout as in its burrowing relative, *I. sordidus*. There is a slight difference in the shape of the ejector hook (Fig. 5D), located on thoracic limb I, in comparison with other members of *Ilyocryptus*. The length of the female (holotype USNM 170599) is 0.80 mm. The color of the body is red-orange indicating the presence of hemoglobin, as in *I. sordidus*, for increased tolerance of environments with low levels of dissolved oxygen.

This animal burrows in the detritus and feeds in a manner almost identical to that of *I. sordidus* and is known to cohabitate with this and other members of the genus in extremely close proximity (personal observation).

Male: Unknown.

Remarks.—When observed live, in the detritus, this species is virtually indistinguishable from *I. sordidus*. Only upon careful examination of the postabdomen can the two be separated. The distinct flexure in the claw

Fig. 6. United States, showing known distribution of *Ilyocryptus gouldeni.*

and the number of curved preanal (proximal) spines are the most obvious and most useful characteristics by which to distinguish *I. gouldeni* from the other *Ilyocryptus.*

Etymology.—This species is named after Clyde E. Goulden, whose assistance and encouragement made this work possible.

Discussion

In an effort to describe the geographical range of *Ilyocryptus* across the United States, whole zooplankton samples from private collections were examined. In 1976, samples from Dr. D. Frey's private collection (Indiana University); the S. F. Light collection, borrowed from the Smithsonian Institution; the Gulf Coast Research Laboratory (Mississippi) and the Virginia Institute of Marine Science were examined, but no *I. agilis* or *I. gouldeni* were found. These samples were from the following states: New Hampshire, New York, Virginia, Florida, Mississippi, Louisiana, Minnesota, Montana, Colorado, Idaho, Nevada, Wyoming, Oregon, Washington, Texas, and Saskatchewan, Canada. In 1977, more samples from the USNM collection were examined. These were from the Mississippi State University collection, and in one of the samples from Franklin County, Alabama, 6 female specimens of *I. gouldeni* were found.

Although samples were not examined from the whole U.S., those examined do indicate that *I. agilis* is not a cosmopolitan species, unlike its well-known U.S. relative, *I. spinifer*, which was found in many of the samples from a wide range of states. *I. gouldeni* appears to be relatively common, as is its closest relative, *I. sordidus.*

At present, the only recorded occurrence of *I. agilis* in the United States has been made by the staff of the Academy of Natural Sciences of Philadelphia, from the Potomac River, Maryland. Specimens have been collected from 9 locations (Sta. 14, 15, 20, 22, 24, BE, BU, PO) distributed along 50 river miles from Watt's Branch, the most northern location, down to Aquia Creek, the most southern site.

During preparation of this paper, mini-core samples sent to the Academy for *Ilyocryptus* identifications contained specimens of *I. agilis, I. gouldeni,* and *I. spinifer.* They were collected from Tidemill Marsh on the James River, Virginia, by the staff at Virginia Institute of Marine Sciences. Tidemill Marsh is a tidal freshwater estuarine system. This is only the second area from which *I. agilis* has been reported, and the fourth area where *I. gouldeni* has been found. The areas with *I. gouldeni* are more temperate, from southern Maryland to east Texas, perhaps indicating a preference for warmer waters.

It is possible that specimens of *I. agilis* have occurred in the United States and have been erroneously labeled *I. sordidus.* This is also true of *I. gouldeni* if identifications were based on E. A. Birge's 1910 description found in Ward and Whipple's *Freshwater Biology* (1959) and in R. W. Pennak's (1953) *Freshwater Invertebrates of the United States.* The illustrations in these sources as well as the description provided concerning preanal and postanal spine counts describe morphological characteristics of *I. gouldeni*; the key, however, attributes these characteristics to *I. sordidus.* It is highly probable that there have been many specimens of *I. gouldeni* wrongly labeled *I. sordidus.* For example, a master's thesis by Shih Chien (1969) on the summer Cladocera of the Pearl River system in Mississippi lists, and illustrates, *I. sordidus* as having "eight to ten spines on the proximal curve of the postabdomen, the proximal one being the longest and the two nearest the anal opening small." Chien's camera lucida illustration does not resemble *I. sordidus*'s postabdomen at all. My experience with *I. sordidus* is that even at a very early stage the postabdomen has at least 10–12 preanal spines, all the same length, since newly hatched young are miniature replicas of adults, which have 12–14 spines. The description given by S. Chien fits *I. gouldeni.* Since samples from Texas and from Alabama (USNM Acc. No. 279470, lot #945) contained the new species, it is likely to be found in the neighboring state of Mississippi. This example indicates that identification of the genus *Ilyocryptus* in the U.S. is highly dubious, if based on keys in the two popular freshwater biology publications previously mentioned.

With the addition of *I. agilis* and the new species *I. gouldeni* to the currently confused *Ilyocryptus* keys in the United States, it may be quite some time before accurate accounts of the genus' distribution across the U.S. are available.

I give below an English translation of N. N. Smirnov's (1976) key to the species of *Ilyocryptus.* The new species *I. gouldeni,* is similar in form to characteristics presented in numbers 3, 4, 5, and 7 of the key. The antennule (key character no. 6) of *I. gouldeni* does not have a series of small spines, but does have a "bumpy" or rough area midway on the outer margin. This area is difficult to see as it has a tendency to collect bits of detritus. The gross morphology of the animal most closely resembles that of *I. sordidus,* so that if placed in Smirnov's key, it would then be necessary to separate the two by an additional characteristic, the number of spines on the proximal part of the postabdomen. *I. sordidus* has 12–14 small spines (subequal in length) on the proximal part of the postabdomen, while *I. gouldeni* has 8–9 spines, increasing in length as they near the natatory setae.

Key to the Species of *Ilyocryptus*

1 (12) Shell smooth
2 (3) Anal opening at the distal part of postabdomen
1. *I. acutifrons* Sars, 1862
3 (2) Anal opening at middle part of postabdomen
4 (11) Length of antennule exceeding breadth by less than 8×
5 (10) Lateral spines of postanal part of postabdomen longer than preanal spines
6 (9) Antennule without small spines on outer margin
7 (8) Preanal margin of postabdomen convex
2. *I. sordidus* (Leiven, 1848)
8 (7) Preanal margin of postabdomen almost straight
3. *I. silvaeducensis* Romijn, 1919
9 (6) Antennule with small spines (teeth) on anterior margin (these teeth weak) 4. *I. agilis* Kurz, 1878
10 (5) Lateral spines of postanal margin of postabdomen shorter than preanal 5. *I. brevidentatus* Ekman, 1905
11 (4) Antennule slender, length 8–10× greater than width
6. *I. spinifer* Herrick, 1882
12 (1) Shell pitted or with a lateral process (not smooth)
13 (16) Shell with pits
14 (15) Postabdomen without indentation on dorsal margin, and without numerous small spines (teeth) on distal part of dorsal margin 7. *I. tuberculatus* Brehm, 1913
15 (14) Postabdomen with distinct indentation on dorsal margin

and with numerous small spines (teeth) on distal part of dorsal margin 8. *I. verrucosus* Daday, 1905

16 (13) Shell with lateral process
9. *I. cornutus* Mordukhai-Boltovskoi and Chirkova, 1972

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Special thanks is given first to Dr. Clyde E. Goulden, Academy of Natural Sciences, Philadelphia, Pa., without whose assistance and encouragement this work would not have been possible, and second to Dr. Thomas E. Bowman, Smithsonian Institution, Washington, D.C., who also assisted in many ways, including translating the Russian key of Smirnov with the help of Dr. Gordan S. Karaman. Other people whose help was greatly appreciated are: Dr. Lars Wallin, Zoological Museum, Uppsala, Sweden; Dr. Geoffrey Fryer, Freshwater Biological Association, Windemere, England; Dr. David Frey, Univ. of Indiana, Bloomington, Ind.; Katie Munson, Virginia Institute of Marine Sciences, Gloucester Point, Va.; Kathleen K. Carrol, Scott Zeger, Academy of Natural Sciences, Philadelphia, Pa.; and Drs. R. W. Ingle and J. Boxshall, British Museum (Natural History), London, England.

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REEXAMINATION OF THE SPECIES REFERRED TO THE GENUS *FLABELLIDERMA* HARTMAN (POLYCHAETA: FLABELLIGERIDAE AND ACROCIRRIDAE)

William J. Light

Abstract.—The polychaete genus *Flabelliderma* (Flabelligeridae) is redefined and its relationship to the genus *Flabelligera* clarified. An expanded description is given for the sole species, *Flabelliderma essenbergae* (Hartman), and the range and bathymetric distribution are extended. *F. commensalis* Moore is referred back to the genus *Flabelligera* in the Fabelligeridae, and an emended description is given for *F. macrochaeta* (Fauchald), now placed in the genus *Flabelligella* in the Acrocirridae.

The discovery of a specimen of *Flabelliderma* from Guadalupe Island off the west coast of Baja California led to an examination of the types of the three species previously assigned to this genus. *Flabelliderma* was established by Hartman (1969:286) for two species: *F. commensalis* (Moore, 1909) and *F. essenbergae* (Hartman, 1961), the latter designated as the type-species. *Flabelliderma macrochaeta* Fauchald, 1972 was subsequently added. As a result of the present study, *F. commensalis* is returned to the genus *Flabelligera* Sars in the Flabelligeridae, where it was originally placed. Following the revision by Orensanz (1974:114), *F. macrochaeta* is referred to *Flabelligella* Hartman in the Acrocirridae. *F. essenbergae* remains in the emended and now monotypic genus *Flabelliderma* in the Flabelligeridae.

Flabelliderma was distinguished from *Flabelligera* by Hartman (1969: 286) "in that the body lacks a mucus-sheath and is covered by papillae; in *Flabelligera* the epithelium is smooth or nearly so, and the body is covered by a thick, mucoid sheath." However, as noted by Pettibone (1954:289) for *Flabelligera affinis* M. Sars, 1829, the type-species of the genus, and by Chamberlin (1919:398) for *F. infundibularis* Johnson, 1901 [= *F. affinis*, according to Pettibone (1954:289)], this mucilaginous sheath is frequently missing. Specimens of *F. infundibularis* from Alaska and Monterey Bay (CAS) show a similar reduction or absence of the mucilaginous sheath. This character thus appears to be of only marginal value in separating the two genera.

The family Acrocirridae was erected recently by Banse (1969:2592–2620) to include *Acrocirrus* Grube and *Macrochaeta* Grube, both genera removed from the family Cirratulidae. Banse commented on the apparent close relationship of the Acrocirridae with the Flabelligeridae. Orensanz (1974:113–118) emended the Acrocirridae to include the genus *Flabelligella*

Hartman, placed originally in the Flabelligeridae (Hartman, 1965a:172–180) and subsequently in the Fauveliopsidae (Hartman, 1971:1411). This revision was followed by Fauchald (1977:30–31), although Orensanz would favor placing the Acrocirridae in the same group with the Flabelligeridae and the Fauveliopsidae, rather than associated with the Cirratulidae (Suborder Cirratuliformia of Fauchald, 1977:29–30).

Family FLABELLIGERIDAE Saint-Joseph

Type-genus.—Flabelligera M. Sars, 1829.

Diagnosis.—Body cylindrical, fusiform or grublike, epidermis typically covered with papillae, often impregnated with sand or mud in gelatinous matrix. Prostomium and peristomium retractable into anterior setigers, with 2 large palpi and numerous filiform branchiae. Setae of first 1–4 setigers usually elongated and directed forward, forming more or less prominent cephalic cage. Parapodia biramous, rami widely separated. Notosetae all slender smooth or annulated capillaries; neurosetae similar to notosetae or distally whiplike, flattened or falcate, tips unidentate or bidentate; neurosetae simple, compound or pseudocompound. Anus terminal. Blood green, containing chlorocruorin.

Genus *Flabelligera* M. Sars, 1829

Type-species.—Flabelligera affinis M. Sars, 1829:31, pl. 3, fig. 16.

Chloraema Dujardin, 1839:648.
Siphonostoma Rathke, 1843:211 [part].
Tecturella Stimpson, 1854:32.

Diagnosis.—Body elongate, vermiform, not dorsoventrally compressed, with only one kind of papillae of long, pedunculate type with clavate tips (see Fig. 3) usually embedded in thick, transparent, mucilaginous sheath or its rudiments; papillae not encrusted with mud or sand. Buccal segment formed of fused prostomium and peristomium and bearing 2 thick palpi and numerous filamentous, retractile gills; prostomium with 4 eyes. Cephalic cage well developed, formed of capillaries from both rami of setiger 1, thereafter all notosetae thin, transversely striated, smooth capillaries and all neurosetae compound or pseudocompound falcigers.

Flabelligera commensalis Moore, 1909

Flabelligera commensalis Moore, 1909:286–288, pl. 9, figs. 62–63.—Hartman, 1961:117–118.—Stasek, 1966:11–12.
Flabelligera haerens Chamberlin, 1919:16. *Fide* Hartman, 1961:117.
Flabelliderma commensalis: Hartman, 1969:285, figs. 1–3.—Spies, 1973:

465–490, pls. 1–9.—1975:187–207, pl. 1, fig. 1, pl. 2, fig. 2.—1977:323–345, pls. 1–6.

Material.—California: Vicinity of Monterey Bay, from among spines of the echinoid *Strongylocentrotus purpuratus* (Stimpson), holotype and 1 paratype (CAS Type Series 41 and 42, respectively). Pigeon Point, San Mateo Co., between spines of *Strongylocentrotus* sp., P. Carlstrom, coll., 1 specimen (CAS 000010). Off NW San Clemente Island, 9-Fathom Reef, 27 Oct. 1975, D. Powell, coll., 1 specimen, associated with the diadematid echinoid *Centrostephanus coronatus* (Verrill) (CAS 002638).

Remarks.—Fauchald (1977:116) erroneously listed *Flabelligera commensalis* Moore, 1909 as the type-species and only member of the genus *Flabelliderma. F. commensalis* was assigned to the genus *Flabelliderma* by Hartman (1969:285–286) solely on the basis of its supposed lack of a mucilaginous sheath enveloping the body. An examination of the above material revealed a rudimentary sheath to be present over scattered parts of the dorsolateral surfaces of the body. In view of the foregoing revision, *F. commensalis* is herein transferred back to the genus *Flabelligera.*

Distribution.—Central and southern California, intertidal to shelf depths (Hartman, 1961:117; 1969:285), free-living in kelp holdfasts or commensal with urchins or polychaetes.

Genus *Flabelliderma* Hartman, 1969, emended

Type-species.—*Flabelligera essenbergae* Hartman, 1961 [= *Stylaroides papillosa* Essenberg, 1922 (homonym)], designated by Hartman, 1969: 286.

Emended diagnosis.—Body short, grublike, dorsoventrally compressed, lacking any trace of mucilaginous sheath. Buccal segment formed of fused prostomium and peristomium and bearing 2 prominent, grooved, ventral palpi and numerous filiform branchiae; prostomial eyes present or absent. Cephalic cage well developed, formed of capillaries from both rami of setiger 1; thereafter all notosetae thin, transversely striated, smooth capillaries and all neurosetae compound or pseudocompound falcigers. With 2 kinds of papillae: (1) long, pedunculate, with clavate tips covering body, heavily encrusted with fine sand or mud grains; (2) much larger, balloon-shaped, attached to notopodia by long, stringlike stalks bearing central canals. Parapodia biramous, rami widely separated; notopodia comprising laterally extended, tangled skeins of pedunculate papillae of first type (see Fig. 3) heavily coated with sand or mud. Anus simple, terminal.

Remarks.—*Flabelliderma* appears to be closely related to the genus *Flabelligera.* It differs in bearing two kinds of epithelial papillae, of which the balloonlike forms are diagnostic for the genus, and in having a

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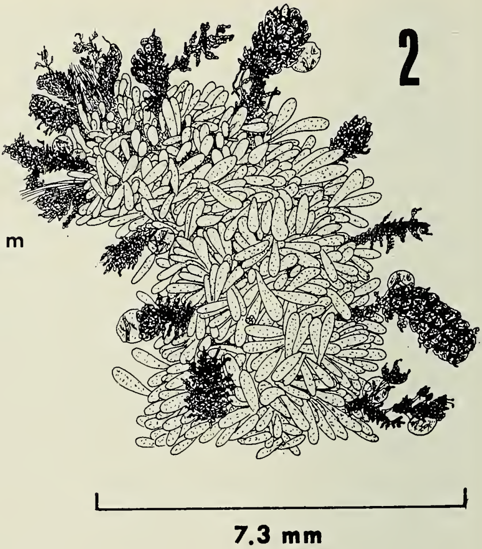

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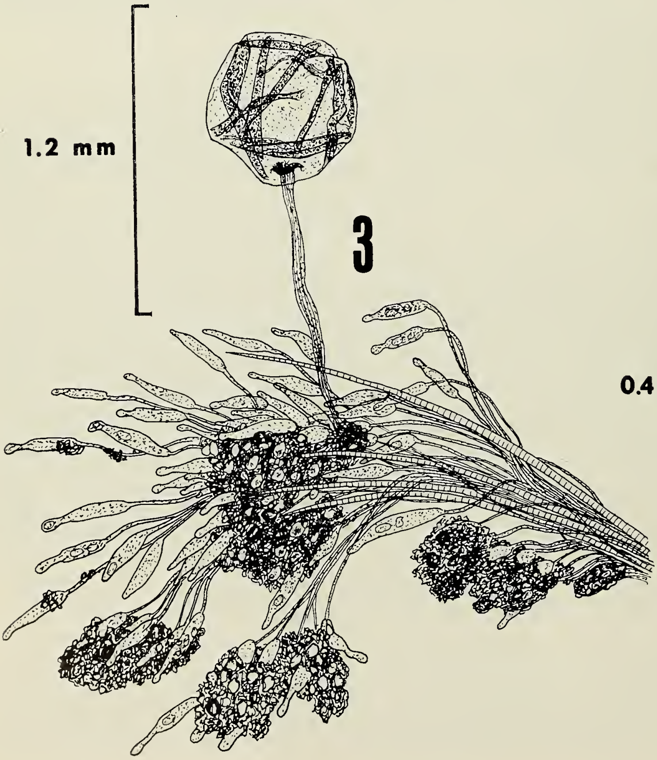

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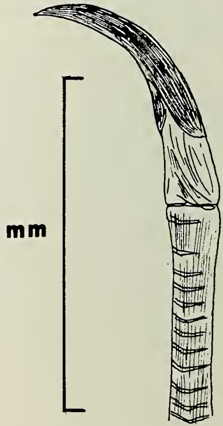

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short, dorsoventrally compressed, grublike body heavily encrusted with mud and sand. *Flabelliderma* never exhibits any trace of a gelatinous sheath, but the frequent absence of such a sheath in the genus *Flabelligera* makes this a doubutful taxonomic character.

Hartman (1969:116) commented that *Flabelliderma essenbergae* and *Flabelligera commensalis* both differ from typical species of *Flabelligera* in bearing neuropodial falcigers that are pseudocompound, rather than fully compound. However, this feature is variable, and compound neurosetae are also exhibited by specimens of *F. essenbergae* from central California and Mexico (Fig. 4).

Flabelligera essenbergae tenebricosa C. Berkeley, 1966 from British Columbia has been referred to *Brada sachalina* Annenkova, 1922 by Hobson (1976:137–138). *Flabelliderma* is thus a monotypic genus.

Flabelliderma essenbergae (Hartman, 1961)
Figs. 1–4

Stylaroides papillosa Essenberg, 1922:379–381, figs. 1–8.
Flabelligera papillosa: Hartman, 1959:416. [Not *Siphonostoma papillosum* Grube, 1840].
Flabelligera essenbergae Hartman, 1961:118–120, pl. 22, figs. 1–2, pl. 23, figs. 1–4.—1965b:60.
Flabelliderma essenbergae: Hartman, 1969:287–289, figs. 1–6.—Spies, 1975: 187–193, pl. 2, fig. 3, pl. 4, fig. 11.

Material.—California: Arch Rock, Corona del Mar, –1.5 tide in eelgrass bed, 2 syntypes of *Flabelligera essenbergae* (AHF 0536). Point Lobos, Monterey Bay, 20 m, 6 May 1972, A. J. Ferreira, coll., 2 specimens (CAS 000012).

Western Mexico: Old Sealer's Cove, Guadalupe Island, off west coast of Baja California, from lower intertidal associated with yellow sponge, 1 January 1975, W. L. Lee and A. J. Ferreira, coll., 1 specimen (CAS 000011).

Description.—Body 20–70 mm long, 5–10 mm wide, 28–40 segments. Body dorsoventrally compressed, grublike in overall appearance (Fig. 1), covered dorsally and ventrally with closely packed, teardrop-shaped globules of mud or sand (Figs. 1–2) enclosing long papillae with clavate tips; globules longer than wide in specimens from Baja and central California (compare

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Figs. 1–4. *Flabelliderma essenbergae* (Guadalupe Island, CAS 000011). 1, Entire animal, dorsal view; 2, Anterior end contained within box in Fig. 1; 3, Left parapodium, comprising skeins of pedunculate papillae, debris, and balloonlike papilla; 4, Neuropodial falciger.

pl. 23, fig. 4, Hartman, 1961). Notopodia formed of loose skeins of long, pedunculate papillae with clavate tips forming sub-groups coated with sand grains resembling small bracts or scales (Figs. 2–3) in Mexican specimen; animals from central California exhibiting similar parapodial configuration, but bracts less well developed; in type specimens notopodial papillae cemented together into large, mud-encrusted, tubular mass (Hartman, 1961, pl. 23, fig. 4); different configurations due solely to nature of encrusting mud or sand. Individual clusters of papillae frequently projecting from notopodial mass, resulting in distinctly tesselated appearance (Figs. 2–3). Large balloonlike papillae arising from notopodia on long, stringlike stalks which apparently connect with body cavity (see Hartman, 1961:120, for discussion of the possible secretory nature of these papillae). Notosetae long, transversely striated capillaries (Fig. 3); neurosetae from setiger 2 on pseudocompound (Hartman, 1969, fig. 5) or compound (Fig. 4) falcigers. Eyes present (central and southern California) or absent (Mexico). Anus simple, terminal.

Remarks.—The anterior end was completely retracted in the Mexican specimen. Dissection revealed a complete absence of eyes and a dense cluster of thick, annulated, filiform gills, together with 2 thick ventral palpi. All California specimens bear 4 prominent eyes on the prostomium just below the gills. The gills in central California specimens are somewhat annulated, whereas those from southern California are delicate and filamentous, and show no evidence of such transverse creases. Examples from Monterey Bay exhibit the parapodial tesselation and scalelike clumping to a lesser degree than in the specimen from Guadalupe Island. The only consistent difference between the animals from California and Mexico is the absence of eyes in the latter. However, it does not seem justifiable to erect a subspecies based solely on this feature in a single specimen from Mexico.

Distribution.—The range of *F. essenbergae* is here extended from southern California north to central California and south to Guadalupe Island; its bathymetric distribution is extended from the intertidal to 20 meters (Monterey Bay).

Family ACROCIRRIDAE Banse; emended Orensanz, 1974

Type-genus.—*Acrocirrus* Grube, 1872.

Diagnosis.—Body vermiform or grublike, with pair of grooved, frontal palpi. Prostomium reduced, generally with eyes, lying dorsally atop peristomium; prostomium and peristomium often retracted into anterior setigers. One pair of gills per segment above notopodia from segment 2 (excluding prostomium and peristomium), generally 1 or 3–4 pairs, or gills absent. No cephalic cage. Parapodia biramous, rami more or less widely separated.

Notosetal capillaries distinctly annulated and spinose; neurosetae compound, with long appendage bearing subterminal, V-shaped hood and with hyaline sheath covering articulation; sometimes with stout, neuropodial aciculae. Anus simple, terminal.

Genus *Flabelligella* Hartman, 1965a; emended Orensanz, 1974

Type-species.—*Flabelligella papillata* Hartman, 1965a, by original designation.

Diagnosis.—Acrocirrids completely covered with soft papillae, often with adhering detritus or mud. Frontal palpi short, globular, or palpi lacking. One pair of very delicate branchiae or branchiae completely lacking. Anterior segments uniramous in some species.

Flabelligella macrochaeta (Fauchald, 1972)

Figs. 5–6

Flabelliderma macrochaeta Fauchald, 1972:222–223, pl. 46. figs. a–b.
Flabelligella macrochaeta: Orensanz, 1974:114, 118.

Material.—Western Mexico: Off Islas Tres Marias, 21°54′30″N, 106°50′00″W, 1480 m, *Velero* IV sta. 13767–70, holotype (AHF F4118); 21°53′00″N, 106°49′00″W, 1536 m, *Velero* IV sta. 13768–70, 1 specimen (AHF F4120).

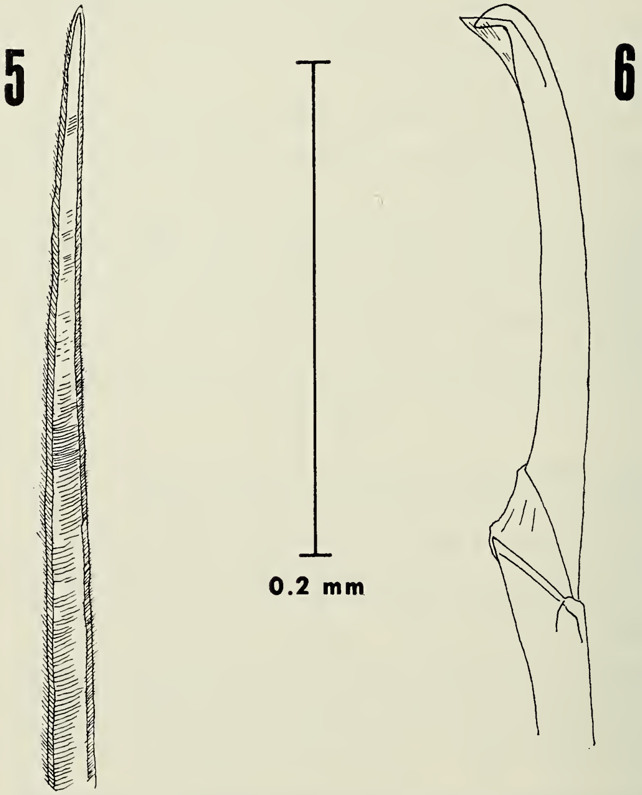
Supplementary description.—Prostomium reduced to small, biscuit-like palpode lying atop peristomium; with pair of distinct eyespots. Partially eversible proboscis present. Capillary notosetae with annulated sheaths bearing many fine spines (Fig. 5), one capillary per ramus; 1–4 compound neurosetae per ramus with long, falcigerous appendage bearing subterminal, V-shaped, transparent hood and with hyaline sheath covering articulation (Fig. 6).

Remarks.—The secondary hyaline sheath was not figured in the original description, although it was alluded to by Fauchald (1972:222–223). The subdistal hyaline hood is a single, V-shaped structure rather than two flaps as originally described, and the sheaths of the notosetae are annulated and spinose (Fig. 5), rather than smooth capillaries as indicated by Fauchald.

Distribution.—Known only from slope depths off western Mexico.

Acknowledgments

I am indebted to Welton L. Lee and Antonio J. Ferriera, California Academy of Sciences (CAS), who collected the specimens of *Flabelliderma essenbergae* from central California and Guadalupe Island. Dr. Lee also made the types of *Flabelligera commensalis* available to me. I also wish to thank Kristian Fauchald, Allan Hancock Foundation, University of South-



Figs. 5–6. *Flabelligella macrochaeta* (holotype, AHF F4118). 5, Notoseta; 6, Compound neuropodial falciger.

ern California (AHF) for the generous loan of the types of *Flabelligera essenbergae* and *Flabelliderma macrochaeta.* The manuscript was written while I held the position of Associate Curator, Division of Natural Sciences, The Oakland Museum.

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BRACHYNOTUS GEMMELLARI (RIZZA, 1839), THE THIRD MEDITERRANEAN SPECIES OF THE GENUS (CRUSTACEA, DECAPODA, BRACHYURA)

Carlo Froglia and Raymond B. Manning

Abstract.—*Brachynotus gemmellari* (Rizza, 1839) is removed from the synonymy of *B. sexdentatus* (Risso, 1827) and is differentiated from that species as well as from *B. foresti* Zariquiey Alvarez, 1968. The latter two species inhabit intertidal habitats in the Mediterranean; *B. gemmellari* occurs sublittorally. A neotype is selected for *B. gemmellari.*

Three Mediterranean-Atlantic species are currently recognized in the grapsid genus *Brachynotus* De Haan, 1833 [type-species, by subsequent monotypy, *Goneplax sexdentatus* Risso, 1827]: *B. sexdentatus* and *B. foresti* Zariquiey Alvarez, 1968, from the Mediterranean, and *B. atlanticus* Forest, 1957, from localities in the adjacent Atlantic Ocean along the African coast; all three of these species are generally found in the intertidal zone.

Our samples of *Brachynotus* from several different localities in the Mediterranean have revealed the presence of a third species there, a relatively long legged species which generally occurs sublittorally on soft bottoms. We believe that this species can be identified with *Cleistotoma gemmellari* Rizza, 1839, originally described from eastern Sicily. Rizza's name until now was considered to be a synonym of *B. sexdentatus. Brachynotus gemmellari* was first encountered by one of us (C.F.) in trawl samples taken in the Adriatic in depths between 4 and 16 m.

Because more detailed studies of Mediterranean Brachyura are now being carried out by both of us, we are restricting our accounts of the three Mediterranean species of *Brachynotus* to abbreviated synonymies, including some older references as well as those published since the monograph on Spanish decapods by Zariquiey Alvarez (1968), differential diagnoses, sketches, lists of material, and comments on habitat and general biology. We hope that these preliminary notes will aid other students of Mediterranean decapods in distinguishing these species.

Part of the field study which provided some of the specimens reported here was carried out by one of us (R.B.M.) from Tunisia between 1972 and 1974 with the support of the Foreign Currency Program of the Smithsonian Institution. Field work in Tunisia was carried out with the collaboration of the Institut National Scientifique et Technique d'Océanographie et des Pêches, Salammbô, under the direction of A. Azouz. Field work in Algeria was carried out with the assistance of Ms. Rabia Seridji and the support of M. S. Tellai, Director, Institut Océanographique, Algiers. Their cooperation is gratefully acknowledged. We thank J. Forest, Muséum National d'Histoire Naturelle, Paris (MNHN), for the loan of material. We thank L. B. Holthuis, Rijksmuseum van Natuurlijke Historie, Leiden, for comments on the manuscript. The illustrations were prepared by Lilly King Manning.

In the lists of material given below, material deposited in the Laboratorio di Tecnologia della Pesca, Ancona, is identified by the acronym LTP and that deposited in the National Museum of Natural History, Smithsonian Institution, Washington, is identified by the acronym USNM. The neotype of *Cleistotoma gemmellari* has been deposited in the Rijksmuseum van Natuurlijke Historie, Leiden (RMNH). The abbreviations cl. and cb. are used for carapace length and carapace width, respectively.

In our sections on "Material," coordinates not given in original data as well as alternate spellings, both taken from gazetteers of the U.S. Board of Geographic Names, are given in brackets.

Key to Mediterranean Species of *Brachynotus*

1. Front strongly sinuous, median notch well marked (Fig. 1*a*). Surface of carapace highly sculptured. Hepatic region distinctly swollen. Third anterolateral tooth of carapace low, blunt. Male gonopod with obtuse prominence subdistally, lacking distinct, convex shoulder (Fig. 2*c*, *d*) *B. foresti*
– Front faintly sinuous, median notch broad, poorly defined (Fig. 1*d*). Surface of carapace smooth, regions low, poorly marked. Hepatic region not swollen. Third anterolateral tooth of carapace distinct, acute or spiniform. Male gonopod with distinct, convex subdistal shoulder (Fig. 2*g*, *k*) 2
2. Pereiopods long, slender (Fig. 1*e*, *f*), merus of fifth half or more than half (more than half in females) as long as carapace, propodus of fifth 1.55–2.30 (mean 1.88) times longer than broad *B. gemmellari*
– Pereiopods short, stout (Fig. 1*h*, *j*), merus of fifth half or less than half as long as carapace, propodus of fifth 1.35–1.80 (mean 1.61) times longer than broad *B. sexdentatus*

Brachynotus foresti Zariquiey Alvarez, 1968

Figs. 1*a–c*, 2*a–d*, 3, 4

Brachynotus sexdentatus ssp.—Holthuis & Gottlieb, 1958:102 [Israel].—Holthuis, 1961:59 [Greece].—Lewinsohn & Holthuis, 1964:60 [Israel] [not *Brachynotus sexdentatus* (Risso, 1827)].

Brachynotus sp.—Forest, 1967:9, 28 [footnote] [Gulf of Taranto; Izmir, Turkey].—Geldiay & Kocatas, 1968:6, figs. 2a,c,e, fig. 1 on pl. [Turkey].

Brachynotus foresti Zariquiey Alvarez, 1968:431, figs. 142d,e, 143b–d, 145

[Spain; references].—Kocatas, 1971:31, pl. 5 fig. 2 [Turkey].—Georgiadis & Georgiadis, 1974: fig. 5 [distribution].—Kattoulas & Koukouras, 1975: 301 [Greece].—Froglia, 1926:172, fig. 2 [Adriatic coast of Italy].—?*Branchynotus foresti*.—Pastore, 1976:113 [erroneous spelling; ?part].

Material.—Middle Adriatic, Italy: Ancona, Falconara Marittima [43°38′N, 13°24′E], Disco beach, on pipe for domestic sewage, among mussels, depth 0.5 m, 11 May 1973, C. Froglia leg.: 3♂, cl. 3.5–8.0 mm, 1♀, cl. 5.0 mm (LTP); 1♂, cl. 6.2 mm, 3♀, cl. 6.9–7.3 mm (USNM).—Same locality, 23 October 1973: 5♂, cl. 6.2–8.0 mm, 6♀, cl. 6.7–8.0 mm (LTP).—Same locality, 11 July 1974: 1 ovigerous ♀, cl. 9.0 mm (LTP).—Same locality, 4 March 1975: 1♂, cl. 3.8 mm, 2♀, cl. 3.4–4.2 mm (LTP).

Ortona [42°21′N, 14°24′E] harbor, near the shipyard, among mussels and algae, depth 0.5 m, 7 July 1973, C. Froglia leg.: 8♂, cl. 6.2–11.2 mm, 5♀, cl. 5.6–7.5 mm (3 ovigerous, cl. 6.9–7.5 mm) (LTP).

Tunisia: Gabès [33°53′N, 10°07′E], port, sandy mud and protected rocky shore, intertidal, under rocks on sand, 5 June 1973, Sta. RBM Tun-143, R. B. Manning, C. Froglia, and M. Jeddi, leg.: 1♀, cl. 7.2 mm (USNM).

Djerba Island, N coast, on dirt road between Houmt Souk [33°53′N, 10°51′E], and Bordj Djillidi, 2 km from Houmt Souk, on and under stones on sand, shore to 0.67 m, 23 August 1973, Sta. RBM Tun-213A, R. B. and Marian Manning, M. L. Jones, M. Jeddi, leg.: 3♂, cl. 6.9–8.5 mm (USNM).—Djerba Island, isolated rocky platform about 2 km W of Houmt Souk, between there and airport, rocky platform grading into *Cymodocea*, shore to 1 m, 7 June 1973, sta. RBM Tun-153, R. B. Manning, C. Froglia, M. Jeddi leg.: 2♂, cl. 8.4–9.2 mm, 1 ovigerous ♀, cl. 7.1 mm (USNM).

Zarzis [33°30′N, 11°07′E], in front of Hotel Sidi Saad, rocky limestone platform, under rocks exposed at low tide, 25 August 1973, Sta. RBM Tun-218C, R. B. and Marian Manning, M. L. Jones, M. Jeddi leg.: 13♂, cl. 3.0–6.9 mm, 4♀, cl. 3.1–6.9 mm (1 ovigerous, cl. 6.5 mm) (USNM).

Algeria: Tomentefous [Bordj Tamentefous; 36°48′N, 03°14′E], across bay from Algiers, beach, under rocks at shore, 10 May 1974, Sta. RBM Alg-10B, R. B. Manning, M. Jeddi, R. Seridji, and J. Quelers leg.: 1♀ juv., cl. 6.5 mm (USNM).

Diagnosis.—Size relatively small, maximum cl. less than 12 mm. Carapace (Fig. 1*a*) strongly sculptured, surface uneven, regions more or less distinct. Adult males and females with distinct, transverse tuberculate branchial ridge extending mesially from third anterolateral tooth. Frontal lobes strongly convex, median emargination deep. Frontorbital width ranging from 1.95–2.13 (mean 2.03) times frontal width. Third anterolateral tooth of carapace blunt. Pereiopods (Fig. 1*b*, *c*) short, merus of fifth half or less than half as long as carapace, stout, propodus of fifth 1.30–1.67 (mean 1.40) times longer than broad. Females generally with slenderer

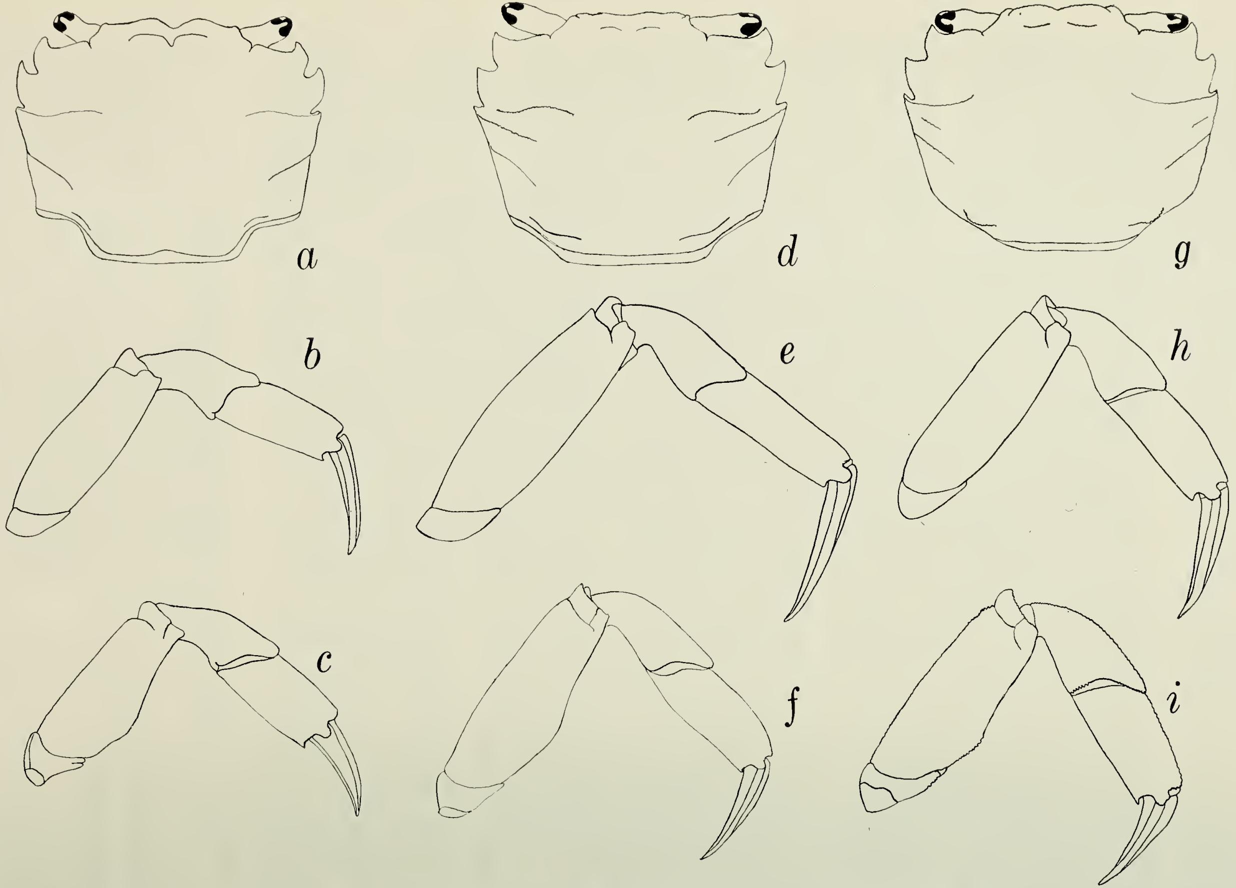

Fig. 1. Dorsal view of carapace (*a*, *d*, *g*), second pereiopod (*b*, *e*, *h*), and fifth pereiopod (*c*, *f*, *i*) of females of: *a–c*, *B. foresti,* ovigerous ♀, cl. 8.5 mm; Tunisia; *d–f*, *B. gemmellari,* cl. 11.5 mm, Adriatic Sea; *g–i*, *B. sexdentatus,* cl. 10.0 mm, Sicily.

walking legs than males. Male pleopod (Fig. 2*c*, *d*) with low prominence subdistally, lacking distinct shoulder.

Size.—Carapace lengths of males 3.0–11.2 mm, of females 3.1–9.0 mm, of ovigerous females 6.5–9.0 mm. The largest specimen recorded so far is the largest male reported here, cl. 11.2 mm (also reported by Froglia, 1976); Holthuis & Gottlieb (1958) reported specimens from Israel measuring cl. 2.5–11 mm. This is a smaller species than either *B. gemmellari* or *B. sexdentatus.*

Distribution.—Mediterranean Sea, from localities between Spain and Israel, suggesting that it could occur anywhere in the Mediterranean in suitable habitats; littoral.

Brachynotus gemmellari (Rizza, 1839)
Figs. 1*d–f*, 2*e–h*, 3, 4, 5

Cleistotoma gemmellari Rizza, 1839:372 [eastern Sicily].

Brachynotus sexdentatus.—Forest & Guinot, 1956:41 [Tunisia, 5–10 m].—Bacescu, 1967:321 [Black Sea; part, records from 6 m or more].—Geldiay & Kocatas, 1968:5 [Turkey; part, records from more than 6–7 m].—Kocatas, 1971:30, pl. 5 fig. 4 [Turkey].—Geldiay & Kocatas, 1972:13, 14, 15 [Turkey; part, records from more than 5 m].—?Georgiadis & Georgiadis, 1974:242 [table], 246 [Greece; ?part, specimens from more than 4 m] [not *Brachynotus sexdentatus* (Risso, 1827)].

Brachynotus sp. Georgiadis & Georgiadis, 1974:fig. 5 [?part; distribution of *Brachynotus*].

Brachynotus foresti.—Pastore, 1976:108 [listed] [not *Brachynotus foresti* Zariquiey Alvarez, 1968].

Branchynotus foresti.—Pastore, 1976:113 [erroneous spelling] [Gulf of Taranto, 12 m; part?] [not *Brachynotus foresti* Zariquiey Alvarez, 1968].

Material.—Northern Adriatic, Italy: Off Po delta, 44°53.7′N, 12°32.7′E, 12 m, muddy sand, 29 July 1973: 7♂, cl. 2.4–9.3 mm, 3 ovigerous ♀, cl. 6.6–8.6 mm (LTP).

Entrance of Ravenna Harbor [44°25′N, 12°12′E], 4 m, sand, 5 October 1974: 1♂, cl. 3.5 mm, 1♀, cl. 5.3 mm (LTP).

Off Cesenatico, 44°16.6′N, 12°28.5′E, 12 m, sandy mud, 27 July 1973: 6♂, cl. 8.5–12.5 mm, 6 ovigerous ♀, cl. 8.6–11.0 mm (LTP).

Off Cattolica, 44°02.8′N, 12°46′E, 13 m, sandy mud, 26 July 1973: 7♂, cl. 9.4–11.5 mm, 4♀, cl. 9.0–10.2 mm (1 ovigerous, cl. 9.3 mm) (1♂, 1♀ parasitized by sacculinids) (LTP).

Middle Adriatic, Italy: Off Pesaro, 43°52.2′N, 13°07.1′E to 43°55′N, 13°00′E, 14 m, muddy sand, trawl, 30 September 1974: 4♂, cl. 3.0–6.4 mm, 3♀, cl. 4.6–11.0 mm (1♀ parasitized by sacculinids) (LTP).

43°47′N, 13°12.1′E to 43°50.4′N, 13°07.3′E, 13 m, muddy sand, 26 July

1973: 6♂, cl. 8.0–12.0 mm, 6♀, cl. 7.4–10.4 mm (LTP); 6♂, cl. 8.5–12.7 mm, 6♀, cl. 8.0–11.5 mm (2 ovigerous, cl. 9.3–11.5 mm) (4♀ parasitized by sacculinids) (USNM).

Three miles off Ancona [43°38′N, 13°30′E], 15 m, 7 July 1969, C. Froglia leg.: 1♂, cl. 8.2 mm, 4♀, cl. 8.9–9.9 mm (3 parasitized by sacculinids) (USNM).

Off Falconara Marittima [43°38′N, 13°24′E], 7 m, sand, 17 April 1973: 1♂, cl. 9.1 mm, 3♀, cl. 5.9–6.4 mm (LTP).

Off Conero Promontory [43°33′N, 13°36′E], 15 m, sandy mud, trawl, 29 April 1971: 1♂, cl. 4.8 mm, 2♀, cl. 3.4–6.6 mm (LTP).

Southern Adriatic, Italy: Off Lago di Varano [41°53′N, 15°45′E], 15 m, sand, trawl, 4 August 1974: 5♂, cl. 10.7–15.7 mm, 2 ovigerous ♀, cl. 11.0–12.3 mm (1♂ parasitized by sacculinid) (LTP).

Golfo di Manfredonia, off Mattinata [41°42′N, 16°03′E], 10 m, sand with *Cymodocea nodosa*, 1 August 1974: 13♂, cl. 12.6–15.4 mm, 12♀, cl. 10.1–14.4 mm (6 ovigerous, cl. 12.6–14.4 mm) (2♀ parasitized by sacculinids), 1 hermaphrodite, cl. 11.2 mm (LTP). ♂, cl. 15.4 mm, is Neotype, RMNH Crust. D. 31719.

Tunisia: Salammbô [36°51′N, 10°19′E], northern Punic Port, sand and mud flat, 25 April 1974, Sta. RBM Tun-339, R. B. Manning leg.: 2♂, cl. 7.0–11.2 mm (USNM).

Gulf of Tunis, off Salammbô [36°51′N, 10°19′E] and Kherredine [36°50′N, 10°19′E], 7–10 m, sand and grass, Zariquiey dredge, 28 February 1974, Sta. RBM Tun-320, R. B. Manning, R. W. and Eileen Ingle leg.: 1♂, cl. 7.2 mm (USNM).

Gulf of Gabès, off Gabès and Zarat, 33°45.5′N, 10°24′E, 21 m, 27 June 1973, *El Maghreb* sta. R9-2, M. Jeddi leg.: 1♂, cl. 7.5 mm (USNM).

Diagnosis.—Size relatively large, maximum cl. about 16 mm. Carapace (Fig. 1d) smooth, regions poorly marked. Adult females with distinct, transverse, tuberculate branchial ridge extending mesially from third anterolateral tooth, ridge absent in males. Frontal lobes strongly convex, median emargination well marked but shallow. Frontorbital width ranging from 2.25–2.80 (mean 2.36) times frontal width. Third anterolateral tooth of carapace distinct, rarely sharp. Pereiopods (Fig. 1*e*, *f*) long, merus of fifth half or more than half as long as carapace (generaly more than half in females), slender, propodus of fifth 1.55–2.30 (mean 1.88) times as long as broad, legs of females slenderer than in males. Male pleopod (Fig. 2*g*, *h*) tapering evenly to apex, with low shoulder subdistally.

Size.—Carapace lengths of males 2.4–15.7 mm, of females 3.4–14.4 mm, of ovigerous females 6.6–14.4 mm. This is a relatively large species, larger than *B. foresti* but smaller than *B. sexdentatus*.

Remarks.—In 1839 Alessandro Rizza described, under the name *Cleistotoma Gemmellari*, a species of *Brachynotus* collected from several localities

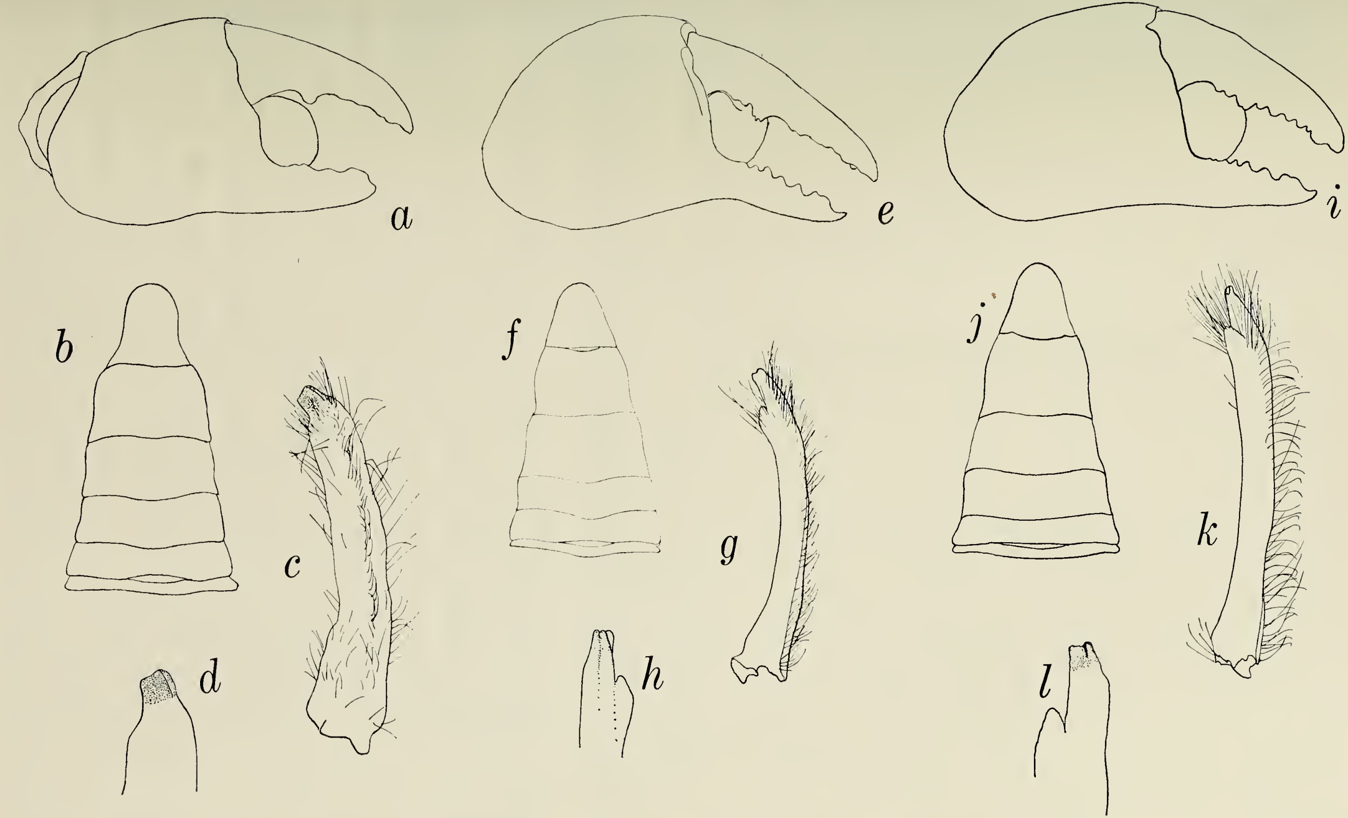

Fig. 2. Outer face of chela (*a*, *e*, *i*), abdomen (*b*, *f*, *g*), gonopod (*c*, *g*, *k*), and apex of gonopod (*d*, *h*, *l*) of males of: *a–d*, *B. foresti*, cl. 10.4 mm Tunisia; *e–f*, *B. gemmellari*, cl. 11.6 mm Adriatic Sea; *g–h*, *B. gemmellari*, cl. 9.2 mm Adriatic Sea; *i–l*, *B. sexdentatus*, cl. 12.8 mm, Sicily.

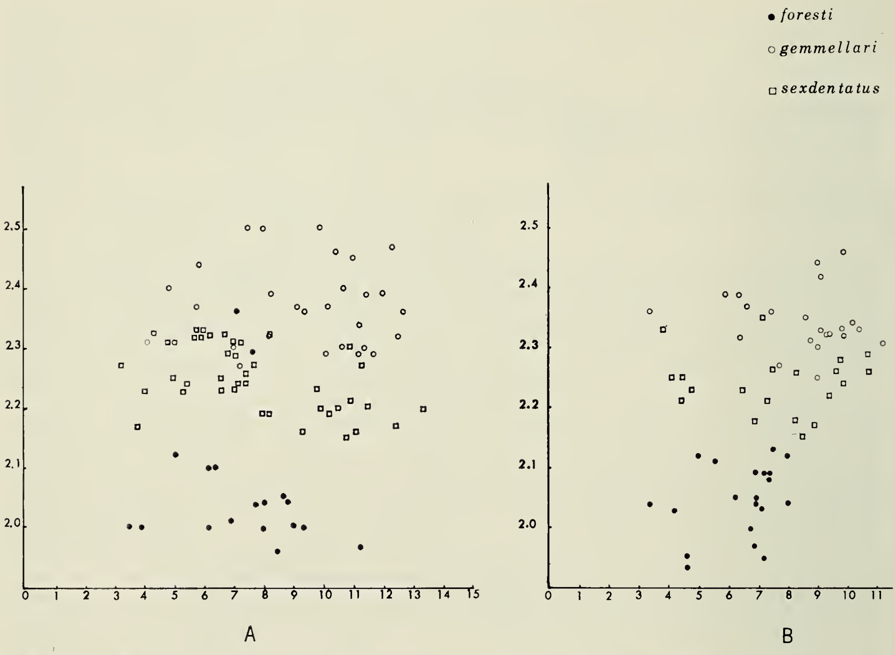

Fig. 3. Ratio of carapace length (abscissa) to frontorbital width in Mediterranean species of *Brachynotus*: A, males; B, females.

off the eastern coast of Sicily. Although *B. gemmellari* is now considered to be a synonym of *B. sexdentatus*, we believe that Rizza's account applies best to the deep water, long-legged species we recognize here rather than to either of the two short-legged, shallow water species of *Brachynotus* from the Mediterranean, *B. foresti* or *B. sexdentatus*.

As in the case of many older accounts, Rizza's description does not fit our material exactly. However, he noted that the front was slightly sinuous (p. 372), "fronte poco inclinata, appena sinuosa nel mezzo," a description which could apply to *B. sexdentatus* but not to *B. foresti*, which has a relatively deep median emargination on the front. The color reported for *B. gemmellari* by Rizza (p. 373), "Colore del corpo cinereo, con le membre più chiare o color di cera.", is that found in our material of *Brachynotus* from relatively deep water; the shallow water species in the Mediterranean are generally uniform brownish in color.

The color, the fact that Rizza's material may have been collected sublittorally (he also reported other sublittoral species such as *Inachus communissimus* Rizza from the same area), and the availability of Rizza's name lead us to apply it to our long-legged, sublittoral species rather than introducing a new name. In order to settle the identity of *Cleistotoma gemmellari*, we here select a neotype for the species, a male cl. 15.4 mm, cb. 18.5

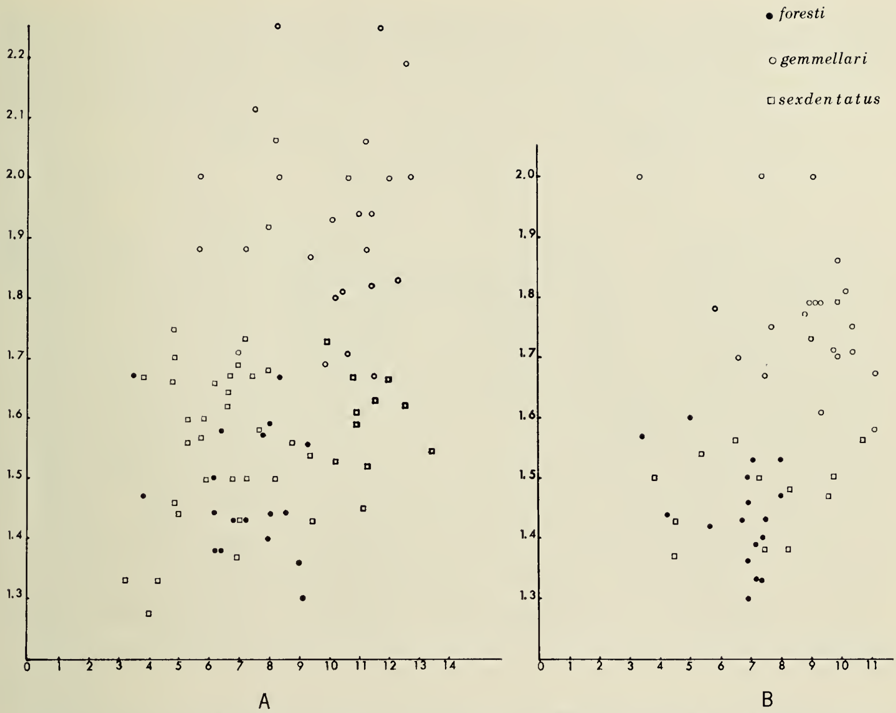

Fig. 4. Ratio of length to width of propodus of fifth pereiopod in Mediterranean species of *Brachynotus*: A, males; B, females. Ratio in ordinate, carapace length in abscissa.

mm, from Italy, Golfo di Manfredonia, off Mattinata [41°42′N, 16°03′E], 10 m, on sand with *Cymodocea nodosa*, collected on 1 August 1974 by C. Froglia. The neotype has been deposited in the Rijksmuseum van Natuurlijke Historie, Leiden, under registry number Crust. D. 31719.

Brachynotus gemmellari, as shown in Figs. 1*d–f* and 2*e–h*, and as indicated in the key, above, can be distinguished readily from the other Mediterranean species of the genus. Two ratios, plotted in Figs. 3 and 4, carapace width vs frontorbital width and the length/width ratio of the propodus of the fifth pereiopods, show some of the differences we have observed. The slenderness and length of the walking legs also are distinguishing features of the species. Finally, its habitat may also be diagnostic. We suspect that almost any *Brachynotus* from depths greater than 5 m will prove to belong to this species rather than to either *B. foresti* or *B. sexdentatus*.

Inasmuch as our collections indicate that neither *B. foresti* nor *B. sexdentatus* occurs in depths greater than a meter or two, we have to conclude that material identified with *B. sexdentatus* by the following authors is all or

Fig. 5. Sternal view of gynandromorph *B. gemmellari*, cl. 11.2 mm, Gulf of Manfredonia.

in part based on *B. gemmellari*: Forest & Guinot, 1956 (Gulf of Tunis, 5–10 m); Bacescu, 1967 (Black Sea, several records below 6 m); and Geldiay & Kocatas, 1968, 1972, and Kocatas, 1971 (Bay of Izmir, Turkey, several records from below 6–7 m). It also seems most likely that the material identified with *B. foresti* from 12 m in the Gulf of Taranto by Pastore (1976) also is *B. gemmellari.*

Kocatas (1971) illustrated *B. foresti* (Pl. 5 fig. 2) and *B. gemmellari* (Pl. 5 fig. 4, as *B. sexdentatus*) from Izmir Bay, Turkey, and his figures clearly show the difference in leg size and proportions in the two species.

One of our specimens of *B. gemmellari* from off Mattinata, Golfo di Manfredonia, in 10 m, is a hermaphrodite, with a highly modified abdomen and a small chela of the typical female form. The specimen, measuring cl. 11.2 mm, cb. 12.3 mm, has the first pleopods of a male, whereas the second pleopods are biramous, typical of those found in females. A sternal view of this specimen is shown in Fig. 5.

In the Adriatic Sea *B. gemmellari* is very common on the intralittoral fishing grounds of the western side and it is actively preyed upon by many fishes of high commercial value such as turbot, plaice, gurnard and eel.

Distribution.—Mediterranean, where it is known with certainty from localities in the Adriatic Sea, eastern Sicily, and off Tunisia; usually sublittoral, in depths between 4 and 21 m. If our identifications of records in the literature are correct, it also occurs in the Gulf of Taranto, the Black Sea, and off Greece and Turkey. It, too, could be expected to occur throughout the Mediterranean where suitable habitats can be found.

Brachynotus sexdentatus (Risso, 1827)
Figs. 1*g–i*, 2*i–l*, 3, 4

Goneplax sexdentatus Risso, 1827:13 [Nice].

Brachynotus sexdentatus.—Lewinsohn & Holthuis, 1964:60 [Israel].—Bacescu, 1967:321, figs. 7, 10A,C,D, 11A–C, 12A, 14G,H, 136, 137A,B, 138A [Black Sea; part, shallower records only].—Zariquiey Alvarez, 1968:431, figs. 142a–c, 143a, 144 [Spain; references].— Geldiay & Kocatas, 1968:5, figs, 1, 2b,d,f, figs. 2–3 on pl.; 1972:13, 14, 17, 29 [both Turkey; part, shallow records only].—Stevcic, 1969:132 [Adriatic; listed]; 1971: 528 [Yugoslavia], 530 [listed]; 1973:115, 116 [Yugoslavia].—?Koukouras, 1973:762, table 1 [Greece; part?].—?Georgiadis & Georgiadis, 1974:242 [table], 246, figs. 5–7 [Greece; possibly more than 1 species].—Kattoulas & Koukouras, 1975:300 [Greece].—Pastore, 1976:106, 108, 113 [Gulf of Taranto; part, shallow records only].—Ramadan & Dowidar, 1976:133 [Egypt].

Material.—Mediterranean Sea: No other data: 2♂, cl. 11.1–17.0 mm (USNM).

Northern Adriatic, Yugoslavia: Canal di Leme [Limski Canal, 45°07′N, 13°38′E], shallow flat at upper end of canal, under stones at low tide, 21 March 1973, Sta. RBM Yugo-11, Barbara, Elaine, and R. B. Manning, C. Froglia, and Z. Stevcic leg.: 5♂, cl. 4.8–8.2 mm, 2♀, cl. 5.8–6.4 mm (1♂, 1♀ parasitized by sacculinids) (LTP); 25♂, cl. 3.3–7.9 mm, 26♀, cl. 3.0–8.3 mm (1♂, 3♀ parasitized by sacculinids) (USNM).

Northern Adriatic, Italy: Porto Garibaldi [44°41′N, 12°14′E], among mussels and fouling organisms of the harbor, depth 1 m, 17 September 1972, C. Froglia leg.: 2♂, cl. 5.8–7.7 mm, 1♀, cl. 5.3 mm (LTP).—Locality same, 0.5 m, 10 October 1974, C. Froglia leg.: 11♂, cl. 3.7–7.0 mm, 5♀, cl. 4.0–5.1 mm (LTP).

Marina di Ravenna [44°25′N, 12°12′E], along piers, among fouling organisms, depth 0.5 m, 4 October 1974, C. Froglia leg.: 11♂, cl. 2.7–6.6 mm, 21♀, cl. 3.5–7.7 mm (LTP).

Southern Adriatic, Italy: Manfredonia Harbor [41°38′N, 15°55′E], among fouling organisms, depth 0.5–1.0 m, 8 July 1974, C. Froglia leg.: 3♂, cl. 5.9–7.2 mm, 3♀, cl. 6.9–7.5 mm (LTP).

Brindisi Harbor [40°39′N, 17°57′E], near port office, among fouling organisms, depth 0.5–1.0 m, 2 August 1974, C. Froglia leg.: 21♂, cl. 2.7–13.8 mm, 12♀, cl. 4.3–12.6 mm (3 ovigerous, cl. 10.1–12.0 mm) (LTP).

Sicily: Trapani, 38°00.5′N, 12°31.1′E, on seawall at mouth of canal from old salt ponds opening on southern edge of harbor, 17 June 1974, RBM Ital-16, C. Froglia and R. B. Manning leg.: 6♂, cl. 8.8–12.5 mm, 3♀, cl. 8.5–10.7 mm (LTP); 2♂, cl. 10.8–11.3 mm, 2♀, cl. 8.3–8.9 mm (USNM).

Italy: Naples [Naples Bay, 40°48′N, 14°16′E], Vimont leg.: 3♂, cl. 12.4–16.9 mm (MNHN).

Spain: Port of Barcelona [41°23′N, 02°11′E], July 1957, R. Zariquiey leg.: 1♂, cl. 10.1 mm, 1 ovigerous ♀, cl. 9.9 mm (USNM).

Tunisia: Salammbô [36°51′N, 10°19′E], southern Punic Port, under rocks along entrance channel, intertidal, 6 October 1972, Sta. RBM Tun-51, R. B. Manning, L. B. Holthuis leg.: 8♂, cl. 4.7–9.1 mm, 6♀, cl. 2.3–9.3 mm (2 ovigerous, cl. 7.0–9.3 mm) (USNM).

Salammbô, intertidal area outside and N of northern Punic Port, under loose rocks on sand, 15 May 1973, Sta. RBM Tun-123, R. B. and Lilly Manning leg.: 4♂, cl. 4.8–5.8 mm, 2♀, cl. 5.5–5.9 mm (1 ovigerous, cl. 5.5 mm) (USNM).—Locality and habitat same, 8 August 1973, Sta. RBM Tun-196B, R. B. Manning and J. Forest leg.: 2♂, both cl. 7.3 mm, 1 ovigerous ♀, cl. 6.7 mm (USNM).

Algeria: Rade d'Alger [36°47′N, 03°03′E] et de Bône [Golfe de Bône, 36°55′N, 07°50′E], Lucas leg. (types of *Heterograpsus Lucasi* ?): 3♂, cl. 7.8–9.6 mm, 1♀, cl. 9.2 mm (MNHN).

Diagnosis.—Size relatively large, maximum cl. to more than 20 mm. Carapace (Fig. 1g) smooth, regions poorly marked. Adult females with distinct, transverse, tuberculate branchial ridge extending mesially from third anterolateral tooth, ridge absent in adult males. Frontal lobes convex but short, median emargination shallow. Frontorbital width ranging from 2.10–2.35 (mean 2.24) times frontal width. Third anterolateral tooth of carapace usually sharp. Pereiopods (Fig. 1*h*, *i*) short, merus of fifth half or less than half as long as carapace in both sexes, stout, propodus of fifth 1.35–1.80 (mean 1.61) times longer than broad. Male pleopod (Fig. 2*k*, *l*) with broad, rounded, projecting subdistal shoulder.

Size.—Carapace lengths of males 2.7–17.0 mm, of females 2.3–12.3 mm, of ovigerous females 5.5–12.0 mm. Lewinsohn & Holthuis (1964) recorded specimens from Israel measuring cl. 7–11 mm, and Forest (1957) recorded a male from Naples, cl. 20.5 mm.

Remarks.—At least two of the records cited above, those of Koukouras (1973) and Georgiadis & Georgiadis (1974), are based on material from several different localities off Greece. We are not able to determine from these accounts whether or not their material included representatives of more than one species. At least part of the material of this species reported by Bacescŭ (1967) from the Black Sea is referable to *B. gemmellari*. So far as we can determine, Naylor (1957) was correct in identifying his material, apparently introduced to Swansea, England, with this species. Whether or not *B. sexdentatus* has established a breeding population in England remains to be determined.

Calman (1927) reported that this species had entered the northern part of the Suez Canal.

Distribution.—Mediterranean Sea, from numerous localities between Spain and Israel, including the Black Sea and the northern part of the Suez Canal; introduced into England; littoral, generally under stones or burrowing in sand.

General Remarks

Adult males of all of the Mediterranean species of *Brachynotus* have an inflated vesicle on the inner face of the chela originating from the articulation of the movable finger with the propodus. Juvenile males not only have a smaller chela, the general shape of which resembles that found in adult females, but also lack the vesicle. The development of the vesicles and the enlargement of the claw in the males probably coincides with the onset of sexual maturity.

The size at which the vesicles can be detected on the chelipeds of males more or less coincides in *B. gemmellari* and *B. sexdentatus* with the smallest size recorded for ovigerous females. We can detect vesicles in specimens as small as cl. 5.8 mm in *B. gemmellari*, 5.0 mm in *B. sexdentatus*, and 4.5 mm in *B. foresti*. The smallest ovigerous females collected had carapace lengths of 6.6 mm in *B. gemmellari*, 5.5 mm in *B. sexdentatus* (Stevcic, 1973, reported ovigerous females of 4.9 mm), and 6.5 mm in *B. foresti*.

Ovigerous females of all three species generally are found in warmer months, from May to October. Zariquiey Alvarez (1968) reported that *B. sexdentatus* from Spain was ovigerous between February and October, and Stevcic (1973) noted that in the northern Adriatic females were ovigerous between April and October. In all three species the eggs are dark brown and their diameter is 0.25–0.30 mm.

Habitat Preferences

The three Mediterranean species of *Brachynotus* occupy different ecological habitats and usually do not live together. *Brachynotus foresti* and *B. sexdentatus* are both shallow water species. The former usually is found in the mediolittoral zone among algae or mussels growing on hard substrates, generally in protected waters with little wave influence; apparently it may also dig in sand. *Brachynotus sexdentatus* apparently prefers soft bottoms, also in the mediolittoral zone in depths of less than one meter. It usually is found under stones but it, too, may burrow in sand, as reported by Lewinsohn & Holthuis (1964). Ramadan & Dowidar (1976) found it on silty sand and mud with seaweeds and *Caulerpa*. The third species, *Brachynotus gemmellari*, usually is limited to the lower part of the infralittoral zone, in depths ranging from 4–21 m, on soft, muddy bottoms where its long, slender legs may be advantageous.

Although the apparent habitat preferences of *B. gemmellari* and *B. sexdentatus* suggest that the two species would not be taken together, we found them together in a shallow water, protected habitat in Salammbô, Tunisia. There, in the northernmost of the two Punic Ports, a circular harbor separated from the Bay of Tunis by a narrow channel to the East, the outer edge is made up of rocks on marl or mud and *B. sexdentatus* is commonly found under the rocks. Toward the mouth of the harbor the bottom is of firm sand, but that grades into very soft, deep mud which fills the inner part of the harbor, and here we found *B. gemmellari.* Apparently it can live in shallow water if soft bottoms are present.

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CONTRIBUTION TOWARD A REVISION OF THE PORCELLANID GENUS *PORCELLANA* (CRUSTACEA: DECAPODA: ANOMURA)

Janet Haig

Abstract.—Four new genera of Porcellanidae are proposed for 9 species previously included in genus *Porcellana*: *Capilliporcellana* (type-species *P. murakamii* Miyake), *Ancylocheles* (type-species *P. gravelei* Sankolli), *Lissoporcellana* (type-species *P. quadrilobata* Miers), and *Heteroporcellana* (type-species *P. corbicola* Haig). Genus *Aliaporcellana* Nakasone & Miyake is restricted through transfer of several species to one of the new genera; *Enosteoides* Johnson, originally described as a subgenus of *Porcellana*, is raised to generic rank and three species are assigned to it.

The anomuran crab family Porcellanidae contains about 225 described species (not including several of uncertain status). Nearly 80 of these were originally included in genus *Porcellana*, but by now most of them have been distributed among other genera. However, *Porcellana* still consists of a heterogeneous grouping of species which have little in common aside from the structure of the basal segment of the antennal peduncles: in all these forms it is produced and broadly in contact with the anterior margin of the carapace, thereby excluding the movable segments from the orbit. Several species have been placed or retained in *Porcellana* only because they do not fit into any of several other genera which share this character. I have already drawn attention to the need for a revision of the genus (Haig, 1960:197; 1965:107).

Basing his study on the porcellanid fauna of the Singapore area, Johnson (1970:8, 21) included in *Porcellana* all species having a produced basal antennal segment, the frontal area not (or not greatly) deflexed, and the carapace never much broader than long. He erected a new subgenus, *Enosteoides*, and reduced *Pisidia*, and even the distinctive genus *Porcellanella*, to subgenera. In my opinion this arrangement is not satisfactory—not only because it further obscures natural relationships, but because it was based on only a few species from a limited geographical area.

In the revision which follows I re-establish the generic status of *Pisidia* (and of *Porcellanella*), erect four new genera to accommodate some of the aberrant species of *Porcellana*, elevate Johnson's subgenus *Enosteoides* to generic rank, and make various changes in the generic placement of species. I have been fortunate enough to examine material of almost all the species involved; for others, I suggest possible relationships on the basis of information in the literature. This proposed arrangement should be considered provisional, but I believe it is a more natural one than those used previously. Future studies on larval development may help to prove or disprove the validity of some of these groupings.

Porcellana Lamarck 1801

Diagnosis.—Carapace usually a little longer than broad; dorsal surface smooth, unarmed, convex. Front horizontal, strongly tridentate or trilobate in dorsal view. Lateral margins unarmed or denticulate posterior to epibranchial angle. Basal antennal segment broadly in contact with anterior margin of carapace, excluding movable segments from orbit. Orbits deep; eyes large.

Chelipeds subequal; chelae large, compressed, lying obliquely, usually with well developed fringe of setae along outer margin. Dactyl of walking legs with a single terminal claw, and with several movable spinules ventrally.

Telson of abdomen 7-plated.

Remarks.—The following species, closely related to the type, *Porcellana platycheles* (Pennant, 1777), should be retained in this genus:

Indo-West Pacific: *Porcellana pulchra* Stimpson 1858, *P. habei* Miyake, 1961, and *P. persica* Haig, 1966.

Eastern Pacific: *Porcellana cancrisocialis* Glassell, 1936, *P. paguriconviva* Glassell, 1936, and *P. hancocki* Glassell 1938.

Western Atlantic: *Porcellana sayana* (Leach, 1820) and *P. sigsbeiana* A. Milne Edwards, 1880. *P. stimpsoni* A. Milne Edwards, 1880 is probably a true *Porcellana*, but its status is uncertain. *P. paivacarvalhoi* Rodrigues da Costa, 1968 was only briefly described and not illustrated; it probably belongs to this genus, because it was said to be similar to *P. platycheles* (Rodrigues da Costa, 1968:405).

Eastern Atlantic: *Porcellana platycheles*, with two subspecies, *P. p. platycheles* (Pennant, 1777) and *P. p. africana* Chace, 1956.

Pisidia Leach 1820

Remarks.—Johnson (1970:8, 21) treated *Pisidia* as a subgenus of *Porcellana*, and included in it three species which I place in a new genus in the present paper. Earlier, I gave a diagnosis of *Pisidia* (Haig, 1965:105; 1966: 43), and my interpretation remains essentially the same except that I transfer *Pisidia spinuligera* (Dana, 1853) to another genus. *Pisidia* now contains the following species:

Indo-West Pacific: *Pisidia dehaanii* (Krauss, 1843), *P. dispar* (Stimpson, 1858), *P. serratifrons* (Stimpson, 1858), *P. streptocheles* (Stimpson, 1858), *P. inaequalis* (Heller, 1861), *P. delagoae* (Barnard, 1955), and *P. gordoni* (Johnson, 1970).

Eastern Pacific: *Pisidia magdalenensis* (Glassell, 1936).

Western Atlantic: *Pisidia brasiliensis* Haig (in Rodrigues da Costa, 1968). *P. melloleitaoi* Rodrigues da Costa, 1968, which was very briefly described without an illustration, is probably assigned correctly to this genus because it was said (Rodrigues da Costa, 1968:406) to resemble *P. bluteli.*

Eastern Atlantic: *Pisidia longicornis* (Linnaeus, 1767) (the type-species), *P. bluteli* (Risso, 1816), and *P. longimana* (Risso, 1816).

Aliaporcellana Nakasone & Miyake, 1969, restricted

Diagnosis.—Carapace as long as broad or slightly broader than long, strongly convex front to back, smooth or roughened, regions usually well marked. Front broad, strongly deflexed; in dorsal view usually appearing rounded-triangular, in frontal view trilobate with median lobe much more produced than lateral lobes. Lateral margins with a few spines posterior to epibranchial angle. Basal antennal segment broadly in contact with anterior margin of carapace, excluding movable segments from orbit. Orbits rather deep; eyes large.

Chelipeds unequal, one larger than the other and the two usually armed differently, these differences dependent on age and sex; chelae lying on or near their outer margin with fingers opening vertically or in sharply oblique plane. Dactyl of walking legs biunguiculate, the 2 fixed spines usually subequal in size, and sometimes with a single movable spinule ventrally.

Telson of abdomen 7-plated.

Remarks.—In a review of the Indo-West Pacific species of *Polyonyx*, Johnson (1958:97) divided the genus into three natural groups. One, which he designated the *P. denticulatus* group, consisted of species which "appear to be transitional towards the genus *Porcellana*." Included were *Polyonyx pygmaeus* (De Man, 1902), *P. pugilator* Nobili, 1905 (a synonym of *P. pygmaeus*), *P. denticulatus* Paulson, 1875 (a synonym of *Porcellana suluensis* Dana, 1852), and a new species, *P. telestophilus.* Nakasone & Miyake (1969:20) proposed a new genus, *Aliaporcellana*, for a number of species having two or more well developed fixed spines on the dactyl of the walking legs, and (usually) the carapace armed with spines posterior to the cervical groove. These included *Aliaporcellana suluensis*, *A. pygmaea*, *A. pugilator*, and *A. telestophila*; a new species allied to them, *A. kikuchii*; *A. carinata* (Ortmann, 1892), which Johnson (1958) had only doubtfully retained in *Polyonyx*; and three species previously included among the aberrant species of *Porcellana*, *A. nitida* (Haswell, 1882), *A. quadrilobata* (Miers, 1884), and *A. furcillata* (Haig, 1965).

Polyonyx carinatus was published with an inadequate description and illustration and, in my opinion, should be considered a nomen dubium until its status can be determined by reexamination of the type-specimens. In this paper I transfer *Porcellana nitida*, *P. quadrilobata*, and *P. furcillata* to a new genus. *Aliaporcellana*, as hereby restricted, is thus the equivalent of Johnson's *denticulatus* group of *Polyonyx*.

The following Indo-West Pacific species are included: *Aliaporcellana suluensis* (Dana, 1852) (the type-species), *A. pygmaea* (De Man, 1902), *A. telestophila* (Johnson, 1958), and *A. kikuchii* Nakasone & Miyake, 1969.

Enosteoides Johnson, 1970, new rank

Diagnosis.—Carapace rounded, about as broad as long; dorsal surface strongly areolate, regions distinct and separated by deep grooves; dorsal surface sometimes spinulate. Front broad, deflexed near tip, sinuously trilobate; in dorsal view the median lobe broad, triangular or rounded, and with a median notch, lateral lobes small, frequently obsolescent; in frontal view, median lobe prominent, subtriangular. Lateral margins ridged, with spines posterior to epibranchial angle. Basal antennal segment broadly in contact with anterior margin of carapace, excluding movable segments from orbit. Orbits deep; eyes small.

Chelipeds subequal; chelae broad, flattened, *Petrolisthes*-like, lying obliquely, often with spines and ridges. Dactyl of walking legs with a single terminal claw, and with several movable spinules ventrally.

Telson of abdomen 7-plated.

Remarks.—*Enosteoides* was established by Johnson (1970:8, 32) as a subgenus of *Porcellana*, and contained only the type-species, *Porcellana corallicola* Haswell 1882 (a synonym of *Porcellana ornata* Stimpson, 1858). It is hereby raised to generic rank and its diagnosis slightly emended to include two closely related species from among the aberrant *Porcellana* forms.

Thus emended, the genus contains the following Indo-West Pacific species: *Enosteoides ornatus* (Stimpson, 1858) (the type-species), *E. melissa* (Miyake, 1942), and *E. palauensis* (Nakasone & Miyake, 1968).

Porcellana caparti Chace, 1956, from the eastern Atlantic, appears to belong near here and should perhaps be included in *Enosteoides*.

Capilliporcellana, new genus

Diagnosis.—Carapace as long as, or a little longer than, broad; dorsal surface rather convex, strongly areolate, regions well defined. Front broad, horizontal, produced beyond eyes, faintly trilobate in dorsal view; dorsal surface concave. Lateral margins unarmed, somewhat expanded posterior to epibranchial angle to form laminiform crest. Basal antennal segment broadly in contact with anterior margin of carapace, excluding movable segments from orbit. Orbits deep; eyes small, partly hidden behind orbital margin.

Chelipeds somewhat unequal in size, large, robust, tuberculated and longitudinally ridged; one or both chelae lying on or near their outer margin with fingers opening vertically or nearly so. Dactyl of walking legs with a single terminal claw, and with several movable spinules ventrally.

Telson of abdomen 7-plated.

Type-species.—*Porcellana murakamii* Miyake, 1942:362, pl. 1 fig. 3, text-figs. 23, 34.

Etymology.—From Latin "capillus," hair, in combination with the generic name *Porcellana*; referring to the heavily setose condition of the epimera of the carapace and the outer margins of the chelae.

Remarks.—This genus resembles *Enosteoides* in several characters, including the strongly areolate carapace and the form of the dactyl of the walking legs. The shape of the front and the structure of the chelipeds are quite different from those of *Enosteoides.* The neotropical genus *Megalobrachium* seems to be close to *Capilliporcellana*, but is characterized by having a deflexed front, the antennules reduced in size, and the fingers opening obliquely.

Capilliporcellana includes only the type-species, *C. murakamii* (Miyake, 1942); the description of a second member of the genus is in preparation. Both these species inhabit the Indo-West Pacific. *Porcellana elegans* Chace, 1956, from the eastern Atlantic, should possibly be placed here as well.

Ancylocheles, new genus

Diagnosis.—Carapace about as long as broad, strongly convex front to back, smooth or somewhat roughened, regions clearly marked. Front horizontal or somewhat deflexed, appearing broadly triangular or rounded in dorsal view; median lobe strongly deflexed, visible only in frontal view. Lateral margins ridged, unarmed posterior to epibranchial angle. Basal antennal segment broadly in contact with anterior margin of carapace, excluding movable segments from orbit. Orbits shallow; eyes large, partly concealed behind orbital margin.

Chelipeds unequal, one distinctly larger than the other, especially in large males; chelae broad, flattened, lying obliquely; dactyl of smaller chela twisted out of plane with manus, this distortion generally more pronounced in large males. Dactyl of walking legs with a single terminal claw, and with several movable spinules ventrally.

Telson of abdomen 7-plated.

Type-species.—*Porcellana gravelei* Sankolli, 1963:280, fig. 1.

Etymology.—From Greek "ankylos," bent or crooked, and "chele," claw.

Remarks.—*Ancylocheles* superficially resembles *Pachycheles* and the neotropical genus *Neopisosoma* in the general aspect of the carapace and frontal area, and in having one cheliped larger than the other. Both *Pachycheles* and *Neopisosoma*, however, belong to the group of genera in which the basal segment of the antennae is short and not, or only narrowly, in contact with the anterior margin of the carapace. *Ancylocheles* agrees with *Pisidia* in having unequal chelipeds with some twisting of the fingers in the smaller chela; but in the latter genus the frontal region is strongly tridentate or trilobate, and there is pronounced sexual dimorphism in the spinulation of the carapace and chelipeds as well as in the degree of distortion of the chelae.

The new genus is proposed for a single species, *Ancylocheles gravelei* (Sankolli, 1963), an inhabitant of the Indo-West Pacific. An eastern Atlantic species, *Porcellana foresti* Chace, 1956, appears to be related to *A. gravelei* but I have not had the opportunity to compare these two species directly.

Lissoporcellana, new genus

Diagnosis.—Carapace as long as, or slightly longer than, broad; smooth dorsally, regions not marked. Front broad, horizontal, tridentate or trilobate, the median lobe broad and usually subdivided medially by a notch or cut into a series of teeth. Lateral margins usually with strong teeth or spines posterior to epibranchial angle. Basal antennal segment broadly in contact with anterior margin of carapace, excluding movable segments from orbit. Orbits shallow, strongly oblique; eyes large, partly hidden behind orbital margin.

Chelipeds unequal, one somewhat larger than the other; chelae subcylindrical, smooth, generally lying on their outer margin with fingers opening vertically; fingers of smaller chela sometimes twisted and opening in sharply oblique plane. Dactyl of walking legs usually with a strongly developed fixed spine, frequently with movable spinule at its tip, on ventral margin adjacent to terminal claw; also a few movable spinules ventrally.

Telson of abdomen 7-plated.

Type-species.—*Porcellana quadrilobata* Miers, 1884:276, pl. 30 fig. D.

Etymology.—From Greek "lissos," smooth, in combination with the generic name *Porcellana.*

Remarks.—*Lissoporcellana* agrees with *Porcellanella* in having a smooth carapace with a broad, horizontal frontal region; smooth, subcylindrical chelae with the fingers opening vertically; and (usually) more than one fixed spine on the dactyl of the walking legs. *Porcellanella* differs in having the carapace distinctly elongate, and the walking legs short and stout with short, quadriunguiculate dactyls. *Lissoporcellana* resembles *Pisidia* in having a trilobate or tridentate horizontal front, in the twisting of the fingers of the smaller chela (at least in some species), and, to some extent, in the form of the ventral spine adjacent to the terminal claw of the dactyl of the walking legs. In one or two species of *Lissoporcellana* this spine takes the form of a movable spinule with an enlarged, fixed base, as in *Pisidia.* However, the new genus differs from *Pisidia* in that the dissimilarity of the two chelae is not due to sexual dimorphism—the sexes are alike in having one cheliped larger than the other, and the degree of distortion of the fingers appears to be a function of size rather than sex—and the females are not more strongly spinulate than males. The genus further differs from *Pisidia* in the smooth carapace, with the regions not indicated, and the smooth, subcylindrical chelae with vertically opening fingers.

This genus contains the following described species, all from the Indo-West Pacific: *Lissoporcellana spinuligera* (Dana, 1853), *L. nitida* (Haswell, 1882), *L. quadrilobata* (Miers, 1884), *L. maculata* (Miyake, 1957), *L. furcillata* (Haig, 1965), and *L. streptochiroides* (Johnson, 1970). The descriptions of two additional species are in preparation.

The illustration of *Porcellana hornelli* Southwell (1906:218, fig. 1) appears to be of a juvenile of some species of *Lissoporcellana,* but specimens will have to be reexamined before the status of this form can be determined.

The specimen cited and illustrated by Monod (1973:11, figs. 44–51) as "*Porcellana* sp." certainly belongs to *Lissoporcellana*; I have seen this specimen but not material of *L. maculata* (Miyake, 1957), of which it is perhaps a synonym. (It should be noted that Miyake's species requires a new name, being a junior primary homonym of *Porcellana maculata* H. Milne Edwards, 1837 = *Neopetrolisthes.*)

Czerniavsky (1884:109) briefly described a new genus, *Porcellanides.* Most of the nominal taxa included in it belong to *Pisidia* (see Holthuis, 1961:43), but the identity of the type-species, *Porcellanides kriczagini* from Singapore, is unknown. From Czerniavsky's diagnosis (p. 111) it might be a member of genus *Lissoporcellana.* If this could be confirmed by direct examination of the type, *Lissoporcellana* would fall as a junior synonym of *Porcellanides.*

Heteroporcellana, new genus

Diagnosis.—Carapace longer than broad, nearly smooth dorsally, regions scarcely indicated. Front horizontal, with a broad median lobe and two narrow lateral teeth. Lateral margins subparallel, unarmed posterior to epibranchial angle. Basal antennal segment broadly in contact with anterior margin of carapace, excluding movable segments from orbit. Orbits shallow, oblique; eyes small.

Chelipeds subequal; chelae subcylindrical, smooth, lying on their outer margin, with fingers opening vertically. Dactyl of walking legs with a single terminal claw; no movable spinules on ventral margin.

Telson of abdomen 5-plated.

Type-species.—Porcellana corbicola Haig, 1960:205, pl. 15.

Etymology.—From Greek "heteros," different, in combination with the generic name *Porcellana.*

Remarks.—Heteroporcellana resembles *Porcellanella* because of its trilobed, horizontal front; smooth, subcylindrical chelae with the fingers opening vertically; and smooth carapace with unarmed posterolateral margins. *Porcellanella,* however, differs in having a 7-plated telson, a much more elongate carapace and frontal region, and short, stout walking legs with quadriunguiculate dactyls.

The genus contains only the type-species, *Heteroporcellana corbicola* (Haig, 1960). It inhabits the eastern Pacific.

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A NEW SPECIES OF GOBIID FISH, *CALLOGOBIUS STELLATUS*, FROM FLORES ISLAND, INDONESIA (TELEOSTEI: GOBIIDAE)

James F. McKinney and Ernest A. Lachner

Abstract.—*Callogobius stellatus*, a new species of the fish family Gobiidae, is described from Flores Island, Indonesia. *Callogobius stellatus* is most closely related to *Callogobius mannarensis* Rangarajan which is known only from the Gulf of Mannar, southern India. These two species differ from all other members of the genus in having a reduced sensory pore system consisting only of the nasal, anterior otic and intertemporal pores, a vertebral number of almost always 11 precaudal and 15 caudal vertebrae and a characteristic color pattern consisting of body saddles, a pectoral ocellus, a dark, oblique cheek mark and a large dark, wedge-like mark on the caudal fin. *C. stellatus* differs from *C. mannarensis* mainly in its coloration, such as the dark, oblique cheek bar not extending to opercle and not joining with dark saddle on nape, a large, dark oval-shaped spot on fleshy base of pectoral fin, a distinct saddle on mid-trunk, and a pale to light basi-caudal bar that is not divided mid-laterally by the dark caudal mark. The salient differences in the color patterns between the juveniles and adults of both species are compared. The ontogenetic development of specific color marks is discussed. This new species is known only from Flores Island, Indonesia.

Introduction

In our recent study of some gobiid collections at the Florida State Museum, Gainesville, Florida, we discovered a new species of *Callogobius*, from Flores Island, Indonesia, which is most closely related to *C. mannarensis* Rangarajan (1970). There are more than 30 nominal species of *Callogobius*, some of which are undoubtedly synonyms. The genus is distributed from the northern Red Sea eastward to the Society Islands. Some species are wide ranging but others apparently are restricted to small geographical areas, such as an island, island group, gulfs and bays, or the temperate waters of Japan or southern Australia. Based on our knowledge of the systematics and distribution of the nominal forms, we speculate that *C. stellatus* and *C. mannarensis* are not widespread.

Characters shared by *C. stellatus* and *C. mannarensis* and not found in other species of *Callogobius* are: a reduced sensory pore system with only the nasal, anterior otic and intertemporal pores present; a vertebral number of almost always 11 precaudal and 15 caudal vertebrae; and a characteristic color pattern consisting of saddles on the body, an ocellus on the proximal portion of the pectoral fin, a dark mark covering most of the caudal fin, and a dark oblique bar extending from the eye toward the opercle. A summary of certain characters of the nominal species of *Callogobius* is listed by McKinney and Lachner (1978).

The methods of taking and recording data are given in Lachner and McKinney (1974, 1978). The underscored item of certain characters includes the count obtained for the holotype.

Callogobius stellatus, new species

Figs. 1 and 3

Holotype.—USNM 217429, formerly UF 23762, female, 31.8 mm SL, Indonesia, Flores Island, Lesser Sunda Islands, 5 km west of Nangapanda, stone reef, in tide pools, collected by F. G. Thompson, 3 Aug. 1971, sta. no. FGT 1711.

Paratypes.—UF 23858, female, 31.9 mm SL; male (?), 18.7 mm SL, taken with holotype and bearing same data.

Diagnosis.—Characters differentiating *C. stellatus* from *C. mannarensis* follow: oblique dark bar extending downward and posteriorly from eye does not reach opercle and does not join nape saddle laterally in *C. stellatus*, whereas this bar extends onto the opercle and joins nape saddle laterally in *C. mannarensis*; a large dark oval-shaped mark present on fleshy base of pectoral fin on adults of *C. stellatus* (Fig. 2), absent or reduced to a small dark spot on upper fleshy base of fin in *C. mannarensis*; an intermediate distinct, dark saddle present on trunk between the two large trunk saddles and passing through origin of second dorsal fin in *C. stellatus*, but diffuse, incompletely developed or absent in *C. mannarensis*; anterior margin of dark caudal spot of adult *C. stellatus* is nearly vertical and bordered by pale basi-caudal bar, whereas the anterior margin of caudal spot of *C. mannarensis* is V-shaped and divides or nearly so the pale basi-caudal bar mid-laterally in adults. Some meristic differences between these two species are: pectoral fin rays 17–18, modally 18 in *C. stellatus*, 16–17, modally 16 in *C. mannarensis*; lateral scale rows about 28–31 in *C. stellatus*, about 33–35 in *C. mannarensis*. The body is more slender (Fig. 1) and the pectoral and caudal fins are more elongate (Table 1) in *C. mannarensis* than in *C. stellatus*.

Description.—Dorsal rays VI-I,10(*3*); anal rays I,8(*3*); pectoral rays 17(*2*), 18(*4*); pelvic rays I,5(*3*); segmented caudal rays 17(*3*); branched caudal rays 15(*3*); lateral scale rows 28–31(*1*); transverse scale rows 12–14(*1*); predorsal scales absent.

Scales cycloid, smaller anteriorly than posteriorly on trunk; scales eccentric, focal area narrow; 28–30 primary radii and 2–4 secondary radii in large anterior field, 7–9 short primary radii and 1–3 secondary radii in small, posterior field.

Fig. 1. *Upper*: *Callogobius stellatus*, new species, USNM 217429, holotype, 31.8 mm SL, female, from Flores Island, Indonesia. *Lower*: *Callogobius mannarensis* Rangarajan, USNM 214113, 37.8 mm SL, male, from the Gulf of Mannar, southern India.

Fig. 2. *Callogobius mannarensis* Rangarajan, FMNH 78808, 31.0 mm SL, male, from the Gulf of Mannar, southern India, with a well developed ocellus on the pectoral fin.

Fig. 3. *Upper*: *Callogobius stellatus*, new species, FSM 23858, paratype, 18.7 mm SL, from Flores Island, Indonesia, showing juvenile coloration. *Lower*: *Callogobius mannarensis* Rangarajan, FMNH 78808, 19.0 mm SL, male, from the Gulf of Mannar, southern India, showing juvenile coloration.

Table 1. Proportional measurements, expressed in thousandths of the standard length, of *C. stellatus* with *C. mannarensis.*

	C. stellatus			*C. mannarensis*
Character	Holotype	Paratype	Paratype	Five specimens
Standard Length (mm)	31.8	31.9	18.7	25.0–36.7
Head Length	236	235	278	234(210–248)
Snout Length	66	69	75	60 (52–63)
Bony Interorbital Width	35	38	37	35 (31–39)
Greatest Diameter of Orbit	35	34	37	34 (30–36)
Upper Jaw Length	72	72	75	66 (58–76)
Predorsal Length	333	339	358	336(305–348)
Greatest Depth of Body	145	160	139	131(116–145)
Pectoral Fin Length	305	307	321	347(336–372)
Pelvic Fin Length	236	235	273	231(223–240)
Caudal Fin Length	362	351	385	422(399–453)
Pelvic Fin Insertion to Anal Fin Origin	355	367	364	376(357–403)

Vertebrae 10 + 15(3); pterygiophore formula 3(22110) in 3 specimens (Birdsong, 1975:137).

Measurements for the holotype and two paratypes are given in Table 1 and compared with measurements of *C. mannarensis.*

A moderate-size species of *Callogobius.* Head depressed, trunk slightly compressed. Interorbital wider than diameter of eye; lower jaw protruding, gape oblique, jaw length short, not reaching vertical from anterior margin of eye; anterior and posterior nares arise from single bulbous structure, both nares open at tips of short tubes; tongue rounded anteriorly, its tip free; gill opening restricted to area anterior of pectoral-fin base; first dorsal fin not quite as high as second dorsal fin, first and second dorsal fins distinctly separate; origin of second dorsal fin slightly anterior to vertical from anal opening, posteriormost rays longest; adpressed pectoral fin extends posteriorly to about a vertical from second dorsal fin origin, pectoral fin longer than deep, its posterior margin rounded; pelvic fin moderate in length, extending about two-thirds distance from pelvic fin insertion to anal fin origin; pelvic frenum well developed, inner rays of pelvic fins joined nearly to tips; anal fin almost as high as second dorsal fin, posteriormost anal rays longest; caudal fin longer than head length, its posterior margin rounded. Genital papilla of female short and broad, wider than long, its tip bilobed.

Teeth in both jaws small, pointed, canine-like; two or three irregular rows of teeth anteriorly in each jaw grading to two rows posteriorly; teeth of outer row slightly larger than those of inner row anteriorly but

Table 2. Comparison of the salient differences in color patterns of juvenile and adult *C. stellatus* and *C. mannarensis*.

	C. stellatus		*C. mannarensis*	
Character	Adult	Juvenile	Adult	Juvenile
Cheek bar.	Oblique, extends to about angle of preopercle, not joining with nape saddle.	As in adults.	Horizontal or nearly so, extends to opercle and joins nape saddle.	As in adult.
Dark mark on fleshy pectoral-fin base.	Large, deep, oval.	Present on central portion.	Reduced to small spot on upper portion, or absent.	Usually absent.
Pectoral fin coloration.	Distinct ocellus.	Distinct ocellus.	Ocellus with or without supplementary dark marks.	Distinct ocellus.
Dark saddle at origin of second dorsal fin.	Conspicuous, narrow, extends to mid-body.	Conspicuous, but reduced and not extending to mid-body.	Absent, or elongate, diffuse dusky mark on mid-trunk and through anterior second dorsal fin, and separated by narrow pale area from similar dark mark dorso-laterally on trunk.	Faint marks, greatly reduced or absent.

Table 2. Continued.

	C. stellatus		*C. mannarensis*	
Character	Adult	Juvenile	Adult	Juvenile
Dark saddle through posterior second dorsal fin.	Oblique, broad, well developed; extends to mid-body or lower caudal peduncle.	Nearly vertical, broad, extends to lower caudal peduncle.	As in adult *C. stellatus.*	As in adult *C. stellatus.*
Caudal fin pigmentation.	Anterior border of large dark mark nearly vertical. Pale basi-caudal bar borders anterior margin of dark mark.	Anterior border of large dark mark crescent-shaped. Pale basi-caudal bar larger than on adult.	Anterior border of large dark mark wedge-shaped, dividing or nearly so the pale basi-caudal area mid-laterally.	Same as juvenile *C. stellatus* but angle of anterior border more acute.

teeth of inner row slightly larger posteriorly; no vomerine or palatine teeth.

The number, size, shape, and distribution of papillose ridges on the head and trunk of *C. stellatus* are identical to those depicted by McKinney and Lachner (1978) for *C. hastatus*.

The cephalic sensory pore system consists of the following bilaterally paired pores: nasals, anterior otics and intertemporals.

Color in preservation.—The salient color pattern of adult *C. stellatus* is shown in Fig. 1 and compared with that of *C. mannarensis*. Juvenile coloration of *C. stellatus* is depicted in Fig. 3.

Four, dark, narrow stripes radiating from eye, one from anterior margin of eye to rictus of jaw, another from posterior margin of eye to transverse papillose ridge behind eye, a third connecting eyes across interorbital region and widened at its central portion, and a fourth, a cheek bar, extending downward and posteriorly from eye to about angle of preopercle. A broad, dark saddle across nape, its posterior margin touching a transverse line connecting upper pectoral fin insertions, and extending laterally to lower opercle. A broad, dark, vertical saddle extending through most of first dorsal fin and descending on trunk to belly.

The salient differences in the color patterns between *C. stellatus* and *C. mannarensis* and between the juveniles and adults are given in Table 2.

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PROC. BIOL. SOC. WASH.
91(3), 1978, pp. 724–730

A NEW SPECIES OF THE GENUS *SPHAEROMICOLA* (OSTRACODA: ENTOCYTHERIDAE: SPHAEROMICOLINAE) FROM TEXAS, WITH NOTES ON RELATIONSHIPS BETWEEN EUROPEAN AND NORTH AMERICAN SPECIES

C. W. Hart, Jr.

Abstract.—A new entocytherid ostracod species, *Sphaeromicola moria*, is described from Rambies Cave, Uvalde County, Texas. This ostracod, commensal on the isopod *Cirolanides texensis* Benedict, is the first member of the subfamily Sphaeromicolinae described from the United States. Danielopol's recently proposed division of the genus *Sphaeromicola* into two groups, typified by *S. cirolanae* in North America and *S. topsenti* in Europe, is discussed in light of two North American species unknown to Danielopol at the time of his writing.

Representatives of the entocytherid ostracod genus *Sphaeromicola* have been described from freshwater habitats in France, Italy, Yugoslavia, and Mexico. Hosts to these commensal organisms are isopods of the families Sphaeromatidae and Cirolanidae in Europe; isopods of the family Cirolanidae in North America.

The species described below (from Uvalde County, Texas) is the first *Sphaeromicola* known from the United States. Two others (*Sphaeromicola cirolanae* Rioja, 1951, and *Sphaeromicola coahuiltecae* Hobbs and Hobbs, 1973) are known from the Western Hemisphere, and are represented by specimens from 18 localities in the Mexican states of Nuevo Leon, San Luis Potosi, and Tamaulipas.

Figure 1 shows the Mexican and United States ranges of *S. cirolanae*, *S. coahuiltecae*, and *S. moria*, new species. Detailed locality data for the previously described species were given by Hobbs and Hobbs (1973) and by Hart and Hart (1974). They are not repeated here.

Sphaeromicola moria, new species
Figs. 2–7

Male.—Eye absent; no pigment spot. Shell (Fig. 2) of single available specimen elongate oval with ventral margin weakly concave in anterior one-third; 0.26 mm in length, 0.13 mm in height, greatest height near midlength. Submarginal setae present on posteroventral margin, absent elsewhere.

Copulatory complex (Fig. 4) with peniferum truncate, subtriangular in lateral aspect, and posteroventral part apparently bilobed. Spermatic duct terminating in poorly developed penis situated at base of, and between posteroventral peniferal lobes. Clasping apparatus C-shaped, tapering dis-

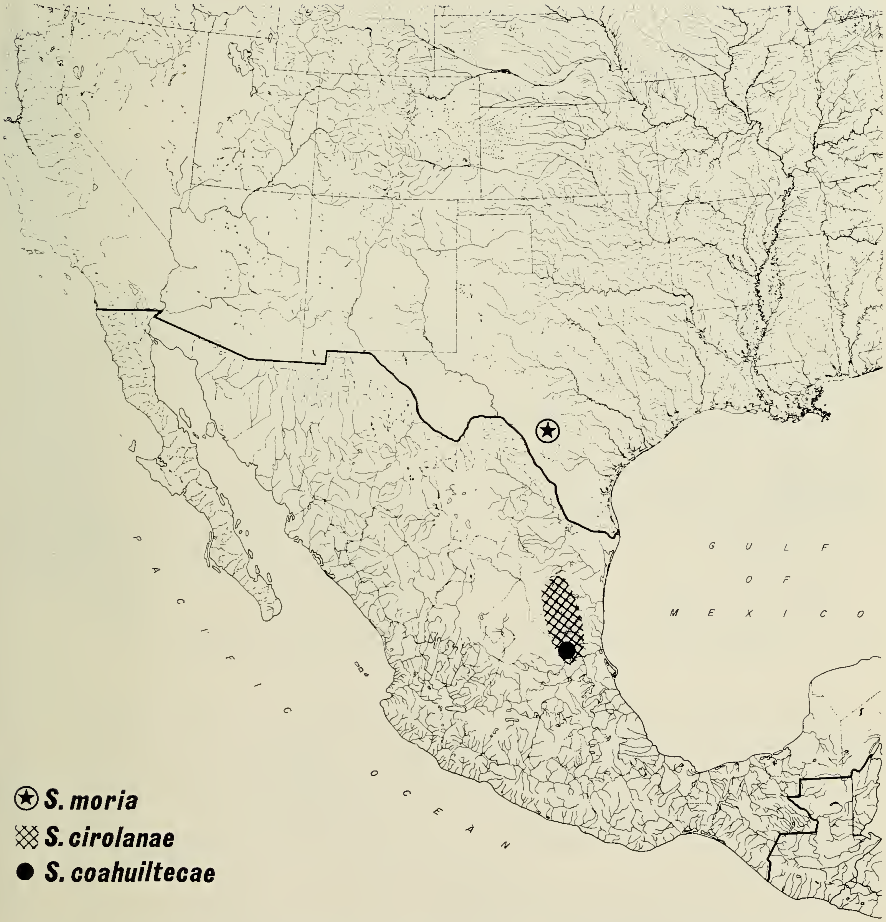


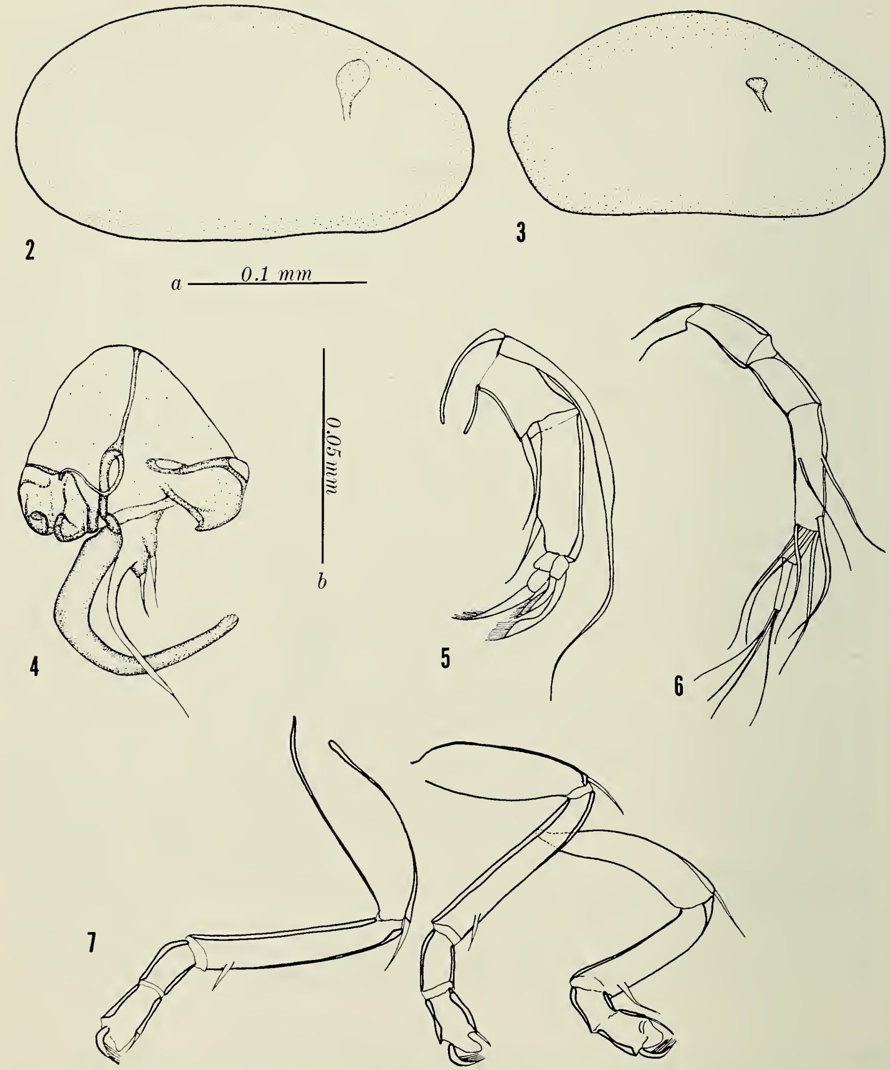
Fig. 1. Distributions of *Sphaeromicola cirolanae*, *S. coahuiltecae*, and *S. moria*.

tally, and terminating in 5 denticles; margins entire. Dorsal finger bifid and slender, ventral finger (flagellum) gently curved in proximal half and extending beyond ventral margin of clasping apparatus.

Antennule (Fig. 6) with segments 4 and 5 fused, segment 5 bearing 5 terminal setae. Segments 3 and 4 of antennal endopodite fused (Fig. 5).

Female.—Eye, as in male, absent (no pigment spot). Shell of single specimen (Fig. 3) similar to that of male, but slightly more vaulted at midlength and with posterior margin not evenly rounded; 0.21 mm in length, 0.12 mm in height. Submarginal setae lacking.

The male and female specimens described above were taken from the same isopod collection, but were not found copulating. Hence there is



Figs. 2–7. S. *moria*: 2, Right valve of male holotype (because of absence of eye spot, the antennal gland is depicted for purposes of orientation); 3, Right valve of female allotype; 4, Copulatory complex; 5, Antenna; 6, Antennule; 7, Thoracic legs.

a possibility that the female does not belong to the same species as the male. Because of the absence of other male ostracods in the collection, however, it was assumed that the two are members of the same species.

Type-locality and host.—Rambies Cave, 2 miles north of Uvalde, Uvalde

County, Texas, the only known locality for the species. The specimens on which the above description is based were found by Thomas E. Bowman on isopods collected by Dale Pate and Charles Yates, 4–5 September 1976, and which were donated to the Smithsonian Institution by James Reddell. The host isopod is *Cirolanides texensis* Benedict (Accession No. 325058).

Disposition and types.—The holotypic male and presumptive allotypic female are deposited in the National Museum of Natural History, Smithsonian Institution, USNM catalog numbers 170898 and 170899, respectively.

Relationships.—*Sphaeromicola moria* has its closest affinities with the Mexican *S. cirolanae*, but only the males of the two can be readily distinguished from one another. In *S. cirolanae* a distinct tooth is present on the internal border of the clasping apparatus, and the penis is developed as a distinct structural entity. In *S. moria*, no tooth is present on the internal margin of the clasping apparatus and the penis is poorly developed.

Name.—From the Elvish word *Moria* (the Black-pit), a name for the vast underground city of the Dwarves (See J. R. R. Tolkein's *The Lord of the Rings*). Used here because this ostracod, as well as most other members of its genus, are known only from cave habitats.

Key to the Subfamilies of Entocytheridae

(From Hart and Hart, 1974)

1	Dorsal claw of antenna without setae on flexor surface (commensal on crayfishes and phreatoicoid isopods)	Notocytherinae
1′	Dorsal claw of antenna with setae on flexor surface	2
2(1′)	Maxilla with respiratory plate and well developed masticatory lobes; penis usually strongly curved (commensal on crayfishes and a species of freshwater crab)	Entocytherinae
2′	Maxilla without respiratory plate or masticatory lobes (occasionally vestigial); penis straight or only slightly curved	3
3(2′)	Antennule consisting of five podomeres; distal flexor margin of ultimate podomeres of legs with brush of setae on finger-like projection opposing terminal claw (commensal on wood-boring isopods)	Microsyssitrinae
3′	Antennule consisting of six or seven podomeres; distal flexor margin of ultimate podomeres of legs lacking setiferous finger-like projection opposing terminal claw	4
4(3′)	Clasping apparatus with terminal denticles (commensal on freshwater isopods)	Sphaeromicolinae
4′	Clasping apparatus without terminal denticles (commensal on marine amphipods)	Hartiellinae

Key to the North American Species of *Sphaeromicola*

1 Clasping apparatus with distinct tooth on internal border of horizontal ramus *Sphaeromicola cirolanae*
1′ Clasping apparatus with no tooth on internal border of horizontal ramus 2
2 Horizontal ramus of clasping apparatus sinuous *Sphaeromicola coahuiltecae*
2′ Horizontal ramus of clasping apparatus not sinuous, but curving gently dorsally *Sphaeromicola moria*

Differences Between the European and North American Members of the Genus *Sphaeromicola*

Danielopol (1977) recently described a new subspecies of *Sphaeromicola* (*S. cebennica juberthiei*) from southern France, reviewed the world distribution of the family Entocytheridae, and discussed the affinities of and differences between the European and North American (Mexican) members of the genus *Sphaeromicola*.

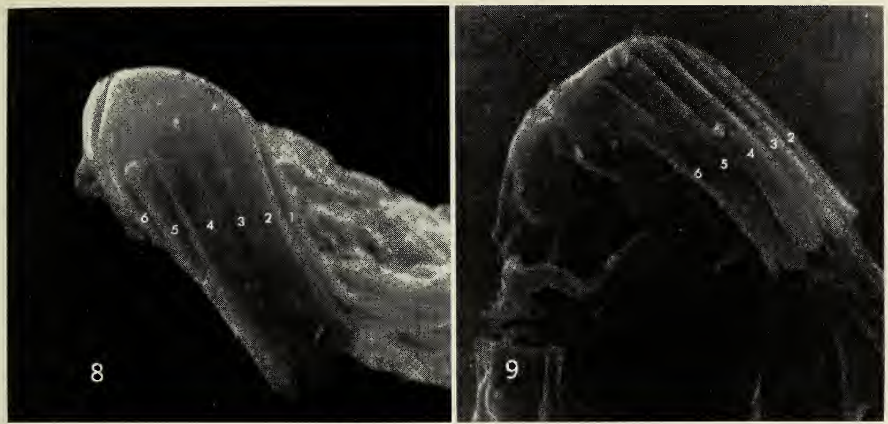
Based on the one North American species known to him at the time (*S. cirolanae*), he proposed that the genus *Sphaeromicola* be divided into two groups: the *cirolanae* group in North America and the *topsenti* group in Europe. He based the division on the following criteria:

	cirolanae group	*topsenti group*
1.	Segments 4 and 5 of antennule fused; segment 5 bearing 5 terminal setae.	Segments 4 and 5 of antennule not fused; segment 5 bearing 4 terminal setae.
2.	Segments 2 and 3 of antennal endopodite fused.[1]	Segments 2 and 3 of antennal endopodite not fused.[1]
3.	Terminal claws of thoracic legs bearing 4 teeth.	Terminal claws of thoracic legs bearing 5–8 teeth.

Criteria 1 and 2 appear to hold for *S. coahuiltecae* and *S. moria* as well as for *S. cirolanae*. However, the third criterion (number of teeth on terminal claws of thoracic legs) does not appear to be valid.

Danielopol states that the terminal thoracic leg claws of *S. cirolanae* bear 4 teeth; those of the European *topsenti* group, 5–8 teeth. My observations, however, indicate that the three North American *Sphaeromicola* species all possess six teeth on the terminal claws of the thoracic legs.

It should be recognized that, because of their small size ($< 1\ \mu$ wide; $< 0.5\ \mu$ thick) and usual clustered orientation on slides prepared for examination by conventional light transmission microscopy, the claws are extremely difficult to resolve. Examination by standard light transmission and phase



Figs. 8 and 9. Ventral SEM views of thoracic leg terminal claws of S. *cirolanae*, showing presence of 6 teeth. Tooth 6 is obscured by tooth 5 (identified by artifact at base) in Fig. 8, but is readily identifiable in Fig. 9 (in which tooth 1 is obscured). Specimens used in making these photographs were collected from Grutas de Quintero, 13 km SW of Mante, Tamaulipas, Mexico, 5 January 1970, by S. Wiley and J. Cooke (USNM Accession No. 308026).

contrast microscopes yield equivocal results, but the claws can be accurately counted by using a microscope equipped with Nomarski differential interference contrast (DIC) condensers.

Slide mounted specimens of S. *cirolanae*, S. *coahuiltecae*, and S. *moria* were examined with Nomarski DIC equipment, and six teeth were found on the terminal thoracic leg claws of each.

Enough specimens of S. *cirolanae* were available to prepare a number of them for examination by scanning electron microscopy (SEM). The resulting photographs (Figs. 8 and 9) clearly show the presence of six claw teeth, and also illustrate why the teeth are so difficult to count by conventional microscopy.

Even with the SEM, the entire complement of teeth can only be seen by tilting the specimen so that the claw can be seen from different angles. Thus, Fig. 8 is a ventral view of the terminal claw of a leg with the mesial face to the right; Fig. 9 is the same claw from a different angle, showing a sixth tooth tucked slightly under the others on the external face. The artifact at the base of the fifth tooth serves as a reference point by which to count the teeth.

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National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.

Footnote

[1] It should be noted that Danielopol's interpretation of the numbers of segments in the antenna differs from the interpretations of other workers. It is thought by others that Danielopol's 1st antennal segment (Danielopol 1977: fig. 10B) is actually the 2nd antennal segment, the 1st (basal) segment being devoid of setae but bearing an exopodite, or "flagellum," on its distal extensor margin that extends for a distance subequal to the remainder of the antenna (Hart, Nair, and Hart, 1967; Rioja, 1951: Plate 1, fig. 4). According to this interpretation, Danielopol's segments 2 and 3 should be considered segments 3 and 4.

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FIVE NEW SPECIES OF HALFBEAKS (HEMIRAMPHIDAE) FROM THE INDO-WEST PACIFIC

Bruce B. Collette and N. V. Parin

Abstract.—*Hemiramphus marginatus* (Forsskal) is confined to the Red Sea and Persian Gulf. The species that has been confused with it in the Indian Ocean and western Pacific Ocean is described as *Hemiramphus archipelagicus* n. sp. It differs from *He. marginatus* in having the lower jaw longer than the head instead of vice versa. It is similar to the Atlantic *He. brasiliensis* (Linnaeus) but has fewer gill rakers and anal fin rays. Four new species are described in *Hyporhamphus*, three in the subgenus *Hyporhamphus* and one in the subgenus *Reporhamphus*. *Hy.* (*R.*) *yuri* n. sp. is restricted to Okinawa. It resembles *Hy. dussumieri* (Valenciennes) and *Hy. affinis* (Günther) but has more vertebrae and a longer preorbital distance. *Hy.* (*Hy.*) *melanopterus* n. sp. is the halfbeak with prominent black spots in the dorsal fin and upper and lower caudal lobes that has been misidentified as *Hy. melanurus* (Valenciennes) which is a synonym of *Hy. quoyi* (Valenciennes). *Hy.* (*Hy.*) *paucirastris* n. sp. from the South China Sea differs from other Indo-Pacific species of the subgenus in the low number of gill rakers on the first arch (19–21) and high number of vertebrae (54–55). *Hy.* (*Hy.*) *unicuspis* n. sp. from India and the Andaman Sea resembles *Hy. knysnaensis* (Smith) from South Africa and *Hy. sindensis* (Regan) from the Persian Gulf and Arabian Sea in several characters. It is similar to *Hy. knysnaensis* in having unicuspid teeth but differs in having the pelvic fins located more anteriorly.

While preparing a review of the tropical marine halfbeaks of the Indo-West Pacific, we have discovered several species that are undescribed or that lack available names. We present here the formal descriptions of new taxa in advance of the review. The genus-group name *Reporhamphus* Whitley is used for a subgenus of *Hyporhamphus* containing those species with a posterior branch to the preorbital canal (see Collette, 1974: fig. 2) and a deeply forked caudal fin. The subgenus *Hyporhamphus* is restricted to those species that lack a posterior branch to the preorbital canal (see Collette, 1974: fig. 1) and have an emarginate caudal fin. Methodology is similar to that in previous papers that we have published on the Hemiramphidae (e.g., Collette, 1974, 1976; Parin and Shcherbachev, 1972). Material examined is in the following collections: AMS—Australian Museum, Sydney; ANSP—Academy of Natural Sciences, Philadelphia; BMNH—British Museum (Natural History), London; CAS—California Academy of Sciences, San Francisco; DASF—Department of Agriculture, Stock, and

Fisheries, Port Moresby, Papua–New Guinea; FMNH—Field Museum of Natural History, Chicago; IO—P. P. Shirshov Institute of Oceanology, Moscow; KUB—Kasetsart University, Bangkok; MCZ—Museum of Comparative Zoology, Harvard University, Cambridge, Mass.; MNHN—Museum National d'Histoire Naturelle, Paris; NHMV—Naturhistorisches Museum, Vienna; NMC—National Museum, Vienna; NMC—National Museum of Canada, Ottawa; RMNH—Rijksmuseum van Natuurlijke Historie, Leiden; SU—Stanford University (specimens now at CAS); UMMZ—University of Michigan Museum of Zoology, Ann Arbor; USNM—National Museum of Natural History, Washington, D.C.; ZMA—Zoological Museum, Amsterdam; ZIN—Zoological Institute, Leningrad; ZMUC—Zoological Museum, University of Copenhagen; ZSI—Zoological Survey of India, Calcutta.

Hemiramphus archipelagicus, new species

Fig. 1a

Hemirhamphus marginatus not of Forsskal. Bleeker, 1886:148–150 (in part; description, Batavia). Günther, 1866:270 (in part; description, BMNH 1866.5.2.15 from Bleeker's collection). Bleeker, 1871:54–55 (in part; description, Batavia, color plate 254, fig. 4). Weber and de Beaufort, 1922:157–159 (in part; description, Batavia).

Hemiramphus marginatus not of Forsskal. Fowler, 1927:263 (Orani, Bataan, Philippine Islands, ANSP 55967–70). Fowler, 1935:130 (Bangkok and Paknam, Thailand, ANSP 61618–24). Herre, 1944:15 (only SU 33938 from Pinang, Malaya).

Diagnosis.—*Hemiramphus achipelagicus* is a member of the group of species in the genus with short pectoral fins (pectoral fin, when extended forward, not reaching beyond the nasal fossa). It differs from *He. far* (Forsskal) and *He. robustus* Günther in the absence (in adults) of bars or spots on the body, the absence of an anterior lobe of the dorsal fin, and the presence of pigment along the entire margin of the dorsal fin. The banded juveniles of *H. archipelagicus* have a shorter head than do equal-sized *He. far*. *He. archipelagicus* differs from the allopatric *He. marginatus* in having the lower jaw longer than the head instead of vice versa. *He. archipelagicus* is similar to *He. brasiliensis* (Linnaeus) from the Atlantic in many respects (see Collette, 1962, 1965) but has fewer anal fin rays (11 or 12 instead of 13 or 14) and averages slightly fewer gill rakers on both the first and second arches.

Brief description (based on specimens 147–220 mm long).—Head 4.1–4.5 times in SL, proportionally increasing with age. Lower jaw 3.1–3.4 times in SL and 0.7–0.8 times in head length. Interorbital distance slightly greater than diameter of eye. Gill rakers on first arch (6–8) + (19–24) = 25–32, on second arch (4–6) + (15–21) = 20–25. Teeth small, distributed in 3–4

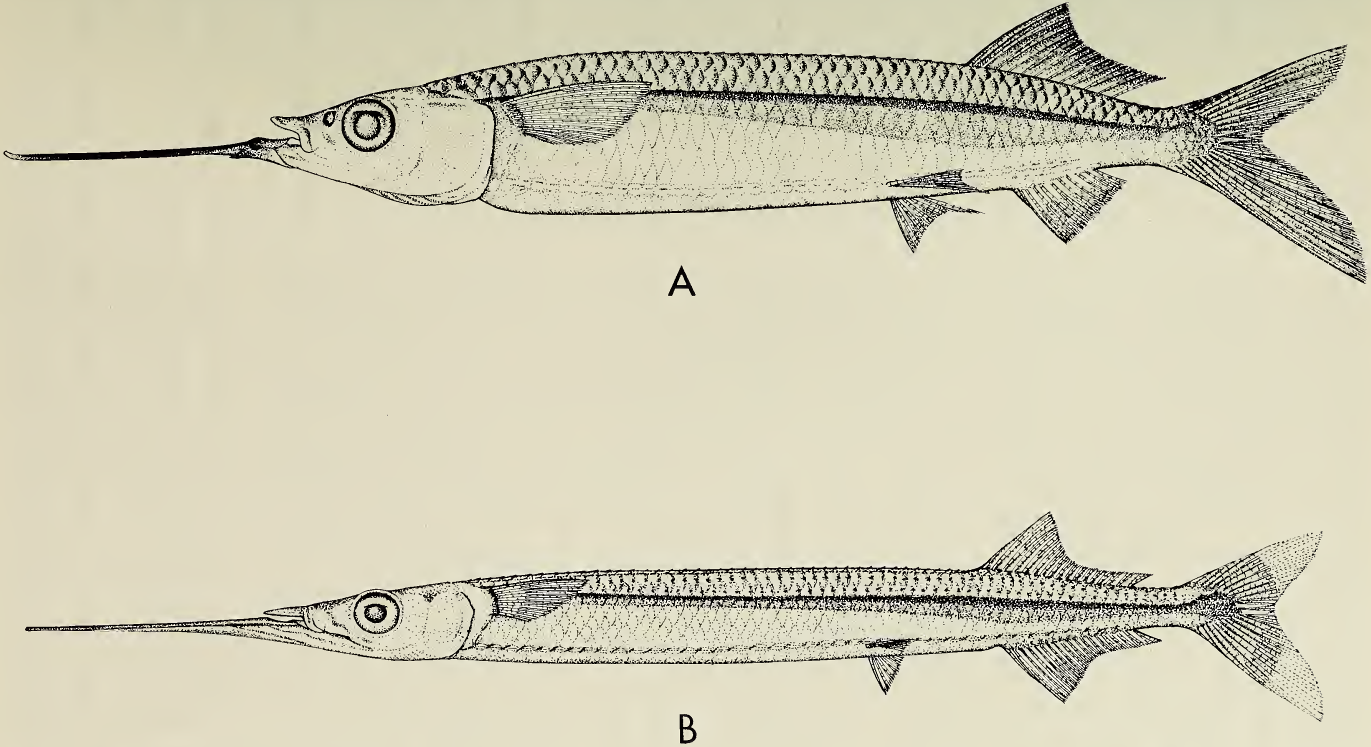


Fig. 1A. *Hemiramphus archipelagicus* n. sp. Collette and Parin, holotype, USNM 218371, mature male, 190 mm SL; 8°21′N, 104°38′E; Dodo sta. 264; 10 Nov. 1965; T. Matsui. 1B. *Hyporhamphus* (*Reporhamphus*) *yuri* n. sp. Collette and Parin, holotype, USNM 218481, 168 mm SL; Okinawa, Naha market; 1906; J. O. Snyder.

rows on both jaws. Greatest body width 1.8–2.0 times in its depth. Vertebrae (34–37) + (16–17) = 50–54, usually 52–54. Predorsal scales 32–34, usually 34–36.

D 11–15, usually 13 or 14; A 10–13, usually 11 or 12. D-A = –1 to 3, usually 1 or 2. Dorsal fin without well-developed anterior lobe. Anal fin originates under 4–5th ray of dorsal, its base contained 1.55–1.8 times in the base of the dorsal. Anterior rays of dorsal (to 2–3rd ray) and anal (to 2–4th ray) fins covered with scales. P_1 11–12(13). Length of pectoral fins 5.8–6.8 times in SL, not exceeding distance between origin of fin and posterior margin (rarely middle) of nasal fossa. Pelvic fins located significantly closer to origin of lower lobe of caudal fin than to origin of pectoral fin (P_1–P_2/P_2–C 1.35–1.55). Length of pelvic fins 9.0–10.5 times in SL.

Dark stripe present along the sides of the body, widening under dorsal fin. No spots present on sides of body. Dorsal fin pigmented only on its edge but inner parts of membranes transparent. Caudal fin gray, darker along the edges; anal, pectoral and pelvic fins transparent (in a specimen 148 mm SL, pigmentation present on posterior part of anal fin and inner part of pelvic fin).

Description of juveniles (based on 27 juvenile He. archipelagicus *24–115 mm long).*—Head length contained 4.0–4.3 times in SL; pelvic fins reach or almost reach origin of anal, their length contained 6.3–7.4 times in SL; length of pectoral fins not exceeding distance between their origin and anterior margin of nasal fossa (usually less than this distance); posterior rays of dorsal fin extend to origin of upper lobe of caudal fin or almost reach it; width of body contained 1.55–2.0 times in SL; interorbital distance less than diameter of eye or equal to it.

On the sides of the body are 3–10 more or less well developed transverse bands (in specimens 115 mm SL almost not visible), almost always extending onto belly. Pigmentation present in preorbital region and behind eyes. Dorsal fin in small juveniles competely pigmented, particularly dense in posterior part, at more than 70 mm SL colored, as in adults, only on the margin; anal fin at 30–70 mm SL completely pigmented, at larger sizes pigment retained only on posterior parts; pectoral fin transparent; pelvic densely pigmented at less than 65 mm SL, at larger sizes beginning to clear along inner edge; caudal fin with dark bases, 2–4 bands on lower lobe and 1–2 bands on upper.

Size.—Females are mature by 194 mm SL, males by 168 mm (USNM 218372, Gulf of Thailand). Maximum length (227 mm) registered in a specimen collected at Manado, Celebes Is. (BMNH 1871.6.18.7).

Distribution.—The range of *He. archipelagicus* extends from the western part of the Indian Ocean to the western islands of Polynesia but most records are concentrated in the Indo-Australian Archipelago and the Gulf of Thailand. *He. archipelagicus* adults usually are found near coasts but juveniles may be found further offshore associated with floating plants. Most of the records of *He. marginatus* from the Indian Ocean and western Pacific in the literature that we have been able to check apply to the long pectoral-finned species *He. lutkei* Valenciennes, a valid species that has been improperly synonymized with *He. marginatus.* All that we have examined (85 specimens at SU, FMNH, UMMZ, BMNH) of the material reported by Herre (1944 and 1953) from the Philippines as *He. marginatus* is *He. lutkei.* Fowler's 1927 report of *He. marginatus* from Bataan is the only published verifiable record of *He. archipelagicus* from the Philippines. Most records of *He. marginatus* from farther east in the Pacific islands, for example the Gilbert Islands (Whitley and Colefax, 1938, AMS IA.6994) and the Marianas Islands (Woods and Schultz, 1953, USNM 123395, 132848), should be attributed to *He. lutkei.*

Remarks.—This species has frequently been reported in the literature as *He. marginatus* (Forsskal) but that species has a short lower jaw and is confined to the Red Sea and Persian Gulf.

Etymology.—The name *archipelagicus* (from the Latin *arcus*, arch and *pelagicus*, pelagic) is selected in reference to the center of distribution of the species around the islands of the Indo-Australian Archipelago.

Holotype.—USNM 218371; 8°21′N, 104°38′E; Dodo sta. 264; 10 Nov. 1965; T. Matsui et al., mature male; 190 mm SL; D 13, A 11, P_1 12; RGR_1 $6 + 21 = 27$, RGR_2 $4 + 16 = 20$; predorsal scales 36; vertebrae $37 + 15 = 52$; head length 44.2 mm; lower jaw length 54.1 mm; pectoral fin length 30.1 mm; pectoral fin length projected forward falls on anterior margin of orbit.

Paratypes.—103 specimens from the Gulf of Thailand, Vietnam, and East Indies.

Gulf of Thailand. Bangkok uncat. (10, 143–202); Thailand, Khan Prov., Prachaubkiri; 14 Dec. 1965. ZSI F 1224/2 (2, 190–220); Thailand, Kilingimedu, 3.5 mi N Karaikkal; A. G. K. Menon; 9 Feb. 1957. UMMZ 181212 (1, 150); Cambodia, Kas Kong Prov., Kas Kapik; J. Bardach; 6 March 1959. CAS GVF 2398 (1, 181); 7°22′00″N, 100°43′30″E; 9 Aug. 1960. CAS uncat. (1, 155); Thailand sta. 60–464, SIO 61–156, CN 855A, Cruise S-10; M/V Stranger; 12 Feb. 1961. ANSP 61624 (1, 165); Paknam; R. M. de Schauensee; 28 Aug. 1934. ANSP 6618–23 (6, 155–183); Bangkok; R. M. de Schauensee; May 1934. CAS 38631 (1, 167); off Songkhla; 7°15′30″N, 100°36′15″E; M/V Stranger; GVF Reg. 2020; 20 Jan. 1960; R. Bolin. CAS 38632 (4, 183–212); Chumphon Prov., off Langsuan; GVF Reg. 2594; 19 May 1961.

Vietnam. ZMUC P-341250–51 (2, 181–183); 9°59′N, 107°23′E; Dana sta. 3692.

East Indies, 74 specimens (24.2–227 mm SL) from 35 collections. MCZ 704 (1, 177); East Indies; Putnam. NMC 63–290 (1, 181); Singapore market; C. C. Lindsey; Dec. 1962–April 1963. NMC 63–287 (2, 162–186); Malaysia, Johore, Maar market; C. C. Lindsey; Feb.–March 1963. ZMUC uncat. (1, 181); Batavia market; T. Mortenson; Sept. 1922. ZMUC 142 (1, 170); Penang; Galathea 141. BMNH 1866.5.2.15 (1, 172); East Indies; Bleeker purchase. BMNH 1871.6.18.7 (1, 227); Celebes, Manado; Meyer. ZMA 114.585 (1, 173); Sumatra, Deli; DeBassy. ZMA 114.586 (1, 155); Reede van Pekalongan; Buitendijk; Oct. 1912. ZMA 114.587 (1, 173); Suribaya, Westgut; K. Haasnoot; 1912. ZMA 114.588 (1, 95.3); Baai van Batavia; Buitendijk; Dec. 1910. ZMA 114.589 (2, 100–169); Ind. Arch.; Bleeker. RMNH 4729 (1, 178); Batavia; Bleeker; 1852–60. RMNH 12191 (2, 141–148); East Indies; Bleeker. RMNH 12190 (7, 168–207); Batavia; Bleeker. NHMV 15893 (1, 187); Batavia; Pietschman; Aug. 1929. RMNH 12188 (1, 173); Java Sea; Buitendijk; Oct. 1910. RMNH 12185 (2, 173–189); Java Sea; Buitendijk; May 1907. RMNH 12182 (3, 157–166); Java Sea; Buitendijk. RMNH 12184 (4, 106–160); Java Sea; Buitendijk; 3 Feb. 1915. RMNH 12186 (2, 96.0–142); Java Sea; Buitendijk. RMNH 12187 (2, 84.1–102); Java Sea; Buitendijk; Aug. 1905. RMNH 12183 (1, 180); Baai van Batavia; Jan. 1916. RMNH 12181 (6, 144–175); Reede van Samarang; Buitendijk; 1912. FMNH 15805–6 (2, 118–129); Java, Batavia; Chancellor-Stuart-Field Mus. Exped.; 1929. RMNH 12180 (2, 55.9–84.5); Java, Reede van Samarang; Buitendijk; Nov. 1915. ZMUC uncat. (3, 40.7–62.5); 4°30′N, 103°28′E; Galathea 373; 6–7 June 1951. ZMA 114.602 (4, 28.9–50.6); Java, Reede van Samarang; Buitendijk; 1902. ZMA 114.601 (5, 24.2–45.8); Java, Reede van Samarang; Buitendijk; Jan. 1914. ZMA 114.600 (1, 39.2); E. Java, Reede van Panarukan; Buitendijk; 2 Aug. 1911. ZMUC P-341743 (1, 56.6); NE of Singapore; 1°46′N, 104°25′E; Galathea 399; 21 June 1951. IO uncat. (1, 200); Djarkarta; Vityaz unnumbered sta. IO uncat. (1, 152); Singapore. IO uncat. (1, 81); Suribaya; Nora unnumbered sta. IO uncat. (6, 57–95); NE of Singapore; 1°58′N, 105°53′E; Vityaz sta. 6487; 13 June 1971. IO uncat. (1, 103); Banda Sea; 5°45′S, 131°30′E; Vityaz sta. 6782; April 1973.

Other material.—Specimens (29, 33–220) from the extremes of the range (Indian Ocean, New Guinea, the Philippine Islands and Polynesia) are not designated paratypes.

Indian Ocean. Phuket 1028–30 (2, 189–202); India, off Cochin; 1 Sept. 1972. Biol. Ans. Helgoland IOES 69 (2, 98.9–105); 10 n. mi W of Goa; Meteor sta. 193; 15 Feb. 1964. ZMUC uncat. (1, 140); S. Malacca; M. Jensen; 9 Oct. 1901. ZIN uncat. (8, 65–220); Bay of Bengal; 20°55′N, 88°02′E; Ob sta. 329; 14 May 1957.

New Guinea. USNM 212041 (1, 158); W. Irian, McCluer Gulf; 1°31.1′S, 130°34′E; J. E. McCosker 72–4; 17 Dec. 1972. DASF uncat. (2, 33–35); Sek Harbor. IO uncat. (2, 83–97); Port Moresby; Dmitry Mendeleev unnumbered sta.; 18 Jan. 1977. IO uncat. (1, 79); Admirality Is., St. Andrew; Dmitry Mendeleev unnumbered sta.; 31 Jan. 1977. IO uncat. (1, 74); Astrolabe Bay; 5°22′S, 146°20′E; Dmitry Mendeleev unnumbered sta.; 13 Feb. 1977.

Philippine Is. ANSP 55967–70 (4, 144–161); Luzon, Bataan Province, Orani; J. Clemens; 28 April 1923. ZIN 4819 (2, 205–206); Philippine Is.

Polynesia. IO uncat. (2, 111–115); Samoa, Apia; Vityaz unnumbered sta. IO uncat. (1, 54); Tonga Is., Nukualofa; Dmitry Mendeleev unnumbered sta.; 10 March 1977.

Hyporhamphus (*Reporhamphus*) *yuri*, new species
Fig. 1b

Hemiramphus sp. Snyder, 1913:494 (badly damaged specimens from Naha market may be *H. pacificus*).

Diagnosis.—*Hy. yuri* resembles *Hy. dussumieri* (Valenciennes) and *Hy. affinis* (Günther) in general appearance and in the shape of the preorbital canal but differs from these species in having more vertebrae (59–61 vs. 53–59) and predorsal scales (43–46 vs. 37–43), a longer upper jaw (upper jaw width in length 0.87–0.96 vs. 0.6–0.85), and a greater preorbital distance (contained 1.09–1.17 times in orbit length vs. 1.35–1.65 times in *Hy. affinis* and 1.7–2.15 times in *Hy. dussumieri*). *Hy. yuri* has about the same number of gill rakers (RGR_1 36–42, RGR_2 25–30) as *Hy. dussumieri* (35–44, 27–33), and more than *Hy. affinis* (28–38, 20–28). *Hy. yuri* averages higher dorsal and anal fin ray counts than *Hy. affinis* and *Hy. dussumieri* but there is extensive overlap. The high vertebral count in *Hy. yuri* is comparable to the Australian *Hy. melanochir* (Valenciennes) which has a range of 55–61. In upper jaw length, *Hy. yuri* overlaps *Hy. acutus* (Günther) and the three temperate species from Australia and New Zealand—*Hy. australis* (Steindachner), *Hy. melanochir*, and *Hy. ihi* Phillipps, which have a range of 0.8–1.1. In preorbital distance, *Hy. yuri* is closest to *Hy. balinensis* (Bleeker) which also has the preorbital distance contained 1.0–1.2 times in the orbit diameter.

Brief description.—Head 4.35–4.64 times in SL. Lower jaw longer than head length, 3.7–3.8 times in SL and 0.83–0.88 times in head length (but only 2 of 9 specimens had unbroken beaks). Triangular upper jaw projection pointed, its width slightly greater than its length, contained 0.87–0.99 times in its length. Preorbital distance shorter than diameter of orbit, contained 1.09–1.17 times in orbit diameter. Preorbital distance longer than upper jaw length, contained 0.83–0.95 times in upper jaw length. Gill rakers on first arch (9–12) + (26–30) = 36–42, on second arch (4–5) + (20–25) = 25–30. Teeth in both jaws unicuspid and moderately long, a few tricuspid teeth near angle of jaws; teeth in 2 rows anteriorly, 3–4 rows posteriorly. Preorbital canal wide, greatly expanded at ventral pore; posterior branch forming an obtuse angle with anterior branch; large pore present on anterior part of canal, slightly above junction of dorsal and ventral branches. Greatest body depth 9.6–11.8 times in SL, width of body 1.0–1.4 times in its depth. Vertebrae (39–41) + (19–20) = 59–61. Predorsal scales 43–46.

D 16 or 17, A 17–18, rarely 19; D–A = –1 or –2. Anal fin originates under rays 3–4 of dorsal fin, its base contained 1.06–1.23 times in base of dorsal fin. No scales present on fins of type series but may be present in specimens in better condition. P_1 11 or 12. Pectoral fin length 8.4–9.3 times in SL. Pelvic fins located closer to caudal base than to pectoral fin origin (P_1–P_2/P_2–C = 1.08–1.17), P_2–C distance projected forward falls on anterior or middle third of adpressed pectoral fin. Length of pelvic fins 1.7–1.8 times in SL.

A dark stripe along sides of body, widening under dorsal fin. A few scattered melanophores along distal portions of dorsal rays 2–4 or 5; other fins mostly unpigmented. Trace of pigment outlining lateral line scales, probably more prominent in fresh material.

Size.—Maximum known size 171 mm SL but probably grows larger.

Distribution.—This species is known only from the type-locality in Okinawa.

Remarks.—The nine type-specimens of *Hy. yuri* plus four specimens of *Hy. dussumieri* (now USNM 218480) were found labelled as *Hemiramphus pacificus* in the USNM collections (see Snyder, 1913:494). Schmidt's 1930 report of *Hy. dussumieri* has been verified (ZIN 23201) but Jordan and Starks' 1907 report could refer to either *Hy. dussumieri* or *Hy. yuri.*

Etymology.—Named in honor of Yuri N. Shcherbachev, P. P. Shirshov Institute of Oceanology, for his assistance with our review of the Indo–West Pacific marine halfbeaks. The name *yuri* is to be treated as a noun in apposition.

Holotype.—USNM 218481; Okinawa, Naha market; Albatross; J. O. Snyder; 1906; 168 mm SL; D 17, A 19; P_1 12–12; RGR_1 11 + 27 = 38, RGR_2 5 + 28 = 33; vertebrae 41 + 19 = 60; head length 38.6 mm; lower jaw length 43.7 mm; upper jaw length 7.2 mm, width 7.5 mm; P_1–P_2 68.9 mm, P_2–C 61.1 mm; P_2–C distance projected forward falls on middle third of adpressed pectoral fin; orbit length 8.8 mm; preorbital distance 8.1 mm.

Paratypes.—USNM 75494 (7, 140–171), and IO uncat. (1, 157), same data as holotype.

Hyporhamphus (*Hyporhamphus*) *melanopterus,* new species
Fig. 2a

Hemirhamphus melanurus not of Valenciennes. Bleeker, 1852:19–20 (description, Batavia, 21 specimens). Bleeker, 1866:156–157 (description, East Indies, 23 specimens). Bleeker, 1871:58–59 (description, East Indies, color plate). Weber and de Beaufort, 1922:151–152 (description, East Indies).

Hemiramphus melanurus not of Valenciennes. Herre 1937:17 and 1944:54 (14 of 22 specimens from the Straits Settlements, SU 30753 and the largest 2 of 5 specimens from Singora, Thailand, SU 30754).

Hyporhamphus melanurus not of Valenciennes. Inger, 1957:352–354 (N. Borneo, only the 3 specimens from the Sandakan fish market, FMNH 51890).

Diagnosis.—*Hy. melanopterus* is most similar to *Hy. neglectus* (Bleeker) and *Hy. limbatus* (Valenciennes) with which it has been confused. However, it differs sharply from these species and all other species of *Hyporhamphus* in having prominent black spots on the tips of the lobes of the dorsal and caudal (both upper and lower lobes) fins. It differs from *Hy. neglectus* and *Hy. limbatus* in averaging more fin rays in the dorsal and anal fins, D:A usually 16:16 in *melanopterus*, 14–15:15–16 in *neglectus*, and 13–14:14–15 in *limbatus*. *Hy. melanopterus* has a relatively long preorbital distance going 1.1–1.3 times in diameter of the orbit (compared to 1.3–1.8 times in *Hy. limbatus*).

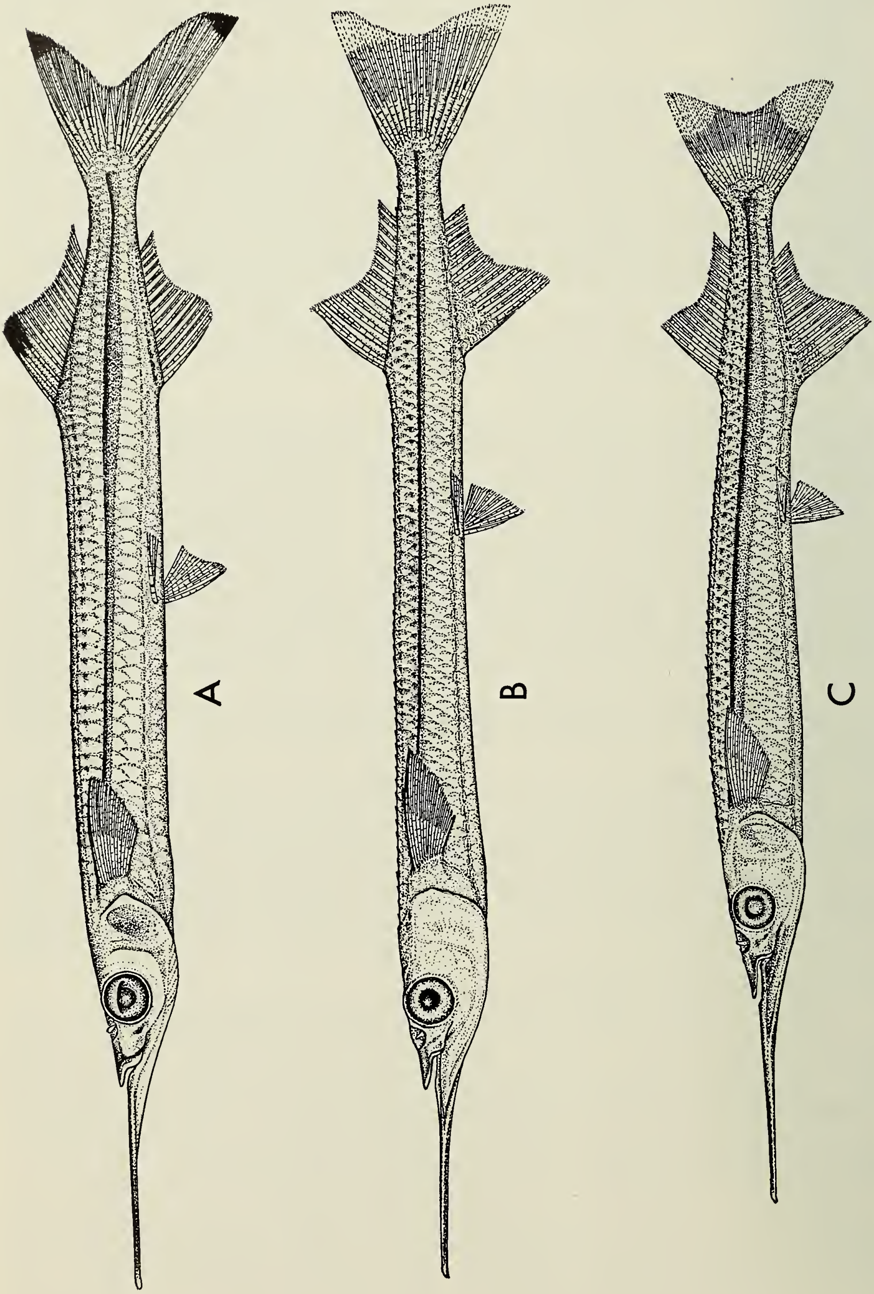
Brief description.—Head 4.4–5.1 times in SL ($\bar{x}$ 4.74). Lower jaw 3.8–4.9 times in SL ($\bar{x}$ 4.44) and 0.82–1.1 times in head length ($\bar{x}$ 0.94). Triangular projection of upper jaw pointed, its width 0.60–0.73 times in its length ($\bar{x}$ 0.67). Preorbital distance 1.1–1.3 times in orbit diameter ($\bar{x}$ 1.18) and 0.6–0.8 times in upper jaw length ($\bar{x}$ 0.70). Gillrakers on first arch (6–8) + (16–20) = 23–28, usually 25–26; on second arch (3–4) + (14–16) = 18–20. Teeth in jaws tricuspid, all 3 cusps about equally well-developed, in 3–4 rows in both jaws. Preorbital canal moderately wide, widening ventrally; median pore usually in center of canal. Greatest body depth 8.2–10.0 times in SL ($\bar{x}$ 9.04). Greatest body width 1.2–1.6 times in its depth ($\bar{x}$ 1.40). Vertebrae (31–33) + (17–20) = 49–53, usually 33 + 18 = 51. Predorsal scales 34–38.

D 14–17, usually 16; A 15–17, usually 16; D–A = –1 to 1. Anal fin base contained in dorsal base 1.0–1.4 ($\bar{x}$ 1.08). Anterior part of dorsal and anal fins (to ray 3) covered with scales, a few scales present posteriorly at the bases of the fins. P_1 11–12, usually 12, 13 on one side of 1 specimen. Pectoral fin length 6.8–7.5 times in SL ($\bar{x}$ 7.18). Pelvic fins located closer to origin of pectoral fins than to base of caudal fin (P_1–P_2/P_2–C = 0.61–0.69). Pelvic fin length 11.1–12.7 times in SL ($\bar{x}$ 11.67).

A silvery or dark stripe present along sides of body, widening under dorsal fin. Dorsal and anal fins gray with prominent black spot in dorsal lobe; caudal fin gray with prominent black spots at tips of dorsal and ventral lobes; pectoral and pelvic fins unpigmented.

Size.—Maximum known size 170 mm SL (female, East Indies, RMNH 6955). Both males and females are mature by 124 mm SL.

Distribution.—This species is known with certainty only from four areas —Malaysia, the Gulf of Thailand, the East Indies, and Sandakan, North Borneo. Published records of *Hy. melanurus* from other localities may be attributable to this species but, in view of the confusion of *Hy. melanop-*


A
B
C

terus with *Hy. neglectus*, *Hy. limbatus* and other species of *Hyporhamphus*, delimiting the exact range of this species will have to await the examination of more material. The specimens (FMNH 52127) reported by Jordan and Richardson (1909:177) as *He. melanurus* from Formosa are *Hy. limbatus*. The specimen (SU 29548) reported by Herre (1944:16) as *Hy. melanurus* from the Celebes is not even a member of the subgenus *Hyporhamphus* but is a juvenile *Hy.* (*Reporhamphus*) *quoyi*.

Geographic variation.—Samples from all four known areas were compared meristically and samples from the Gulf of Thailand, East Indies, and North Borneo were compared morphometrically. There does not appear to be any significant variation among the localities studied.

Remarks.—This species has been frequently reported in the literature as *Hyporhamphus* (or *Hemiramphus*) *melanurus* (Valenciennes). However, as shown by Collette (1974:81), the holotype of *He. melanurus* (MNHN B.1057, Celebes) is a specimen of *Hy. quoyi* (Valenciennes). Collette placed *melanurus* in the synonymy of *quoyi* thereby leaving this species without a name.

Etymology.—This species is named *melanopterus* in reference to the diagnostic prominent black spots in the lobes of the dorsal and caudal fins.

Holotype.—USNM 218363; N. Borneo, Sandakan Harbor; TeVega 210; D. M. Cohen and W. P. Davis; 28 Jan. 1965; female; 124 mm SL; D 16, A 17, P_1 11–12; RGR_1 8 + 18 = 26, RGR_2 4 + 15 = 19; predorsal scales 38; vertebrae 32 + 19 = 51; head length 28.0 mm; lower jaw length 26.9 mm; upper jaw length 4.1 mm, width 9.1 mm; P_1–P_2 40.0 mm, P_2–C 59.4 mm.

Paratypes.—58 specimens (80.2–170 mm SL) from 14 collections from the Gulf of Thailand, Malaysia, the East Indies, and N. Borneo.

Gulf of Thailand, 18 specimens (102–153) from 6 collections. UMMZ 191142 (1, 102); Prachuab Khiri Khan Prov., S of Klong Wan; S. Monkolprasit; 7 Dec 1963. UMMZ 191258 (2, 111–129); same locality; K. F. Lagler et al., L64-1324; 12 Dec 1964. UMMZ 191502 (8, 130–146); same locality; K. F. Lagler et al., L64-1322; 12 Dec 1964. KUB uncat. (2, 131–134); same locality; S. Monkolprasit, L64-1322; 13 Dec. 1964. KUB uncat. (3, 139–153); same locality; L64-1322. CAS SU 30754 (2, 137–148); Singora (= Songkhla); given to Herre Expedition, 1934.

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Fig. 2A. *Hyporhamphus* (*Hyporhamphus*) *melanopterus* n. sp. Collette and Parin, paratype, KUB uncat., 134 mm SL; Gulf of Thailand, Prachuab Khiri Khan Province, south of Klong Wan; 13 Dec. 1963; S. P. Monkolprasit. 2B. *Hyporhamphus* (*Hyporhamphus*) *paucirastris* n. sp. Collette and Parin, holotype, ANSP 84959, mature male, 140 mm SL; China, Fukien Province, San-Tu; Oct. 1935; T. H. Cheng. 2C. *Hyporhamphus* (*Hyporhamphus*) *unicuspis* n. sp. Collette and Parin, holotype, USNM 218364, mature female, 120 mm SL; Thailand, southern tip of Ko Talibong; 7°12′N, 90°22′05″E; 9 Feb. 1966; V. A. Gallardo.

Malaysia, 15 specimens (80.2–127) from 2 collections. CAS SU 30753 (14, 80.2–127); Straits Settlements, Dindings, Lumut; W. Birtwistle MCZ 54059 (1, 118); Singapore; F. Putnam.

East Indies, 14 specimens (95.4–170) from 3 collections. BMNH 1866.5.2.17 (1, 133); "East Indies"; Bleeker. RMNH 6955 (12, 110–170); "East Indies"; Bleeker. RMNH uncat. (1, 95.4); Java, Semerang; P. Buitendijk; March 1902.

N. Borneo, 11 specimens (92.4–154) from 3 collections. USNM 217450 (7, 92.4–110); same data as holotype; USNM 137632 (2, 154); Sandakan; Albatross. FMNH 51890 (2, 126–131); Sandakan fish market; R. F. Inger; 1950.

Hyporhamphus (*Hyporhamphus*) *paucirastris*, new species

Fig. 2b

Diagnosis.—This species is well differentiated from all other Indo-Pacific species of the subgenus *Hyporhamphus* in the large number of vertebrae (54–55) and the low number of gill rakers on the first arch (19–21). It has a high number of predorsal scales (42–43), more than *Hy. limbatus* (Valenciennes) (30–38) and *Hy. gernaerti* (Valenciennes) (35–40) but fewer than *Hy. intermedius* (Cantor) (48–63). It has a short upper jaw (width in length 0.65–0.83), similar to *Hy. limbatus* but shorter than both *Hy. gernaerti* (0.8–1.0) and *Hy. intermedius* (1.0–1.4).

Brief description.—Head 4.7–5.0 times in SL. Lower jaw 4.7–6.3 times in SL and 1.1–1.3 times in head length. Triangular upper jaw projection somewhat pointed, its width contained 0.65–0.83 times in its length. Length of preorbital 1.4–1.75 times in diameter of orbit and 0.9–1.35 times in length of upper jaw projection. Gill rakers on first arch (5–6) + (13–16) = 19–21, on second arch 3 + (13–15) = 16–18. Upper jaw teeth tricuspid, arranged in 3–5 rows in both jaws. Preorbital canal narrow, slightly widened ventrally; median pore in center of canal or at anterior margin. Greatest body depth 9.5–10.2 times in SL, width of body 1.2–1.6 times in its depth. Vertebrae (35–37) + (18–20) = 54–55. Predorsal scales 42–43.

D 14–15, A 14–16, D–A = –2 to 0. Anal fin originating under rays 1–3 of dorsal fin, its base contained 1.1–1.2 times in base of dorsal fin. Anterior lobe of dorsal and anal fins well developed. Anterior part of dorsal (to ray 2–4) and anal (to ray 3–5) fins covered with scales. P_1 12–13. Pectoral fin length 7.2–8.1 times in SL, equidistant from its origin to middle of eye or slightly more than this distance (but not more than distance to anterior margin of eye). Pelvic fins located slightly closer to origin of pectoral fin than to origin of lower lobe of caudal fin (P_1–P_2/P_2–C 0.85–0.95). Length of pelvic fins 10.8–19.5 times in SL.

A silvery stripe along the sides of body, widening under dorsal fin.

Dorsal and anal fins gray, without spots in lobes; caudal fin gray, slightly darker on posterior margins; pectoral and pelvic fins unpigmented.

Size.—Apparently a relatively large species, because all five known specimens are quite large (140–156 mm SL). The 156 mm specimen (ZIN 36925) is from Hainan Island.

Distribution.—All 5 specimens were collected in the basin of the South China Sea. Precise data on the locality of the two ZIN collections are absent, leaving open the question of whether this species belongs to the marine fauna (it is possible that the fish were caught in brackish or fresh water). The ANSP specimen is from San-tu, probably the same as San-tuao, a coastal port in Fukien Province that formerly had a large sea trade.

Etymology.—Named *paucirastris* in reference to the diagnostically low number of gillrakers.

Holotype.—ANSP 84959; China; Fukien Province, San-Tu; T. H. Cheng; Oct. 1935; mature male; 140 mm SL; D 14, A 16, P_1 13–13; RGR_1 $6 + 13 = 19$ (right), $6 + 15 = 21$ (left); RGR_2 $3 + 13 = 16$ (both sides); predorsal scales 43; vertebrae $37 + 18 = 55$; head length 29.6 mm; lower jaw length 27.8 mm; upper jaw length 5.3 mm, width 6.4 mm; P_1–P_2 50.3 mm, P_2–C distance 59.4 mm, P_2–C extended forward falls on anterior third of opercle; dorsal fin base 20.8 mm; anal fin base 19.2 mm; orbit length 6.9 mm, preorbital distance 4.4 mm.

Paratypes.—Four specimens (140–156 mm SL) from two collections in the South China Sea. ZIN 8396 (2, 150–154); "Hamen"; Herz; 1888. ZIN 36925 (2, 150–156); Hainan Is.; B. E. Bykhovsky and Nagibina; 1959 (gill arches missing).

Hyporhamphus (*Hyporhamphus*) *unicuspis*, new species
Fig. 2c

Diagnosis.—This species most closely resembles *Hy. knysnaensis* (Smith) from South Africa and *Hy. sindensis* (Regan) from the Persian Gulf and north coast of the Arabian Sea in its relatively long upper jaw (upper jaw width in length 0.8–1.1 times), posterior location of pelvic fins (P_2–C distance extended forward falling posterior to the orbit), and high number of anal fin rays (16–18 in *unicuspis*, 15–17 in *knysnaensis* and *sindensis*). *Hy. unicuspis* is unusual in the subgenus *Hyporhamphus* in usually having two median pores in the preorbital canal (instead of only one) and this condition is also found in the holotype of *Hy. sindensis*. *Hy. unicuspis* resembles other Indo–West Pacific species of the subgenus and differs from *Hy. sindensis* in not having a shortened preorbital distance(preorbital distance in orbit length 1.4–1.6 in *unicuspis*, 2.0–2.7 in *sindensis*). *Hy. unicuspis* has small unicuspid teeth, thus differing from the large tricuspid teeth present in *Hy. sindensis* but further resembling *Hy. knysnaensis*. In most other counts and measurements, *Hy. unicuspis* is similar to *Hy. knysnaensis*, but the pelvic fins are not located as far posteriorly (P_1–P_2/P_2–C = 0.8–0.9 in *unicuspis*, 0.9–1.0 in *knysnaensis*; P_2–C distance projected forward falling on preopercle or opercle in *unicuspis*, on pectoral base or opercle in *knysnaensis*).

Brief description.—Head 4.1–4.6 times in SL ($\bar{x}$ 4.36). Lower jaw 2.9–4.3 times in SL ($\bar{x}$ 3.76) and 0.79–0.95 times in head length ($\bar{x}$ 0.87), decreasing with growth from 0.89–0.95 times in specimens 112–142 mm SL to 0.79 and 0.65 in two specimens 84 and 73 mm SL respectively. Triangular upper jaw projection slightly pointed, its width 0.85–1.14 times in its length ($\bar{x}$ 1.02). Length of preorbital 1.4–1.6 times in diameter of orbit ($\bar{x}$ 1.52) and 1.2–1.5 times in length of upper jaw projection ($\bar{x}$ 1.38). Gill rakers on first arch (9–11) + (20–23) = 30–34, gill rakers on second arch (4–6) + (17–20) = 22–26. Jaw teeth small, pointed, and unicuspid (tricuspid in posterior part of lower jaw), arranged in 3–5 rows. Preorbital canal narrow, slightly widened ventrally; two median pores in 9 of 10 specimens. Greatest body depth 7.3–12.1 times in SL ($\bar{x}$ 10.02), body width 1.3–1.7 times in its depth ($\bar{x}$ 1.52). Vertebrae (31–33) + (17–20) = 49–51. Predorsal scales 33–40.

D 14–16, A 16–18, D–A = –3 to –1. Anal fin originates under first or second dorsal ray or anterior to a vertical with origin of dorsal fin (origin of dorsal fin over space between 1st and 2nd anal rays), its base about equal to dorsal fin base (dorsal base divided by anal base 0.94–1.07, $\bar{x}$ 0.99). Anterior lobe of dorsal and anal fins poorly developed. P_1 11, rarely 10 or 12. Length of pectoral fin 7.6–8.9 times in SL ($\bar{x}$ 8.35). Pelvic fins located noticeably closer to origin of pectoral fins than to origin of lower lobe of caudal fin (P_1–P_2/P_2–C = 0.81–0.89, $\bar{x}$ 0.87). Pelvic fins 12.7–15.4 times in SL ($\bar{x}$ 13.61).

A dark stripe present along sides of the body, widening under dorsal fin. Dorsal, anal, pectoral, and pelvic fins unpigmented; caudal fin gray, slightly darker on edges.

Size.—Reaches at least 142 mm SL (ZSI 2311/2, Madras) but it is known only from 12 specimens and may grow larger. Matures at a small size, 84 mm for males, 112 mm for females.

Distribution.—Known from southern India (Kerala on the Malabar coast, Pondicherry and Madras on the Coromandel coast), Bangladesh, and off the west coast of Thailand in the Andaman Sea. Two specimens from the Persian Gulf are considered as *Hy. unicuspis* for the present.

Geographic variation.—The 5 specimens from southern India and Bangladesh resemble the 5 specimens from Thailand in all meristic characters. However, there appear to be several morphometric characters in which the Indian specimens (73–142 mm SL) differ from the Thai specimens (84–120 mm). The head is shorter in the Indian sample (head in SL 4.31–4.59, $\bar{x}$ 4.49 compared to 4.10–4.31, $\bar{x}$ 4.23). The body depth is less in the

Indian sample (9.47–12.10 in SL, $\bar{x}$ 10.42 compared to 9.02–10.24, $\bar{x}$ 9.62) and the body width is greater (1.35–1.54 in depth, $\bar{x}$ 1.44 compared to 1.56–1.71, $\bar{x}$ 1.60 in the Thai sample). The upper jaw is shorter in the Indian sample than in the Thai sample (upper jaw width in length 0.85–1.05, $\bar{x}$ 0.96 times compared to 1.02–1.14, $\bar{x}$ 1.08; preorbital distance in upper jaw length 1.22–1.38, $\bar{x}$ 1.30 times compared to 1.22–1.52, $\bar{x}$ 1.38). Additional material is needed to determine if these differences have any taxonomic significance.

The two specimens from the Persian Gulf (ZMUC CN-4, 121 mm and USNM 148023, 48.4 mm) differ from the Indian Ocean specimens of *Hy. unicuspis* in several respects but have unicuspid teeth and counts that generally agree with *unicuspis*. The preorbital distance (1.27 and 1.56 in orbit length) is similar to that for *unicuspis* (and *limbatus*) and completely different from *sindensis* (2.0–2.7). The P_2–C distance extended forward falls on the preopercle or preopercle–opercle margin as in *unicuspis* (and *sindensis*), posteriorly on the orbit as in *limbatus*. The smaller specimen fits our concept of *unicuspis* better than does the larger specimen. ZMUC CN-4 has too high a gill raker count ($RGR_1 = 36$, $RGR_2 = 30$), too few predorsal scales (33) and vertebrae ($31 + 18 = 49$) and too short a lower jaw projection (1.11 in head length). The combination of characters suggests that these two specimens represent a differentiated Persian Gulf population of *unicuspis*, an undescribed subspecies of *unicuspis*, or a distinct species. Correct identification of these specimens must await examination of additional material of Indian Ocean *unicuspis* and of the Persian Gulf population that we refer to *unicuspis* for the present.

Etymology.—Named *unicuspis* with reference to the predominantly unicuspid teeth found on both jaws.

Holotype.—USNM 218364; Thailand, S tip of Ko Talibong, 7°11′60″N, 99°22′05″E; V. A. Gallardo, 5th Thai-Danish Exped.; 9 Feb. 1966; 120 mm SL; mature female; D 15, A 16, P_1 11–11; RGR_1 $10 + 21 = 31$; RGR_2 $6 + 19 = 25$; predorsal scales 39; vertebrae $33 + 18 = 51$; head length 28.0 mm; lower jaw length 30.0 mm; upper jaw length 6.5 mm, width 5.8 mm; P_1–P_2 42.6 mm, P_2–C 49.2 mm, P_2–C distance extended forward falls on anterior margin of opercle; dorsal fin base 18.6 mm, anal fin base 18.4 mm; orbit length 6.7 mm, preorbital distance 4.3 mm; maximum body depth 13.3 mm, maximum body width 8.4 mm.

Paratypes.—Nine specimens (48.4–144 mm SL) from five collections from the Arabian Sea, Bay of Bengal, and Andaman Sea. USNM 218361 (2, 104–107); India, Kerala, Kottayam; S. D. Trividi. ZSI F1538/2 (1, 138); India, Vaithiluppan, 2 mi N of Pondicherry; 8 Feb. 1958. ZSI 2311/2 (1, 142); India, Madras; Zool. Sur. India. USNM 218365 (4, 84.0–114); same data as holotype. ZIN uncat. (1, 72.6); Bay of Bengal; 20°55′N, 88°02′E; Ob sta. 329; 14 May 1957.

Other material.—Persian Gulf. ZMUC CN-4 (1, 121); Iran, Bushire.

USNM 148023 (1, 48.4); Saudi Arabia, Tarut Bay; D. S. Erdman; April–June 1948.

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A NEW BURROWING CRAWFISH OF THE GENUS *CAMBARUS* FROM SOUTHWEST ALABAMA (DECAPODA, CAMBARIDAE)

J. F. Fitzpatrick, Jr.

Abstract.—A new burrowing crawfish *Cambarus* (*Lacunicambarus*) *miltus*, is described from Baldwin County, Alabama. It is apparently restricted in distribution, having been collected only from the type-locality despite search elsewhere in the vicinity. It is easily discernable in the field from other *Lacunicambarus* occurring in the immediate vicinity by its small size and concolorous brick-red color. Some problems in the identity of the populations of the subgenus are briefly discussed.

All of the recent treatments of the genus *Cambarus* (Hobbs, 1969; 1972; 1974) recognize that the subgenus *Lacunicambarus* represents a species complex rather than the two subspecies currently employed. Despite the fact that Marlow (1960) was able to find no significant morphometric variation in an examination of 1234 specimens from an undetermined number of localities extending from New Jersey and Wyoming to Texas and Florida, subsequent collectors and investigators have become convinced that a number of discrete breeding populations exist, and this apparently extensive range is really occupied by several distinct species. Among the characters which seem to indicate species identification are rostral length and width, areola length, size and proportions of the chela, and overall size. Marlow's (1960:234–236) treatment of the different color patterns as merely variants likewise seems no longer tenable; additional color patterns in the complex have been observed. Members of many populations are markedly more robust in construction than others, and geographically stable differences exist in the relative measurements of the triangle described by the anteriomesial limits of the branchiostegites. Tuberculation of the principal elements of the cheliped also seem to be distinct in different populations in specific parts of the "range." Marlow's restriction, copied in subsequent treatments, of the *ludovicianus* form to Assumption, Jefferson, Orleans, St. Bernard, St. Charles, St. Tammany, Tangipahoa, Terrebonne and Washington Parishes in Louisiana is not consistent with collections I have made in areas east of the Mississippi River. I have numerous specimens from the "Delta" region of Mississippi and extreme western Tennessee which I am unable, at present, to distinguish, on the basis of morphology or color pattern, from specimens from the vicinity of New Orleans (the type-locality). Payne and Riley (1974) also encountered this apparent enigma in the Chickasaw Basin in Tennessee. West of the Mississippi River, Reimer and his students have reported a much more extensive range for *C.* (*L.*) *diogenes ludovicianus* Faxon, 1885 (Reimer, 1969; Reimer and Clark, 1974); he even strongly questioned the conspecificity of *ludovicianus* with *C.* (*L.*) *d. diogenes* Girard, 1852 (Reimer, 1969:53), a position I share. [Reimer does not give the depository of his specimens, but those on which Payne and Riley's conclusions are based are at Memphis State University (loc. cit.: 125) and mine are at the National Museum of Natural History, Smithsonian Institution.]

Clearly, then, the subgenus is badly in need of thorough revision, including a more intensive morphometric analysis than that offered by Marlow. Under such circumstances, one ordinarily would not describe a new species without careful examination of the interrelationships of the several species. The new species here presented, however, is so clearly distinct from other populations in the subgenus that its description offers no potential for confusing a more complete study. Its range is limited and is located in an isolated coastal area, away from other populations.

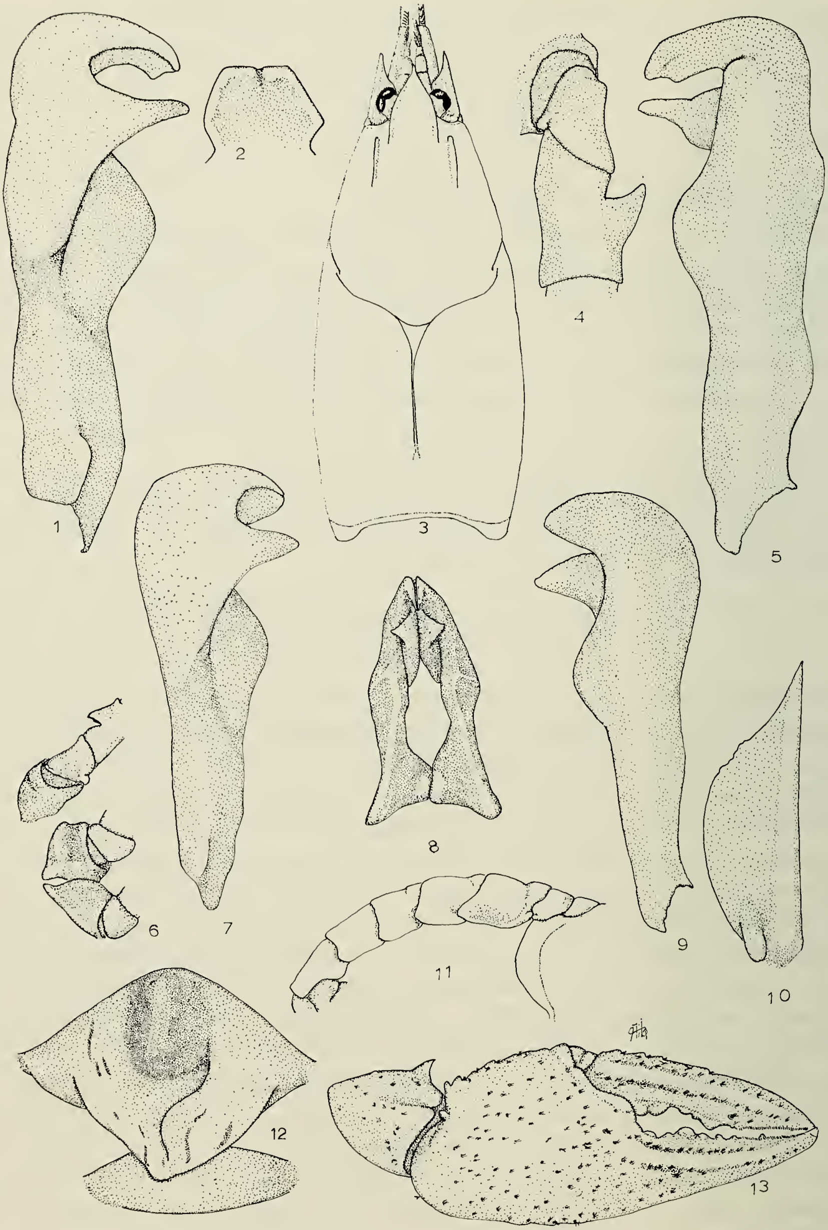
I am grateful to Ms. Barbara A. Laning and Mr. Vergil E. Lee, Jr., for help with the field work, and Dr. Horton H. Hobbs, Jr., as usual, gave unstintingly of his time and knowledge.

Cambarus (*Lacunicambarus*) *miltus*, new species

Figs. 1–13

Diagnosis.—Pigmented; eyes scarcely, if at all, reduced. Rostrum depressed, lacking marginal spines or tubercles; acumen prominent and acute but poorly delimited at base from rostrum. Areola 35.9–42.5 (avg. 39.36) percent of total length of carapace and linear. Cervical spine absent; branchiostegal spine obsolete. Suborbital angle acute. Antennal scale about 2–3 times longer than broad, widest near midlength, cephalolateral margin terminating in long, acute spine. Cephalic margin of cephalic part of epistome broadly truncate. Chela with mesial row of 5–6 tubercles, second row of 4–5 medial to it; basal half of opposable margin of movable finger with broad concavity. Hook on ischium of third pereiopod only and slightly overlapping basis. Coxa of fourth pereiopod with longitudinally oriented prominent caudomesial boss. First pleopod of male terminating in 2 subequal rami, both bent at angle of approximately 90° to main axis of shaft of pleopod; first form male with caudal knob at caudolateral base of central projection; subapical margin of central projection of first form male with nearly obsolete, broad, shallow notch. Annulus ventralis of female roughly subquadrangular, with deep broad cephalomedian trough; highly elevated (ventrally) posteriorly, overhanging postannular sternite.

Holotypic male, Form I.—Body subovate, depressed (Fig. 3). Abdomen shorter than thorax (21.8 and 24.5 mm) and narrower (7.4, 9.8 mm); carapace nearly as high as wide at level of caudodorsal margin of cervical groove (9.6, 9.8 mm). Areola 39.8 percent of total length of carapace



Figs. 1–13. *Cambarus* (*Lacunicambarus*) *miltus* (all figures of holotype, unless otherwise noted): 1, Mesial view of first pleopod; 2, Cephalic part of epistome; 3, Dorsal aspect of carapace; 4, Basis and ischium of right third pereiopod; 5, Lateral view of first pleopod; 6, Proximal podomeres of third through fifth pereiopods; 7, Mesial view

(holotype with sinistrocephalic irregularity—not illustrated—in areola, probably from molt difficulty). Rostrum depressed, sharply convergent margins with moderately well developed ridges flanked mesially by usual submarginal row of setiferous punctations; acumen acute and prominent, not sharply delimited from rostrum at base. Subrostral ridges well developed and visible in dorsal aspect to level of suborbital angle. Postorbital ridges strong, terminating cephalically in tubercles. Carapace sparsely punctate, punctations grading to widely scattered ventrocephalic granulations. Cervical spine absent; branchiostegal spine obtuse. Cephalic section of carapace 1.55 times longer than areola.

Abdominal pleura (Fig. 11) broadly rectangular in lateral aspect, none markedly expanded caudoventrally or cephaloventrally. Cephalic section of telson with one spine in each caudolateral corner. Spines associated with distal parts of both rami of uropod all tiny and subequal in size.

Cephalic lobe of epistome (Fig. 2) subtrapezoidal in outline, cephalic margin truncate, and all margins except caudal ridged; fovea of caudal lobe obtuse.

Antennae extending to second abdominal segment; antennal scale (Fig. 10) 3.17 times longer than wide, broadest near midlength, thickened lateral part terminating cephalically in long acute spine. Antennules of usual form and peduncle without spines.

Right chela (Fig. 13) depressed with palm inflated. Mesial margin of latter with row of 5 small, nearly squamous tubercles, another row of 4 similar tubercles just dorsomedial to it and pair of small tubercles ventromedial to it in distal third. Dactyl with row of 4 squamous tubercles in basal half of mesial margin and second row of 3 dorsomedial to it; opposable margin broadly excised in basal half with 4 tubercles in excision, larger tubercle beyond distal border of excision and crowded minute denticles thence to tip, denticles interrupted ventrally by small tubercle at base of distal fourth of finger. Opposable margin of immovable finger with 2 small and one prominent tubercle in basal half, distal half with 4 small tubercles, 3 near base and distalmost interrupting crowded minute denticles distal to former. Both fingers with submedian longitudinal ridge flanked by setiferous punctations above; similar ridges below, that on dactyl more prominent; upper and lower surfaces with setiferous punctations more numerous marginally than medially.

←

of first pleopod of morphotype; 8, Caudal view of first pleopods; 9, Lateral view of first pleopod of morphotype; 10, Right antennal scale; 11, Lateral aspect of pleura of abdomen; 12, Annulus ventralis and postannular sternite of allotype; 13, Distal podomeres of cheliped.

Carpus longer than broad with dorsally placed oblique furrow running along long axis; mesial surface with 3 or 4 small squamous tubercles and single, strong, acute spine at base of distal third; lower laterodistal and mesiodistal corners with acute spine; entire carpus sparsely punctate.

Upper surface of merus with 2 small spines distally, otherwise margin entire; lower mesial margin with row of 11 equidistant, subequal tuberculiform spines; lower lateral margin with row of 7 similar spines. Ischium with row of 3 small tubercles on mesial margin and single large tubercle at mesiodistal margin; lateral margin smooth except hook-like sufflamen articulating with large articular condyle of coxa. Basis and coxa without spinose ornamentation. Proximal 4 podomeres all very sparsely punctate.

Hook on ischiopodite of third pereiopod only (Fig. 4); hook simple, extending over basis slightly. Coxa of fourth pereiopod (Fig. 6) with prominent caudomedial boss oriented longitudinally. Coxae of second through fifth pereiopods and sternites without dense tufts of setae.

First pleopods (Figs. 1, 5, 8) symmetrical, not markedly deflected mesially; terminating in 2 elements, both bent at angle of approximately 90° to main shaft of pleopod; central projection corneous, broad, subapical margin with broad, shallow, nearly obsolete notch; caudal knob at caudolateral base of central projection; mesial process non-corneous, subconical, laterally inclined. Pleopods reaching coxae of third pereiopod when abdomen flexed.

Allotypic female.—Differing from holotype in following respects: mesial margin with only 2 rows of tubercles, mesialmost of 6 and dorsomedian one of 5; lower mesial margin of merus with 9 spines. Cephalic section of telson with 2 spines in each caudolateral corner.

Annulus ventralis (Fig. 12) subrhomboidal in outline; centrocaudal portion elevated (ventrally) and projecting over postannular sternite; centrocephalic part with deep trough divided by low longitudinal ridge; sinus originating in sinistrocaudal corner of trough and describing broadly sigmoid curve before terminating at midline anterior to caudal margin; several deep grooves on posterior and sinistrocephalic surfaces of annulus. Postannular sternite spindle-shaped, highest (ventrally) along median line.

Morphotypic male, Form II.—Differing from holotype in following respects: ventromesial margin of merus with row of 8 spines, ventrolateral margin with row of 5; mesialmost row of 5 tubercles on palm. Ischia of third pereiopods with small tubercles at site of hooks. Both elements of first pleopod (Figs. 7, 9) non-corneous and blunter.

Type locality.—In burrows along d'Olide Creek under old highway 98 bridge, 0.1 mi (161 m) S of the junction of U.S. highways 90, 98, and I-10 at Spanish Fort, Baldwin County, Alabama. Numerous grasses and frontland shrubs are nearby, but most of the area under the bridge pilings is bare, or at most with a few grasses. The burrows are relatively simple, but the chamber is never directly below an opening, and 2–3 openings with small

Table 1. Measurements (mm) of types of *Cambarus* (*Lacunicambarus*) *miltus*.

	Holotype	Allotype	Morphotype
Carapace—			
length	24.5	27.5	20.1
width	9.8	11.1	8.7
height	9.6	11.5	8.6
Rostrum—			
length	4.6	4.6	3.8
width	3.3	3.8	2.7
Areola—			
length	9.6	11.7	7.6
Antennal scale—			
length	3.8	4.0	3.2
width	1.2	1.7	1.2
Chela—			
length of inner margin of palm	6.5	7.4	5.1
total length	19.6	20.5	14.2
width	8.8	9.6	7.0
dactyl length	12.5	12.5	9.0
Abdomen—			
length	21.8	24.3	18.3
width	7.4	9.6	6.6

chimneys are usual. The surface is a brick-red colored sandy clay and relatively stable, but below the water level it turns to a near slush, making excavation of the burrows difficult. Most, but not all, of the animals were captured when they came to the surface in response to agitation of the water within the burrow.

Disposition of the types.—The holotypic male, Form I; the allotypic female; and the morphotypic male, Form II, are in the U.S. National Museum of Natural History, Smithsonian Institution, numbers 148556, 148557, and 148558, respectively. All paratypes are topoparatypic and are likewise at NMNH: 148559 (1♂ II, 1♂ j, 1♀), 148560 (1♀, 2♀♀/ov.), 148561 (1♂ j).

Range.—*Cambarus* (*Lacunicambarus*) *miltus* has been collected only from the type-locality, although I have searched the environs on several occasions. I estimate that there are about 24–25 active burrows for the species at the type-locality. Three collections have been made: 2 March 1974 (1♂ I, 1♀, 1♀ j, 2♀♀/ov.), Barbara A. Laning and JFF, colls.; 24 May 1975 (1♂ j), BAL and JFF, colls.; 21 February 1976 (2♂♂ II, 1♂ j, 1♀), Vergil E. Lee, Jr., and JFF, colls.

Variations.—Relatively little variation was noted. The only significant differences were in the numbers of tubercles in the several rows along the mesial margin of the palm. There is less sexual dimorphism than usual in crawfishes in the morphology of the cheliped.

Size and color.—The allotype is the largest animal collected, and I have collected none with a carapace length of less than 17.0 mm (a female). This crawfish is a concolorous brick-red, closely matching the color of the substrate in which it lives.

Life history notes.—The only Form I male was collected on 2 March, and 2 of the 3 females simultaneously collected were ovigerous. The third female, the allotype, has the exuviae of recently departed young still attached to her pleopods. At this time several tiny juveniles were seen in the burrow during excavation. No signs of reproductive activity were seen during other visits, and each burrow always had a solitary inhabitant (except possibly recently independent young).

Relationships.—The closest relatives of this species currently bear the appelations *Cambarus* (*Lacunicambarus*) *diogenes diogenes* and *C.* (*L.*) *d. ludovicianus. C.* (*L.*) *miltus* is easily separated from both by the caudal knob on the first pleopod, the truncated epistome, and the deep, broad cephalomedian trough in the annulus. Further analysis of its relationships must await study of the subgenus.

Etymology.—The name "miltus" is taken from the Greek, *miltos*: red earth; it is given because of the brick-red color of the animal and the red clay substrate from which it was dug.

Associates.—One specimen of *Procambarus* (*Scapulicambarus*) *clarkii* (Girard, 1852) was taken from a burrow in the same area as *C.* (*L.*) *miltus. Cambarellus lesliei* Fitzpatrick and Laning (1976) was collected from flooded grassland adjacent to the type-locality. For full citation of the species not referenced here, readers should consult Hobbs (1974).

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A NEW POLYCHELATE SHRIMP FROM THE GREAT BARRIER REEF OF AUSTRALIA AND ITS BEARING ON THE FAMILY BRESILIIDAE (CRUSTACEA: DECAPODA: CARIDEA)

Fenner A. Chace, Jr., and Diane E. Brown

Abstract.—*Pseudocheles enigma*, a new genus and species of marine caridean shrimp characterized most remarkably by the presence of functional chelae on all 5 pairs of pereopods, is recorded from Lizard Island, Queensland, Australia. Because it displays characters associated with both of the families Disciadidae and Bresiliidae, the former is subjectively synonymized with the latter in order to accommodate the species with least disruption of currently accepted concepts of caridean classification.

The shrimp described below offers fresh evidence that many still undescribed species must be discovered before a definitive classification of the decapod Crustacea of the world can be attempted. When Holthuis published his invaluable review of the genera of caridean shrimps in 1955, all of the more than 1,500 species then known were characterized by the presence of one or, usually, two pairs of chelate pereopods. Except for prehensile, subchelate posterior pereopods in a few species, there were no exceptions to this established pattern. During the less than a quarter-century since the appearance of that work, however, two species without any chelate appendages—*Procaris ascensionis* Chace and Manning, 1972, and *P. hawaiana* Holthuis, 1973—have been discovered on Ascension Island and in Hawaii, and now the Great Barrier Reef has contributed a species in which all five pereopods are functionally chelate. The pincers on the three posterior pairs of pereopods of the Australian shrimp are not true chelae and therefore are perhaps not of genuine familial significance, but other characteristics, especially of the mouthparts, have thwarted all attempts to accommodate the species in the currently conceived classification of the Caridea.

We are most grateful to the staff of the Fish Department of The Australian Museum, particularly Helen Larsen and D. F. Hoese, for collecting this unusual shrimp and making the specimens available to us. We thank Raymond B. Manning for participating in discussions relating to the systematic problem posed by this discovery as well as for reviewing the manuscript. Horton H. Hobbs, Jr., also suggested welcome ways to improve the paper.

Genus *Pseudocheles*, new genus

Diagnosis.—Rostrum compressed laterally in anterior half, with narrow supraorbital eaves posteriorly, armed with series of dorsal teeth and 1 small tooth on ventral margin. Carapace with antennal spine, without branchiostegal or pterygostomian spines. Telson armed with 3 pairs of dorsolateral spines and 3 pairs of posterior spines, posterior margin acutely triangular. Antennal scale narrowing distally, blade not overreaching distolateral tooth. Mandible with 2-segmented palp, without distinct separation between incisor and "molar" processes. Second maxilla with endites bearing long, stout setae, distal lobe strapshaped and directed distally. First maxilliped without exopodal lash. Second maxilliped with terminal segment attached transversely to preceding segment. Third maxilliped conventional, distal segment not flattened. First and 2nd pereopods with ischium and merus fused. First pereopod more robust but no longer than 2nd, fingers elongate, carpus broader than long, partially recessed in hollowed end of merus. Three posterior pairs of pereopods spuriously chelate. Exopods on all 5 pairs of pereopods. Gills on pereopodal somites represented by pleurobranchs only.

Type-species.—*Pseudocheles enigma*, new species.

Etymology.—From the Greek, "pseudos," falsehood, and "chele," claw, in reference to the false chelae on the 3 posterior pairs of pereopods. The gender is feminine.

Pseudocheles enigma, new species
Figs. 1–4

Material.—Bommie (reef) No. 2, west side of lagoon, Lizard Island, Queensland, Australia; 1–15 m; 17 November 1975; Sta. LZ 75-42: 1 female holotype (Australian Museum P. 24190), 2 ovigerous female paratypes (AM P. 26830).

Description.—Integument thin but not fragile. Rostrum (Fig. 2*a*, *b*) reaching nearly to level of distal end of 2nd segment of antennular peduncle (Fig. 1), dorsal margin thin, armed with 6 equidistant teeth on rostrum proper, lateral carinae forming narrow supraorbital eaves widening posteriorly, ventral margin armed with single minute tooth situated about midway between anteriormost dorsal tooth and apex of rostrum. Carapace with denticle in dorsal midline on posterior slope of posteriormost tooth of true rostral series, followed by rather prominent tooth situated about as far posterior to 1st rostral tooth as distance between 1st and 4th rostral teeth, and acute denticle at about posterior ⅐ of carapace length; antennal spine distinct, arising just ventral to broadly rounded ventral orbital lobe; latter bent mesially and forming horizontal shelf beneath eye (Fig. 2*b*).

Abdomen of female (Fig. 1) with pleura of 2 anterior somites quite

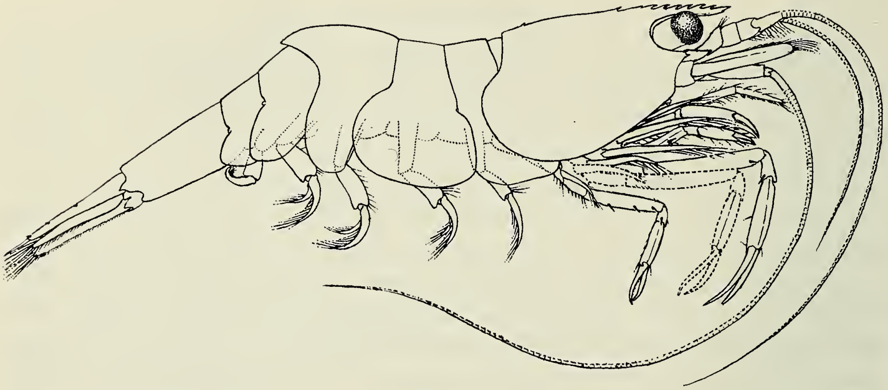

Fig. 1. *Pseudocheles enigma*, female holotype ×9.

broadly rounded, of 3 following somites narrowly rounded, 3rd somite projecting as low cap over anterior part of 4th somite. Sixth somite more than 2½ times as long as 5th and about twice as long as high. Telson (Fig. 2*c*), not including posterior spines, about as long as 6th somite, about 4 times as long as anterior width, armed with 3 pairs of dorsolateral spines, anterior pair situated at about midlength of telson, posterior pair overreaching bases of lateral pair of posterior spines; posterior margin (Fig. 2*d*) subtriangular, armed with 3 pairs of long spines, lateral pair sinuous and about 3 times as long as subequal submedian and intermediate pairs; posteromedian part (Fig. 2*e*) with pair of setae arising from dorsal surface and armed with sharp median point posteriorly.

Eye (Fig. 2*b*) with cornea well-pigmented, fully as long as stalk, and having pebbly appearance because of rather markedly convex *square* facets.

Antennular peduncle (Fig. 2*f*) reaching about to distal ⅓ of antennal scale; stylocerite tapering to acute tip reaching about level of distal ⅓ of basal segment of otherwise unarmed peduncle; basal segment of peduncle twice as long as 2nd and about 1⅗ times as long as 3rd, all measured on mesial margins. Dorsolateral flagellum about 3½ times as long as carapace; ventromesial flagellum less than twice as long as carapace.

Antennal scale (Fig. 2*g*) slightly more than 3 times as long as wide, distolateral tooth small, barely overreaching rounded distal margin of blade. Antennal peduncle unarmed, reaching to about distal ⅓ of scale. Flagellum nearly 5 times as long as carapace.

Mandibles (Fig. 3*a*, *b*) similar, with robust 2-segmented palp, incisor process extensive, armed with 10 marginal teeth, "molar" process small, not distinctly separated from incisor process, consisting of spinose lobe with row of spines extending laterally on anterodorsal surface. First maxilla (Fig. 3*c*) with proximal endite distally rounded, bearing about 9 long setae

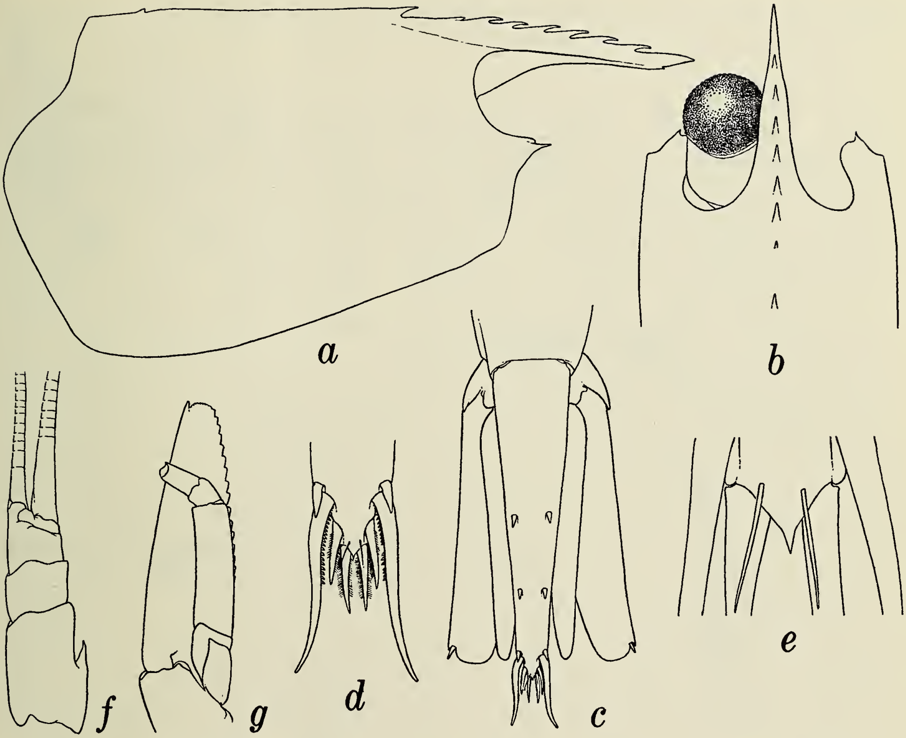

Fig. 2. *Pseudocheles enigma*, ovigerous female paratype, carapace length 2.1 mm: *a*, Carapace, including rostrum; *b*, Frontal region, dorsal aspect; *c*, Telson and uropods; *d*, Posterior end of telson; *e*, Same, more highly magnified; *f*, Right antennule, dorsal aspect; *g*, Right antenna, ventral aspect. (*a–c*, *f*, *g*, ×25; *d*, ×62; *e*, ×260.)

along distal margin and about 6 spines, increasing in length mesially, on proximal and mesial margins; distal endite armed with 6 stout spines and few smaller ones on mesial margin; palp bifurcate, with long distal spine on proximomesial branch and single subdistal seta on distal branch. Second maxilla (Fig. 3*d*) with 2 proximal endites represented by rather narrow lobes directed mesiodistally, distal endite strapshaped, directed distally subparallel with palp and bearing 3 long, mesially curved setae extending far beyond palp; scaphognathite rather broad and short, barely overreaching strong palp. First maxilliped (Fig. 3*e*) with subquadrate endite, slender palp, exopod terminating in slight projection perhaps representing vestigial lash, and large, bilobate epipod. Second maxilliped (Fig. 3*f*) somewhat pediform, distal segment bearing 5 stout spines, one at flexor angle of distal margin bearing subacute tubercles arranged in 2 rows (Fig. 3*g*); exopod rather short, barely overreaching antepenultimate segment. Third

Fig. 3. *Pseudocheles enigma*, ovigerous female paratype, carapace length 2.1 mm: *a*, Mandibles, anterodorsal aspect; *b*, Opposable margin of left mandible; *c*, Right 1st maxilla; *d*, Right 2nd maxilliped; *g*, Same, distal spines; *h*, Right 3rd maxilliped; *i*, Same, distal end. (*h*, ×25; *a*, *c–f*, *i*, ×62; *b*, ×130; *g*, ×260.)

maxilliped (Fig. 3*h*) slender, 5-segmented, reaching nearly to level of distal end of antennal scale; distal end of terminal segment constricted into rod-like tip (Fig. 3*i*).

First pereopod (Fig. 4*a*) reaching nearly to level of distal end of antennal peduncle; fingers (Fig. 4*b*) slender, curving toward flexor margin, about ⅔ as long as palm, tips crossing slightly when flexed, dactyl obscurely dentate on opposable margin; palm rather stout, slightly carinate on extensor margin; carpus fully twice as wide as long, partially recessed in distal end of merus when extended; ischiomerus with longitudinal carina; exopod well-developed, reaching to about midlength of palm. Second pereopod (Fig. 4*c*) about as long as 1st but more slender; fingers (Fig. 4*d*) slightly more than ½ as long as palm, opposable margins bearing movable spines or stout setae; palm not noticeably carinate; carpus about ⅕ as long as chela, slightly longer than wide; ischiomerus with longitudinal carina and single stout spine in distal ¼ of flexor margin; exopod reaching end of proximal ⅓ of palm. Three posterior pairs of pereopods with curved dactyl opposing subequally long, curved spine arising from distal end of propodus to form pincers resembling those found on 2 anterior pereopods of pasiphaeid shrimps, resemblance enhanced by pectinations on opposable margin of dactyl (Fig. 4*i*, *j*) and close-set series of spinules on opposable margin of seta (Fig. 4*k*). Third pereopod (Fig. 4*e*) overreaching antennal scale by length of dactyl and most of propodus; dactyl (Fig. 4*f*) slightly shorter than propodus; carpus fully ⅓ as long as propodus, armed with pair of spines near distal end of flexor margin; merus 1⅔ times as long as propodus, armed with 4 strong spines on or near flexor margin; ischium about ⅖ as long as merus, armed with single strong marginal spine; exopod overreaching proximal ¼ of merus. Fourth pereopod (Fig. 4*g*–*k*) overreaching antennal scale by length of dactyl and about ¼ of propodus; dactyl fully as long as propodus; carpus less than ½ as long as propodus, armed with stout spine near distal angle of flexor margin; merus twice as long as propodus, armed with 6 strong spines on or near flexor margin; ischium about ⅖ as long as merus, armed with 2 strong marginal spines; exopod nearly reaching end of proximal ¼ of merus. Fifth pereopod (Fig. 4*l*, *m*) reaching approximately to level of distal ¼ of antennal scale; dactyl about as long as propodus; carpus less than ½ as long as propodus, armed with stout spine; merus about 1⅘ as long as propodus, armed with 4 strong spines on or near flexor margin; ischium ½ as long as merus, armed with 4 marginal spines; exopod reaching end of proximal ⅓ of merus.

Uropod (Fig. 2*c*) with branches subequal in length, reaching slightly beyond base of triangular endpiece of telson, lateral branch with movable spine mesial to distolateral tooth.

Eggs with late embryos oval, measuring about 0.4 × 0.3 mm.

Size.—Female holotype with carapace length of 2.2 mm (total length

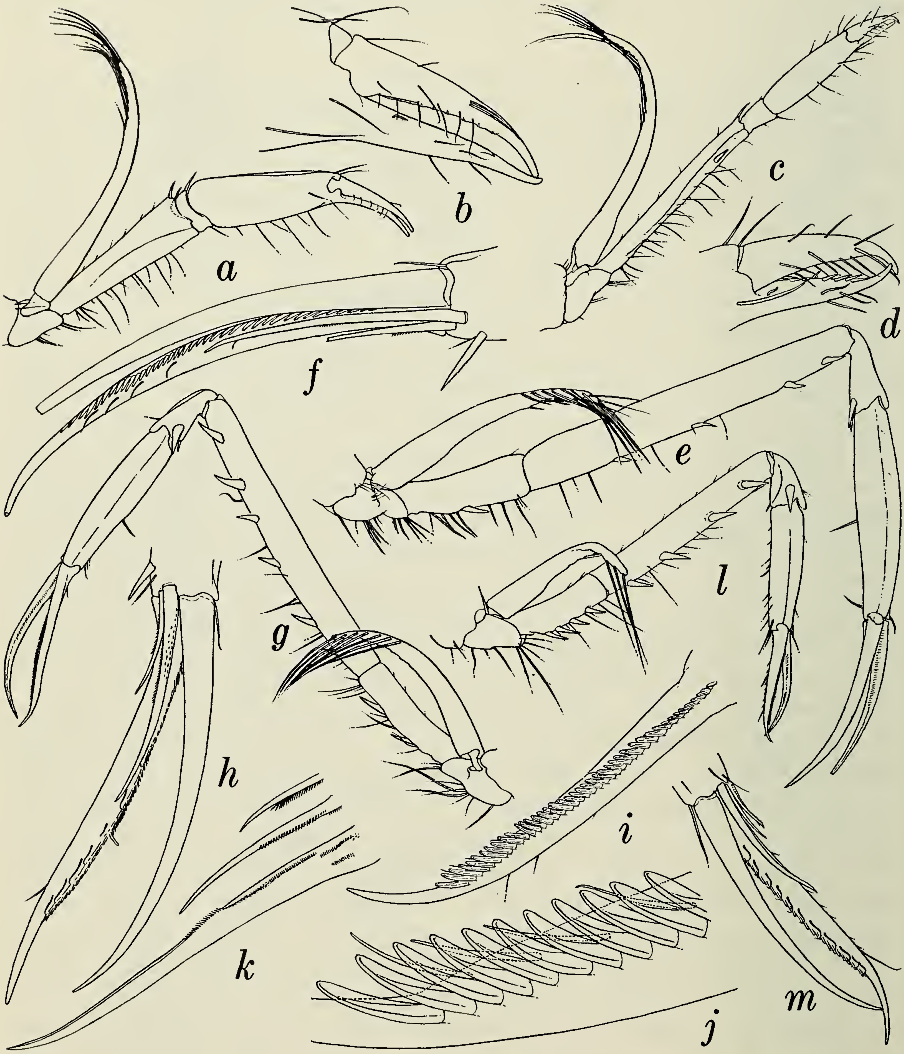

Fig. 4. *Pseudocheles enigma*, female holotype: *a*, Right 1st pereopod; *b*, Same, fingers; *c*, Right 2nd pereopod; *d*, Same, fingers; *e*, Right 3rd pereopod, remotor aspect; *f*, Same, dactyl and distal propodal spines, promotor aspect; *g*, Left 4th pereopod, remotor aspect; *h*, Same, dactyl and distal propodal spines, promotor aspect; *i*, Same, dactyl; *j*, Same, distalmost series of spines on flexor margin of dactyl; *k*, Same, distal propodal spines; *l*, Right 5th pereopod, remotor aspect; *m*, Same, dactyl and distal propodal spines, promotor aspect. (*a*, *c*, *e*, *g*, *l*, ×25; *b*, *d*, *f*, *h*, *i*, *k*, *m*, ×62; *j*, ×260.)

about 11.5 mm); ovigerous female paratypes with carapace lengths of 2.1 and 2.2 mm.

Type-locality.—Bommie (reef) No. 2, west side of lagoon, Lizard Island, Queensland, Australia; 1–15 meters.

Habitat.—There are few data about the station at which the type-series of *Pseudocheles enigma* was taken except the mention of "clumps of *Isis* and assorted soft corals around the bottom of the bommie." As the shrimp seems especially adapted for clinging to a marine plant or animal, this information about associated organisms may eventually prove to be meaningful.

Etymology.—The specific name is derived from the Latin neuter noun "aenigma," a riddle or enigma, in reference to the puzzling systematic status of the species.

Systematic Discussion

We are in complete agreement with the decision of Forest (1977) to transfer the genus *Lucaya* Chace, 1939, from the Bresiliidae Calman, 1896, to the Disciadidae Rathbun, 1902, and the senior author regrets very much the circumstances that so long delayed the correction of his misassignment of that genus.

Pseudocheles conforms with the Bresiliidae, as restricted, and differs from the Disciadidae in having: (1) a small but distinct tooth on the ventral margin of the rostrum, (2) the proximal endite of the 1st maxilla nearly as long as the distal endite, (3) the endites of the 2nd maxilla rather widely separated and at least one of them strapshaped, (4) no distinct lash on the exopod of the 1st maxilliped, (5) the terminal segment of the 2nd maxilliped attached transversely rather than obliquely to the penultimate segment, (6) the terminal segment of the 3rd maxilliped relatively slender, not broadly flattened, and (7) the 1st pereopod not longer than the 2nd and with elongate fingers.

It agrees with the Disciadidae and differs from the Bresiliidae in (1) lacking a pterygostomian spine on the carapace and in having: (2) no more than 3 pairs of dorsolateral spines on the telson and (3) the posterior margin of that component convex or pointed rather than truncate, (4) the scaphognathite of the 2nd maxilla short and broad, (5) the terminal segment of the 2nd maxilliped armed with stout spines, (6) the 2 anterior pairs of pereopods with the ischium and merus fused, (7) the 1st pair of pereopods with the carpus very short and partially recessed in the excavate distal end of the merus when the appendage is extended, (8) all of the pereopods provided with exopods and (9) contiguous ventrally, thereby inhibiting the development of spines on the thoracic sternum, and (10) all 5 pleurobranchs well-developed.

Inasmuch as *Pseudocheles* combines many of the characters used by

Forest (1977:878) to distinguish the Disciadidae from the Bresiliidae, especially the spines on the "molar" process of the mandible (disciadid), the form of the endites of the 2nd maxilla (bresiliid), the form of the 3rd maxilliped (bresiliid), the fusion of the ischium and merus of the 2 anterior pairs of pereopods (disciadid), and the form of the carpus and of the distal end of the merus of the 1st pereopods (disciadid), the possibility of combining the Disciadidae with the Bresiliidae is clearly suggested. On the other hand, the form of the mandible and of the 1st and 2nd maxillipeds would seem to narrow the gap between the resulting family and the Oplophoridae Dana, 1852, thereby reinforcing the belief of Forest (1977: 879) that *Bresilia* Calman, 1896, *Discias* Rathbun, 1902, and *Lucaya* are oplophoroid in nature. Prehaps even more disturbing is the revelation that the mandible and 2nd maxilliped of *Pseudocheles* are remarkably reminiscent of those structures in the Pasiphaeidae Dana, 1852, but the other mouthparts are so distinctly different that no consideration of that relationship can be entertained.

After considerable indecision about the relative merits of proposing another monogeneric family—characterized by an undivided mandible and spurious chelae on the 3 posterior pairs of pereopods—or of accommodating the genus in the revised family Bresiliidae (combined with the Disciadidae), we have finally selected the second choice as, hopefully, the most likely means of contributing to the eventual definitive classification of the Caridea. The reduction of the branchial complement of the bresiliid pereopodial somites to pleurobranchs alone (see partial review of caridean branchial formulae in Thompson, 1967:315, Table I) seems to be sufficient reason to separate that family from the Oplophoridae. The relative importance of a character of this kind probably varies from family to family and can be determined satisfactorily only when the evidence from the study of caridean larval characters is more nearly completed. In the meantime, the assignment of the Bresiliidae to the superfamily Oplophoroidea or to a separate superfamily must be a largely subjective decision.

The revised concept of the family Bresiliidae may be defined as follows: Mandible with palp; 2nd and 3rd maxillipeds and at least 1st and 2nd pereopods bearing well-developed exopods; 1st pereopod more robust than 2nd; gills on pereopodal somites consisting of pleurobranchs only.

Key to the Genera of the Family Bresiliidae

1. Rostrum armed ventrally with at least 1 small tooth; 2nd maxilla with endites widely separated, at least 1 strapshaped; 1st maxilliped without exopodal lash; 2nd maxilliped with terminal segment attached transversely to preceding segment; 3rd maxilliped with terminal segment slender, not flattened; 1st pereopod no longer than 2nd, with elongate fingers 2

– Rostrum unarmed ventrally; 2nd maxilla with endites partially overlapping, none strapshaped; 1st maxilliped with distomesial lash on exopod; 2nd maxilliped with terminal segment attached obliquely to preceding segment; 3rd maxilliped with terminal segment broad, flattened; 1st pereopod longer than 2nd, fingers short and stout 3

2. Carapace with pterygostomian spine; telson posteriorly truncate, armed with 5–11 pairs of dorsolateral spines; antennal scale broad distally, blade far overreaching distolateral tooth; mandible with incisor and "molar" processes deeply separate; 1st and 2nd pereopods with ischium and merus distinct, not fused; 1st pereopod with carpus as long as broad, not partially recessed in distal end of merus; 3 posterior pairs of pereopods conventional, not chelate; exopods on 1st and 2nd pereopods only *Bresilia*

  Two species: *B. atlantica* Calman, 1896, from the North Atlantic southwest of Ireland, 1,200–1,400 m, and *B. corsicana* Forest and Cals, 1977, from the Mediterranean Sea east of northern Corsica, 450 m.

– Carapace with antennal spine only, without pterygostomian spine; telson posteriorly acute, armed with 3 pairs of dorsolateral spines; antennal scale narrowing distally, blade not overreaching distolateral tooth; mandible without deep division between incisor and "molar" processes; 1st and 2nd pereopods with ischium and merus fused; 1st pereopod with carpus broader than long, partially recessed in distal end of merus; 3 posterior pairs of pereopods spuriously chelate; exopods on all 5 pereopods *Pseudocheles*

  One species: *P. enigma* (see above)

3. Rostrum not reaching level of distal segment of antennular peduncle; 3rd abdominal somite not forming gibbous cap over base of 4th somite; 3rd maxilliped with terminal segment distally lanceolate; 1st pereopod with dactyl semicircular; 3 posterior pairs of pereopods with ischiomeral suture well-marked *Discias*

  Five species, associated with sponges in all tropical and some temperate seas (see Bruce, 1976).

– Rostrum reaching level of distal end of antennular peduncle; 3rd abdominal somite forming gibbous cap over base of 4th somite; 3rd maxilliped with terminal segment obliquely truncate distally; 1st pereopod with dactyl not semicircular; 3 posterior pairs of pereopods with ischiomeral suture somewhat obscure *Lucaya*

  One species: *L. bigelowi* Chace, 1939, from the western North Atlantic off the Bahamas and Bermuda, pelagic to a possible depth of 4,773 m (see Chace, 1940:189 and Forest, 1977).

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SYNODUS CAPRICORNIS, A NEW LIZARDFISH FROM EASTER AND PITCAIRN ISLANDS

Roger Cressey and John E. Randall

Abstract.—*Synodus capricornis,* new species, is described from Easter and Pitcairn Islands. It is distinguished from all known Indo-West Pacific *Synodus* except *S. ulae* Schultz by its high vertebral count (64–65). The shape of the nasal flap and pigmentation on the snout separates the new species from *S. ulae.* Notes on endemism of fishes of Easter Island and the distribution of fish in Easter, Pitcairn and Rapa Islands are included.

The species described here was collected by Randall, who suggested in a popular article describing fish collecting in Easter Island (Randall, 1970) that it might be a new species. Cressey is doing a systematic revision of the Indo-west Pacific species of *Synodus* in conjunction with a comprehensive study of their copepod parasites.

Most counts and measurements were made according to Hubbs and Lagler (1958). Two characters not previously used in synodontid fishes are the shape of the nasal flap of the anterior nares and the number of peritoneal spots. The size and form of the nasal flap is consistent within species and is thus taxonomically useful. The dark peritoneal spots reported by various authors (i.e. Anderson et al., 1966; Gibbs, 1959; Gopinath, 1946; Norman, 1935) in postlarvae persist in adults. These spots, no longer visible externally in adults, can be easily seen on the peritoneal wall by cutting open the abdomen. They generally occur from the anteriormost portion of the peritoneum to slightly posterior of the origin of the anal fin. The number of spots is useful in separating juveniles of synodontid species, and this is true for adults as well. A more comprehensive discussion of these characters will be included in the forthcoming paper by Cressey.

Vertebral counts include the urostylar vertebra. Length of snout measurements are from tip to anterior margin of fleshy orbit. Diameter of orbit pertains to fleshy orbit (measured anterior–posterior).

The halftone illustration was done by Penelope Kay Hollingsworth.

Synodus capricornis, new species
Figs. 1–3

Synodus sp. Randall, 1970, p. 57 (Easter Island).

Holotype.—BPBM 6560, 131.3 mm SL, Easter Island, off Ahu Akapu, coral and sand bottom, 21 m, rotenone, J. E. Randall and B. A. Baker, 3 February 1969.

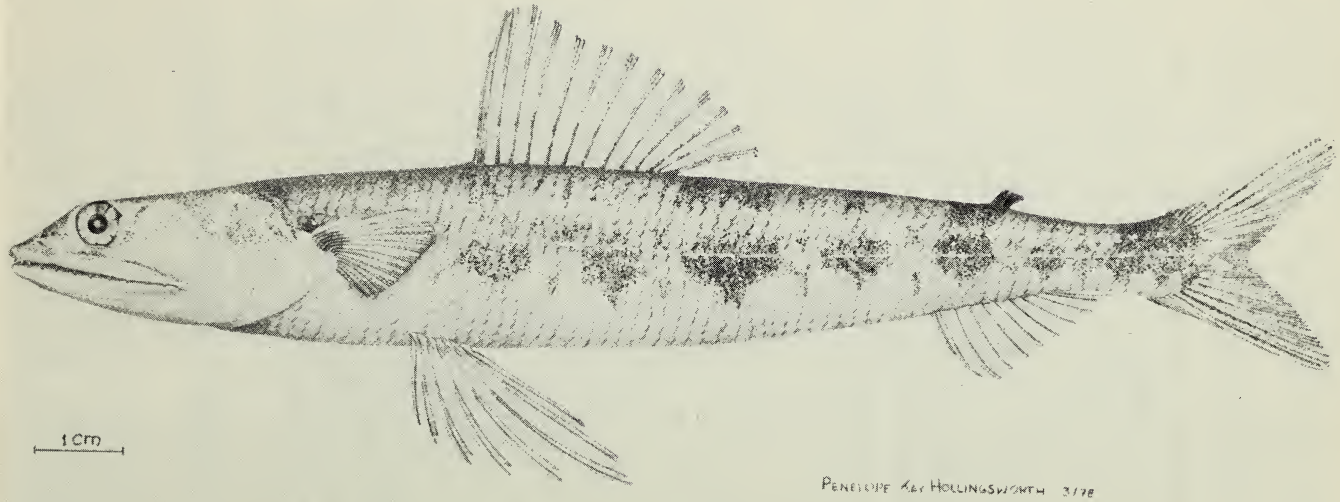

Fig. 1. *Synodus capricornis*, BPBM 6560, holotype, female, 131.3 mm SL, Easter Island (drawn from preserved specimen).

Paratypes.—BPBM 6562, 185.4 mm SL, Easter Island, off Motu Tautara, 38 m, rotenone, J. E. Randall and B. A. Baker, 12 February 1969; USNM 218461 167.8 mm SL, same data as preceding; BPBM 16860, 2; 74.2–92.7 mm SL, Pitcairn Island, off Bounty Bay, reef at edge of sand, 31–40 m, rotenone, J. E. Randall, D. B. Cannoy, and J. D. Bryant, 26 December 1970; USNM 218462, 99.6 mm SL, same data as preceding.

Description.—Holotype counts in parentheses. Small roman numerals refer to unbranched rays; arabic numerals to branched rays. Vertebrae 64–65 (65); dorsal-fin rays ii, 10-ii, 12 (ii,12); anal-fin rays vii, 1-ix,1 (ix,1); pectoral-fin rays ii,12; pelvic-fin rays i,7; branchiostegal rays 13; caudal-fin rays 19; procurrent caudal-fin rays 32–33 (32) 16–18 (16) dorsal, 15–16 (16) ventral; peritoneal spots 10–12 (11); lateral-line scales 64–65 (65); scales above lateral line 5.5–6.5 (6.5); scales below lateral line 7.5; predorsal scales 15; cheek with 5 rows of scales, covering anterior ⅔ of cheek; adipose eyelid narrow; interorbital space concave; eye midway between snout and angle of upper jaw; no keel on peduncle; upper jaw with single row of teeth, 2 v-shaped palatine bands each with 3 rows of teeth, inner row teeth longest; lower jaw with band of teeth of approximately 3 rows, teeth of inner row longest; tip of lower jaw with 2 incisorlike teeth within band of teeth, separated from posterior longest teeth by a gap filled with short teeth; lingual teeth well developed, backwardly directed on free end of tongue; nasal flap produced as a short tube with posterior margin forming a short triangular process; snout with 2 dark spots at tip; a series of 7–8 saddlelike dark bars, first bar anterior to origin of dorsal fin lighter than second bar at origin of dorsal fin, bars alternate lighter-darker caudally; paler below lateral line (dorsal bands may extend below lateral line); peritoneum pale except for dark spots; posterior pelvic process wide.

Color of holotype when fresh from an Ektachrome transparency (reproduced herein in black and white as Fig. 2): upper half of body greenish gray dorsally shading to orange-yellow on side, with a series of hourglass-shaped dark brown bars containing central areas of ground color; a row of dark brown blotches, one per pale interspace, just above lateral line and a second row of less distinct dark blotches above this; lower half of body whitish shading ventrally to pale salmon, with 15 narrow light orange-yellow bars, the upper part of each with some dark brown pigment; head mottled dark brown, greenish gray and orange-yellow dorsally, whitish with faint orange-yellow streaks ventrally; dorsal fin with pale membranes, the rays brown basally, light orangish distally, with two narrow whitish zones on lower half except rays 2–5 which have three and the last two rays which have one; caudal fin brown basally, the rest of the fin with pale membranes and orangish rays except some dark brown pigment on lobes and two converging whitish blotches in basal central part of fin; anal fin pale, the first few rays faintly orange-yellow; pectoral fins pale with a brown

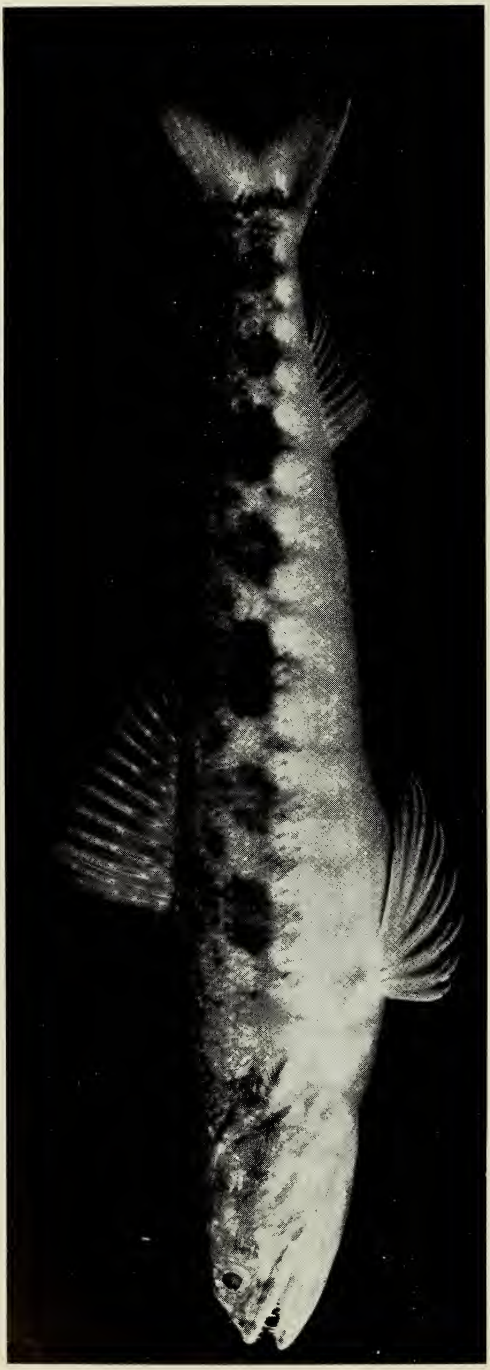

Fig. 2. *Synodus capricornis*, BPBM 6560, holotype, female, 131.3 mm SL, Easter Island (fresh specimen, photo by J. E. Randall).

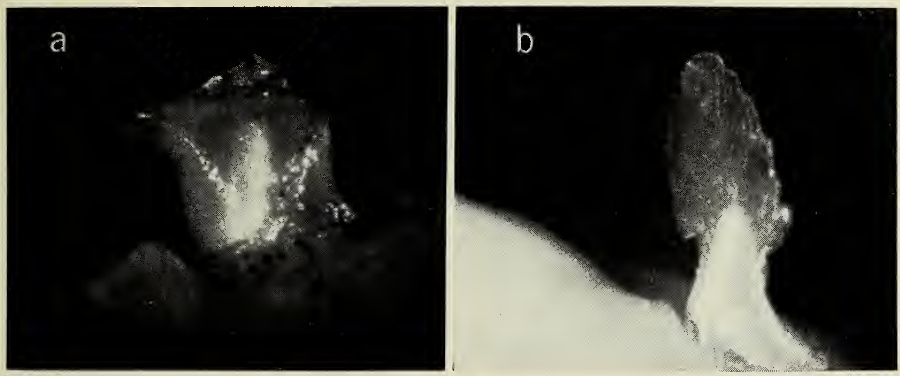

Fig. 3. Nasal flaps of *Synodus capricornis* and S. *ulae*. a. S. *capricornis*, USNM 218462, paratype, male, 99.6 mm SL, Pitcairn Island. b. S. *ulae*, ANSP 97832, male, 156 mm SL, Honolulu, Hawaii (photos by R. F. Cressey).

streak at base; pelvic fins with pale membranes, the rays white mixed with orange-yellow.

Morphometric data are presented in Table 1.

Etymology.—The name *capricornis* refers to the locality of the type material near the Tropic of Capricorn.

Remarks.—The high vertebral count distinguishes this species from all other known Indo-West Pacific *Synodus* except S. *ulae* Schultz from which it can be easily separated by the nasal flap. The nasal flap of S. *ulae* is produced as a large spatulate process (Fig. 3b), whereas in S. *capricornis* the flap is reduced to a short tube with the posterior margin produced as a short triangular process (Fig. 3a). It can be further separated from S. *ulae* as the new species typically has 2 dark spots at the tip of the snout (S. *ulae* often with some dark pigment on the snout but not in the form of discrete spots). The new species is similar to S. *ulae* in other meristic characters as well (dorsal and anal-fin ray and peritoneal spot counts). *Synodus ulae* is so far known only from Japan and Hawaii in the northern hemisphere, with the new species perhaps its counterpart in the southern hemisphere. Both species are on the periphery of Indo-West Pacific *Synodus* distribution.

The depth of capture data indicate that this species prefers depths of 70–130 ft.

The second author, Gerald R. Allen, and Bruce A. Baker collected fishes in Easter Island for a month in early 1969, resulting in the first specimens of *Synodus capricornis*. They brought the total number of species known from the island to 109 (Randall, 1970). A preliminary estimate of the level of endemism for fishes was given as 40%. It was predicted, however, that collections at the islands of the Pitcairn Group and Rapa to the

Table 1. Morphometric data for type specimens of *Synodus capricornis* new species (percent standard length in parentheses, measurements in mm).

Character	Paratype ♀ BPBM 6562	Paratype ♀ USNM 218461	Holotype ♀ BPBM 6560	Paratype ♂ USNM 218462	Paratype ♂ BPBM 16860	Paratype ♀ BPBM 16860
Standard length	185.4	167.8	131.3	99.6	92.7	74.2
Head length	51.5 (28)	47.4 (28)	36.9 (28)	31.8 (32)	28.0 (30)	23.1 (31)
Greatest depth	27.2 (15)	27.4 (16)	21.8 (16)	13.3 (13)	13.2 (14)	11.4 (15)
Least depth-caudal peduncle	11.2 (6)	10.7 (6)	7.6 (6)	5.8 (6)	5.2 (6)	4.3 (6)
Fleshy interorbital space	11.2 (6)	10.2 (6)	7.5 (6)	5.3 (5)	4.8 (5)	3.8 (5)
Body width	28.6 (15)	26.1 (16)	19.3 (15)	14.0 (14)	13.0 (14)	09.6 (13)
Length of snout	12.7 (7)	10.9 (6)	7.7 (6)	6.6 (7)	6.5 (7)	4.3 (6)
Length of upper jaw	32.3 (17)	28.2 (17)	21.8 (17)	18.7 (19)	16.5 (18)	13.4 (18)
Diameter of orbit	7.1 (4)	6.9 (4)	6.0 (4)	5.5 (5)	4.5 (5)	4.0 (5)
Snout to dorsal origin	77.4 (42)	68.7 (41)	53.9 (41)	43.0 (43)	40.0 (43)	32.4 (44)
Snout to adipose origin	160.7 (87)	144.2 (86)	114.8 (87)	86.4 (87)	79.6 (86)	63.0 (85)
Snout to anal origin	153.0 (83)	138.2 (82)	109.3 (83)	81.1 (81)	77.1 (83)	60.6 (82)
Snout to pectoral insertion	50.3 (27)	44.0 (26)	33.6 (26)	29.7 (30)	28.2 (30)	22.6 (30)
Snout to pelvic insertion	64.5 (35)	58.0 (35)	44.7 (34)	36.7 (37)	34.5 (37)	27.2 (37)
Snout to anus	148.1 (80)	135.7 (81)	105.3 (80)	80.3 (81)	74.0 (80)	57.6 (78)
Pelvic origin to anus	87.2 (47)	79.3 (47)	58.7 (45)	43.5 (44)	41.5 (45)	31.9 (43)
Length of pectoral fin	18.0 (10)	15.9 (10)	10.8 (8)	8.9 (9)	9.2 (10)	7.5 (10)
Length of pelvic fin	37.4 (20)	35.6 (21)	27.1 (21)	23.6 (24)	20.7 (22)	16.6 (22)
Length of caudal fin	31.6 (17)	25.8 (15)	20.3 (16)	15.3 (15)	13.9 (15)	11.1 (15)
Height of adipose fin	4.9 (3)	4.6 (3)	3.9 (3)	3.0 (3)	2.4 (3)	2.3 (3)
Dorsal-fin base	29.1 (16)	27.9 (17)	21.9 (17)	16.4 (17)	15.6 (17)	11.1 (15)
Anal-fin base	15.8 (9)	13.7 (8)	12.5 (10)	8.7 (9)	6.5 (7)	6.0 (8)
Length of 1st dorsal ray	16.7 (9)	14.6 (9)	11.5 (9)	8.5 (9)	8.3 (9)	7.4 (9)
Length of longest dorsal ray	24.0 (13)	21.1 (13)	17.5 (13)	12.5 (13)	13.0 (14)	10.8 (15)
Length of longest anal ray	15.0 (8)	14.5 (9)	9.0 (7)	damaged	7.0 (8)	5.0 (7)

west (at approximately the same latitude) would reveal the presence of some of the Easter Island "endemics." This proved to be true (Randall, 1973, 1974), and *S. capricornis* was among those species whose distribution was extended. Still other Easter fishes range even farther to the west in the southern subtropical zone. A recalculation of the level of endemism of fishes at Easter Island, as a result of extralimital collections and analyses, has produced the figure of 27.3% (Randall, 1976). This, however, is still tentative pending the further study. Thus the distribution pattern of Easter Island-Pitcairn (or Easter to Rapa) is not unique to *Synodus capricornis.* It is shared by other species such as the moray *Gymnothorax nasuta* De Buen, the soldierfish *Myripristis tiki* Greenfield, the hawkfish *Amblycirrhitus wilhelmi* (Lavenberg and Yañez) (generic classification uncertain), an undescribed morwong (*Goniistius*), the wrasse *Pseudolabrus fuentesi* (Regan), and the angelfish *Centropyge hotumatua* Randall and Caldwell.

One interesting observation was made by Randall (1970:57) on the predatory behavior of *Synodus capricornis* at Easter Island. After commenting that lizardfishes, in general, are voracious predators which usually dart upward from a resting position on the bottom to seize small fishes he wrote, "I was surprised, therefore, to see one of the Easter Island lizardfish slowly swim upward from the bottom at a depth of forty feet nearly halfway to the surface. But I noted that he was rising to the level of a small dense school of juvenile mackerel scads (*Decapterus*). He then rushed into the school, and as he emerged, I could see that he held one still struggling scad sideways in his jaws. It seemed nearly as large as the lizardfish, and I have since wondered if he ever managed to swallow it."

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FIVE NEW GENERA OF ANTHURID ISOPOD CRUSTACEANS

Brian Kensley

Abstract.—Three new genera and species of anthurid isopods are described, viz. *Heptanthura* and *Rhiganthura* from off New Zealand, and *Venezanthura* from Venezuela. *Cyathura siamensis* Barnard is transferred to the new genus *Caenanthura*, *Anthelura abyssorum* Norman & Stebbing is transferred to the new genus *Valoranthura*, and *Anthelura* Norman & Stebbing is redefined.

While preparing a generic revision of the isopod family Anthuridae, scattered samples from widely separate areas, often containing only 1 or 2 animals, were examined. The present paper provides descriptions of 5 new genera, prior to their inclusion in the aforementioned revision.

The specimen from Venezuela was collected by the Hancock Pacific Expedition of 1939. The 2 genera from off New Zealand were collected by the USRV *Eltanin* during the United States Antarctic Research Program, while the new genus from Thailand was collected by the Danish Theo Mortensen Expedition of 1900. The *Anthelura elongata* type material was collected by the British 'Porcupine' Expedition of 1870, while the type material of *Valoranthura* was collected by the British 'Valorous' Expedition of 1875.

Suborder ANTHURIDEA
Family Anthuridae
Heptanthura, new genus

Diagnosis.—Eyes present. Antennular flagellum of 2 articles, antennal flagellum of 6 articles. Mandibular palp 3-segmented; incisor, lacinia, and molar present. Maxilliped 7-segmented; endite lacking. Pereopod 1 subchelate, propodus expanded. Pereopods 2 and 3 smaller than 1, not subchelate. Pereopods 4–7, carpus triangular, underriding propodus. Pleopod 1 exopod operculiform. Pleonites 1–5 fused, 6 free. Telson lacking statocysts.

Type-species.—*Heptanthura novaezealandiae*, new species.

Gender.—Feminine.

Etymology.—The prefix 'hept' in the generic name refers to the seven segments of the maxilliped.

Remarks.—*Neohyssura* Amar and *Ocsanthura* Kensley possess a 7-segmented maxilliped, but the latter genus has rectangular rather than triangular carpi of the posterior three pairs of pereopods. *Neohyssura* possesses a well developed maxillipedal endite, which is lacking in *Heptanthura*, while the first pair of pleopods are not operculiform as in the New Zealand genus.

Heptanthura novaezealandiae, new species
Figs. 1, 2

Description.—Female: Integument not indurate. Body proportions: $C < 1 = 2 = 3 = 4 < 5 > 6 > 7$. Cephalon with rounded anterolateral lobes extending beyond small triangular rostrum. Eyes present. Pleonites 1–5 fused, with grooves over dorsum indicating individual segments; pleonite 5 with concave posterior margin; pleonite 6 with deep middorsal incision in posterior margin. Telson with hyaline border; wider distally than proximally, margin distally serrate, evenly convex in outline, with several simple setae. Statocysts not apparent.

Antennule with 4-segmented peduncle, basal segment broadest and longest, fourth segment short, oblique; flagellum of 2 articles. Antenna with 5-segmented peduncle; flagellum of 5 or 6 short articles. Mandibular palp 3-segmented, middle segment longest; incisor broad, almost no in-indication of cusps; lacinia serrate; molar short and blunt. Lower lip complex with 2 short processes at apex of each lobe. Maxilla with single strong terminal spine and 6 smaller spines. Maxilliped 7-segmented, lacking endite; terminal segment very short, with 4 setae; second segment longest; third segment very short. Pereopod 1 unguis one-third length of dactylus, with short supplementary spine; propodus proximally broad, palm straight, unarmed; carpus short, triangular. Pereopod 2 prododus less robust than 1, with strong bipartite sensory spine at ventrodistal angle. Pereopods 4–7 carpus triangular, underriding propodus; latter and carpus each with strong bipartite sensory spine at ventrodistal angle. Pleopod 1 exopod and endopod operculiform; endopod slightly longer but narrower than exopod; both rami with numerous distal plumose; basis with 3 retinaculae. Uropodal exopod distally emarginate, forming slender dorsal apically bidentate dorsal part, with dorsal margin bearing numerous plumose setae, and broader rounded ventral part; endopod shorter than basis, almost reaching telsonic apex, broadly rounded, distal margin dentate, bearing simple setae; outer margin of basis with row of plumose setae.

Material.—Holotype, USNM 171227, ♀ TL 3.5 mm. Paratype USNM 171228, ♀ TL 3.5 mm. *Eltanin* cruise 19, station 1498, 37°32′S, 178°42′W 101 m (off North Island, New Zealand).

Etymology.—The species was collected close to New Zealand, hence the name.

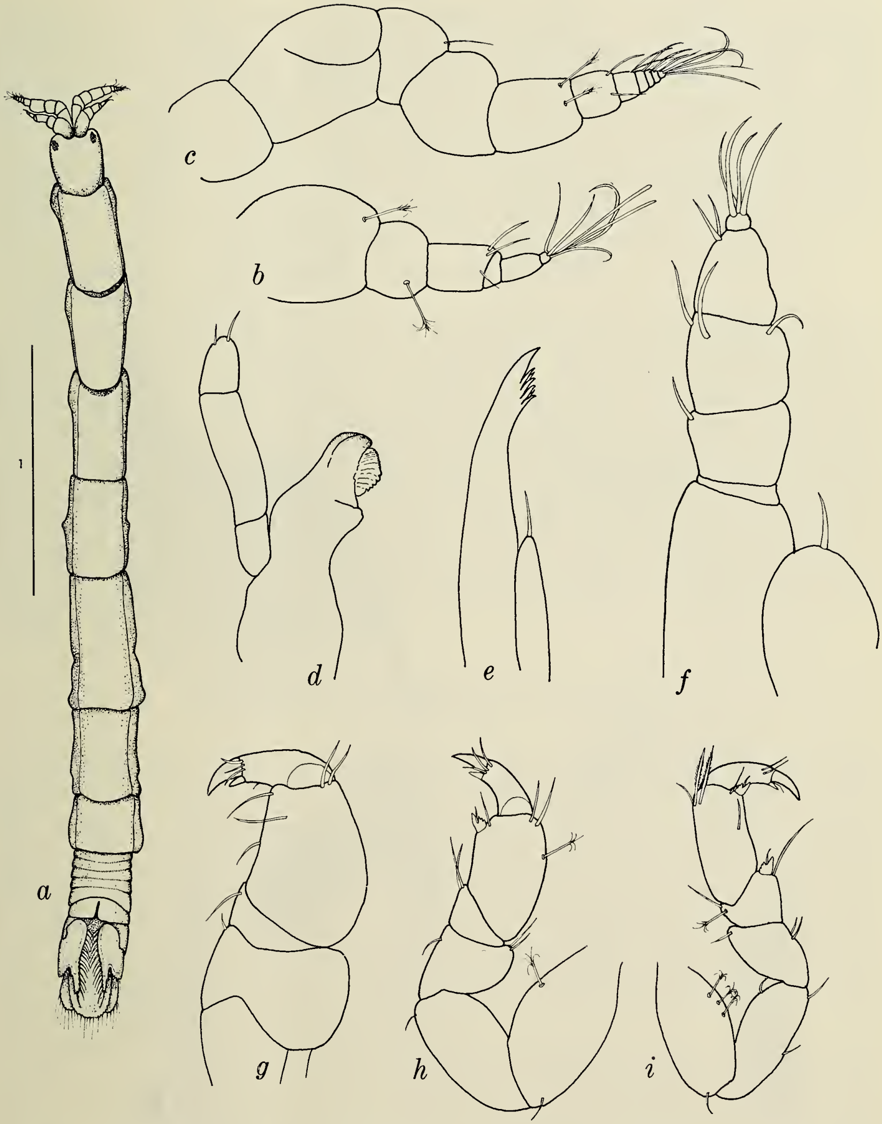

Fig. 1. *Heptanthura novaezealandiae*: a, Holotype in dorsal view; b, Antennule; c, Antenna; d, Mandible; e, Maxilla; f, Maxilliped; g, Pereopod 1; h, Pereopod 2; i, Pereopod 7.

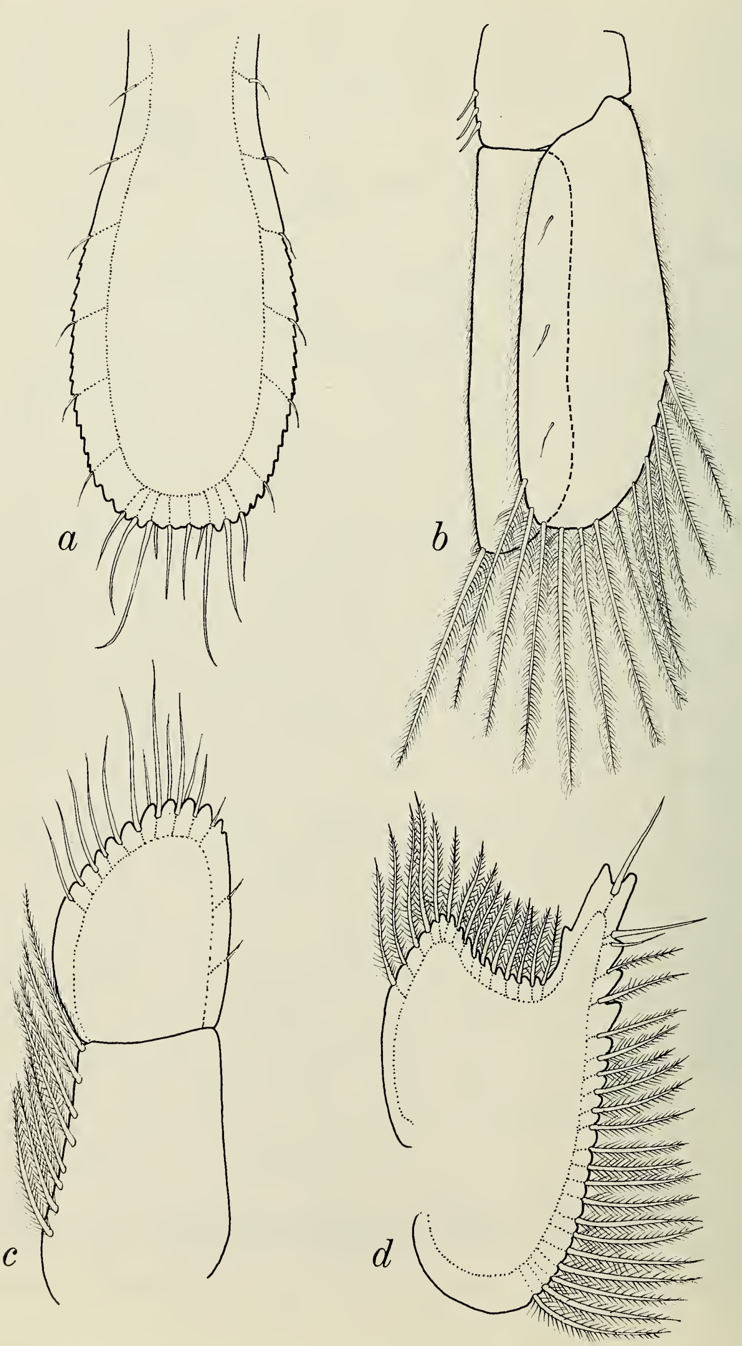

Fig. 2. *Heptanthura novaezealandiae*: a, Telson; b, Pleopod 1; c, Uropodial endopod and basis; d, Uropodial exopod.

Rhiganthura, new genus

Diagnosis.—Eyes present. Antennular flagellum of 4 articles. Antennal flagellum of 6 articles. Mandibular palp 2-segmented; incisor, molar, and lacinia present. Maxilliped 5-segmented, endite present. Pereopod 1 subchelate, propodus expanded. Pereopods 2 and 3 smaller than 1. Pereopods 4–7 with triangular carpus underriding propodus. Pleopod 1 endopod and exopod together forming operculum over branchial chamber. Pleonites 1–5 free, relatively short; pleonite 6 large, with deep middorsal excavation. Telson apparently lacking statocysts. Uropodal exopod bipartite.

Type-species.—*Rhiganthura spinosa*, new species.

Gender.—Feminine.

Etymology.—The generic name is derived from the Greek 'rhigos' meaning cold or frosty, alluding to the relatively cold water from which the specimens were taken, plus the commonly-used suffix 'anthura'—a flower.

Remarks.—The differences between *Rhiganthura* and *Venezanthura*, the only other anthurid with a 2-segmented mandibular palp, are discussed under the latter genus. A further distinguishing feature of *Rhiganthura* lies in the nature of the first pleopods, where both endopod and exopod together form the operculum over the remaining pleopods. This feature is seen to a limited degree in species of *Panathura* but is never as well developed as in the present material.

Rhiganthura spinosa, new species

Figs. 3, 4

Description.—Female: Integument, except for tail-fan, not indurate. Body proportions: $C < 1 = 2 < 3 = 4 = 5 > 6 > 7$. Cephalon with triangular rostrum extending well beyond rounded anterolateral corners; latter containing eyes. Pereonite 6 with 2 anterodorsal shallow pits. Pereonite 7 very short. Pleonites free, separate; pleonite 1 almost hidden by pereonite 7; pleonites 2–4 subequal, 5 slightly longer; 6 as long as 3 preceding segments, broader than rest of pleon, with deep middorsal excavation. Pleonites with dense ventrolateral plumose setae. Telson basally broad, tapering distally, margins spinose, moderately indurate.

Antennular peduncle 4-segmented, basal segment equal in length to 3 distal segments together; fourth segment very short; flagellum of 4 articles, basal article longest. Antennal peduncle 5-segmented, first and third segments short, subequal, segments 2, 4, and 5 somewhat longer; flagellum of 6 articles, basal article longest, entire flagellum equal in length to fifth peduncular segment. Mandibular palp of 2 subequal segments, distal segment with single fringed seta; incisor of 3 rounded cusps; lacinia with faint indications of few marginal serrations; molar bluntly triangular. Maxilla with strong distal spine and 5 or 6 smaller spines. Maxilliped 5-segmented, 3 distal segments subequal, distal segment rounded, with several simple

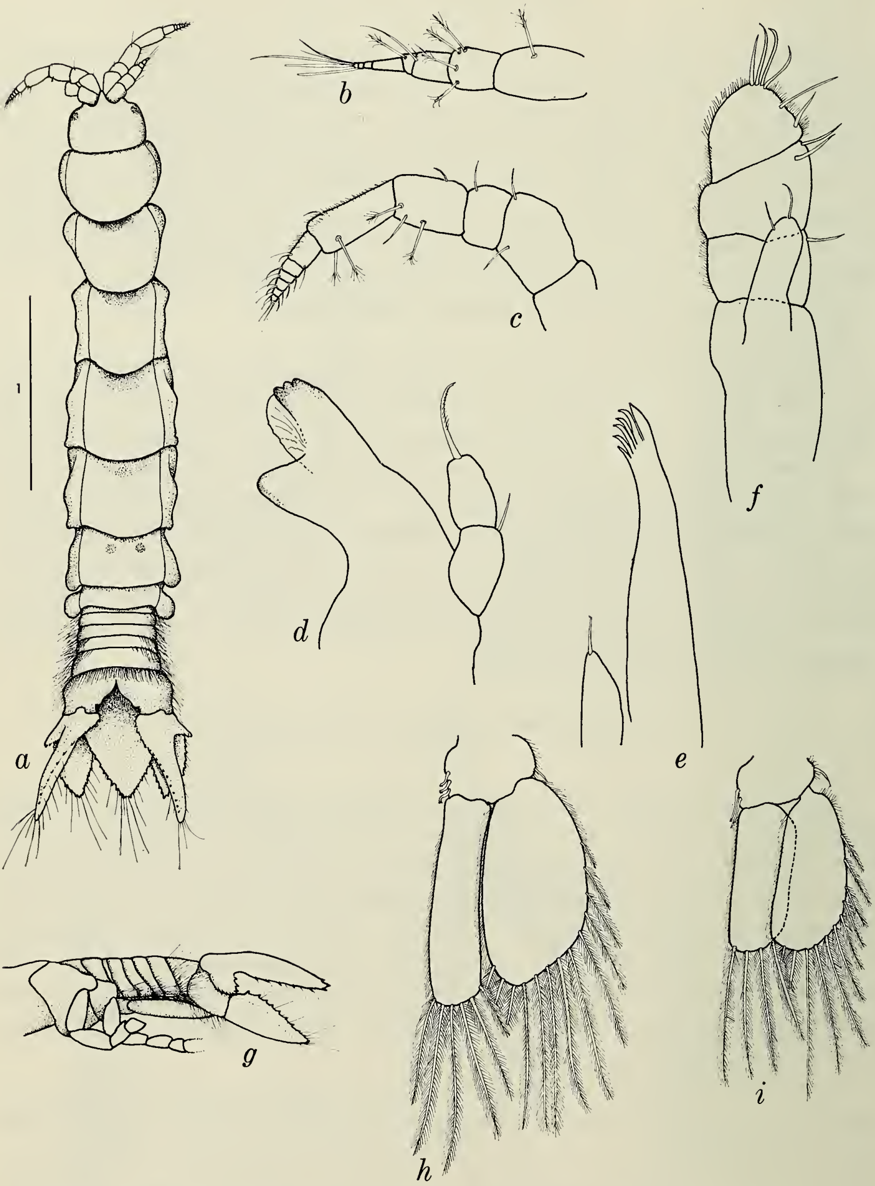

Fig. 3. *Rhiganthura spinosa*: a, Holotype in dorsal view; b, Antennule; c, Antenna; d, Mandible; e, Maxilla; f, Maxilliped; g, Pleon in lateral view; h, Pleopod 1; i, Pleopod 2.

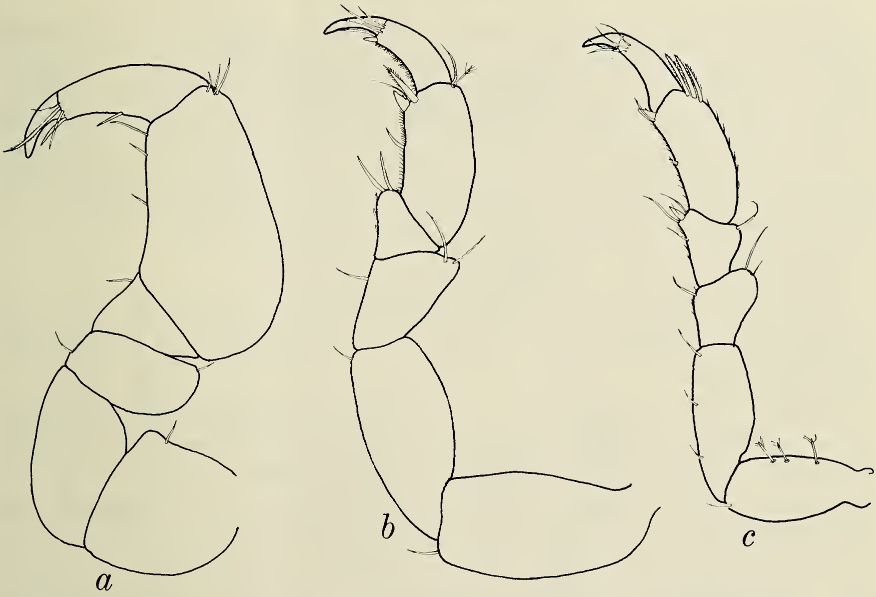

Fig. 4. *Rhiganthura spinosa*: a, Pereopod 1; b, Pereopod 2; c, Pereopod 7.

setae, second segment relatively elongate; delicate endite present, tipped with 2 setae. Pereopod 1 unguis one-third length of dactylus; propodus proximally broader than distally, palm almost straight, unarmed. Pereopod 2 unguis slightly more than half length of dactylus; propodus with 2 posterodistal spines; carpus triangular, with no free anterior margin. Pereopods 4–7 unguis half length of dactylus; propodus with 3 anterodistal fringed spines, single short ventrodistal spine; carpus triangular, with short anterior margin, short posterodistal spine. Pleopod 1 with exopod and endopod lying side by side, endopod slightly longer, together forming operculum; both rami with numerous elongate plumose setae; basis with 3 retinaculae. Pleopod 2 rami subequal. Uropod indurate, exopod dorsal, consisting of narrow dorsal section extending beyond telson, and short broad ventral part; both parts marginally spinose; endopod basally broad, tapering distally, margins spinose.

Material.—Holotype ♀ USNM 171229, TL 4.0 mm. Paratype ♀ USNM 171230, TL 3.7 mm; 2 juveniles, TL 1.8 mm. *Eltanin* cruise 19, station 1498, 37°32′S, 178°42′W, 101 m (off North Island, New Zealand).

Etymology.—The specific name refers to the spinose nature of the tail-fan.

Venezanthura, new genus

Diagnosis.—Eyes very small, weakly pigmented. Antennular and antennal flagella of one article. Basal antennular segment and second antennal segment interlocked. Mandibular palp 2-segmented. Maxilliped 3-segmented, with endite. Pereopod 1 subchelate, propodus expanded. Pereopods 2 and 3 smaller than 1, hardly subchelate. Pereopods 4–7 with short, roughly triangular carpus underriding propodus. Pleopod 1 exopod operculiform. Pleonites 1–5 fused, 6 free. Telson with 2 basal statocysts.

Type-species.—*Venezanthura confixa*, new species.

Gender.—Feminine.

Etymology.—The generic name is derived from Venezuela, where the specimen was collected, and 'anthura,' the frequently-used Greek suffix meaning a flower.

Remarks.—The combination of a 3-segmented maxilliped, a triangular carpus underriding the propodus in the posterior pereopods, and pleonites 1–5 fused, places this specimen close to the genus *Pendanthura.* The maxilliped of *Pendanthura*, with its lobe-like endite, is very similar to that of *Venezanthura.* Comparison of mandibular palps, however, easily separates the genera, *Pendanthura* having the mandibular palp reduced to one or two setae. *Rhiganthura,* described elsewhere in this paper, is the only other known anthurid possessing a 2-segmented mandibular palp, but is easily separated from *Venezanthura* by its 5-segmented maxilliped and free pleonites.

Venezanthura confixa, new species

Figs. 5, 6

Description.—Male: Integument and appendages indurate, brittle. Body proportions: $C < 1 > 2 > 3 = 4 = 5 < 6 > 7$. Cephalon with marked lateral keel; low rostrum separating antennal bases; eyes small, very faintly pigmented. Pleonites 1–5 fused, barely indicated ventrolaterally; pleonite 6 free. Telson strongly indurate, proximal two-thirds parallel-sided, distal third tapering to evenly rounded apex; proximally thickened, with rounded ridge between uropodal exopod bases, becoming distally flattened and thinner, with 2 proximal statocysts.

Basal antennular segment and second antennal segment firmly interlocked and forming flattened dorsal surface. Antennule situated slightly ventral to antenna; peduncle 4-segmented, second and third segments each with group of 6 elongate ventral setae; fourth segment short; flagellum of 1 very short article set obliquely in fourth peduncle segment, directed ventrally, bearing cluster of terminal filiform aesthetascs. Antennal peduncle 5-segmented, second segment longest; flagellum a single very short article bearing cluster of short setae. Mandibular palp 2-segmented, distal seg-

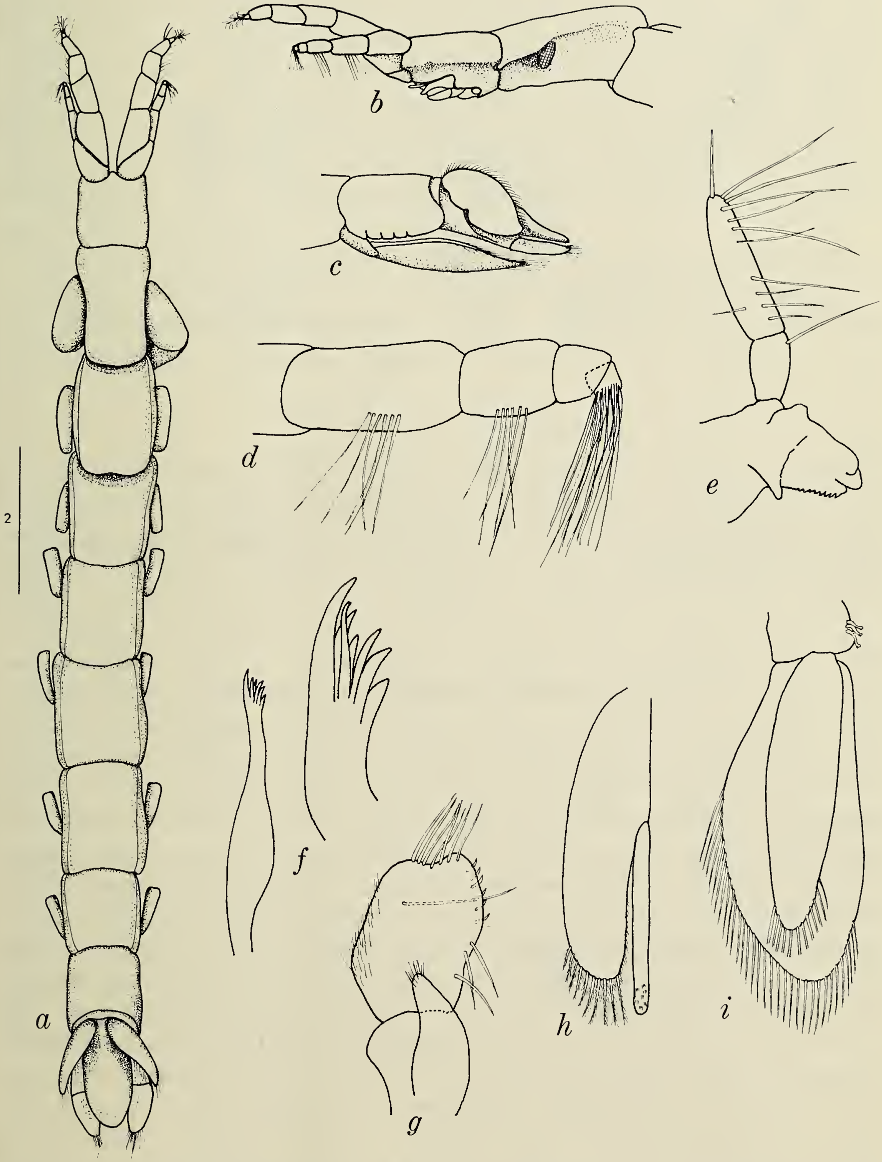

Fig. 5. *Venezanthura confixa*: a, Holotype in dorsal view; b, Cephalon in lateral view; c, Pleon in lateral view; d, Antennule; e, Mandible; f, Maxilla, with apex enlarged; g, Maxilliped; h, Pleopod 2 endopod; i, Pleopod 1.

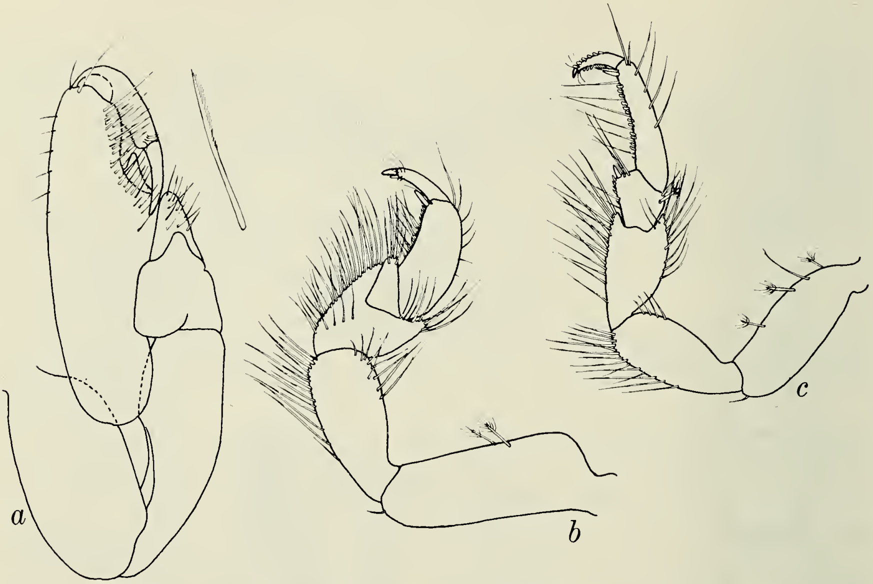

Fig. 6. *Venezanthura confixa*: a, Pereopod 1, with propodal spine enlarged; b, Pereopod 2; c, Pereopod 7.

ment twice length of first segment, bearing several elongate simple setae; molar process reduced to narrowly triangular process; lacinia of 8 or 9 serrations; incisor of 3 broadly rounded cusps. Maxilla slender, with 7 distal spines. Maxilliped 3-segmented, terminal segment broadest and longest, with 7 or 8 elongate distal setae and 6 short setae along median margin; thin-walled lobe-like endite present on inner surface, bearing a few fine distal setae. Pereopod 1 unguis almost half length of dactylus; propodus with pronounced posterior extension, palmar margin concave, armed with strong proximal digitiform tooth and numerous slender serrate spines; carpus short, triangular, bearing several simple setae. Pereopod 2 less robust than 1; unguis one-fifth length of dactylus with short spine; dactylus half length of propodus; latter curved, with strong posterodistal spine and several setae and very short spinules on posterior margin; carpus very short, triangular; carpus, merus, and ischium with numerous simple setae on posterior surfaces. Pereopods 5–7 with dactylus one-third length of propodus, unguis very short, anterior and posterior surfaces bearing short fringed scales; propodus with strong simple spine and fringed spine at posterodistal corner, posterior surface bearing 6 simple elongate setae and several short flattened fringed spines; carpus roughly pentagonal, anterior shorter than posterior margin, underriding propodus, with strong spine at posterodistal angle and few smaller spinules and several simple setae; merus and ischum bearing numerous simple setae. Pleopod 1 exopod indurate, operculiform, with dense distal fringe of plumose setae; endopod half width of, and slightly shorter than exopod, with 12 distal setae; basis bearing 3 retinaculae. Pleopod 2 endopod with 10 plumose setae on distal margin, copulatory stylet on median margin articulating at midpoint of ramus, extending beyond ramus, simple rod-shaped, with groups of very fine setules distally, apically rounded. Uropodal exopod ovate, folding dorsally over telson, apically subacute, extending just beyond basis, margins bearing plumose setae; endopod distally rounded, bearing clump of setae, extending beyond telsonic apex.

Material.—Holotype ♂ USNM 171226, TL 13.4 mm. Cubagua Island, Venezuela; taken in 4–10 m from sand and algal bottom.

Etymology.—The specific name 'confixa' refers to the firmly interlocked first antennular and second antennal segments.

Caenanthura, new genus

Diagnosis.—Eyes absent. Antennular flagellum of 2 articles. Antennal flagellum of 1 article. Mandibular palp 1-segmented; incisor, lacinia, and molar present. Maxilliped 4-segmented, endite absent. Pereopod 1 subchelate, propodus expanded. Pereopods 2 and 3 smaller than 1, subchelate. Pereopods 4–7 carpi triangular, underriding propodi. Pleopod 1 exopod operculiform. Pleonites 1–5 fused, 6 free. Telson with 2 basal statocysts.

Type-species.—*Caenanthura siamensis* (Barnard), 1925.

Gender.—Feminine.

Etymology.—The generic name is derived from the Greek 'kainos' meaning new, and 'anthura' the commonly-used suffix meaning a flower.

Remarks.—Barnard (1925) placed the present material in *Cyathura* mainly because of the 4-segmented maxilliped and the triangular carpus of the posterior pereopods. He did not examine the mandible and so missed the distinctive 1-segmented palp. Two genera possess a 1-segmented mandibular palp, viz. *Pendanthura* and *Ptilanthura*, both of which, however, possess 3-segmented maxillipeds. Further differences include the presence of a maxillipedal endite in *Pendanthura*, and rectangular carpi of the posterior 3 pairs of pereopods in *Ptilanthura*.

Caenanthura siamensis (Barnard)

Fig. 7

Cyathura siamensis Barnard, 1925:140, pl. 4, fig. 6.—Nierstrasz, 1941:6.—Miller & Burbanck, 1961:66.

Description.—Female: Integument not indurate. Body proportions: $C < 1 < 2 < 3 < 4 > 5 > 6 > 7$. Cephalon lacking eyes; with very low

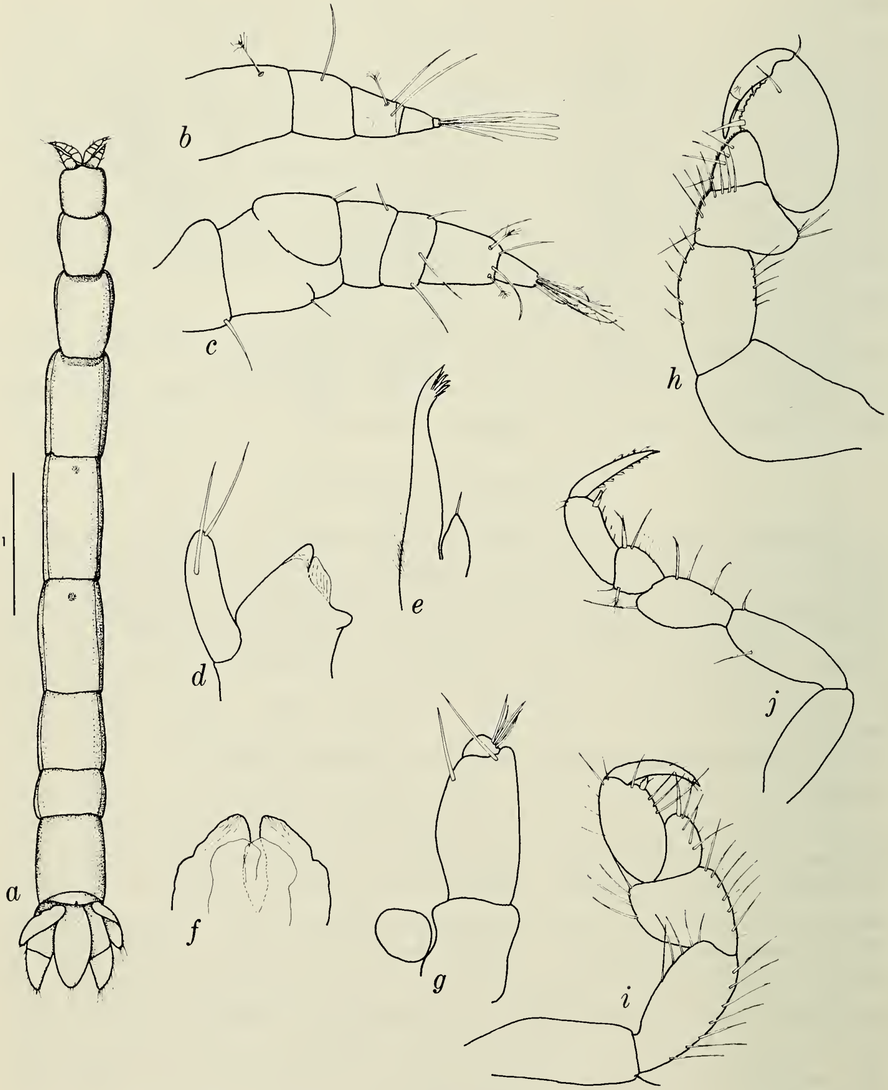

Fig. 7. *Caenanthura siamensis*: a, Lectotype in dorsal view; b, Antennule; c, Antenna; d, Mandible; e, Maxilla; f, Lower lip; g, Maxilliped; h, Pereopod 1; i, Pereopod 2; j, Pereopod 7.

rostrum. Pereonites 4 and 5 each with very shallow anterodorsal pit. Pleonites 1–5 fused, with no indication of segmentation dorsally, barely indicated ventrolaterally; pleonite 6 free, short, posterior margin with mediodorsal notch. Telson thin, dorsally flattened, lanceolate, apex narrowly rounded, with 2 basal statocysts. Antennular peduncle 4-segmented, fourth segment very short, indistinct; flagellum of 2 articles, terminal article small, with 3 aesthetascs. Antennal peduncle 5-segmented, second segment longest, grooved to accommodate antennule; flagellum of single setose article. Mandibular palp of single segment, bearing 2 elongate simple setae; incisor of single rounded cusp; lacinia unserrated; molar small, bluntly rounded. Maxilla with 1 strong and 5 smaller apical spines. Maxilliped 4-segmented, terminal segment small, semicircular, with 4 or 5 simple setae; third segment basally slightly constricted. Pereopod 1 unguis about one-third length of dactylus; propodus basally broad, palm gently convex, faintly crenulated; carpus triangular, with 4 simple setae on posterior margin; merus with 7 or 8 simple setae on posterior margin. Pereopods 2 and 3 smaller but similar to 1; propodus with short posterodistal serrated sensory spine; posterior margin of carpus strongly convex; propodus, carpus, merus, ischium all with simple setae. Pereopods 4–7 unguis of dactylus very short; dactylus bearing fringed scales; propodus with posterodistal sensory spine; carpus roughly triangular, anterior margin shorter than posterior, slightly underriding propodus. Brood pouch formed by 3 pairs of oostegites on pereonites 3–5. Pleopod 1 exopod operculiform; endopod slightly shorter and about one-third width of exopod. Uropodal exopod just reaching to endopodal base; outer margin gently sinuous; endopod triangular, outer margin convex, apex narrowly rounded.

Material.—The type-series consists of 8 syntypes from the Copenhagen museum. A lectotype has now been chosen for this species. Lectotype ovig. ♀ TL 5.8 mm. Paralectotypes 7 ♀♀ TL 3.9–6.4 mm; Theo Mortensen Expedition, 1900; Koh Chang, Thailand, 6–10 m.

Anthelura Norman & Stebbing

Diagnosis.—Eyes absent. Antennular flagellum of 5–7 articles. Antennal flagellum of 11 articles. Mandibular palp 3-segmented; incisor, lacinia, and molar present. Maxilliped 5-segmented, endite present. Pereopods 1–3 subchelate, similar, pereopod 1 largest. Pereopods 4–7 carpi rectangular, not underriding propodi. Pleopod 1 exopod operculiform. Pleonites 1–6 free. Telson with 2 basal statocysts.

Type-species (by subsequent designation).—*Anthelura elongata* Norman & Stebbing, 1886.

Gender.—Feminine.

Material examined.—Syntypes, B.M. 1903.5.20.41–44, ♂ TL 18.2 mm, juv. 8.7 mm; *Porcupine* Expedition, off Portugal, 1,500 m. Syntypes, B.M. 1911.11.8.7543–7544, ♀ TL 13.8 mm juv. 7.0 mm; *Porcupine* Expedition, off Portugal, 1,590 m.

Remarks.—Norman & Stebbing (1886) described the new genus *Anthelura*

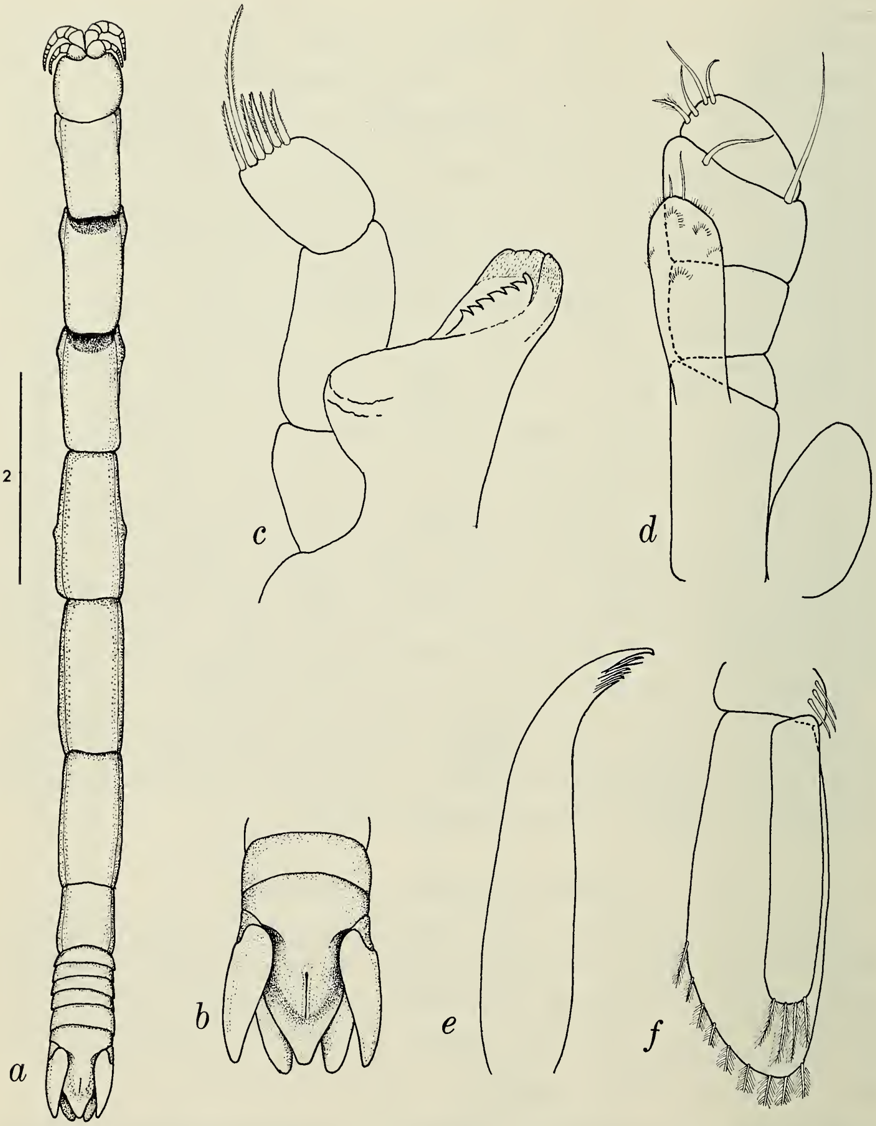

Fig. 8. *Valoranthura abyssorum*: a, Syntype ♀ in dorsal view; b, Telson further enlarged; c, Mandible; d, Maxilliped; e, Maxilla; f, Pleopod 1.

for 2 species, but designated neither as the type-species. Barnard (1925) described the new genus *Ananthura* for 2 new species, and transferred *Anthelura abyssorum* to *Ananthura*. Menzies (1962) designated *Anthelura elongata* as the type-species of the genus *Anthelura*, and *Ananthura sulcati-*

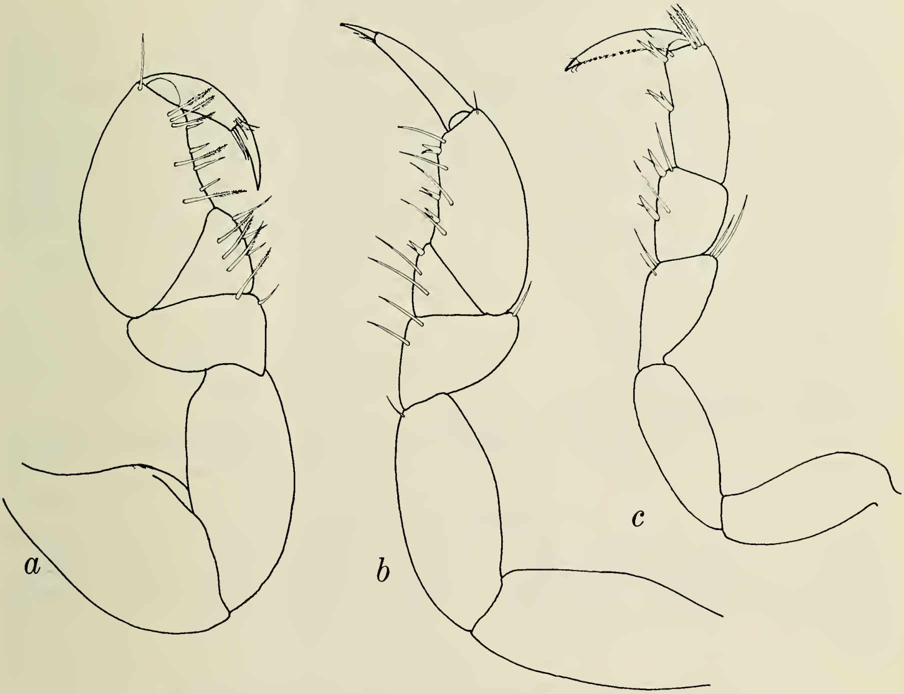

Fig. 9. *Valoranthura abyssorum*: a, Pereopod 1; b, Pereopod 2; c, Pereopod 7.

cauda as the type-species of the genus *Ananthura.* By the criteria used for generic separation in this work, and after examining both Norman & Stebbing's and Barnard's type material, no reason can be found to separate the 2 genera. As Norman and Stebbing's genus has priority, the genus *Ananthura* is suppressed, and *Anthelura elongata*, *Ananthura sulcaticauda*, and *Ananthura ovalis* are placed in *Anthelura.*

Anthelura abyssorum, because of the condition of the maxilliped and pleon, must be accommodated in a separate genus.

Bathura Schultz, 1966, agrees with all the criteria for *Anthelura* as redefined above. Schultz remarked that this deep-water Californian genus was most like *Ananthura,* but differed in "general pattern of peraeopodal hand with a tooth on palm, and characteristic pattern of setae on apex of telson and uropodal rami" (1966:12). However, when looking at the overall structure of all the pereopods, *B. luna* closely agrees with the species of *Anthelura,* while the telsonic and uropodal setal distribution is probably a specific feature. The telson of *B. luna* further possesses the proximal telsonic ridge seen in the species of *Anthelura*; thus *Bathura luna* is now regarded as a species of *Anthelura.*

Valoranthura, new genus

Diagnosis.—Eyes absent. Antennular flagellum of 6 articles. Antennal flagellum of 9 articles. Mandibular palp 3-segmented; molar, incisor, and lacinia present. Maxilliped 6-segmented; endite present. Pereopod 1 subchelate, propodus broadened proximally. Pereopods 2 and 3 subchelate, less robust than pereopod 1. Pereopods 4–7 carpi rectangular, not underriding propodi. Pleopod 1 exopod operculiform. Pleonites 1–5 free, pleonite 6 fused with telson.

Type-species.—*Valoranthura abyssorum* (Norman & Stebbing), 1886.

Gender.—Feminine.

Etymology.—The generic name is derived from H.M.S. *Valorous*, the ship used in the collection of the present material, plus 'anthura' the commonly-used suffix meaning a flower.

Remarks.—Amongst the anthurid genera, only *Quantanthura* Menzies & George possesses both a 6-segmented maxilliped and a rectangular carpus of the posterior 3 pairs of pereopods. *Quantanthura*, however, is characterized by having pleonites 1–5 fused, pleonite 6 free, and 2 basal telsonic statocysts, whereas *Valoranthura* has pleonites 1–5 free, and 6 indistinguishably fused with the telson, and lacks a pair of basal telsonic statocysts.

Valoranthura abyssorum (Norman & Stebbing)

Figs. 8, 9

Anthelura abyssorum Norman & Stebbing, 1886:127, pl. 27, fig. 2.—Hansen, 1887:181.—Richardson, 1900:215; 1901:508; 1905:69, fig. 54.

Ananthura abyssorum: Barnard, 1925:137.—Menzies, 1962:193, fig. 72B,C.—Schultz, 1969:101, fig. 138.

Description.—Female: Integument moderately indurate. Body proportions: $C < 1 < 2 = 3 < 4 < 5 > 6 > 7$. Cephalon lacking eyes; anterolateral corners rounded, not extending beyond low rostrum. Pereonites lacking middorsal pits. Pleonites 1–5 free, subequal; pleonite 6 fused with telson. Telson indurate, with strongly convex proximal area bearing fine middorsal longitudinal slit (possibly indicating the single opening of a statocyst), distolateral area flattened, apex rounded.

Antennular flagellum of 6 articles. Antennal flagellum of 9 articles. Mandible with 3-segmented palp, terminal segment broad, with 1 elongate and 5 short fringed spines; incisor broad, with faint indications of 4 cusps; lacinia with 7 serrations; molar broadly rounded. Maxilla with 1 strong and 6 smaller distal spines. Maxilliped 6-segmented, second segment longest, third segment wedge-shaped, terminal segment rounded, with 4 setae on mesial margin; endite well developed, broad, extending to penultimate palpal segment. Pereopod 1 subchelate, unguis one-third length of dactylus; propodus proximally broad, palm gently concave, with few fringed and simple setae; carpus triangular, with few fringed setae on posterior margin. Pereopods 2 and 3 subchelate, unguis one-third length of dactylus; propodus with 3 short sensory spines on posterior margin; carpus triangular, with single short sensory spine. Pereopods 4–7, propodus with 2 strong bifid sensory spines on posterior margin, 3 fringed setae anterodistally; carpus roughly rectangular, with 2 posterior sensory spines, not underriding propodus. Pleopod 1 exopod operculiform; endopod shorter and narrower; basis with 3 retinaculae. Uropodal basis shorter than endopod, latter tapering to rounded apex; exopod triangular, basally broad, apically narrowly rounded.

Material.—Syntype, B.M. 1911.11.8.7545, ♀ TL 10.0 mm; Syntype B.M. 1903.5.20.40, ?♀ (cephalon & pleon missing); dredged by H.M.S. *Valorous*, entrance to Davis Straits, 59°10′N, 50°25′W, 3,500 m.

Acknowledgments

My thanks are due to Dr. Torben Wolff of the Zoological Museum, Copenhagen, and Dr. R. Lincoln and Miss J. Ellis of the British Museum (Nat. Hist.) for the loan of type-material, Dr. Frank Ferrari of the Smithsonian Sorting Center for the USARP material, and to Dr. T. E. Bowman of the Smithsonian Institution for commenting on the manuscript.

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Department of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.

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A NEW SPECIES OF *NEOFEDRIZZIA* FROM SARAWAK (ACARINA: MESOSTIGMATA: FEDRIZZIIDAE)[1]

Robert Pope and Neil Chernoff

Abstract.—A new species of Mesostigmatid mite of the family Fedrizziidae is described. The new species, *Neofedrizzia tani*, was collected in Sarawak, Malaysia. As is the case with all other species within this family, it was found on beetles of the family Passalidae.

The family Fedrizziidae (Trägårdh, 1937) contains 20 species of mites belonging to three genera; *Fedrizzia*, *Neofedrizzia*, and *Parafedrizzia*. All of the known species have been found on beetles of the family Passalidae collected in Australia, New Guinea, and the Mollucas. The genus *Neofedrizzia*, erected by Wormersly (1959) can be distinguished from the other genera in the family by the absence of a free jugular shield in the male. The genus contains 11 species, 9 from Australia, and 1 each from New Guinea and the Mollucas. In the present paper a new species is described from passalid beetles collected in Sarawak.

Neofedrizzia tani, new species
(Figures 1 and 2)

Female.—General body shape oval, narrower at the anterior end; idiosoma 784 μ long, 560 μ wide. DORSUM. Covered by single plate extending over gnathosoma as a narrow hyaline shield. Numerous pores and simple setae present. A pair of large simple setae at anterior portion of shield; small simple setae on lateral margin at intervals of approximately 30 μ. VENTRUM. Jugular plates coalesced, with 1 pair setae at anterior margin, 1 pair pores at base. Plate 49 μ long, 107 μ wide at anterior margin. Sternal plate 37 μ long, 90 μ wide at the junction of the jugular plate, with 3 pair setae, 1 pair pores. Sternogynial shield concave at anterior margin; with 1 pair pores. Plate 135 μ long, 160 μ wide at the level of legs II and III. There are 2 pair of vaginal sclerites beneath the sternogynial plate. One pair beneath posterolateral margin of plate, the other pair extends from anterolateral to posteromedial portion of plate. Ventral plate 175 μ long, 365 μ wide at the border of anal plate, with scattered pores and pairs of setae. Anal plate 365 μ wide, 141 μ long; with 6 pair setae, 1 pair lateral to anal opening much larger (approximately 50 μ) than others; numerous scattered pores. Stigmatal opening between coxae III and IV; peritreme curves around coxae III and extends anteriorly to lateral margin of mite. Tritosternal base arises beneath jugular plates, 2 long barbed lacinae present.

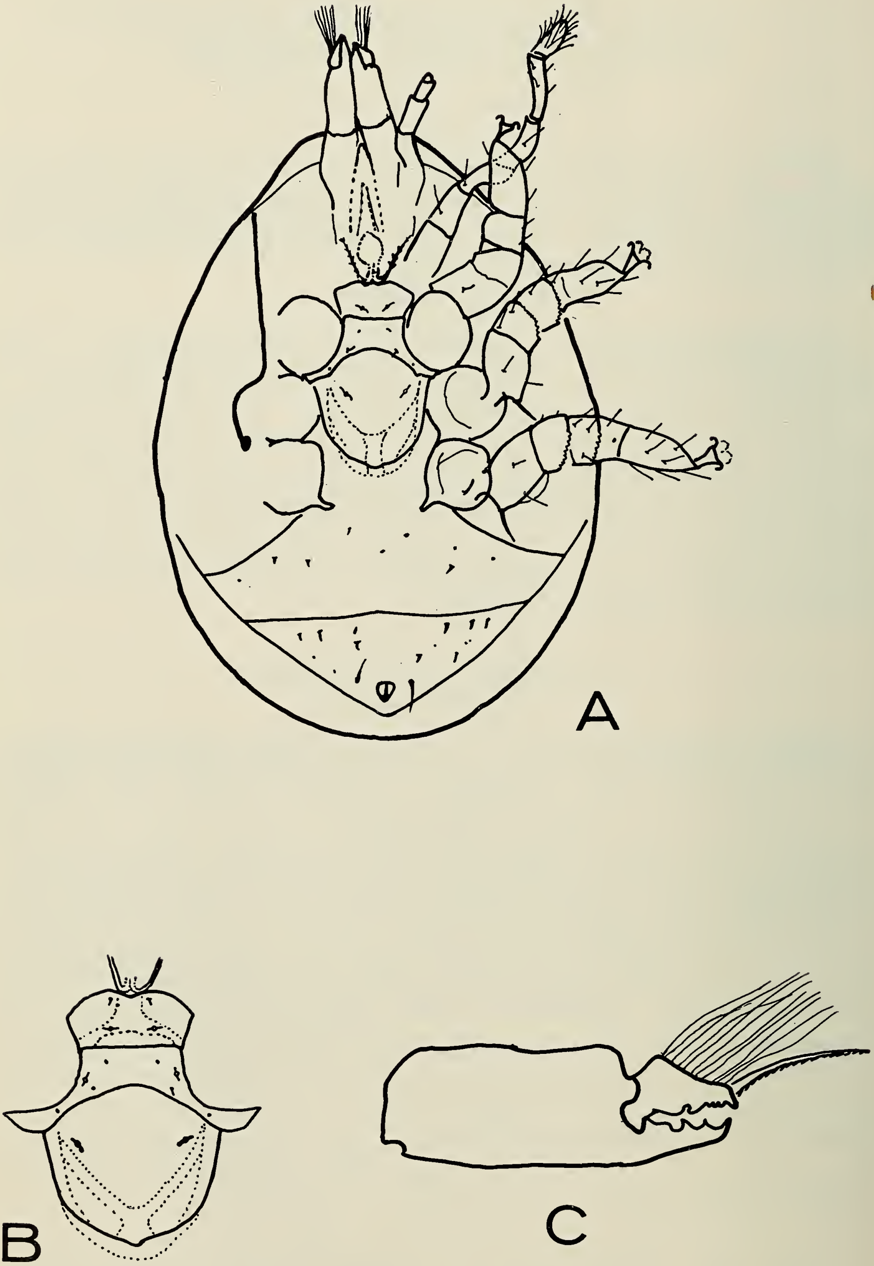


Fig. 1. *Neofedrizzia tani*: FEMALE: A, ventrum; B, genital area; C, chelicera.

GNATHOSOMA. Palps 5-segmented; some simple setae on all segments, most numerous on tarsus; broad flattened seta on femur, tarsi with apotele 2-tined; distal portion of trochanter extended and bifid with 2 long barbed setae. Chelicera chelate, fixed digit with 2 large teeth; movable digit with 1 large, 3 small teeth. Movable digit has filamentous excrescences; 1 thick and barbed seta arises from distal portion. Tectum with a single point, bordered by small barbs. LEGS. Legs II, III, and IV with caruncles and claws, leg I without such structures. All leg setae simple, numerous setae on tarsus of leg I; distal margin of genu and femur of legs II, III, and IV serrated; single flange-like structures on femora of legs II, III, and IV; large stout setae at posteromedial section of femora II, III, and IV.

Male.—Body shape similar to female. Dorsum as in female, idiosoma 810 μ long, 580 μ wide. VENTRUM. Jugular plates coalesced. Sternal plate extended anteriorly by a pair of lateral processes which curve anteromedially. Two semicircular genital plates cover the genital aperture which is 75 μ wide, 65 μ long; bordered by a variable number of pores (9–11) at lateral margins. Two pair pores and 3 pair setae lateral to genital plates. Ventral plate 290 μ long, 380 μ wide; with scattered setae and pores. Anal plate 130 μ long, 380 μ wide, pores and setae as in female. Tritosternal base large and bulbous; arises anterior to sternal plate, base with 2 long barbed lacinae at tip. Gnathosoma as in female except for presence of 2 thick barbed setae in excrescences of movable digit of chelicera. Legs and peritreme as in female.

The species was described on the basis of 4 female and 10 males. The species was collected at Santubong, Sarawak, Malaysia, 100′ elevation, on August 23, 1969 (collected by Kiat W. Tan and Rhea Warren). The specimens were taken from alcohol vials which contained a species of beetle of the family Passalidae.

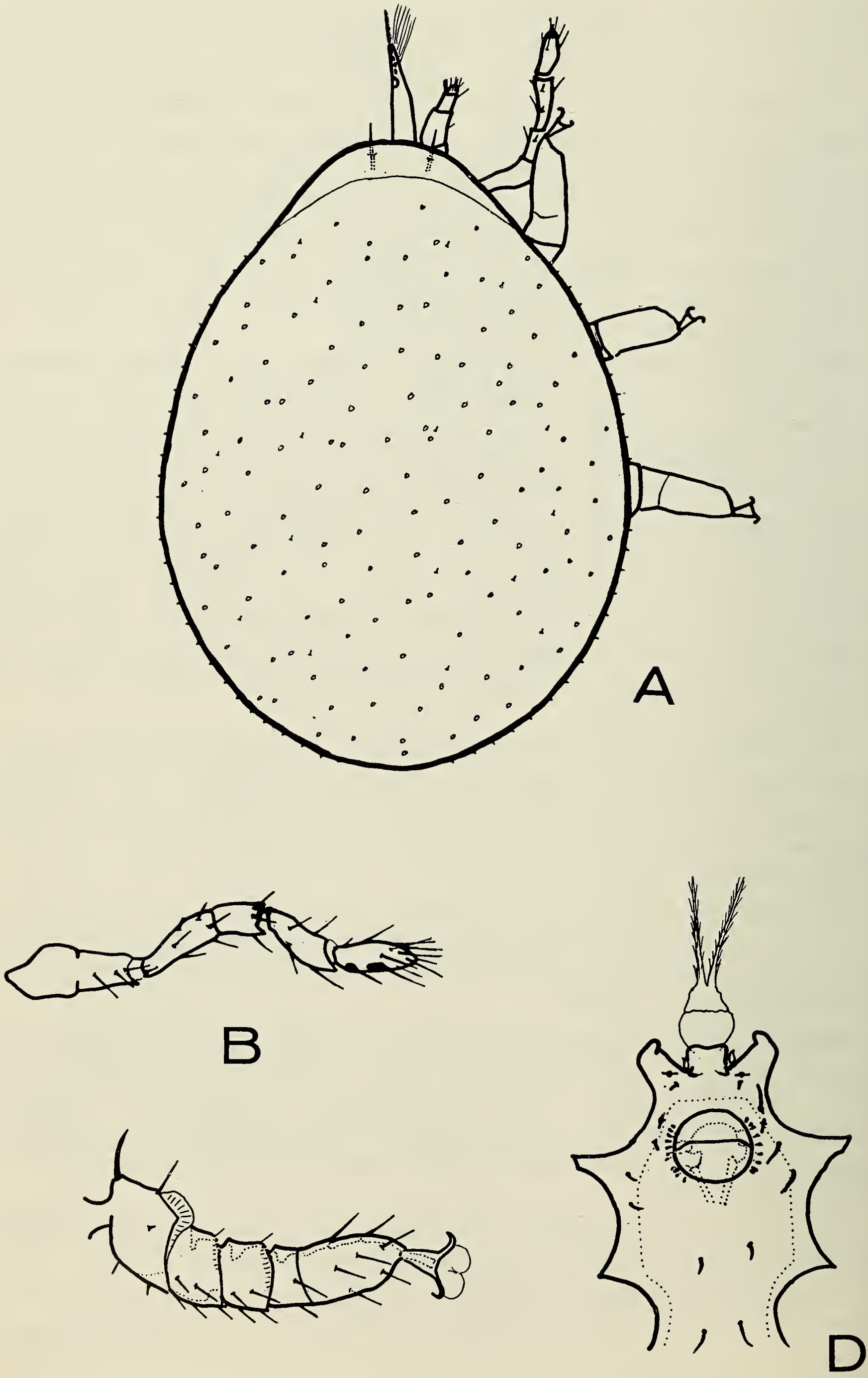
The size of the mites and their individual plates differed slightly throughout the series. Average measurements in microns and the standard deviations for parameters used in the type description were made on the entire series of mites and are given below:

Females.—Idiosoma 768 ± 9 long, 551 ± 8 wide; jugular plates 100 ± 9 long, 43 ± 5 wide; sternogynial plates 139 ± 5 long, 156 ± 4 wide; ventral plates 159 ± 17 long, 337 ± 27 wide; anal plate 131 ± 13 long, 337 ± 27 wide.

Males.—Idiosoma 806 ± 31 long, 597 ± 19 wide; genital aperture 71 ± 2 long, 65 ± 3 wide; ventral plate 283 ± 10 long, 380 ± 9 wide; and plate 135 ± 5 long, 380 ± 9 wide.

N. tani may be distinguished from other mites in the genus by means of the following key which has been adapted from Wormersly (1959).

1 Male genital orifice between coxae III or between III and IV *N. laevis* (Canest.)


A
B
D

1′ Male genital orifice between coxae II or between coxae II and III 2
2(1′) Hyaline portion of dorsal shield prolonged laterally and posteriorly to level of anterior margin of anal shield *N. scutata* Worm.
2′ Hyaline portion of dorsal shield not prolonged 3
3(2′) Anterior margin of sternogynial shield equal to or shorter than length of the shield all other mites in the genus not listed below
3′ Anterior margin of sternogynial shield longer than the shield 4
4(3′) Sternal plates of male prolonged anterolaterally *N. brooksi* Worm.
4′ Sternal plate of male prolonged anteromedially 5
5(4′) Genital orifice of male without any pores flanking it on posterior half *N. canestrinii* Worm.
5′ Genital orifice of male flanked posteriorly by distinct pores on each side *N. tani* Pope and Chernoff

The holotype and allotype of *N. tani* have been deposited in the United States National Museum, Washington, D.C. One female and 6 male paratypes have also been deposited in the U.S.N.M. Two female (1 dissected) and 3 male (1 dissected) paratypes are in the authors' collection.

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(RP) Miami Dade Community College, South Campus, Miami, Florida 33156; (NC) Environmental Protection Agency, Research Triangle Park, North Carolina 27711.

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[1] This research was aided by O. T. S. Pilot Grant 69-3.

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Fig. 2. *Neofedrizzia tani*: FEMALE: A, dorsum; B, leg I; C, leg IV. MALE: D, genital area.

PROC. BIOL. SOC. WASH.
91(4), 1978, pp. 798–814

NATURAL HISTORY AND LIFE-CYCLE STAGES OF *NOTIPHILA CARINATA* (DIPTERA: EPHYDRIDAE)

D. L. Deonier, W. N. Mathis, and J. T. Regensburg

Abstract.—Adults of *Notiphila carinata* Loew have been collected in eight states, all east of the Mississippi Valley and within the distribution range of *Justicia americana* (L.) Vahl, or water willow, the only macrophyte species with which the larvae and puparia have been associated. Adults were observed feeding on exposed periphyton on stems and leaves of water willow; females deposited eggs in irregular masses of 3–20 on folded or curled leaves on or near the water or mud surface. The incubation period for 35 eggs ranged from 1 to 3 days at 18–24°C. The first larval stadium was not precisely measured, but it was definitely more than 3 days in laboratory cultures. The second stadium was not measured, but the third ranged from 42 to 44 days for 3 overwintering specimens and the puparial phase ranged from 12 to 18 days for 3 specimens.

Larvae are metapneustic in all instars. The posterior spiracles are retractile, aciculate, and contiguous, with the spiracular atria often fused. The larva forces its needle-like spiracles into the aerenchyma of water-willow roots from which it apparently procures oxygen. However, available evidence indicates that third instars, and perhaps earlier instars, move about for long periods of time (up to 8 days in laboratory) between insertions of spiracles in the roots. Larvae of all instars ingested sapropel, or black ooze, which surrounded the roots of many water-willow plants. The high transparency of the larval integument greatly facilitated larval feeding observations. The species overwintered in Ohio only as late second- or third-instar larvae between the clustered roots of water willow.

All stages of the life cycle are described and illustrated.

In North America the 69 genera and 377 species of Ephydridae presently recorded make them the largest drosophiloid family on the continent. However, this large family of semiaquatic and aquatic acalyptrate flies has been so little studied biologically that the life histories of only relatvely few species have been described.

Nearly all of the known larvae and puparia of Ephydridae are aquatic—living and feeding in algal mats, diatom-covered mud flats, wet sand shores, and black ooze, or sapropel (Brock *et al.*, 1969; Dahl, 1959; Deonier, 1961, 1974; Deonier and Regensburg, 1978; Eastin and Foote, 1971; and others). The larvae of the notiphiline genus *Hydrellia* live and feed in the leaves and stems of aquatic macrophytes (Deonier, 1971) and those of various other genera scavenge on dead noninsectan animals (Bohart and Gressitt, 1951;

Disney, 1969; Soan and Adolph, 1971; Wirth, 1971; and others), parasitize spider eggs and frog eggs (Becker, 1926; Bokerman, 1957), or scavenge on dead oil-pool-entrapped insects (Crawford, 1912; Thorpe, 1930).

For the genus *Notiphila*, Müller (1922) and Torelli (1922) presented the first known descriptions of any immature stages. Müller gave a brief description of the larva of *N. riparia* Meigen and Torelli described and figured the immature stages of *N. chamaeleon* Becker. Varley (1937), in a paper on root-piercing aquatic insect larvae, discussed the respiratory modifications in the puparium of *N. riparia.* Meijere (1941) recorded *Notiphila brunnipes* Robineau-Desvoidy as mining the roots of *Nymphaea.* Houlihan (1969) described at length the spiracular structure and root-piercing behavior of *N. riparia* and presented valuable data on the use of roots of various plant species by the larvae in relation to epidermal thicknesses or distances to root gas spaces.

Until very recently, the only life-history information available on Nearctic *Notiphila* was that presented by Berg (1950) for *N. loewi* Cresson. However, Busacca and Foote (1978) have now contributed significantly to the knowledge base for Nearctic *Notiphila* with their work on the life histories and immature stages of *N. aenigma* Cresson and *N. solita* Walker.

Materials and Methods

Larvae and puparia were collected by sieving, with a U.S. Standard Sieve Series, substrates from water-willow root systems previously extracted by spade. Eggs were obtained by caging gravid females. Larvae and puparia were reared both in individual culture bowls containing sapropel and one water-willow plant and en masse in a transplanted culture of water willows. The pH was measured with a Hach portable pH meter.

All larvae and puparia were collected in Four-Mile Creek near Oxford, Butler Co., Ohio, and in Brashear's Creek near the Salt River, Spencer Co., Kentucky. Field observations were made principally at the Four-Mile Creek site and secondarily at Adams Lake, Adams Co., Ohio.

Voucher specimens for the life history and immature stages are in the Water Resources Laboratory of the University of Louisville and the collection of D. L. Deonier. Adult specimens studied are principally in the National Museum of Natural History (Smithsonian Institution) and the Miami University Insect Collection.

Abbreviations

AN, anus; ANT, antenna; ARR, aristal ray; BP, basal part of mouthhook; DB, dorsal bridge; DC, dorsal cornu; DCC, dorsocephalic cap; DT, dorsal tibial macrochaeta; ES, epistomal sclerite; FA, facial macrochaeta; FC,

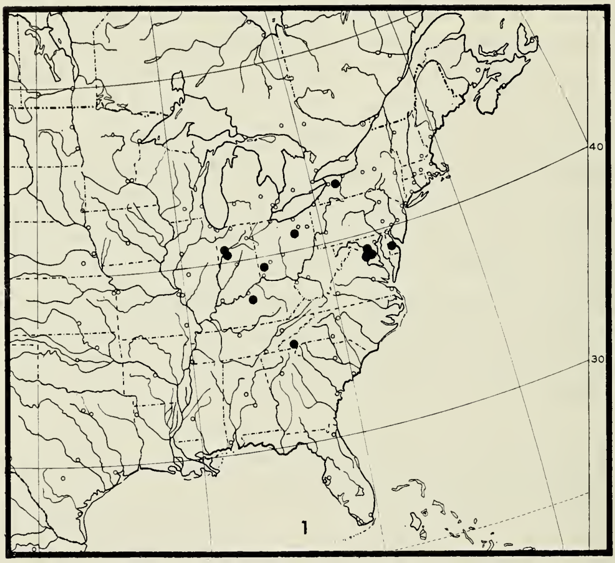


Fig. 1. *Notiphila carinata.* Distribution of collection localities of adults.

femoral comb; FS, furcate structure; GE, genal macrochaeta; HB, hypostomal bridge; HL, head-lobe; HP, hook part of mouthhook; HS, hypostomal sclerite; $LPT_{1,2,3}$, lateral postanal tubercles; LS, ligulate sclerite; MH, mouthhook; MP, micropyle; PAE, postanal elongation; PAP, perianal pad; PB, parastomal bar; PSP, posterior spiracle; SA, spiracular atrium; SSP, subantennal sensory plate; TH_1, prothorax; VC, ventral cornu; VPT, ventral postanal tubercle.

Natural History

Adult.—The adults of *Notiphila carinata,* some of the smallest in the genus, have been collected in eight states in the eastern United States (Fig. 1). This distribution is entirely within the distributional range of the only known larval host plant, *Justicia* (=*Dianthera*) *americana* (L.) Vahl, which occurs in North America south of Quebec and east from the Mississippi Valley. Adults have been collected from marsh-reeds, sedge-meadow, grass-shore, limnic-wrack, and floating-vegetation types of habitat, but the single most consistent habitat of many adults and all larvae has been *Justicia,* or water willow.

Adults of *N. carinata* are not common. Observed adult populations were only moderately abundant and fewer than 150 preserved specimens were available from collections of North American museums. The paucity of adults, however, may be an artifact of our observational and collecting techniques. Of the preserved specimens studied, over half were from one site, Plummers Island, Maryland, and were the recovered prey from a number of completely and partially provisioned cells of the Hibiscus Wasp, *Ectemnius* (*Hypocrabro*) *paucimaculatus* (Packard) (Krombein, 1964).

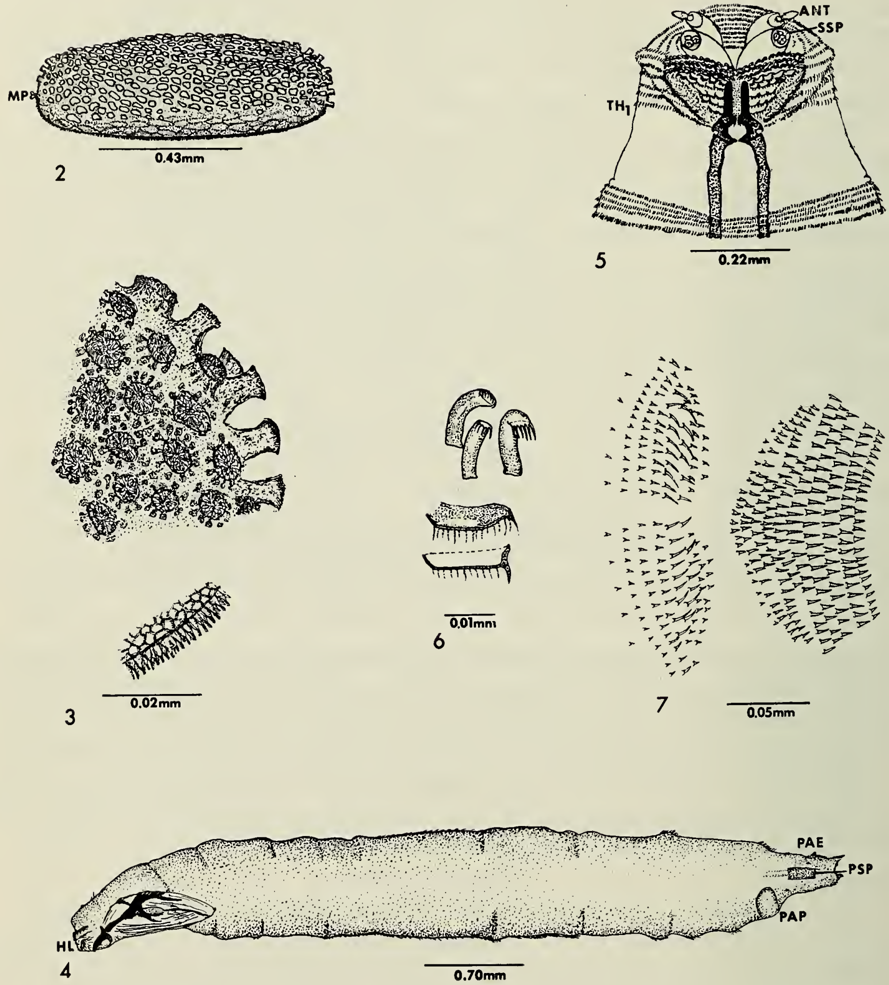
The gut contents of three specimens and scrapings from the labella of three dry-mounted specimens as well as close observations of feeding in laboratory and field indicate that the adults feed on periphyton. The gut contents appeared to contain green and yellow pigments and the labellar scrapings consisted of probable fungal fragments, sand particles, and naviculoid diatoms. Busacca and Foote (1978) observed adults of *N. aenigma* and *N. solita* applying their mouthparts to surfaces of emergent vegetation and surmised that they probably graze on microflora on the emergent vegetation. When abducted or spread, the labella form a wide, shallow inverted cup lined with the cross-striated canaliculi and having a flexible margin.

As with several congeners, adults of this species seemed to spend much of the daytime resting head downward on the lower branches of water willow, although we did frequently observe them walking and feeding over leaves on the water or mud surface. Courtship and copulation were not observed. Oviposition occurred on leaves, often curled or folded ones, on or near the water or mud surface. The females moved slowly and intermittently over their ovisites while they laid irregular masses of 3 to 20 eggs. In the laboratory, newly laid eggs could be moved, but day-old eggs were mostly cemented to the ovisite. One caged female, when not provided with water-willow leaves, oviposited on sphagnum moss and glass-cage walls.

Although we were unable to measure maximum egg capacity, we did obtain some production data. One of 2 females collected September 13, 1977 laid 35 eggs in a 24-hour period and the other laid 27 eggs in a 72-hour period. Also, a gravid female collected October 6, 1977 was found to have ovaries consisting of 6 ovarioles each and containing a total of 22 recognizable oocytes, including 12 moderately late-stage and 10 without well-differentiated choria. Since the mean daily temperature was decreasing and adults were scarce by this collection date, these data likely include some seasonal influence. Busacca and Foote (1978) estimated the total egg production for *N. aenigma* to be 110 to 180.

Egg.—The incubation period ranged from 1–3 days for 35 eggs at 18–24°C.

Newly laid eggs are pure white and, in contrast to the illustrated eggs of other *Notiphila* (*chamaeleon* by Torelli, 1922; *annulipes* by Dahl, 1959; and *aenigma* and *solita* by Busacca and Foote, 1978), the upper half of the chorion is deeply sculptured into numerous erect and semierect projections (Fig. 2). Since the overall appearance of this sculpturing is one of an extensive aeropyle, or respiratory plastron surface, it may be an adaptation to the more frequent inundation occurring in the labile stream and back-



Figs. 2–7. *N. carinata.* 2, egg, dorsolateral view. 3, egg chorion, upper and lower halves magnified. 4, third-instar larva, habitus, lateral view. 5, third-instar larva, head-lobe and prothorax, ventral view. 6, third-instar larva, facial-mask structures magnified. 7, third-instar larva, creeping welt and succeeding spinular zone on abdominal segment 7, ventral view.

water habitats characteristic of water willow. It could also be an egg-predator or parasite defense. The fine chorionic reticulation described for the egg of *N. aenigma* (Busacca and Foote, 1978) may serve as an aeropyle, but the relatively more stable marsh-reeds habitat of this species and the apparently higher ovisite are probably less demanding for this function.

In *N. chamaeleon*, on the other hand, the illustrations and description of the chorion and ovisite by Torelli (1922) indicate that it has a moderately developed aeropyle. The egg chorion of *N. annulipes* is apparently smooth and, according to Dahl (1959), equipped with a sharp structure on one end which allows it to be drilled into plant tissue.

Larva.—Although the necessity for keeping the larvae in ooze essentially precluded accurate measurement of the larval stadia, we were able to obtain some estimated durations for this species. The first larval stadium based on observations of 23 specimens is probably 3–5+ days. The third stadium lasted 42–44 days in 3 overwintering specimens which were collected as second-instar larvae January 4, 1978. We were unable to rear larvae entirely through the first and second stadia.

The larvae eclose from the egg by slitting one end of the chorion with their mouthhooks. Larvae are metapneustic in all instars; they possess a pair of retractile, spinous posterior spiracles which are used to pierce the roots and rootlets of water willow. We sieved larvae only from sapropel, or black ooze, around the root systems of water willow. One hundred plants without abundant sapropel around at least part of the root system yielded no larvae or puparia whereas 60 plants growing in sapropel yielded 34 second- and third-instar larvae and 10 puparia.

All field-collected larvae had sapropel in their guts. In microscopic observations of three first-instar larvae held in petri dishes containing small, isolated areas of sapropel in distilled water, the larvae showed a strong tendency to move into and remain in the sapropel cloud. Negative response to light was undoubtedly involved here, but the larvae protracted and retracted their head-lobes much faster in the sapropel indicating that active ingestion occurred there. The gut contents of a first-instar and a third-instar larva consisted of some yellow-green pigment, bacteria, sand particles, and organic detritus particles. Busacca and Foote (1978) found only bacteria and detritus in the guts of third-instar larvae of *N. aenigma* and *solita.*

Since larvae of *N. carinata* and these two species together with those of *Dichaeta caudata* (Fallén) (illustrated by Eastin and Foote, 1971) have comblike components in the facial mask, it seems probable that all are filter-feeders and that particles from the ooze are collected by the comblike structures and then transferred into the mouth during partial head-lobe involution and retraction. The mouthhooks, although possibly involved here in an ancillary fashion, retain their primary locomotory function.

Although we failed to observe actual penetration of the posterior spiracles into roots, we did observe microscopically what we interpreted as attempted penetration in which the larva was coiled around the rootlet and probing at its surface with the posterior spiracles. As Houlihan (1969) explained for *N. riparia*, the larvae protract and insert their spiracles solely by increasing their blood pressure and they therefore require the compression of mud or ooze for effective spiracular insertion. However, in the first-instar larvae of *N. carinata*, the well-developed creeping welts, which are only weakly developed in the last two larval instars, may provide anchorage needed for spiracular insertion by these small larvae as well as secure locomotion necessary for remaining on the root system.

The larvae are at least partially dependent upon the roots for oxygen, for although two third-instar larvae survived 6 and 8 days respectively in ooze without access to roots and several survived 24 hours in distilled water, we successfully reared only larvae having access to roots. Our data and those of Busacca and Foote (1978) do strongly indicate however that larvae roam free of roots for fairly long periods of time. The latter authors reported that older third-instar larvae of *N. aenigma* survived low oxygen conditions for more than a month in the laboratory and also that almost all larvae were free of *Typha* rootlets when originally collected.

We found larvae of *N. carinata* only in stands of water willow. Thorough examination of 25 plants of *Eleocharis* sp. and ten plants of *Leersia* yielded no larvae or puparia whereas 50 nearby water-willow plants yielded five puparia. Busacca and Foote (1978) discovered a similar degree of apparent specificity in *N. aenigma* and *N. solita.*

Notiphila carinata overwinters as second- and third-instar larvae in Ohio. On January 4, 1978, we collected seven second-instar and seven third-instar larvae from the sapropel around root systems of an old stand of *Justicia* covered by Four Mile Creek. We sieved ten of these from one root system. The sapropel pH ranged from 5.6–6.4. This sieving also yielded numerous larvae of four species of Tipulidae, ten species of Chironomidae, two of Tabanidae, six of Trichoptera, and one species of Elmidae. Adults of *N. carinata* became scarce in September and disappeared in October.

In order to determine something about larval dispersal in this species, we placed seven of these overwintering larvae at one point in a 120 × 55 cm tank containing a dense, uniform culture of transplanted water willow, the roots of which were free of *N. carinata* stages. After 30 days, one had moved approximately 35 cm, three 30 cm, and three undetermined distances. All of these larvae pupariated in February and the adults emerged in March.

Pupariation.—The time from pupariation to emergence of adult was 12–18 days in three specimens and approximately 18 days in two others.

When ready to pupariate the third-instar larva inserts its spiracles in a root where they remain throughout pupariation and subsequent pupation (Fig. 20). One specimen from a group of seven third-instar larvae collected January 4, 1978 required 24 hours to pupariate. During this process the posterior spiracles became thicker and darker and their slitlike spiracular orifices enlarged. The spiracles also came to be directed ventrad and often anteroventrad giving them a hooked, or acanthous shape. We found only the distal one-fifth or less of abdominal segment 8 inserted and slightly enlarged, but in larvae of *N. riparia* most of the segment must be embedded in the root before pupariation begins (Houlihan, 1969). In nature, the spiracles apparently must remain intact and inserted for successful pupation and emergence. Puparia, even some enclosing nearly pharate adults, which we accidentally detached never produced adults. Berg (1950) reported similar results with *N. loewi* and Busacca and Foote (1978) found no viable detached puparia. For *N. riparia*, Houlihan (1969) stated that "the development of the pupa and the pharate adult inside the puparium is dependent on the oxygen in the gas spaces in the plant." He found that intact, detached puparia filled with water and sank in a few days.

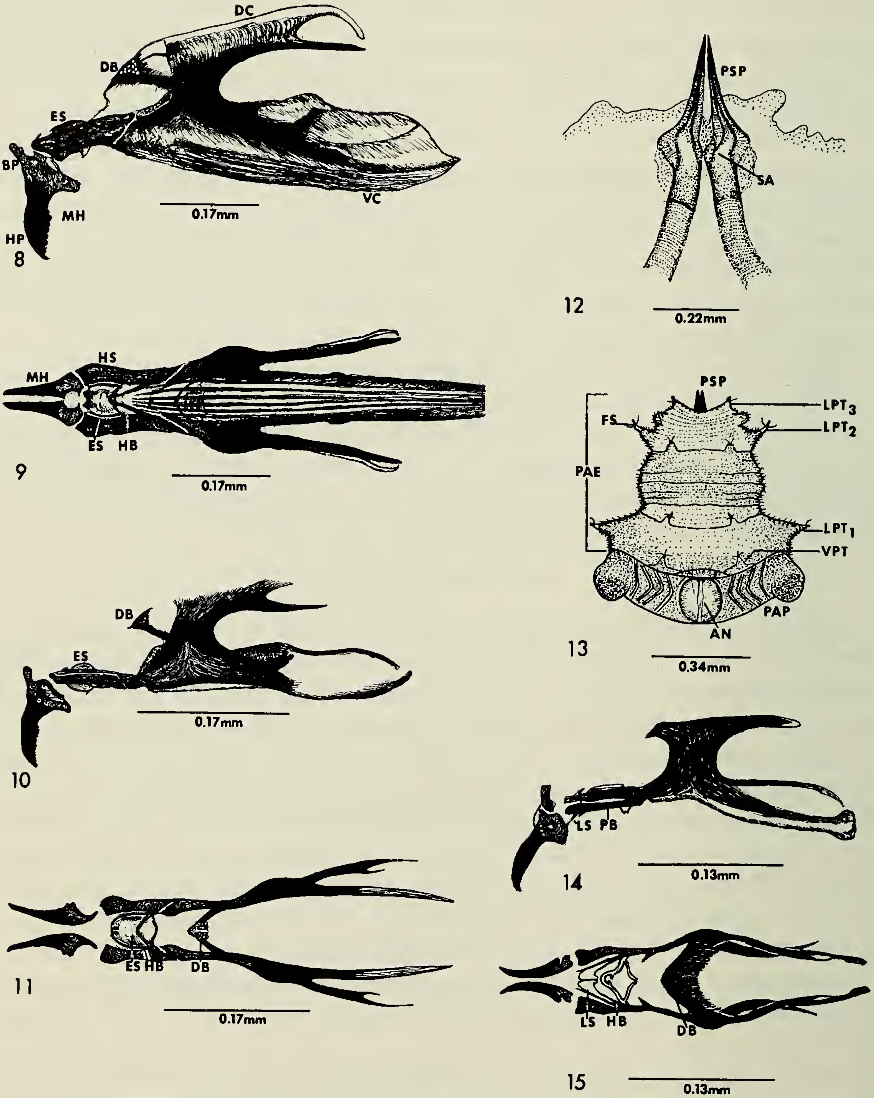
Although it was not mentioned by Houlihan (1969) or Busacca and Foote (1978), in *N. carinata* we found all puparia to have membranous, flexible postanal elongations which allowed movement of the main body through an arc of about 180°. We surmise that this is an adaptation which reduces the risk of the puparium being broken off by shifting roots and substrate and also allows greater maneuvering by the emerging adult.

Description of Adult

Diagnosis.—*Notiphila carinata* is one of the smaller members of the tribe Notiphilini and specimens may be distinguished from those of similar taxa by the following combination of character states: Length 2.58–3.57 mm; costal vein short, extending to vein R_{4+5}; 2 pairs of dorsocentral setae (1+): 1 pair of small, proclinate, fronto-orbital setae laterad of larger reclinate, fronto-orbital seta; middle leg of male with femoral comb of closely-set setae along posteroventral margin; middle leg with 3 dorsal tibial setae; antenna partially pale; mesanepisternum often with dark-colored spot; mesonotum generally immaculate; male terminalia diagnostic with widely U-shaped, ventral process of epandrium; extending arms of ventral process not curved or sinuate; and basiphallus short with slightly expanded apex.

Description.—Moderately-small to medium-sized shore flies with grayish-brown to light brown background coloration and a few darker brown markings.

Head (Fig. 18).—Head width-to-height ratio averaging 1:0.78; postfrons (frons) width-to-length ratio averaging 1:0.64; most of frons light brown, pollinose, median triangular area and lateral fronto-orbits lighter in color, generally concolorous. Dorsalmost paravertical seta large, approximtely double size of ocellars; at most with one proclinate fronto-orbital seta. Antennal segments mostly dark brown, third segment with basal half, especially posteroventral portion pale, usually yellowish; arista with 8 or 9 dorsal rays. Face lightly pollinose, unicolorous, light yellow; prefrons



Figs. 8–15. *N. carinata.* 8, third-instar larva, cephalopharyngeal skeleton, lateral view. 9, same, ventral view. 10, second-instar larva, cephalopharyngeal skeleton, lateral view. 11, same, ventral view. 12, third-instar larva, posterior spiracles, dissected, dorsal view. 13, third-instar larva, perianal pad and postanal elongation, ventral view. 14, first-instar larva, cephalopharyngeal skeleton, lateral view. 15, same, ventral view.

(face) height-to-width ratio averaging 1:0.69; facial setae small, hairlike. Eye height-to-width ratio averaging 1:0.83; eye-to-cheek ratio averaging 1:0.16. Gena narrow, generally concolorous with face, especially anteriorly, becoming grayer posteriorly; genal seta approximately subequal to dorsalmost paravertical seta. Maxillary palp pale, yellowish orange.

Thorax.—Mesonotum light brown, darker than pleural areas and generally immaculate. Mesanepisternum often with dark brown spot, especially in specimens from Atlantic Coast area. Chaetotaxy of thorax as follows (macrosetae): 2 pairs of dorsocentrals (1+1); 1 pair of prescutellar acrostichals, widely separated, situated between alignment of dorsocentrals and acrostichals; 1 pair of presuturals; 1 pair of interalars, transversely aligned with prescutellar acrostichals; 1 pair of supra-alars; 1 pair of postalars; 2 pairs of lateral scutellars, posterior pair inserted apically; 1 pair of humerals; 2 pairs of notopleurals, one inserted near each ventral corner, anterior seta larger; 2 pairs of mesanepisternals near posterior margin, dorsal one about ½ length of posterior seta; 1 pair of mesokatepisternals. Femora gray, with some darker areas along dorsum; tibiae generally concolorous with femora, although front pair slightly darker, usually with darker preapical spot or annulation; tarsi pale, yellow; setal fascicle of hind basitarsus dark. Middle leg (Fig. 19) with 3 dorsal tibial setae; middle leg of male (Fig. 19) with femoral comb of closely-set setae along posteroventral margin. Wing length-to-width ratio averaging 1:0.45; costal vein extending to vein R_{4+5}; costal vein index averaging 1:0.55; M_{1+2} index averaging 1:0.97.

Abdomen.—Abdomen length-to-width ratio of males averaging 1:0.84; length of fourth tergum to fifth tergum ratio of males averaging 1:1.1; fifth tergum width-to-length ratio of males averaging 1:0.48. Maculation pattern variable, best developed on terga 3 and 4; usually with 2 oblong spots on either side of median, sometimes with darker area connecting spots anteriorly. Male terminalia as in diagnosis.

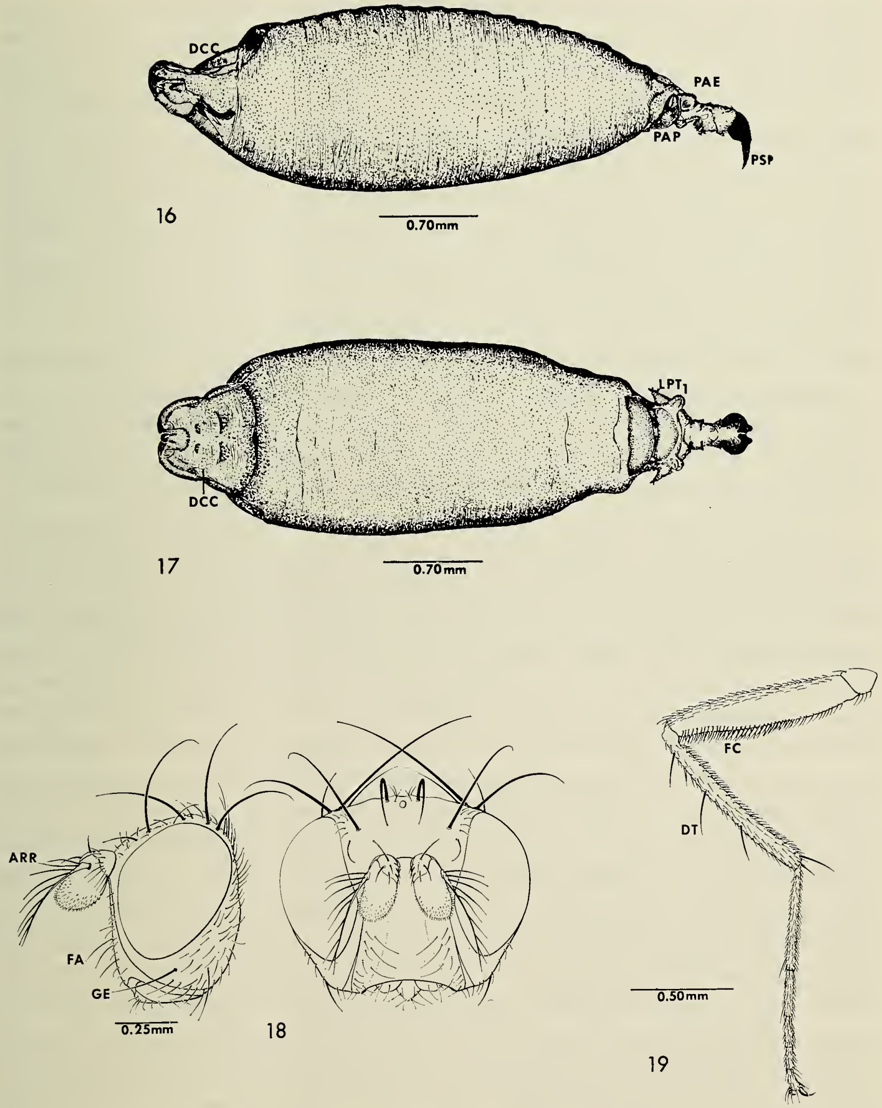
Description of Immature Stages

Egg (Figs. 2, 3).—Length 0.72–0.95 mm ($\bar{x} = 0.87$); maximum width 0.23–0.28 mm ($\bar{x} = 0.87$). Newly laid egg pure white, elliptical, slightly flattened ventrally, transversely convex dorsally; micropyle stalk, minute, inconspicuous; micropylar end slightly blunter than opposite end. Upper ½ of chorion deeply sculptured into 2 types of numerous erect, distally concave projections: longer, narrower ones mostly restricted to ends of egg and shorter, broader projections; lower ½ of chorion appearing finely reticulate at 90× magnification, micropapillate at 430×. (Based on 64 specimens from field-collected females.)

First-instar larva.—Length 1.17–1.70 mm; maximum width 0.23–0.28 mm. Body grayish white (integument semitransparent). Similar to third instar except in following characters: Setulosity darker, more distinct, relatively longer and setuloid. Facial mask with tips of all spinular units light to medium brown; labium padlike; prothorax with about 14 bands of spinules, all uniordinal except posterior band with longer spinules; pair of medium brown spinule patches anterolateral to mouth; meso- and metathorax each with zone of about 9–14 bands, all essentially uniordinal except about last 2 posterior bands with much longer spinules. Abdominal segments 1–7 each with distinct creeping welt composed of 2 bands of hooked microspinules directed anteriad and 2 posteriad, microspinules in 2 inner bands about twice as large as in 2 outer bands; abdominal segment 1 with 2 spinule zones each having 4–7 partially overlapping bands of posteriorly-directed, multiordinal spinules; segments 2–7 each with similar spinulosity arranged in 3 zones; perianal pad nearly rectangular, often darker with numerous small spots. Postanal elongation relatively shorter, only about 1⁄12 as long as preanal length; postanal tubercles less distinct; ventral postanal spinule patch relatively smaller; posterior spiracles very light yellow-brown, 3.2–3.8 times as long as greatest diameter and with spiracular atria fused; distal 2⁄3 of spiracle with indistinct microcribiform slits.

Cephalopharyngeal skeleton (Figs. 14, 15) length (excluding mouthhooks) 0.28–0.46 mm. Pharyngeal sclerite slightly paler; mouthhooks with ventral edge of hook part nearly straight (4–5 minute teeth visible at 430×); mouthhook part with small irregular fenestra; base part anticulated anteriorly with small, curved sclerite and dorsally with larger projecting sclerite; hook part about 1.5 times as long as greatest dimension of base part. Hypostomal and pharyngeal sclerites apparently fused; parastomal bars distinguishable parallel to and fused to hypostomal sclerite posteriorly; ligulate sclerite projecting anteriad between anterior arms of hypostomal sclerite; apparent straplike hypostomal bridge present at midlength and projecting anteroventrad behind ligulate sclerite. Dorsal bridge in lateral view, not greatly projecting, continuous with dorsal cornua; bridge, in ventral view, arching anteriad (U- or V-shaped) with wide fibrous posterior fringe. Dorsal cornua unforked distally, with slightly acute tip; ventral cornua forked into thin straplike dorsal arm and downcurving ventral arm 2–4 times as wide as and nearly meeting the dorsal arm posterodorsally; ventral cornua 1.5–1.7 times as long as dorsal cornua. Ventral length of pharyngeal sclerite 2.4–2.8 times hypostomal length; ventral cornu length 1.5–1.7 times hypostomal length. (Based on 27 reared specimens.)

Second-instar larva.—Length 3.40–3.69 mm; maximum width 0.36–0.86 mm. Body grayish white, integument including spinulosity mostly transparent. Similar to third instar except in following characters: Facial mask relatively wider, apparently with more rows of pectinate cultriform structures; prothoracic spinule bands with larger, slightly curved spinules postero-



Figs. 16–19. *N. carinata.* 16, puparium, habitus, lateral view. 17, same, dorsal view. 18, adult, head, lateral and anterior views. 19, adult, middle leg, male, posterior view.

lateral to mouth. Abdominal creeping welts somewhat fainter; lateral and dorsal spinulosity relatively slightly longer; ventral postanal spinule patch relatively smaller; postanal tubercles relatively less distinct.

Cephalopharyngeal skeleton (Figs. 10, 11) length (excluding mouthhooks)

0.42–0.53 mm. Pharyngeal sclerite dark brown or black, with hyaline periphery reduced; other sclerites light to medium brown. Mouthhooks slightly longer than hypostomal sclerite, base part darker and with distinct, small, circular fenestra; mouthhooks with 10–12 fine teeth on distal ½, 5 largest near midlength. Epistomal sclerite (plate) pale and domelike above hypostomal sclerite in lateral view with anterior end rounded, bearing small paired oval structures, and projecting between anterior hypostomal arms; apparent hypostomal bridge projecting anteroventrad in V-shape below epistomal sclerite. Pharyngeal sclerite with dorsal bridge straplike, smaller and sharply V-shaped in ventral view; dorsal cornua ending in open V-shaped recess with lower arm 2–3 times as long as upper arm of recess; posterior ½ of ventral cornua hyaline with dark border usually incomplete at posterior end; dark part of ventral cornua V-shaped in lateral view; ventral cornua 1.5–1.8 times as long as dorsal cornua. Ventral length of pharyngeal sclerite 3.4–3.8 times hypostomal length; ventral cornu length 2.5–2.8 times hypostomal length. (Based on 3 field-collected specimens.)

Third-instar larva (Figs. 4–7, 12, 13).—Length 3.06–6.75 mm; maximum width 0.54–1.17 mm. White or creamy white except very light-brown posterior spiracles; integument including nearly all spinulosity transparent; body subcylindrical, tapering only very slightly from middle to head-lobe and to perianal pad. Head-lobe (segment 1 of authors) retractile, bilobate (Fig. 5) with each lobe bearing 3-segmented antenna distally and subantennal sensory plate ventrally; antennae slightly longer than mouthhooks, segment 3 elliptical, about 3 times as long as wide, and slightly longer than segment 2; pair of subantennal sensory plates round and about same diameter as antennal segment 1. Facial mask (Figs. 5, 6) with 3 rows of decumbent, palmately-tipped spinules anterior to mouth, 1 row of pectinate cultriform structures lateral to mouth, and 4 rows of apically hooked, pectinate plates posterolateral to mouth; labium indistinct. Prothorax (segment 2 of authors) with 14–16 bands of minute microspinules on anterior ⅓–½, posterior ½ apparently glabrous; tracheae for anterior spiracles visible but spiracles absent; meso- and metathorax each with 6–8 bands of microspinules and 8 bands of slightly larger spinules on anterior ½–⅔ followed by glabrous posterior zone. Abdominal segments 1–7 each with numerous bands of spinules, indistinct glabrous zone, slight dorsal protuberance, and slight creeping welt distinguishable by 4–9 close-set rows having longer, posteromedially curved ventrolateral spinules (Fig. 7); anterior welt preceded by 2 zones of about 14 bands of microspinules separated by a narrow glabrous zone; remaining welts preceded by zone of 9–14 bands of short, slightly hooked microspinules and zone of straight slightly larger spinules arranged in multiordinate bands and increasing from about 6 on anterior to 14 on posterior segments; bands of slightly hooked microspinules more widely spaced ventromedially; posterior creeping welt separated from perianal pad by wide zone of 6–9 bands of multiordinal straight spinules. Perianal pad convex anteromedially, extending laterally onto sides of segment as roundly bulging lobes; 14–22 close-set, usually pigmented spinules in ventral-postanal patch between inconspicuous, ventral postanal tubercles. Postanal elongation (respiratory or breathing tube of authors) of abdominal segment 8 about ⅒ as long as preanal length, tapering very slightly to posterior spiracles, with 3 pairs of lateral, 1 ventral pair just posterior to perianal pad, and 1–2 pairs of somewhat irregular dorsal and ventral postanal tubercles (first lateral pair posterolateral to perianal pad); tubercles with terminal furcate structure (rayed sensilla of authors); postanal elongation partly retractile, with numerous annulations and about 30 bands of setuloid spinules. Posterior spiracles completely retractile, light brown, straight aciculate, contiguous or nearly so throughout, and often with spiracular atria fused; spiracles 2.6–3.3 times as long as greatest diameter and only about ⅔ as long as postanal elongation; distal ½–⅔ of spiracle with spiracular orifices inconspicuous dorsal, ventral, and lateral microcribiform slits.

Cephalopharyngeal skeleton (Figs. 8, 9) length (excluding mouthhooks) 0.42–0.67 mm. Pharyngeal sclerite dark brown or black centrally, with wide fiber-streaked hyaline periphery; other sclerites generally light to medium brown. Mouthhooks paired, separate basally and slightly shorter than hypostomal sclerite; hook part black, slightly or not at all decurved, with 6–8 teeth (largest pyriform and at midlength); base part medium brown, faintly fenestrate, and with conspicuous dorsal and ventral projections; base part articulating posteriorly with anterior arm of hypostomal sclerite; hook part slightly shorter than greatest dimension of base part (including dorsal and ventral projections). Hypostomal sclerite, in ventral view, broad, with ends of posterior arms acutely angled and juxtaposed to ends of pharyngeal sclerite and with very narrow hypostomal bridge projecting anteroventrad to point below posterior margin of light-brown, shield-shaped epistomal sclerite (plate); anterior margin of epistomal sclerite with paired minute medial toothlike projections (= ligulate sclerite?). Hypostomal and pharyngeal sclerites not fused; dorsal bridge, in ventral view, strongly arched anteriad and, in lateral view, steeply angled (about 45°); bridge multifenestrate and reticulate posteromedially; dorsal cornua ending in deep, often nearly closed obovate recess, with lower arm sometimes projecting beyond upper arm; ventral cornua 1.7–2.8 times as long as dorsal cornua, widest at midlength (1.5–2.0 times dorsal cornu width) and with undulant, mainly hyaline posterodorsal margin; 7–9 ventral pharyngeal (cibarial) grooves visible in ventral view. Ventral length of pharyngeal sclerite 3.4–4.2 times hypostomal length; ventral cornu length 2.2–3.0 times hypostomal length. (Based on 6 reared and 15 field-collected specimens.)

Fig. 20. *N. carinata.* 20, puparia attached to roots of water willow, *in situ.*

Puparium (Figs. 16, 17).—Length 3.50–4.95 mm ($\bar{x} = 4.24$); maximum width 0.99–1.80 mm ($\bar{x} = 1.33$). Empty puparium translucent, light to medium brown, fusiform with dorsal surface slightly flatter than ventral surface. Anterior spiracles absent; dorsocephalic cap rounded anterolaterally, indented anteromedially at longitudinally rugulose head-lobe scar, and undulant posteriorly; cap, in dorsal view, often with large and small pair of crescentric depressions and showing 3 zones of numerous fine, close-set transverse ridges bearing extremely minute longitudinal interconnecting fibrils, with apparent microspinules in 2 rows on metathorax. Puparium with 18 annuli between dorsocephalic cap and perianal pad, each with numerous faint, close-set, transverse micro-ridges and 6–14 bands of transparent microspinules; microspinules slightly larger on abdominal segments 3–7; abdominal venter with bands expanded into 7 indistinct creeping-welt patterns; segment 8 (above perianal pad) with 2 flat, dorsal, platelike areas and 6–8 bands of longer spinules immediately posterior to perianal pad. Perianal pad with anteromedial margin often arched anteriad between roundly bulging lateral lobes (extending onto sides of segment); pad with sclerotized chevron-shaped ridges in membrane; ventral postanal spinule patch present between relatively small ventral postanal tubercles. Postanal elongation paler, largely membranous (flexible), annulated, and about ⅒ as long as preanal length; postanal elongation with 3 pairs of lateral postanal tubercles—a large pair slightly posterolateral to perianal pad and smaller pairs near and at posterior end—and 2–3 pairs of somewhat irregular dorsal and ventral tubercles; tubercles mostly with terminal furcate structure. Posterior spiracles aciculate, black, thicker than in third instar, directed ventrad and often acanthous (curving anteriad); spiracles 2.4–2.8 times as long as greatest diameter and about as long as postanal elongation; distal ½–⅔ of spiracle twisted, with dorsal, ventral, and lateral micro-cribiform slitlike spiracular orifices. (Based on 5 reared and 30 field-collected specimens.)

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FOUR NEW SPECIES OF *POLYGYRA* (GASTROPODA: PULMONATA: POLYGYRIDAE) FROM COAHUILA, MÉXICO

Artie L. Metcalf and David H. Riskind

Abstract.—Four new species of the pulmonate land snail genus *Polygyra* are described from the state of Coahuila, México: *P. multiplicata* and *P. burlesoni* from the Serranías del Burro, *P. sterni* from the Sierra San Vicente and *P. dalli* from the Sierra de Guadalupe. Relationships within the group are discussed.

Within the state of Coahuila, México, occur numerous insular mountain ranges, most of which have not been investigated malacologically. Herein, 4 new species of the polygyrid land snail genus *Polygyra* are described from 3 such ranges. Differential diagnoses, etymologies, habitats and localities of collections for all species are described collectively in appropriate sections after the descriptions. The following abbreviations for repositories of materials are employed: DMNH = Dallas Museum of Natural History; UA = University of Arizona; USNM = National Museum of Natural History; UTEP = University of Texas at El Paso. We are grateful to Sr. Raul Diego of Piedras Negras, Coahuila, for granting us permission to enter the Rancho el Bonito. We thank Dr. C. J. Durden, Mr. Ernest Marsh and Mr. William Murray for help in making collections.

Descriptions of New Species

Polygyra dalli, new species

Plate I, Figs. D, E

Descriptions of shell of holotype.—Shell small for genus, 8.1 mm in diameter and 4.0 mm high, rounded peripherally, depressed, with spire only a slight bulge upward; umbilicus 1.3 mm wide, contained 6.23 times in shell diameter; aperture obliquely oriented, restricted by denticles; upper lip descending greatly, for ca. 80% of height of body whorl, terminating 2.5 mm from lower lip terminus; outer margin of lip flared, slightly twisted, upper part downward directed; upper lip continuous with upper end of parietal tooth, a complex denticle that extends from lip ventroposteriorly as an erect wall for 1.0 mm where it gives rise anteriorly to a sharply downward-declining spur and, posteriorly, to a very narrowly U-shaped denticle terminating immediately above terminus of lower lip; U-shaped denticle bearing microdenticles, these most numerous on lower, thicker-walled arm of "U" and assuming the form of minute serrations on edge of thinner-walled upper arm of "U"; parietal callus moderately thick, trans-

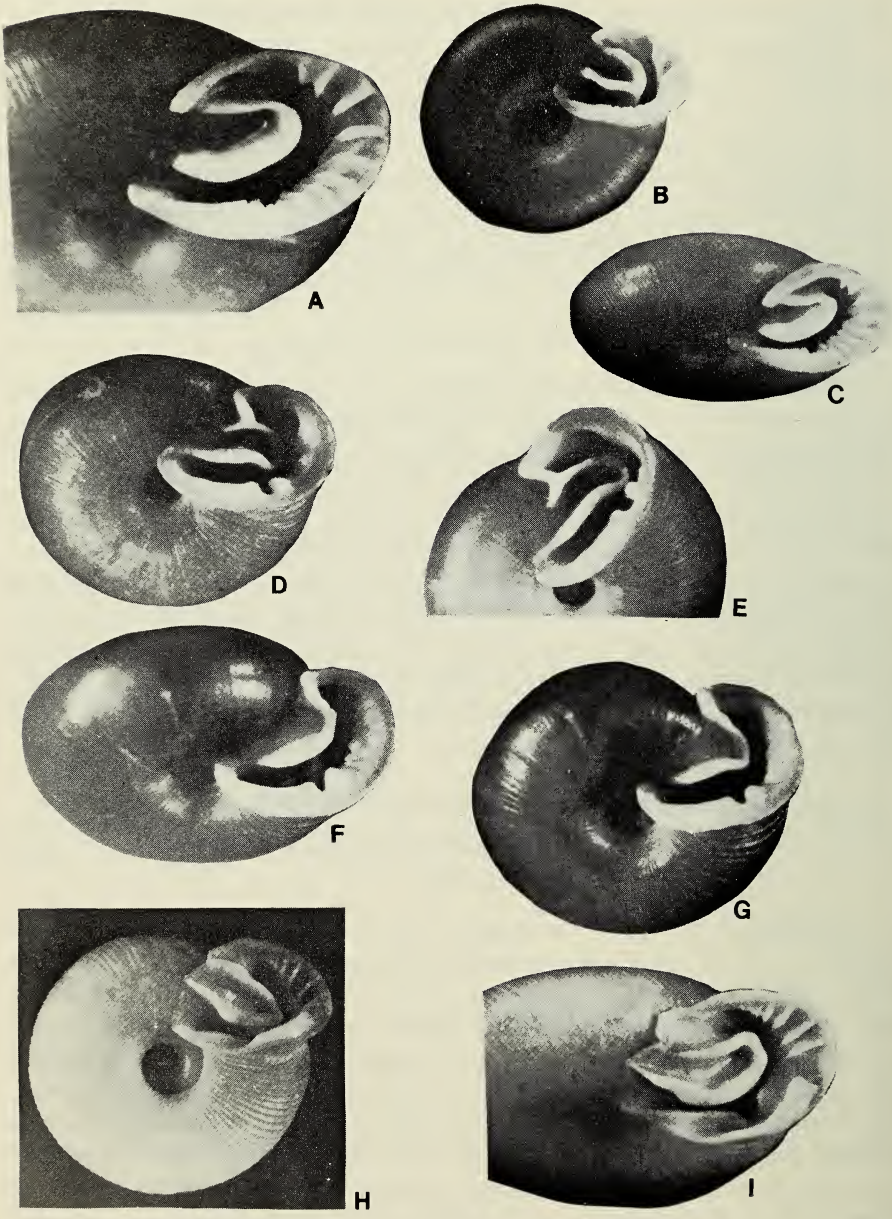

Plate I. Shells of holotypes of new species of *Polygyra* from Coahuila, México. National Museum of Natural History catalog numbers and diameters of shells are indicated. A–C, *P. multiplicata*, USNM 758818 (12.8 mm); D, E, *P. dalli*, USNM 758554 (8.1 mm); F, G, *P. burlesoni*, USNM 758816 (8.4 mm); H, I, *P. sterni*, USNM 758821 (11.75 mm).

lucent, glossy; outer lip of peristome bearing upper and lower flanges, each of which is confluent towards center of lip with a higher tubercle; upper flange beginning 2 mm behind upper lip terminus, occupying most of upper half of lip, greatly bowed posteriorly and showing some weak transverse corrugations in middle part, tubercle at lower end of upper flange rising 0.25 mm above remainder of flange and separated by U-shaped concavity, 0.4 mm wide, from tubercle at upper end of lower flange; lower flange plus its tubercle 2.1 mm long, extending to lower lip terminus; all these lip teeth bearing thick-set microdenticles, these producing a serrate margin on thin upper flange but forming a dense cover on outer surfaces of the 2 tubercles and thicker lower flange; shell with numerous minute pitlike scars of former cuticular hairs, a few hairs still persisting on body whorl behind lip and on flared outer surface of lip itself, numerous hairs persisting on walls of umbilicus; first half of nuclear whorl smooth, thereafter occur growth lines that become gradually stronger on dorsal surface and grade to small ribs immediately behind aperture; lower surface smoother with low growth lines; shell color light tan, teeth white.

Paratype.—There are only 2 specimens in the type-series. The paratype is slightly bleached, 8.3 mm in diameter and 3.9 mm high; umbilicus 1.5 mm wide; lower flange of outer lip 2.1 mm long; teeth and other features essentially as described for holotype.

Disposition of types.—Holotype, USNM 758554; paratype, USNM 758815.

Polygyra burlesoni, new species
Plate I, Figs. F, G; Fig. 1, C, D

Description of shell of holotype.—Shell small for genus, 8.4 mm in diameter and 4.0 mm high, depressed, with spire low, forming angle of 155°, rounded peripherally; umbilicus 1.65 mm wide, slightly overlapped by lower lip, contained 5.09 times in shell diameter; aperture obliquely oriented at angle of 40° to vertical; margin of upper lip descending for half the height of body whorl, lip slightly flared outward, distance between upper and lower termini of lip 2.8 mm; upper lip connecting to upper end of V-shaped parietal tooth, this tooth terminating 0.8 mm dorsoposteriorly from terminus of lower lip, tooth forming erect wall throughout, except where descending gradually at lower end; parietal callus thin, translucent; lip of peristome complexly denticulate with the following denticles, from top to bottom: (1) upper half of lip occupied by a series of 6 minutely serrate (on edge) plications oriented transversely to lip, originating near outer margin of lip and extending onto inner surface of lip in cavity of body whorl, (2) at midpoint of outer lip is a wide, blunt tubercle, separated by a U-shaped excavation from (3) a long flange, highest at its upper end and descending gradually to lower terminus of lip; number of whorls 5.1; nuclear whorl

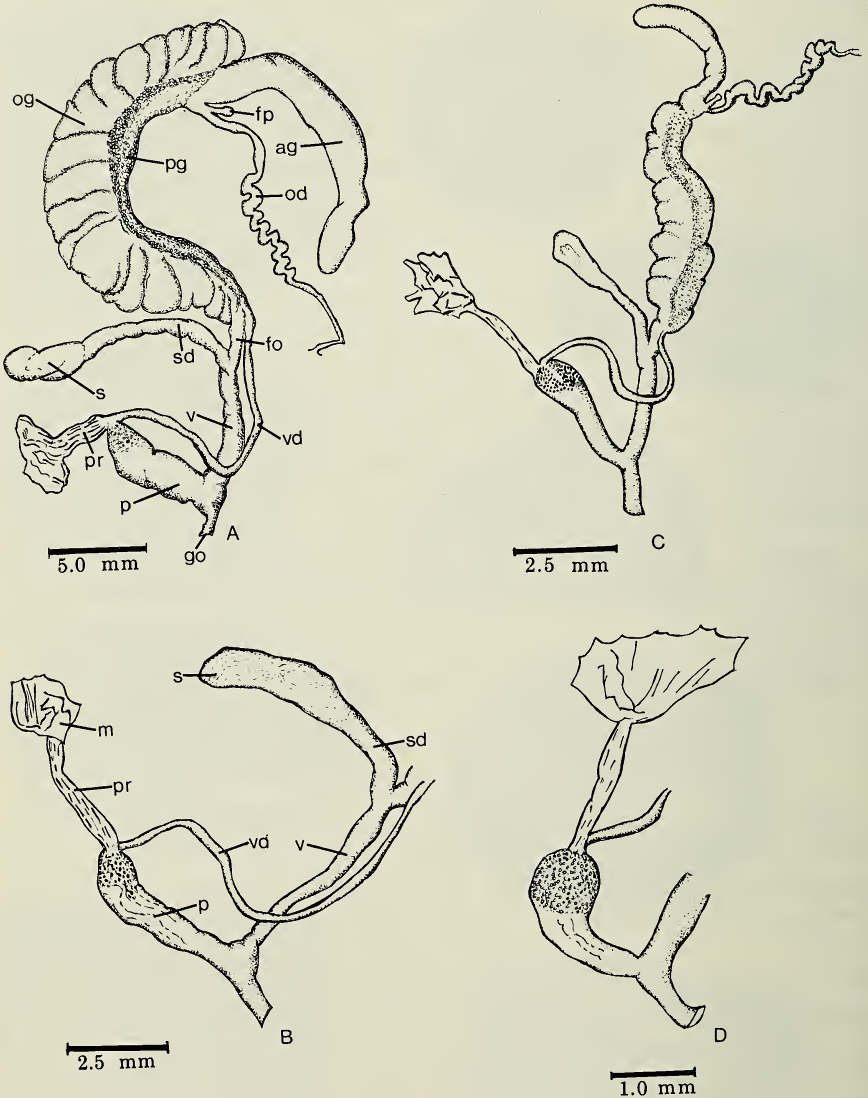

Fig. 1. A and B, Genitalia of *Polygyra multiplicata*; C and D, Genitalia of *Polygyra burlesoni.* ag = albumen gland; fo = free oviduct; fp = fertilization pouch; go = genital orifice; m = mantle; od = ovotestis or hermaphroditic duct; og = oviducal gland; p = penis; pg = prostate gland; pr = penial retractor muscle; s = spermatheca; sd = spermathecal duct; v = vagina; vd = vas deferens.

smooth except for some weak growth lines along suture on last ¼ of whorl; growth lines gradually becoming more prominent on succeeding whorls and riblike on upper surface of last ¾ of body whorl (lower surface of body whorl smoother); numerous minute pits on shell surface indicate former presence of cuticular hairs, with some hairs still persisting on walls of umbilicus; shell color brown except for denticles and flared lip, which are white to orangish-white; shell glossy.

Coloration of live animal.—Upper tentacles black, as is background color of upper half of body anterior to shell; however, extending from base of upper tentacles over the upper half of the body are yellowish-white reticulations; color of face below upper tentacles and of lower tentacles light tan, this color extending posteriorly onto lower half of sides, top of foot and tail (behind shell) but with small, darker brown maculations in these areas; sole light gray.

Genitalia.—Genitalia of 2 specimens are depicted in Fig. 1: C, D. Penis is elongate with upper part enlarged and having walls with granular appearance. A long, slender retractor muscle and a short vas deferens both attach at terminal end of penis. Vagina is long, giving rise at its upper end to a spermathecal duct with moderately large spermatheca. Talon is minute.

Variation in shells of paratypes.—The number of transverse plications in the upper lip varies from 5 to 8 in 33 paratypes observed from Localities 1 and 2 (described hereafter) with a mean of 6.3. Variation observed for some other shell characters from the 2 localities is indicated in Table 1; shells from the two localities prove to be similar. On some specimens cuticular hairs are much more widespread on the body whorl than is the case with the holotype.

Disposition of types.—Holotype, USNM 758816. Paratypes: DMNH 5361; UA 6260; USNM 758817; UTEP 5209, 5216, 5751, 5901.

Polygyra multiplicata, new species
Plate I, Figs. A–C; Fig. 1, A, B

Description of shell of holotype.—Shell moderately thick, 12.8 mm in diameter and 5.2 mm high, moderately depressed with spire forming angle of 157°, rounded peripherally; umbilicus 2.6 mm wide, contained 4.9 times in shell diameter; aperture oriented obliquely to vertical; upper lip margin descending greatly, for 90% of height of body whorl so that upper lip terminates only slightly above lower, the 2 termini 2.7 mm apart, obliquely; peristome flared outward and twisted; thin lamellar callus on parietal wall bearing a U-shaped denticle, upper ramus of "U" terminating 0.5 mm behind terminus of upper lip while lower ramus terminates 1.1 mm dorsoposteriorly from terminus of lower lip; rami arising abruptly from these termini and forming a wall 0.7–0.9 mm high throughout their extent; short, tail-like spur

Table 1. Some measurements and proportions for shells of paratypes of three new species of *Polygyra*. Upper numerals indicate extremes, lower numerals mean and standard deviation (the latter in parentheses). Localities noted are explained in text.

	P. multiplicata Locality 1	*P. multiplicata* Locality 3	*P. burlesoni* Locality 1	*P. burlesoni* Locality 2	*P. sterni*
No. of specimens	12	20	17	15	9
Diameter	13.1–14.2	11.45–13.1	7.3–8.1	7.35–8.45	10.9–11.95
	13.70(.300)	12.49(.421)	7.76(.248)	7.68(.350)	11.31(.467)
Height	4.85–5.9	4.7–5.75	3.6–4.7	3.5–4.0	4.35–4.75
	5.41(.318)	5.11(.271)	3.90(.258)	3.74(.173)	4.54(.133)
No. of whorls	5.25–5.4	4.75–5.4	4.8–5.3	4.7–5.6	4.6–5.0
	5.30(.054)	5.08(.186)	5.08(.118)	5.04(.257)	4.74(.133)
Apertural height	2.8–3.4	2.9–3.8	2.4–3.2	2.6–3.0	2.6–3.3
	3.10(.186)	3.27(.270)	2.77(.190)	2.84(.135)	3.03(.240)
Apertural width	5.6–6.5	5.8–7.0	2.9–3.8	3.2–3.8	4.8–5.7
	5.93(.293)	6.42(.380)	3.45(.181)	3.48(.207)	5.32(.349)
Umbilical width	2.3–3.1	2.5–3.5	1.3–1.7	1.4–1.9	1.7–2.2
	2.54(.231)	2.97(.237)	1.49(.104)	1.54(.149)	2.07(.144)
Diameter/height	2.33–2.81	2.09–2.62	1.68–2.11	1.82–2.17	2.37–2.64
	2.54(.130)	2.45(.135)	2.00(.102)	1.99(.103)	2.49(.093)
Diameter/umbilical width	5.07–6.00	3.71–4.89	4.41–6.08	4.40–6.25	5.12–6.44
	5.51(.300)	4.23(.315)	5.22(.400)	5.20(.503)	5.48(.412)
Apertural width/apertural height	1.73–2.07	1.71–2.34	1.13–1.38	1.00–1.24	1.63–2.04
	1.92(.110)	1.98(.186)	1.25(.058)	1.16(.071)	1.76(.144)

descending from posterior, rounded end of "U"; lip of peristome bearing series of 13 plications, in 5 series, as follows: (1) uppermost plication beginning 1.5 mm from upper lip terminus and slightly internal to peristomial margin, minutely but distinctly serrate on edge, extending back for 3.4 mm on inner surface of outer lip; (2) beginning 1.4 mm from the first-mentioned fold are a series of 8 plications, which are similar to each other in morphology, all minutely serrate on their edges, the upper and central folds descending obliquely back along inner surface of lip; the longer ones extending for a distance of 2.2 mm, lower folds becoming progressively smaller and grading in size to the following; (3) two small, serrate plications, which barely rise above the subtending peristomial callus and do not extend back along inner surface of lip (4) the above 2 minute folds are followed by a slightly larger one, extending back 0.8 mm on inner surface of lip; (5) a final and lowermost fold rises slightly above the peristomial callus 2.7 mm from lower terminus of outer lip and then descends gradually, ventrally, to merge with callus; number of whorls, 5.25; first (nuclear) whorl smooth; dorsal surfaces of other whorls with low, closely crowded growth lines, these becoming progressively more prominent on dorsal and lateral surfaces of body whorl (but not on its ventral surface) and becoming almost riblike immediately behind flared peristome; shell color grayish-tan except for white parietal denticles and inner and outer surface of lip peristome and its plications.

Coloration of live animal.—Tentacles gray with numerous minute black, raised maculations arranged in irregular rows; dorsal background color gray but with large black maculations arranged in well defined rows anterior to aperture, these becoming lighter in color and more scattered on sides, on which color grades to uniform gray ventrally; sole with dark gray border, lighter gray in center.

Genitalia.—Genitalia of 2 specimens are shown in Fig. 1: A, B. Penis is moderately long and of generally uniform diameter, making juncture, at its terminus, with a long penial retractor and short vas deferens. The vagina is long and gives rise to a thick spermathecal duct at its upper end, which, in turn, bears a large, club-shaped spermatheca. The talon is relatively small.

Variation in shells of paratypes.—Number of apertural plications varied from 11 to 17 in 12 paratypes from Locality 1, with a mean number of 13.9 and from 10 to 14 in paratypes from Locality 2 with a mean of 11.55. Variation for some other shell measurements and proportions are shown in Table 1. It will be noted that shells from the lower elevation (1,220 m) and more xeric habitat of Locality 3 are smaller than those from the higher elevations (1,600–1,830 m) of Locality 1, with almost no overlap in shell diameter between the two. However, apertural and umbilical dimensions average larger in the shells from the lower locality. Thus, the combinations (1) large shell-small aperture and (2) small shell-large aperture are distinctively different.

Disposition of types.—Holotype, USNM 758818. Paratypes: DMNH 5363; UA 6259; USNM 758819; UTEP 4939, 5208, 5219, 5680, 5688, 5919.

Hybrids.—Two shells found in upper Cañon el Bonito (Locality 1) seem to be hybrids between *P. burlesoni* and *P. multiplicata.* They are intermediate in size between the two species (10.1 and 10.4 mm in diameter and 4.9 and 5.0 mm in height). The upper lip descends almost to bottom of the body whorl as in *P. multiplicata.* In denticulation they are closer to *P. burlesoni.* As in *P. burlesoni*, only the upper half of the lip bears transverse plications while the lower part bears a long flange. However, in the position of the centrally located, small tubercle of *P. burlesoni* is a structure that appears to have formed from fusion of two or three plications like those above. This structure is not found in either of the postulated parent species.

Polygyra sterni, new species

Plate I, Figs. H, I

Description of shell of holotype.—Shell thick, 11.75 mm in diameter, 4.74 mm high, depressed, with spire forming angle of 147°, rounded peripherally; umbilicus 2.4 mm wide, contained 4.9 times in shell diameter;

aperture oriented obliquely to vertical; upper lip margin descending to half height of subtending body whorl, upper lip terminus 3.0 mm, obliquely, from lower lip terminus; parietal wall covered with well developed lamellar callus, raised dorsoanteriorly from underlying whorl, bearing large denticle, irregularly U-shaped, and with sinuous, erect walls, ca. 1 mm high, walls 0.9 mm apart at anterior margin of parietal callus, distance from this margin to posterior end of denticle 3.9 mm.

Outer lip peristome wide, flared outward, bearing a complex array of plications and denticles, described, clockwise, from upper lip terminus as follows: (1) a series of plications occupies upper half of lip (a) the first of these near the upper lip terminus, originating on outer part of peristome and extending back for 2.5 mm on inner surface of lip, (b) a small tubercle occurs, immediately adjacent to the preceding plication, on middle part of peristome, (c) at a distance of 0.5 mm beyond the tubercle begins a series of 7 folds, the highest being smallest and the lower 3 largest; uppermost, smaller folds restricted to middle part of flared peristome, lower, larger ones originating at outer margin of peristome and extending completely across it; edges of inner half of folds minutely serrate; (2) lower half of peristome with one large denticle produced by outer margin of peristome and 2 by its inner part, these inner and outer teeth separated by ca. 1 mm distance on peristome; outer tooth beginning at center of outer lip margin as an erect flange perpendicular to the peristomial wall, highest at upper end (0.9 mm) and gradually descending to merge with peristome at distance of 3 mm (2 minute spurs descend from upper end of this tooth onto surface of peristome); upper inner tooth 1.5 mm long, confluent with inner part of lowermost of the 7 folds noted above, separated by an indentation of 0.5 mm from lower, inner tooth; lower inner tooth elongate, 3.4 mm long, highest at upper end and descending gradually to near lower lip terminus; 3 low folds pass across peristomial wall from outer tooth, one to the upper inner tooth and two to the area of indentation between the upper and lower inner teeth.

Number of whorls 4.75; nuclear 1.5 whorls with very weak growth wrinkles, these grading to more prominent growth lines on succeeding 2 whorls, with growth lines becoming riblike on last 1.5 whorls dorsally and on sides but only on last 0.75 whorl on ventral surface, these ventral ribs extending to umbilicus; shell color light tan with peristome and associated denticles of a slightly lighter shade of the same color (because shell was dead when collected there may have been some bleaching from original color).

Variation in shells of paratypes.—In *Polygyra sterni* there is considerable variation in the elaborate denticulation, even within the 10 specimens observed. In some specimens the parietal denticle complex is not walled anteriorly. In others a wall forms anteriorly and the complex takes on the aspect of an elongate basin with walls encircling a central depression. The number of folds in the upper lip varies from 5 to 8 with a mean of 7.1. The structure termed an "upper inner tooth" in the holotype is especially variable, ranging from 0.6 to 2.3 mm in length. In some specimens it seems to be only an enlarged lowermost fold, like those above it, whereas in others, it appears to consist of several fused folds. It is not clear whether it represents, evolutionarily, a tooth that is fragmenting into folds or a tooth that is being formed by the fusion of several folds. The outer tooth varies considerably in development, ranging from 2.4 to 2.9 mm in length (mean, 2.42) and 0.7 to 1.3 mm in height (mean, 0.89). Variation in some other shell measurements and proportions is indicated in Table 1.

Disposition of types.—Holotype, USNM 758821. Paratypes: DMNH 5362; UA 6261; USNM 758822; UTEP 4936.

Etymologies

Dr. Paul Bartsch, associated with the National Museum of Natural History from 1895 to 1946, commenced preparation of a work concerning the Mexican Polygyras. He left notes and labels in the Museum indicating names that he proposed. *Polygyra dalli* was one of these names, which, we assume, honored William H. Dall, eminent malacologist, who lived from 1845 to 1927.

Polygyra burlesoni and *P. sterni* are named in recognition of Mr. Robert Burleson, Temple, Texas, and Dr. Edward Stern, University of Wisconsin at Stevens Point, who generously provided transportation, companionship and much assistance on the field excursions on which the respective species were collected.

The name *multiplicata* (L., *multus* + *plicatus*) refers to the numerous plications or folds found in the outer lip of that species.

Differential Diagnoses

Genitalia are known only for *P. burlesoni* and *P. multiplicata.* In addition to overall smaller size of the genitalia of *P. burlesoni,* the penis in specimens dissected was relatively more expanded in its upper part. Genitalia for most species of *Polygyra* from México have not been figured. The genitalia of the species discussed here are similar to those of *P. texasiana* (Moricand, 1833) as figured in Pilsbry (1940:Fig. 392A).

The background color of the upper tentacles and adjoining dorsum is gray with blackish maculations in *P. multiplicata,* whereas in *P. burlesoni,* the background color of these areas is black with a distinctive network of yellowish-white reticulations.

The parietal denticle differs in the 4 species. It is most complex in *P. dalli*, comprising a high-walled, straight upper section, confluent with the upper lip, and a narrowly U-shaped lower part almost reaching the lower lip. *P. burlesoni* bears a simple V-shaped tooth, confluent dorsally with the upper lip. The U-shaped parietal tooth of *P. multiplicata* does not reach the upper lip and the tooth of *P. sterni* is restricted to the central part of the parietal wall, where, in gerontic specimens, it is walled on all sides (open anteriorly in younger specimens).

Transverse plications occur in the outer lip of 3 of the species described and differentiate them from shells of other known Polygyras. These plications extend along almost the full extent of the lip in *P. multiplicata* but are restricted to its upper half in *P. sterni* and *P. burlesoni.* In *P. dalli* a flange in the upper part of the outer lip displays weak corrugations, which are probably homologous to the plications of the other species. The lower half of the outer lip is occupied by a simple elongate flange in *P. dalli* and *P. burlesoni.* In *P. sterni* both inner and outer flanges occur in the lower part of the lip.

Tiny toothlike projections (termed microdenticles) are numerous on the teeth of *P. dalli.* Cuticular hairs and their scars occur in *P. dalli* and *P. burlesoni.* Ribs are well developed on the entire body whorl, dorsally, in *P. sterni* but occur only on the youngest part of the whorl in the other species.

Habitats and Localities of Collections

Polygyra dalli.—*Polygyra dalli* was collected on the expeditions of Edward W. Nelson and Edward A. Goldman in México. Data with specimens state: "9,500 ft. Sierra Guadalupe, Coahuila, Mex. May 1, 1902. Nelson & Goldman." The Sierra de Guadalupe is described by Goldman (1951:133–135) as being situated ca. 20 miles southwest of Saltillo, Coahuila, and being "mainly limestone." Nelson and Goldman visited the eastern part of the range, sometimes indicated as the Sierra de la Concordia, from 20 April to 3 May 1902 and ascended to a height of "9,500 ft." Recent maps indicate that the eastern segment of the range reaches a height of 11,286 ft (3,440 m). In regard to specimens taken on this excursion, Goldman noted (p. 133) "Specimens were all labeled 'Sierra Guadalupe'." Thus, it is impossible to ascertain exactly where the type-locality of *P. dalli* may be within the range. This range complex was visited by H. A. Pilsbry on 14–17 July 1934 and discussed by him (Pilsbry, 1953:136). He found no *Polygyra* on this excursion to the range, which suggests that the genus may be relatively rare there.

Polygyra burlesoni *and* P. multiplicata.—The Serranías del Burro are mountains located ca. 120 km WSW of Del Rio, Texas, and Ciudad Acuña, Coahuila, and are visible, in the distance, from these cities. The uplift is roughly quadrate in shape and occupies some 700 km². Highest peaks of the range reach 2,105–2,125 m (6,906–6,975 ft). Smith (1970:8–10; Pl. 1) indicated that the range is predominantly of Cretaceous limestone bedrock and described it as a "long, low upwarp" within which considerable folding, faulting and topographic dissection have taken place. We visited only one major, northeast-draining canyon of the range, Cañon de la Zorra, and collected in tributary canyons of its extreme upper, western end: Cañon el Toro and Cañon el Bonito, located on Rancho el Bonito, Mcpo. de Villa Acuña, in February and September, 1977. *Polygyra burlesoni* and *P. multiplicata* were taken in both canyons. *Polygyra burlesoni* was found only along the floors of these canyons where there are well developed, dense stands of deciduous and evergreen trees and shrubs. These include *Juniperus* aff. *virginiana* L., *Ostrya* sp., *Quercus* spp., *Crataegus* sp., *Prunus serotina* Ehrh., *Cercis canadensis* var. *mexicana* (Rose), *Acer grandidentatum* Nutt., *Rhamnus* sp., *Tilia* sp., *Arbutus xalapensis* H.B.K. and *Viburnum* sp. *Polygyra multiplicata* occurred in more xeric habitats in the lower, more open parts of canyons, on alluvial terraces along canyons, on hillsides and on hillcrests. In these more open woodlands occur such shrubs and trees as *Pinus arizonica* Engelm., *Juniperus flaccida* Schlecht, *Dasylirion* sp., *Agave* sp., *Philadelphus* sp., *Fendlera linearis* Rehd., *Cercocarpus* spp., *Ceanothus* sp., *Garrya ovata* Benth. and *Salvia regla* Cav.

At one place, intermediate in habitat, in both Cañon el Bonito and in Cañon el Toro, *P. burlesoni* and *P. multiplicata* were taken together and in Cañon el Bonito 2 probable hybrid specimens were found (discussed under account of *P. multiplicata*, above). Three localities in the above canyons at which specimens were collected are:

Locality 1: 29°01′20″ to 02′00″N; 102°05′55″ to 07′00″W. Uppermost end of Cañon el Bonito from near a concrete watering tank for livestock (*pila*) to head of canyon, 1,600–1,830 m elevation. Type-localities of both *P. burlesoni* and *P. multiplicata* are in this canyon with that of *P. burlesoni* at ca. 1,600 m elevation and that of *P. multiplicata* at ca. 1,675 m.

Locality 2: 29°03′15″N; 102°04′00″W. Upper end of Cañon el Toro, elevations approximately as at Locality 1. Both species taken.

Locality 3: 29°01′30″N; 101°58′00″W. At entrance gate to Rancho el Bonito in degraded grassland with *Mimosa-Yucca-Prosopis* desert scrub. Here only *P. multiplicata* was taken, under rotting pine saw-logs (1,230 m).

Polygyra sterni.—This species was collected on the lower, north slope of the extreme north end of the Sierra San Vicente, Mcpo. de Sacramento, immediately south of México Federal Highway 30 and 2.25 km east of Boquillas (village on highway, between Nadadores and Cuatro Ciénegas de Carranza), 27°00′00″N; 101°52′20″W, at 750 m elevation on 20 May 1976. Shells were collected from limestone talus (visible from highway) on a sparsely vegetated (mainly xeric shrubs) slope. It occurred with specimens of two species of *Rabdotus.* No live specimens of any of these snails were taken.

Discussion

It seems likely that the four species described here form part of a related group of Polygyras inhabiting the mountains of Coahuila. Shells of *Polygyra idiogenes* Pilsbry, 1956, indicate that it also appertains to this group. The type-locality of *P. idiogenes* (San Lorenzo Cañon in the Sierra Zapaliname, 25°18′30″N; 100°57′00″W) is not far (ca. 50 km ENE) from that of *P. dalli,* although they are in separate ranges. Further collecting in the area may reveal intermediate forms between *P. idiogenes* and *P. dalli* and demonstrate them to be conspecific. They seem to be the most plesiomorphic of the 5 species discussed. No transverse plications are found in shells of *P. idiogenes* and *P. dalli* but, in *P. dalli,* weak corrugations in the upper flange of the outer lip suggest such plications and may be their progenitor. Microdenticles cover all teeth in *P. dalli,* producing minute serrations on edges of the thinner teeth. Similar, but somewhat coarser, serrations are seen on edges of plications in the remaining species.

Polygyra burlesoni is small, like the 2 species discussed above, and shares some of their plesiomorphic characters. However, it has evolved to a stage where the corrugations, barely discernible in *P. dalli,* have now become separate plications occupying the upper half of the outer lip.

In *P. sterni* the upper part of the outer lip bears, as in *P. burlesoni,* a series of transverse, serrate plications. However, denticles of the lower half of the outer lip seem to be highly apomorphic, especially as regards occurrence of a separate, outer flange paralleling the inner one. *Polygyra multiplicata* also seems to be apomorphic but has taken a different tack, evolutionarily, from *P. sterni* in that the outer lip is occupied exclusively by transverse, serrate plications.

Despite the unusual denticulation of the more apomorphic members of the group it seems clear that they are derived from a *Polygyra* of the *idiogenes* kind of morphology and that all should be placed in the subgenus *Erymodon* Pilsbry, 1956:20.

It is highly likely that additional members of this group will be found in the mountains of Coahuila, probably allowing a better appraisal of evolutionary trends.

The plications of the outer lip that are characteristic of most of the species described seem not to have been reported in *Polygyra* previously. They bear superficial resemblance to plications illustrated for some species of Fijian endodontid land snails treated by Solem (1973:Figs. 16, 18).

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THE DISTRIBUTION AND TAXONOMY OF *TAMIAS STRIATUS* AT THE SOUTHERN LIMITS OF ITS GEOGRAPHIC RANGE

Clyde Jones and Royal D. Suttkus

Abstract.—Thirteen characters (4 external, 9 cranial) were subjected to univariate and multivariate analyses in order to determine the taxonomic relationships among the southernmost populations of *Tamias striatus.* Information is presented also on the ecology and distribution of the eastern chipmunk in the southern parts of its geographic range.

Tamias striatus ranges across much of eastern North America from Manitoba through Quebec to southern Labrador, south through Virginia, and southwest across central North Carolina, western South Carolina, and central Georgia, Alabama, and Mississippi to Louisiana (Hall and Kelson, 1959). The species was not reported from west Florida and adjacent Alabama until 1962 (Stevenson, 1962).

Eleven subspecies are recognized currently (Hall and Kelson, 1959, Long, 1971). There is no recent treatment of southern chipmunks other than the reviews of distribution and taxonomy of *Tamias* in Louisiana and adjacent areas by Lowery (1943, 1974). The presence of a population of eastern chipmunks in Florida stimulated us to review the ecology, distribution, and taxonomic status of the southernmost populations of *T. striatus.*

Methods and Materials

Field studies of *T. striatus* were carried out intermittently from 1968 through 1976. The purposes of field work were to obtain specimens for study, to document the southern distributional limits of the species, to determine the distribution and status of the species in west Florida, and to obtain general information on the ecology of the species in the most southern portions of its range. Field notes, catalogues, and specimens collected are deposited at the National Fish and Wildlife Laboratory, National Museum of Natural History, and the Museum of Natural History, Tulane University.

Specimens, consisting of study skins, skulls, or both, were examined from 75 localities. Because of small sample sizes, it was necessary to pool data from some localities for statistical analysis. The 13 samples analyzed are listed below. Precise localities are given in the list of specimens examined.

Sample A.—Tishomingo County, Mississippi. Sample B.—Sunflower, Bolivar, and Coahoma Counties, Miss. Sample C.—Yazoo and Holmes Counties, Miss. Sample D.—Warren and Claiborne Counties, Miss. Sample E.—Lauderdale County, Miss. Sample F.—Copiah County, Miss. Sample G.—Adams County, Miss. Sample H.—Lincoln County, Miss. Sample I.—Jones County, Miss. Sample J.—Wilkinson County, Miss. Sample K.—Okaloosa County, Florida, and Covington County, Alabama. Sample L.—Clark, Gordon, Hall, Towns, and Macon Counties, Georgia. Sample M.—East Baton Rouge, East Feliciana, and West Feliciana Parishes, Louisiana.

Specimens with all cheek teeth fully erupted were considered adults. All measurements were recorded in millimeters. External dimensions (total length, tail length, hindfoot length, ear length) were taken from the specimen labels. The following skull measurements were taken to the nearest 0.05 mm with dial calipers.

Greatest length of skull.—The overall length from the anterior tip of the nasals to the posterior bulge of the braincase.

Zygomatic breadth.—The greatest distance across the zygomatic arches perpendicular to the long axis of the skull.

Interorbital breadth.—The least distance across the top of the skull between the orbits.

Cranial breadth.—The greatest distance across the braincase immediately posterior to the zygomatic arches.

Cranial depth.—The distance from a line connecting the tips of the upper incisors with the most ventral portion of the posterior part of the cranium to the highest part of the cranium.

Maxillary tooth row length.—The alveolar distance from the anterior border to the posterior border of the upper cheek teeth.

Nasal length.—The measure from a line connecting the anteriormost parts to a line connecting the posteriormost extensions of the nasal bones.

Nasal width.—The distance from the most lateral points of the two nasal bones.

Mandibular tooth row length.—The alveolar distance from the anterior border to the posterior border of the lower cheek teeth.

The initial statistical analysis included computation of standard statistics (range, mean, standard deviation, standard error of the mean) for 13 variables of the specimens from each of the individual or pooled samples. These computations were made using a computer program (BMDO1D) developed at the Health Sciences Computing Facility, UCLA (Dixon, 1973).

Unknown and questionable specimens were allocated and among-group relationships were examined for specimens with complete data in a stepwise discriminant function analysis BMDO7M (Dixon, 1973). Wilson (1973) discussed this method of allocating specimens and provided some additional references.

Museums with specimens examined in this study are identified as follows: Museum of Zoology, Louisiana State University (LSUMZ); Mississippi State Wildlife Museum (MSWM); National Museum of Natural History, Biological Survey Collection (USNM); Museum of Natural History, Tulane University (TU); University of Georgia (UG).

Specimens examined (total 331).—LOUISIANA: East Baton Rouge Parish: Mississippi River, 2 mi W Baton Rouge, 1 (LSUMZ); 3.5 mi S Port Hudson, 1 (LSUMZ). East Feliciana Parish: 27 mi N Baton Rouge, 1 (LSUMZ); 3 mi NW Port Hudson, 1 (LSUMZ). West Feliciana Parish: 5 mi SE Angola, 1 (LSUMZ); Bains, 7 (TU), 2 (LSUMZ); Cornor, 12 (LSUMZ); 1 mi W Laurel, 1 (LSUMZ); 9 mi NW St. Francisville, 1 (LSUMZ); 6 mi N St. Francisville, 2 (LSUMZ); 5 mi NW St. Francisville, 1 (LSUMZ); 10 mi NE St. Francisville, 1 (LSUMZ); St. Francisville, 3 (LSUMZ); 1 mi E St. Francisville, 1 (LSUMZ); 2 mi E St. Francisville, 1 (LSUMZ); 3 mi S, 2 mi E St. Francisville, 1 (LSUMZ); 5 mi ENE St. Francisville, 1 (LSUMZ); 5.5 mi ENE St. Francisville, 1 (LSUMZ); 2 mi W St. Francisville, 1 (LSUMZ); 1 mi W St. Francisville, 1 (LSUMZ); 5.6 mi ENE St. Francisville, 1 (LSUMZ); 38 mi NNW Baton Rouge, 1 (LSUMZ); Tunica, 5 (LSUMZ); 5 mi S Tunica, 2 (LSUMZ); 1 mi N Jct. La. Hwy. 66 and 969, 1 (TU). MISSISSIPPI: Adams County: Natchez, 14 (MSWM); Auburn, 2 (MSWM); no locality, 7 (MSWM). Bolivar County: 2.5 mi N Rosedale, 1 (LSUMZ); Bogue Phalia, 6 (LSUMZ), 5 (MSWM). Claiborne County: Rocky Springs, 4 (MSWM). Coahoma County: Sunflower River, 5 (MSWM). Copiah County: Arista Ranch, 2 (MSWM); Crystal Springs, 1 (MSWM); Smyrna, 3 (MSWM). Holmes County: No locality, 1 (MSWM). Jones County: Boquehoma, 5 (MSWM); no locality, 1 (MSWM). Lauderdale County: Cauys Merridale, 1 (MSWM); Cow Creek near Mehon, 1 (MSWM); Meridian, 2 (MSWM); no locality, 3 (MSWM). Lincoln County: Auburn, 4 (MSWM). Sunflower County: Sunflower River, 1 (MSWM). Tishomingo County: 12 mi NE Burnsville, 2 (MSWM). Warren County: Fort Hill, 1 (MSWM); NE Military Park, 1 (MSWM); Riley's Area, 2 (MSWM); Yazas Canal, 1 (MSWM). Wilkinson County: No locality, 1 (LSUMZ), 4 (MSWM); 6.7 mi W Centerville, 1 (TU); Percy's Creek, 1 (MSWM); Tunica Hills, 1 (LSUMZ); 8 mi NE Woodville, 2 (TU); 2 mi SE Woodville, 10 (USNM), 15 (TU); 3.3 mi SE Woodville, 1 (TU); 6 mi SE Woodville, 4 (USNM), 4 (TU); 1.5 mi W Woodville, 2 (TU); 4.1 mi SW Woodville, 1 (TU); 5 mi W Woodville, 1 (TU); 5.9 mi W Woodville, 1 (TU); 9 mi SW Woodville, 3 (TU); 11 mi SW Woodville, 50 (TU); 12.4 mi W Woodville, 28 (USNM). Yazoo County: Phoenix, 28 (MSWM); Yazoo City, 1 (LSUMZ). FLORIDA: Okaloosa County: 5 mi SW Laurel Hill, 2 (USNM); 7 mi SW Laurel Hill, 7 (USNM), 11 (TU). ALABAMA: Covington County: 5 mi SE Wing, 1 (TU). GEORGIA: Clark County: Athens, 13 (UG); no locality, 2 (UG). Gordon County: Plainville, 1 (UG). Hall County: About 5 mi N Gunville, 1 (UG). Macon County: Highlands, 5 (UG). Towns County: Enota Gaade, 1 (UG).

Results and Discussion

The specimens examined in this study encompass most known records of *T. striatus* at the southern limits of its range. For some additional summaries of records of the species in Mississippi, see the works by Wolfe (1971) and Kennedy, Randolph, and Best (1974). Details of the occurrence of the eastern chipmunk in Louisiana are provided by Lowery (1974).

The population of *T. striatus* that occurs in a restricted area of northern Okaloosa County, Florida, and adjacent southern Covington County, Alabama, seemingly is isolated from other populations of eastern chipmunks, although it may be at the southern end of a peninsula of distribution extending from the more northern range of the species. There are reports of chipmunks elsewhere in southern Alabama (Stevenson, 1962), and people living in the outer suburbs and rural areas north and east of Mobile Bay sometimes comment about the presence of "ground squirrels" in the region. However, extensive field activities and investigations of mammals in west Florida and southern Alabama in recent years have yielded no concrete evidence of *Tamias* (Linzey, 1970). The unusual ecological conditions of the panhandle of Florida and the patterns of distribution of numerous animals and plants that occur there were discussed by Neill (1957). Some additional discussions of the mechanisms for development of the distributions of animals in west Florida and adjacent Alabama were presented by Collette and Yerger (1962).

In Wilkinson County, Mississippi, and adjacent Louisiana eastern chipmunks occur mostly in ravines and along small streams bordered by considerable amounts of deciduous hardwood vegetation. The ravines typically have dense growths of ferns and underbrush. The animals occasionally are found in strips of vegetation either alongside or between fields, especially pecan groves. In west Florida *Tamias* is found in a rather mature deciduous woods. The vegetation of this area includes *Pinus glabra, Taxodium distichum, Sabal minor, Smilax* sp., *Myrica cerifera, Carya* sp., *Carpinus caroliniana, Betula nigra, Fagus grandifolia, Quercus alba, Q. stellata, Q. lyrata, Q. virginiana, Q. nigra, Magnolia grandiflora, Illicium floridanum, Asimina parviflora, Persea borbonia, Itea virginica, Hamamelis virginiana, Liquidambar styraciflua, Crataegus marshallii, C. lacrimata, Amelanchier arborea, Prunus angustifolia, Gleditsia triacanthos, Rhus radicans, Cyrilla racemiflora, Ilex cassine, I. vomitoria, I. opaca, Euonymus americanus, Acer floridanum, A. drummondii, Aesculus pavia, Parthenocissus quinquefolia, Vitis rotundifolia, Hypericum* sp., *Cornus florida, Nyssa aquatica, Kalmia*

Table 1. Variation of external characters of *Tamias striatus* from Wilkinson County, Mississippi. The numbers for each measurement include the mean plus and minus two standard errors, the extremes, the sample size, and the standard deviation.

Sex	Total length	Tail length	Hindfoot length	Ear length
Males	245.95 ± 8.04	83.90 ± 6.50	36.20 ± 0.56	19.83 ± 0.36
	205.00–275.00	40.00–105.00	34.00–38.00	18.00–21.00
	21 18.42	21 14.91	24 1.41	24 0.91
Females	251.21 ± 8.60	89.34 ± 5.20	36.03 ± 0.48	19.59 ± 0.74
	220.00–300.00	58.00–115.00	34.00–38.00	17.00–28.00
	23 20.65	23 12.49	27 1.25	27 1.92

latifolia, Rhodendron canescens, R. austrinum, Vaccinium sp., *Diaspyros virginiana, Symplocos tinctoria, Halesia diptera, Styrax grandifolia, Fraxinus* sp., *Chionanthus virginica, Gelsemium sempervirens, Callicarpa americana, Lonicera sempervirens*, and *Viburnum dentatum.* Most of the animals collected or observed in west Florida were near the edges of a low area that is flooded occasionally by the Yellow River. Stevenson (1962) noted that eastern chipmunks in west Florida occurred infrequently in either pine woods or deciduous woods without an undergrowth of yaupon (*Ilex vomitoria*).

Tamias striatus seems unusually secretive and difficult either to observe or capture in the most southern areas where it occurs. For example, in Wilkinson County, Mississippi, most animals were encountered as they moved along the upper levels of the sides of ravines, usually just beneath the overhanging edges. In Okaloosa County, Florida, nearly all the chipmunks found were at the entrances to burrows. Stevenson (1962:110) reported that "Chipmunks were heard frequently, but seen rarely, for a period of two years before a specimen could be secured." Following the report by Stevenson (1962) of the presence of *Tamias* in west Florida, numerous searches, including both trapping and hunting efforts, were made for chipmunks in the area, but no animals were obtained until October, 1971.

At the southern edge of its geographic range, *T. striatus* is active outside of the burrows throughout the year. Specimens were obtained by shooting in each month of the year; most animals were taken in October, and the fewest specimens were collected during July. Lowery (1974) reported a summer lull in activity of *Tamias* in Louisiana, and Dunford (1972) documented a summer lull during July for chipmunks studied in New York. Our observations reveal that chipmunks were most active in the fall when cold fronts were present, feeding and carrying food. Most animals taken at this time of the year were carrying acorns and pecans in their cheeks. Chipmunks seemed to range greater distances from the entrances to burrows, and

Table 2. Variation of skull characters of *Tamias striatus* from Wilkinson County, Mississippi. The numbers for each measurement include the mean plus and minus two standard errors, the extremes, the sample size, and the standard deviation.

Sex	Greatest length of skull	Zygomatic breadth	Interorbital breadth	Cranial breadth	Cranial depth
Males	43.16 ± 0.64	23.47 ± 0.58	12.11 ± 0.28	17.45 ± 0.20	16.40 ± 0.18
	41.10–44.65	21.30–24.75	10.95–13.00	16.65–18.10	15.60–16.80
	13 1.18	13 1.07	18 0.61	15 0.40	12 0.34
Females	42.77 ± 0.92	23.44 ± 0.42	11.77 ± 0.20	17.64 ± 0.14	16.45 ± 0.12
	40.20–44.65	21.70–24.55	11.00–12.65	17.05–18.10	16.15–17.00
	10 1.46	16 0.84	18 0.44	15 0.30	12 0.23

Sex	Maxillary tooth row length	Nasal length	Nasal width	Mandibular tooth row length
Males	6.68 ± 0.10	14.88 ± 0.38	3.46 ± 0.20	6.78 ± 0.12
	6.25–7.05	13.70–16.40	2.75–4.50	6.15–7.30
	19 0.23	14 0.72	17 0.44	19 0.26
Females	6.61 ± 0.10	14.63 ± 0.28	3.41 ± 0.12	6.68 ± 0.08
	6.00–7.15	13.05–16.05	2.90–4.20	6.10–7.15
	24 0.25	21 0.65	22 0.30	23 0.22

thus were collected more easily, in the fall than at other times of the year. Information on home range in relation to the burrow system was provided by Yahner (1978), and a detailed review of foraging ecology of eastern chipmunks was presented by Elliott (1978). The chronology of annual events in populations of eastern chipmunks in relation to climate was summarized by Yahner and Svendsen (1978).

Entrances to burrows of *Tamias* in Louisiana and adjacent Mississippi were at the upper edges of ravines and often near or among roots of trees, as noted by Thomas (1974) and Lowery (1974). In Florida, openings to burrows were frequently on the forest floor, and were usually nearly obscured by leaves and litter.

Sexual variation in the sample of *T. striatus* from Wilkinson County, Mississippi, is documented in Tables 1 and 2. Females appear slightly larger than males in two of the four external characters compared (Table 1). However, males average slightly larger than females in seven of the nine skull characters analyzed (Table 2). Because sexual differences are slight (also see Lowery, 1974) for the measurements recorded, data from the sexes are considered together for the subsequent analysis of geographic variation.

Character variation among the samples considered is shown in Tables

Table 3. Variation of external characters among samples of *Tamias striatus*. Geographic origins of samples are provided in the text. The numbers for each measurement include the mean plus and minus two standard errors, the extremes, the sample size, and the standard deviation.

Sample	Total length	Tail length	Hindfoot length	Ear length
B	250.09 ± 11.74	85.80 ± 11.06	32.31 ± 3.30	15.30 ± 1.72
	223.00–292.00	45.00–110.00	20.00–38.00	11.00–20.00
	12 20.33	12 19.17	12 5.74	12 2.98
C	262.09 ± 10.88	100.47 ± 7.20	32.99 ± 2.94	18.00 ± 2.58
	218.00–310.00	60.00–132.00	20.00–47.00	11.00–30.00
	21 24.93	21 16.51	21 6.76	21 5.95
D	270.00 ± 13.60	113.00 ± 3.04	29.33 ± 17.52	13.66 ± 2.40
	257.00–280.00	110.00–115.00	13.00–43.00	12.00–16.00
	3 11.78	3 2.64	3 15.17	3 2.08
F	290.20 ± 16.24	104.60 ± 5.70	22.50 ± 8.66	11.60 ± 3.20
	275.00–310.00	100.00–113.00	10.00–30.00	10.00–18.00
	5 18.17	5 6.38	4 8.66	5 3.57
G	252.50 ± 18.00	94.87 ± 8.76	35.18 ± 1.36	12.81 ± 1.30
	150.00–290.00	65.00–115.00	30.00–42.00	14.00–23.00
	16 36.00	16 17.54	16 2.73	16 2.61
I	259.80 ± 19.82	91.80 ± 11.22	32.80 ± 4.48	17.80 ± 0.74
	233.00–284.00	75.00–109.00	22.00–37.00	17.00–19.00
	5 22.16	5 12.55	5 6.14	5 0.83
J	248.58 ± 8.32	86.62 ± 5.84	36.11 ± 0.52	19.71 ± 1.10
	212.00–288.00	46.00–110.00	34.00–38.00	17.00–25.00
	40 19.53	40 13.70	51 1.33	51 1.41
K	242.42 ± 7.34	90.36 ± 6.12	36.57 ± 0.50	18.33 ± 0.44
	215.00–270.00	48.00–100.00	35.00–39.00	17.00–20.00
	19 16.02	19 13.37	19 1.12	18 0.97
L	234.15 ± 10.82	87.25 ± 5.28	35.64 ± 1.32	15.66 ± 4.04
	182.00–267.00	71.00–114.00	32.00–42.00	12.00–19.00
	14 20.26	14 9.87	14 2.47	3 3.51
M	252.21 ± 6.48	91.85 ± 4.26	34.90 ± 1.10	18.85 ± 0.66
	226.00–285.00	46.00–115.00	26.00–40.00	15.00–22.00
	28 12.17	28 11.30	32 3.13	32 1.87

3 and 4. Because of either incomplete data or small sample sizes, Samples A, E, and H are not included in these tables. External measurements vary more than most skull measurements.

In external features, the smallest animals are from Georgia and western Mississippi, with larger animals occurring in southwestern Mississippi, Florida, and Louisiana (Table 3). Study of skull measurements also shows that the smallest animals are from Georgia, with larger forms from southwestern Mississippi, Louisiana, and Florida (Table 4). Lowery (1943, 1974) characterized the eastern chipmunks from Louisiana (*T. s. pipilans*) as the largest of all *T. striatus*. The animals from Florida are similar, although

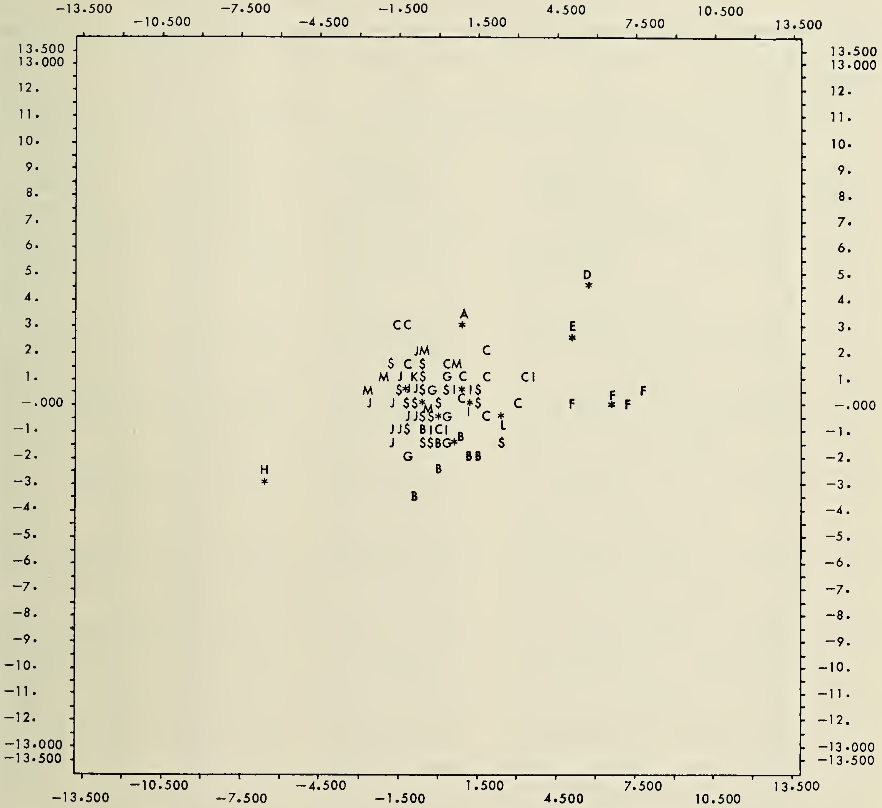

Fig. 1. Plot of the first and second canonical variates. Letters refer to the samples listed in the text. Overlaps are indicated by $ and group means are indicated by *.

sometimes slightly larger in some characters, to those from Louisiana and nearby localities in Mississippi. From north to south, then, across about five degrees of latitude, there is a general increase in the size of the animals studied. The largest animals are found at about the same latitudes in west Florida, Louisiana, and southwestern Mississippi. For a discussion of the large size of southern *Tamias*, as well as information about size in connection with the fossil history of the genus, see Ray (1965).

We did not analyze pelage color because of the foxed condition of many of the museum specimens examined. Lowery (1943) states that *T. s. pipilans* is the most richly colored of all eastern chipmunks. Specimens of *Tamias* from west Florida seem similar in color to those from Louisiana and southwestern Mississippi.

The plot of the specimens on the first and second canonical variates from

Table 4. Variation of skull characters among samples of *Tamias striatus*. Geographic origins of samples are provided in the text. The numbers for each measurement include the mean plus and minus two standard errors, the extremes, the sample size, and the standard deviation.

Sample	Greatest length of skull	Zygomatic breadth	Interorbital breadth	Cranial breadth	Cranial depth
B	42.92 ± 0.76	23.87 ± 0.38	11.62 ± 0.26	17.32 ± 0.26	16.01 ± 0.14
	41.65–44.45	22.40–24.60	11.10–12.55	16.55–18.15	15.75–16.50
	9 1.14	12 0.69	14 0.50	14 0.49	10 0.23
C	43.36 ± 0.52	24.06 ± 0.34	12.13 ± 0.24	17.55 ± 0.14	16.36 ± 0.14
	41.00–45.75	21.80–25.15	11.05–12.95	16.80–18.15	15.70–16.85
	19 1.15	17 0.71	19 0.53	20 0.34	18 0.31
D	43.42 ± 1.84	23.67 ± 0.94	11.82 ± 1.54	17.65 ± 0.20	16.52 ± 0.14
	42.50–44.35	23.20–24.15	11.05–12.60	17.50–17.25	16.45–16.60
	2 1.30	2 0.67	2 1.09	2 0.14	2 0.10
F	44.18 ± 1.00	24.40 ± 0.30	12.36 ± 1.10	17.23 ± 0.34	16.65 ± 0.90
	43.25–45.00	24.25–24.55	11.35–13.95	16.90–17.50	16.20–17.10
	3 0.88	2 0.21	4 1.11	3 0.30	2 0.63
G	42.25 ± 1.02	23.47 ± 0.50	11.83 ± 0.24	17.67 ± 0.30	16.39 ± 0.24
	39.45–43.90	22.55–24.05	11.00–12.55	16.75–18.35	15.90–16.75
	8 1.46	7 0.63	13 0.46	9 0.45	6 0.31
I	42.95 ± 1.16	23.00 ± 0.56	11.91 ± 0.46	17.25 ± 0.34	16.20 ± 0.42
	41.20–45.15	22.50–23.80	11.10–12.66	16.55–17.65	15.65–16.95
	6 1.43	4 0.47	6 0.58	6 0.43	5 0.47
J	42.96 ± 0.78	23.45 ± 0.25	11.90 ± 0.24	17.54 ± 0.85	16.43 ± 0.14
	40.65–44.65	21.50–24.65	10.97–12.82	16.85–18.10	15.87–17.00
	23 1.32	29 0.80	36 0.52	30 0.35	24 0.28
K	43.87 ± 0.34	23.84 ± 0.46	12.29 ± 0.72	17.81 ± 0.28	16.63 ± 0.38
	43.50–44.45	23.20–24.65	11.45–13.45	17.55–18.20	16.25–16.90
	5 0.38	6 0.58	5 0.82	4 0.28	3 0.34
L	42.25 ± 0.64	23.10 ± 0.44	11.45 ± 0.40	17.19 ± 0.28	15.97 ± 0.30
	40.40–44.10	22.35–23.85	10.55–12.60	16.35–17.80	15.30–16.60
	9 0.97	8 0.64	11 0.67	9 0.43	10 0.49
M	43.11 ± 0.80	23.12 ± 0.44	11.53 ± 0.28	17.49 ± 0.22	16.30 ± 0.22
	39.90–45.75	20.15–24.40	9.70–12.90	16.35–18.10	15.45–17.45
	17 1.66	22 1.04	23 0.71	16 0.45	17 0.47

the discriminant function analysis depicts the relationships among the samples studied (Fig. 1). The extensive overlap indicates the difficulty of separating the samples from each other, at least on the basis of the measurements used in this study. These results are in concordance with the extensive overlap in the univariate data.

From these data, there is no apparent reason to consider the population of *T. striatus* in Florida and adjacent Alabama taxonomically distinct from the populations in Louisiana and Mississippi. Further, in view of the general

Table 4. Continued.

Sample	Maxillary tooth row length	Nasal length	Nasal width	Mandibular tooth row length
B	6.70 ± 0.16	14.13 ± 0.50	3.34 ± 0.28	6.99 ± 0.20
	6.10–7.20	11.80–15.60	2.45–4.40	6.40–7.75
	14 0.31	14 0.94	14 0.55	14 0.40
C	6.68 ± 0.12	14.79 ± 0.14	3.59 ± 0.18	6.85 ± 0.14
	6.05–7.45	13.40–15.70	2.80–4.70	6.15–7.60
	22 0.32	23 0.59	23 0.44	23 0.36
D	6.93 ± 0.22	14.95 ± 1.10	3.75 ± 0.00	6.80 ± 0.34
	6.60–7.05	14.40–15.50	3.75–3.75	6.50–7.25
	4 0.22	2 0.77	2 0.00	4 0.34
F	6.53 ± 0.24	15.25 ± 0.38	3.40 ± 0.28	6.68 ± 0.36
	6.25–6.80	14.85–15.80	3.00–3.70	6.40–7.20
	4 0.25	4 0.39	4 0.29	4 0.36
G	6.39 ± 0.16	14.56 ± 0.40	3.26 ± 0.12	6.52 ± 0.16
	5.85–7.05	12.95–15.90	2.90–3.85	6.05–7.00
	16 0.34	15 0.80	15 0.23	15 0.32
I	6.49 ± 0.24	15.16 ± 0.48	3.75 ± 0.48	6.75 ± 0.24
	6.15–6.85	14.45–16.00	2.95–4.65	6.35–7.15
	6 0.31	6 0.60	6 0.61	6 0.30
J	6.64 ± 0.10	14.75 ± 0.32	3.44 ± 0.32	6.75 ± 0.10
	6.00–7.15	13.15–16.40	2.75–4.50	6.10–7.30
	43 0.24	35 0.68	39 0.37	42 0.24
K	6.67 ± 0.74	15.17 ± 0.32	3.72 ± 0.28	6.95 ± 0.18
	6.50–6.80	14.60–15.80	3.15–4.35	6.70–7.30
	7 0.09	7 0.43	7 0.39	7 0.24
L	6.35 ± 0.14	14.33 ± 0.48	3.49 ± 0.30	6.54 ± 0.16
	6.00–6.80	12.70–15.70	2.50–4.25	6.05–6.95
	11 0.26	11 0.80	12 0.54	10 0.26
M	6.67 ± 0.08	14.43 ± 0.38	3.39 ± 0.10	6.82 ± 0.08
	6.30–7.15	12.80–16.25	2.90–4.05	6.20–7.20
	32 0.23	27 0.99	31 0.30	31 0.24

trend in size from north to south and the variation in size among animals from several places in Mississippi (Tables 1–4, Fig. 1), we see little justification for taxonomically separating the populations of eastern chipmunks in Louisiana and Mississippi from populations of *T. s. striatus* that occur to the north. We believe that all eastern chipmunks in Florida, Alabama, Mississippi, and Louisiana should be assigned to *T. s. striatus.*

Tamias striatus is recognized as rare on the lists of rare and endangered vertebrates of the state of Florida (Jones, 1976). This determination is based primarily on the restricted range of the species in Florida and the destruction of habitat in the area.

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KEYS TO SUBORDERS AND FAMILIES OF TANAIDACEA (CRUSTACEA)

Jurgen Sieg and Richard Winn

Abstract.—A brief review is presented of the current status of the systematics of the Tanaidacea. Identification keys and illustrations are given to the suborders and families of the entire order.

Advances in the study of the Tanaidacea have been slow in comparison to the other commonly collected microcrustaceans from marine benthic environments. These small peracarids are usually abundant in benthic samples and often rank numerically above or near amphipods, isopods and cumaceans. Systematic problems have made identification of many specimens to species or even to family extremely difficult. Knowledge concerning the biology of most species is entirely lacking.

In an attempt to identify the tanaids collected as part of the Southern California Baseline Study and Analysis: Benthic Macrofauna (University of Southern California—U.S. Bureau of Land Management), the authors have searched for clearly distinguishable and reliable characters to separate the species. These characters are presented here in the identification keys to the suborders and families of the entire order Tanaidacea worldwide. Additional keys, new species descriptions and comments on distributions of the southern California tanaidaceans will be presented in subsequent papers, each of which will deal with the members of one or more families. This paper is Allan Hancock Contribution number 366.

The order Tanaidacea Hansen 1895, was divided by Lang (1956) into two suborders: Monokonophora and Dikonophora. Sars' (1882) Tanaidae may be regarded as equivalent to the former and his Apseudidae as equivalent to the latter.

Monokonophora

At present, 8 families are commonly accepted in the Monokonophora: Apseudidae, Leiopidae, Metapseudidae, Kalliapseudidae, Apseudellidae, Pagurapseudidae, Cirratodactylidae and Tanzanapseudidae. Gutu (1972) fused the families Apseudidae and Leiopidae into a single family (Apseudidae) and proposed subfamilies within it, and other subfamilies within the families Kalliapseudidae and Metapseudidae. He also proposed the new family Apseudellidae for the exceptional *Apseudella.* We follow Lang (1970) and accept the family Apseudellidae but not Gutu's proposed subfamilies. Such subfamilies may be warranted should more extensive studies

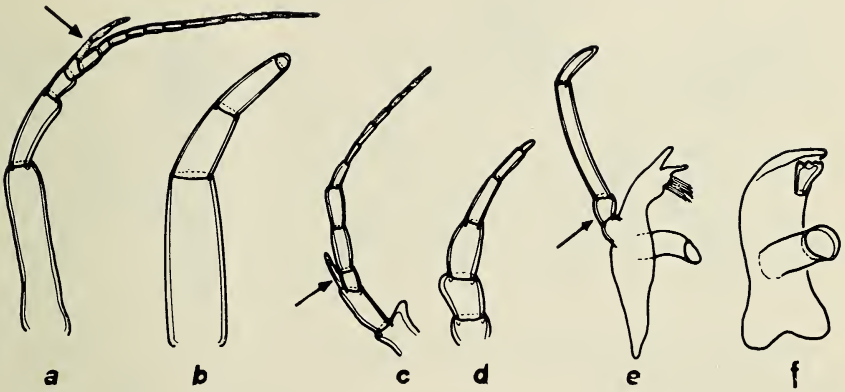


Fig. 1. a, c, Antenna 1 (and usually 2) with inner and outer flagellum (=biramous); b, d, Antenna with outer flagellum only; e, Mandible with palp; f, Mandible without a palp.

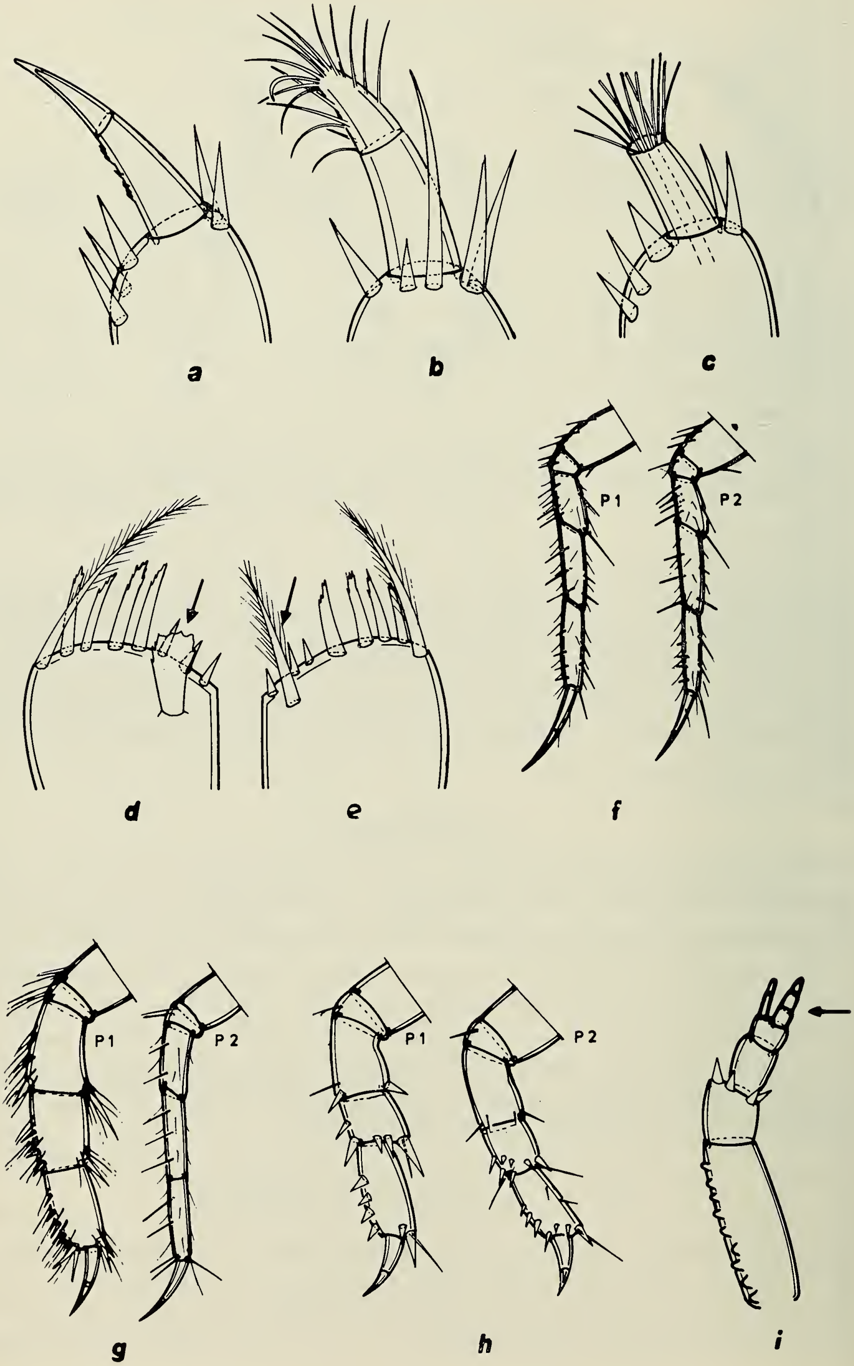
provide evidence of probable phylogenetic lines within the suborder. Another family, Tanzanapseudidae was recently created (Bascescu, 1976) for the genus *Tanzanapseudes* from Tanzanian waters. Although no diagnosis was given, some note was made that it may be related to Metapseudidae but possesses rather unique characters possibly justifying a new familial designation.

Dikonophora

There are at present 8 families in the Dikonophora: Tanaidae, Paratanaidae, Neotanaidae, Agathotanaidae, Anarthruridae, Leptognathiidae, Pseudotanaidae and Nototanaidae. When erecting the suborder, Lang (1956) included the already existing families Tanaidae and Paratanaidae as well as his new family Neotanaidae. He later (1970, 1971, 1973) separated 3 additional families (Agathotanaidae, Anarthruridae and Leptocheliidae) from the Paratanaidae. Sieg (1976) however, suppressed Leptocheliidae as a junior synonym of Paratanaidae and established 3 new families, Leptognathiidae, Pseudotanaidae and Nototanaidae.

Key to the Suborders of Tanaidacea

1. First antenna (and usually second) with inner and outer flagellum (Fig. 1a, c); mandible with palp (Fig. 1e) Monokonophora Lang
– First and second antennae with outer flagellum only (Fig. 1b, d); mandible without palp (Fig. 1f) Dikonophora Lang


a
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e
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P1
P2
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P1
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h
i

Key to the Families of Monokonophora (Modified from Lang, 1970)

1. Body extremely flattened dorsoventrally, produced into 31 long triangular acute expansions Tanzanapseudidae Bascescu
– Body not extremely flattened 2
2. Dactyl of pereopod I with esthetasc (Fig. 2c) Kalliapseudidae Lang
– Dactyl of pereopod I without esthetasc (Fig. 2a, b) 3
3. Dactyl of pereopods II–VI with a distal spine covered with strongly recurved setae (Fig. 2b) Cirratodactylidae Gardiner
– Dactyl of pereopods II–VI with distal spine not covered with recurved setae (Fig. 2a) 4
4. Pereopod I cylindrical, not more strongly expanded than pereopods II–VI (Fig. 2f) Pagurapseudidae Lang
– Pereopod I not cylindrical, more strongly expanded than the following pereopods (Fig. 2g, h) 5
5. Inner caudodistal seta of maxillipedal endite transformed into expanded scale (Fig. 2d) Leiopidae Lang
– Inner caudodistal seta of maxillipedal endite not transformed into expanded scale (Fig. 2e) 6
6. Pereopod I similar to pereopods II and III (Fig. 2h); flagellum of first antenna short, with few joints (Fig. 2i) Metapseudidae Lang
– Pereopod I distinguished from II and III by its flattened form (Fig. 2g); flagellum of first antenna not short, with many joints 7
7. Exopod of maxilla I with apically setose palp; epignath of maxilliped scale-shaped Apseudidae Sars
– Exopod of maxilla I without palp; epignath of maxilliped not scale-shaped Apseudellidae Gutu

Key to the Families of the Suborder Dikonophora Lang (After Sieg, 1976)

1. Mouthparts reduced 2
– Mouthparts not reduced 3
2. Antenna 2 with 9 joints Neotanaidae Lang (males)
– Antenna 2 with 7 joints or less 4

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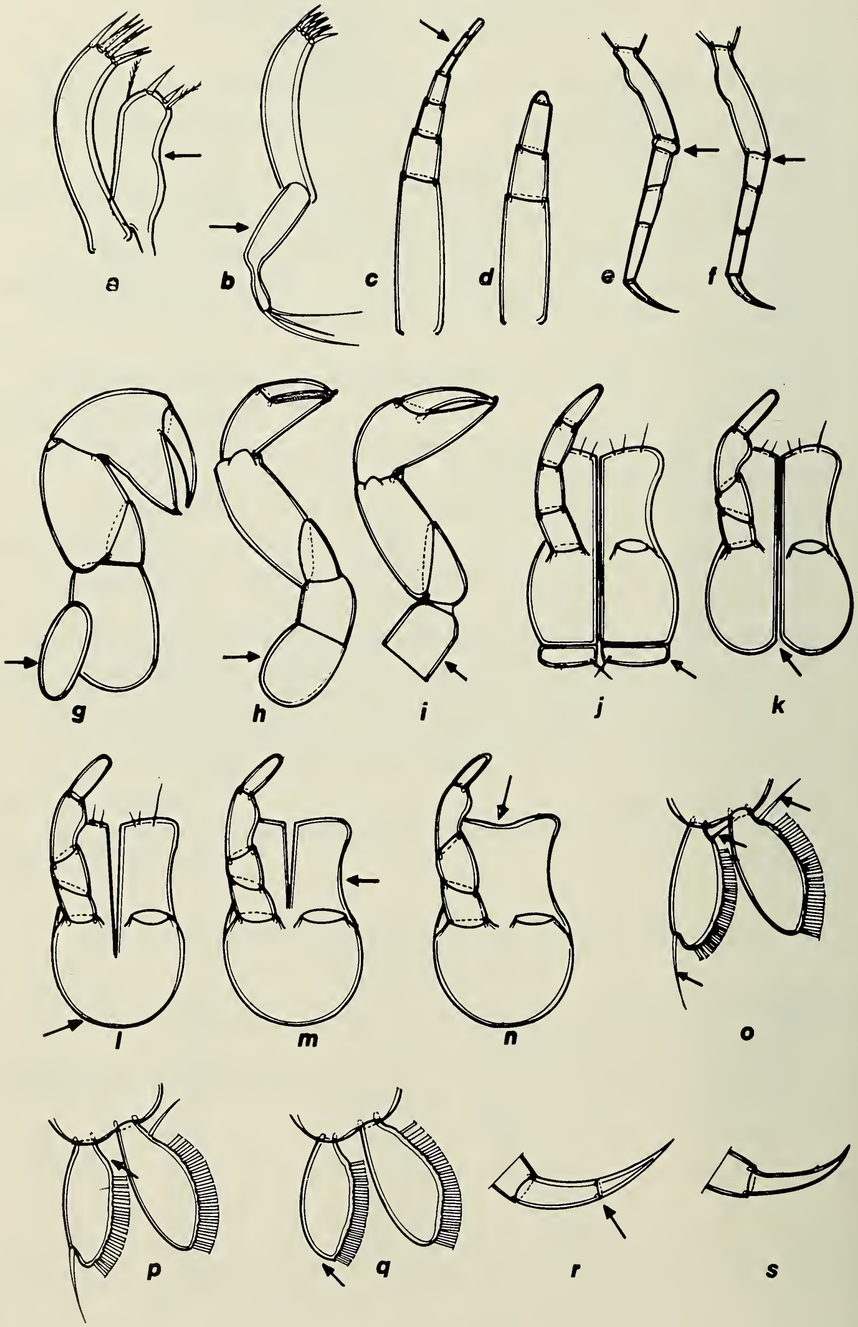
Fig. 2. a, Dactyl of pereopod 1 without esthetasc, with recurved setae; b, Dactyl of pereopod 1 without esthetasc; c, Dactyl of pereopod 1 with an esthetasc; d, Maxillipedal endite seta expanded; e, Maxillipedal endite seta not expanded; f, Pereopod 1 cylindrical; g, Pereopod 1 not cylindrical, flattened; h, Pereopod I cylindrical, similar to pereopods II and III; i, Flagellum of antenna I very short.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3. Maxilla 1 with inner and outer endite, without palp (Fig. 3a); antenna 1 with 3-jointed peduncle and 4- or 5-jointed flagellum (Fig. 3c) Neotanaidae Lang (females)
– Maxilla 1 with only outer endite and palp (Fig. 3b); first antenna with 3-jointed peduncle and 1- or 2-jointed flagellum (Fig. 3d) 4
4. Pereopods I–VI without ischium (Fig. 3f); uropods uniramous; maxilliped with coxa not fused to basis (Fig. 3j) Tanaidae Dana
– Pereopods I–VI with ischium (Fig. 3e); uropods nearly always biramous (consisting of peduncle, exopod and endopod; maxilliped with coxa fused to basis 5
5. Cheliped without coxa (Fig. 3i) Agathotanaidae Lang
– Cheliped with coxa (Fig. 3g, h) 6
6. Coxa of cheliped articulated with proximal margin of basis (Fig. 3h) Anarthruridae Lang
– Coxa of cheliped articulated with mediolateral margin of basis (Fig. 3g) 7
7. Basis of maxilliped (or its rudiments) not fused medially, without coxa (Fig. 3k); endopod of pleopods with 1 terminal seta on inner margin and with many seta (one very close to basis) on outer margin; exopod of pleopods with inner marginal seta near basis thick and irregularly plumose (Fig. 3o) Paratanaidae Lang
– Basis of maxilliped more or less fused medially (Fig. 3l, n); endopod of pleopods without marginal seta near basis (Fig. 3p); exopod with or without seta thick and irregularly plumose 8
8. Basis of maxilliped not completely fused (Fig. 3l) Leptognathiidae Sieg
– Basis of maxilliped completely fused (Fig. 3m, n) 9
9. Pereopods IV–VI dactyl with suture separating unguis (Fig. 3r) Pseudotanaidae Sieg (subfamily Cryptocopinae)
– Pereopods IV–VI dactyl without suture separating unguis (Fig. 3s) 10

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Fig. 3. a, Maxilla I with inner and outer endite, without palp; b, Maxilla I with only outer endite and palp; c, Antenna I with 3-jointed peduncle and 4- and 5-jointed flagellum; d, Antenna I with 3-jointed peduncle and 1- or 2-jointed flagellum; e, pereopod with ischium; f, Pereopod without ischium; g, Coxa of cheliped articulated with mediolateral margin of basis; h, Coxa of cheliped articulate with proximal margin basis; i, Cheliped with coxa; j, Maxilliped with coxa not fused (males); k, Maxilliped with basis not fused, without coxa; l, Maxilliped with basis incompletely fused; m, Maxilliped with basis completely fused; n, Maxilliped with basis completely fused, endite fused; o, Exopod of pleopod with thick and irregularly plumose marginal seta; p, Endopod of pleopod without marginal seta near basis; q, Inner margin of endopod of pleopod without terminal seta; r, Pereopod dactyl with suture separating unguis; s, Pereopod dactyl without suture.

10. Endites (inner lobes) of maxilliped fused (Fig. 3n); inner margin of endopod of pleopods without terminal seta (Fig. 3q); females with 1 pair of oostegites
Pseudotanaidae Sieg (subfamily Pseudotanainae)

– Endites (inner lobes) of maxilliped not fused; inner margin of endopod of pleopods without terminal seta (except *Tanaissus*, with terminal seta); females with 4 pairs of oostegites
Nototanaidae Sieg

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NATURAL HISTORY OF PLUMMERS ISLAND, MARYLAND. XXIV. BITING MIDGES (DIPTERA: CERATOPOGONIDAE) 2. THE SPECIES OF THE TRIBES HETEROMYIINI AND SPHAEROMIINI

Willis W. Wirth and William L. Grogan, Jr.

Abstract.—A short review is made of the published biological information on the adults and immature stages of the predaceous midge tribes Heteromyiini and Sphaeromiini. In both tribes the larvae are aquatic and are most characteristic of the margins and shallow waters of lakes, ponds, and large and small streams. Adult females prey on small Diptera, usually chironomid midges and even the males of their own species, which they usually capture in the male swarms. Diagnoses are presented of all taxa, tribes, genera, and species; and keys are given for identification of the species of the lower Potomac Valley. Seventeen species belonging to eight genera are found in the study area, including one species described as new: *Sphaeromias bifidus*, n. sp.

I. Introduction

The first paper of this series (Wirth, Ratanaworabhan, and Messersmith, 1977) provided a short review of the anatomy, systematics and biology of the biting midges of the family Ceratopogonidae, and a key for the identification of the North American genera. As the series continues, keys and descriptions will be given for the species occurring in the lower Potomac River valley in the Maryland and Virginia counties immediately adjacent to Plummers Island and the District of Columbia. Discussion of taxonomic characters and explanation of our terminology was given in our first contribution. Although it would be desirable to treat the Potomac Valley species in phylogenetic sequence, some difficult groups scattered through the sequence require additional collection and study, and we have been forced to delay their study until later in the series. For the present study we have selected two tribes of Ceratopogoninae for which collections have been more adequate and the taxonomy is more advanced. The North American Sphaeromiini were studied in some detail by Wirth (1962a), and several genera of Sphaeromiini and Heteromyiini have recently been revised by Grogan and Wirth (1975, *Clinohelea*; 1977, *Jenkinshelea*) and Wirth and Grogan (1977, *Heteromyia*).

II. Biology and Immature Stages of the Tribes Heteromyiini and Sphaeromiini

Only a limited amount of information is available on the habits and life histories of the midges of the tribes Heteromyiini and Sphaeromiini. So far as known, the adult females are predaceous on chironomid midges and other smaller, soft-bodied insects. Observations of this habit were reported by Staeger (1839), who stated that the females of all the Ceratopogonidae (the old genus *Ceratopogon*, as he knew it) were predaceous. Staeger's statement was much too sweeping but showed that he must have made many observations on the habit. Walker (1856b) noted that "The species whose femora are armed with spines make a prey of other small insects, which they pierce with their sharp proboscis," a statement as much too conservative as Staeger's was too broad.

Loew (1864) noted that females of *Macropeza albitarsis* Meigen preyed on other small insects along streams during the day and in the evening hours could be found in large numbers with the males, held in copulation by the females so tightly that they could not be separated with a forceps and when one pinned the females, the males remained attached and died thus.

Published prey records for the predaceous Ceratopogoninae are few, and apparently nothing more was written until Malloch (1914) noted that he had seen a large species of *Palpomyia* feeding on a perlid stonefly in Britain. Edwards (1920) was the first to devote full attention to recording the prey species of the predaceous Ceratopogoninae, and (1923) listed prey of the following genera (nomenclature brought up to date): *Ceratopogon*, *Isohelea*, *Serromyia*, *Stilobezzia*, *Bezzia*, *Palpomyia*, *Mallochohelea*, and *Macropeza*. Only the last two genera fall in the tribes Heteromyiini and Sphaeromiini.

Gad (1951) gave an excellent comprehensive account of the morphology of the head capsule and mouthparts of the family Ceratopogonidae and reviewed the adult feeding habits in detail. The new prey records he gave were for the genus *Serromyia* in the tribe Stilobezziini. As a typical representative of the predaceous ceratopogonids, he chose to illustrate and describe the head and mouthparts of *Probezzia seminigra* (Panzer) (as *Dicrobezzia venusta* (Meigen)). In this group the mandibles are broad blades with unusually large teeth, but the laciniae, though still present, are reduced. All mouthparts are present in the male, but the armature is reduced.

The adult feeding habits of the predaceous ceratopogonids were summarized by Downes (1960): "The females of insectivorous Ceratopogoninae (typical genera: *Ceratopogon*, *Stilobezzia*, *Clinohelea*, *Palpomyia*) feed on small insects that are captured in flight. The prey is almost always the male of species of Nematocera and Ephemeroptera, and it is frequently, and probably typically, captured in the male swarms (mating swarms) that are so often produced in these groups. Such swarms are formed near, and are controlled by, visible landmarks. At least in many genera the prey of the female also includes the male of her own species, captured in the specific male swarms; under these circumstances, capture of the male by the female, as prey and capture of the female by the male, as mate, take place simultaneously. During mating the female pierces the male through the head and injects salivary enzymes; the male is ultimately reduced to a brittle cuticle that breaks away except for the terminalia, which may adhere for some time. The female, as in other Nematocera of less dramatic feeding habits, finds the specific mating swarm probably by responding to the same landmarks as do the males. But whereas, e.g., *Culicoides* [sic] hunts for its food by quite other means, these insectivorous females hunt by responding to landmarks of the kind that are used also and originally in connection with mating. They thus reach, perhaps almost indifferently, the male swarm of their own or another species and proceed to capture prey." Downes (1978) published a detailed summary and elaboration of his earlier studies on the feeding and mating habits of the insectivorous Ceratopogoninae. The photograph showing the female *Probezzia concinna* (Meigen) feeding on her mate during copulation appearing in Downes' papers (1971, 1978) was kindly furnished by Dr. Downes and is reproduced in Fig. 1.

Egg.—The oviposition of *Johannsenomyia argentata* (Loew) was reported by Johannsen (1905) and Thomsen (1937) from observations made at Ithaca, New York. The eggs are deposited in more or less spiral bands 30 to 40 mm in length by females hovering several inches above the water surface in sheltered places near the shore of the pond habitats. "With the head pointing toward the shore and the body swaying rhythmically to and fro, the egg-laying begins. The eggs are enclosed in a gelatinous ribbon, placed at right angles to the long axis. . . . The lateral swaying of the body at the beginning of the egg-laying is of about one inch amplitude, but as the ribbon of eggs increases, the amplitude decreases until just before deposition it is less than ½ inch. When the egg string is about ¼ inch long the fly seizes it with her hind and middle legs, the hind legs guiding, the middle legs paying out the string as its length increases. The fore legs are folded up under the body. This egg-laying process occupies from three to five minutes; when completed the fly suddenly darts down to the water's surface, deposits her eggs and flies away. The eggs when first laid are whitish, but later, as development progresses, they become brown. Each egg is about 0.4 mm in length by 0.07 in width; somewhat pointed at one end and flattened at the other, the latter with a minute rectangular bolster with knobbed corners" (Johannsen, 1905). Hamm (1919) and Wesenberg-

Fig. 1. *Probezzia concinna*: simultaneous feeding (female, left) and mating (after Downes, 1971).

Lund (1943) described similar habits for *Mallochohelea nitida* (Macquart) and *Probezzia concinna* (Meigen) respectively, in Europe.

Larva.—Larvae of all Ceratopogoninae with rare exceptions swim or crawl with snakelike side to side undulations. The speed of movement usually is characteristic of the genus. The following diagnosis is taken mostly from Glukhova (1971).

Larvae vermiform, lacking prolegs, mostly aquatic. Head prognathous; head capsule well developed, narrower at anterior end, broader at posterior third, convex on dorsal side; ventral side flattened. Frontal plate, located between the arms of the epicranial suture, not delineated on anterior half of head (characteristic of tribes Heteromyiini, Sphaeromiini, and Palpomyiini). Head capsule with five pairs of sensory pits and 13 pairs of setae, the arrangement of which is diagnostic. They are homologous throughout the family and given letter designations as shown in Figs. 9, 14 and 20. Antenna 3-segmented, with small papilla on second segment. Mandible elongate and curved, pointed distally and bearing a small tooth at about midlength. Maxilla with parts fused in a single, weakly sclerotized lobe located to side and below mouth opening; a small maxillary palpus with small sensory papilla present. Labium sunken into oral cavity, anterior margin of ventral wall of head capsule comprising the hypostomium with free margin often denticulate. Pharyngeal apparatus consisting of a hypopharynx and epipharynx. A conical membranous hypopharynx extending forward and downward toward the labium. Epipharynx lying in a depression formed by the broadened part of the epipharynx; consisting of two lateral arms and a central portion bearing several combs with characteristic arrangement of denticles.

Body with 12 elongate and subcylindrical segments, usually similar in size and shape and about the same width as head. Thoracic segments little broader than abdomen except before pupation. Anal segment usually longer than the others, narrower and rounded caudad; bearing caudally a series of small or long hairs of characteristic shape and position. Anal papillae more or less protrusible within or outside the body; comprising two processes, each with four lobes. Body pigmentation may occur in the inner fat body.

Pupa.—Pupa of characteristic ceratopogonine shape (see part 1 of this series). Respiratory horn clavate; length variable from short to only moderately long; numerous spiracles borne in a row at apex. Abdominal segments 3–7 similarly bristled, the arrangement of tubercles and setae quite constant for each genus, but the degree of development with specific differences. In the Sphaeromiini the pupae of a number of genera bear membranous glandular discs on the venter of several abdominal segments. Anal segment with a bristle-bearing tubercle and with well-developed, usually long and tapering, apicolateral processes. Operculum with one or more pairs of setae or tubercles.

Larval biology.—The larvae are usually found in greatest frequency and abundance at the margins of larger ponds, lakes, and streams. Krivosheina (1957) found the early stages of *Probezzia*, *Mallochohelea*, and *Sphaeromias* in the surface layer of sand along the banks of larger rivers and their tributaries. She found larvae of *Sphaeromias* also abundant in natural bodies of water without vegetation situated close to cattle pens in pastures.

There are few data available on the food preferences of the larvae of Heteromyiini and Sphaeromiini but those that have been published indicate that the larvae are predaceous, feeding on any small animals of the appropriate size found in the larval habitat. Dendy (1973) found ceratopogonid larvae (presumably including representatives of these tribes) preying on egg masses and newly hatched larvae of Chironomidae in Alabama. Weerekoon (1953) was of the opinion that the red substance found in the gut of *Probezzia venusta* and *Johannsenomyia* sp. (? *nitida*) in Loch Lomond in Scotland could only be hemoglobin from the larvae of *Chironomus* bloodworms that they had fed upon. He described the manner of feeding of the larvae of *Palpomyia quadrispinosa* Goetghebuer, a species with habits similar to those of the tribes under discussion here.

Williams (1955) found a large concentration of pupae of *Probezzia williamsi* Wirth (reported as *P. sabroskyi* Wirth) on the beach at the Douglas Lake, Michigan, Biological Station. Apparently they had migrated from an area 30–40 feet out in the lake where a clump of submerged pondweed (*Potamogeton natans* L.) broke the surface. The exposed leaves of the pondweed were covered with ceratopogonid egg masses, which unfortunately could not be identified to genus; the larvae that hatched from the masses perished before they could be reared to pupation. Presumably the egg masses were mainly if not entirely those of *P. williamsi*, and the larval habitat was in this area of the lake. Further ecological assocation of *P. williamsi* with the pondweed could not be demonstrated.

Williams also reported an aggregation of sphaeromiine pupae in a sand spit beach pool at Sedge Point in Douglas Lake. A few cat-tails (*Typha latifolia* L.) were growing in the shallow water of the lake side of the sand spit and many grew in the shallow water (10 inches or less) in the adjacent pool. Many sphaeromiine pupae were found attached to the cat-tails on the lake side of the spit, but none was found on those growing in the pool. From this it was concluded that the larvae of these species lived in the lake itself rather than in the beach pool. Most of the pupae were attached to the leaves within six inches of the water surface although some had crawled a foot or more up the leaf shaft. The pupae themselves were very active when disturbed and could make their way along the leaf with the aid of sticky, transparent pads on the venter of some of the abdominal segments and spines on the body wall. The presence of larval skins on the cat-tail leaves indicated that the larvae had migrated up the stems and onto the leaves where they pupated. In most cases the pupae had migrated farther. Adults of four species were reared from the pupae: *Probezzia williamsi* Wirth, *P. atriventris* Wirth, *Jenkinshelea albaria* (Coquillett), and *Mallochohelea halteralis* (Malloch) (nomenclature brought up to date). The ceratopogonids were not found associated with sedges in the lake, and it was not determined whether the association with the cat-tails was fortuitous, and the normal place of pupation might possibly be the sandy beach itself.

III. Special Habitats on Plummers Island and Vicinity

Two excellent larval habitats yielding an unusual concentration of sphaeromiine species in the Plummers Island study area warrant further discussion.

The first location was the sandy margin of the Potomac River just upstream from Plummers Island at the mouth of Scott Run in Fairfax County, Virginia. Here a small peninsula juts downstream into the river, leaving a small sand bar with a quiet leeward pool on the landward side. Fig. 21 shows a similar habitat on the north bank of the Potomac River at the lower end of Plummers Island. On 4 and 7 June 1955, Wirth and Jones found a heavy concentration of ceratopogonid pupae in the damp sand on the beach from six to 12 inches above the water level and from six inches to as much as six feet horizontally from the water's edge. There was no vegetation on this beach or in the shallow water nearby, although there was an abundant growth of buttonbush (*Cephalanthus* sp.) several hundred yards away in the river where the stream forms a series of rock-strewn rapids. Six species of Ceratopogoninae were reared from pupae collected on this beach, isolated in glass vials, and brought into the laboratory: *Jenkinshelea albaria* (Coquillett) (extremely abundant), *Johannsenomyia argentata* (Loew), *Probezzia albitibia* Wirth, *P. pallida* Malloch, and *P. smithii* (Coquillett) (all Sphaeromiini), and *Palpomyia subaspera* (Coquillett) (Palpomyiini). Three larvae of *J. albaria* were isolated from samples of the beach sand.

The second habitat was a freshwater pond at the Patuxent Wildlife Research Center near Laurel in Prince George's County, Maryland, known as Knowles Marsh no. 1 (Fig. 22). Dominant vegetation along the margins of this pond included cat-tails, primrose, willows, and several species of grasses. The pond also supported a fairly large growth of white (*Nymphaea*) and yellow (*Nuphar*) water lilies. Growing along the margins and in the pond was a common water plant, marsh purslane, *Ludwigia palustris* (L.) Elliott, a member of the family Onagraceae. Where this species grew in the water, it was covered with algae (*Spirogyra*), thus providing a perfect habitat for ceratopogonid larvae. Numerous larvae and pupae of *Mallochohelea atripes* Wirth were isolated from the algae-covered purslane in Berlese funnels, and then reared to adults in cotton-stoppered vials. The larvae of this species were extremely active and swam near the surface of the water in which they were recovered. A female of *Sphaeromias longipennis* (Loew) was also reared from a pupa from this habitat. The following other ceratopogonid genera were also reared from larvae and pupae from this habitat: *Alluaudomyia*, one species; *Bezzia*, two species; *Dasyhelea*, one species; *Palpomyia*, one species; *Stilobezzia*, one species.

IV. Systematic List of the Heteromyiini and Sphaeromiini of Plummers Island and Vicinity

Tribe Heteromyiini

Genus *Clinohelea* Kieffer
1. *bimaculata* (Loew)
2. *curriei* (Coquillett)
3. *pseudonubifera* Grogan and Wirth

Genus *Heteromyia* Say
4. *fasciata* Say
5. *prattii* Coquillett

Genus *Neurohelea* Kieffer
6. *nigra* Wirth

Tribe Sphaeromiini

Genus *Jenkinshelea* Macfie
7. *albaria* (Coquillett)

Genus *Johannsenomyia* Malloch
8. *argentata* (Loew)

Genus *Mallochohelea* Wirth
9. *albibasis* (Malloch)
10. *albihalter* Wirth
11. *atripes* Wirth

Genus *Probezzia* Kieffer
12. *albitibia* Wirth
13. *pallida* Malloch
14. *smithii* (Coquillett)
15. *xanthogaster* (Kieffer)

Genus *Sphaeromias* Curtis
16. *bifidus*, new species
17. *longipennis* (Loew)

V. Diagnoses of Species and Biological Notes

Tribe HETEROMYIINI Wirth

References.—Wirth, 1962a (diagnosis; key to genera); Debenham, 1974 (diagnosis; revision of Australia and New Guinea species); Wirth, Ratanaworabhan, and Blanton, 1974 (included genera; key)

Diagnosis.—Large, nearly bare, predaceous species. Antenna usually elongate; segments cylindrical in female (Fig. 2a). Palpus slender, five-segmented. Female mandible (Fig. 2c) with 7–10 coarse teeth. Mesonotum often with prominent anteromedian spine or tubercle. Legs (Fig. 2d) long, usually slender; femora often somewhat swollen distally, armed or unarmed; fourth tarsomere cordiform, prolonged in bifid spinose lobes or greatly elongated on hind legs; fifth tarsomere not armed with ventral spines or batonnets, that of fore leg often inflated, fusiform. Claws of female usually unequal, at least on hind leg, or a single claw with basal tooth. Wing without macrotrichia, often fasciate or infuscated; medial fork barely to broadly sessile; one or two radial cells; costa extending to more than 0.7 of wing length. Female abdomen (Fig. 2e) without eversible glands or sclerotized internal gland rods, often petiolate. Two large sclerotized spermathecae usually present. Male genitalia (Fig. 2f) usually long and slender; basistyle simple; dististyle long and slender; aedeagus simple, with basal arch low or high, distal portion short; parameres separate, slender, distal blades usually clavate.

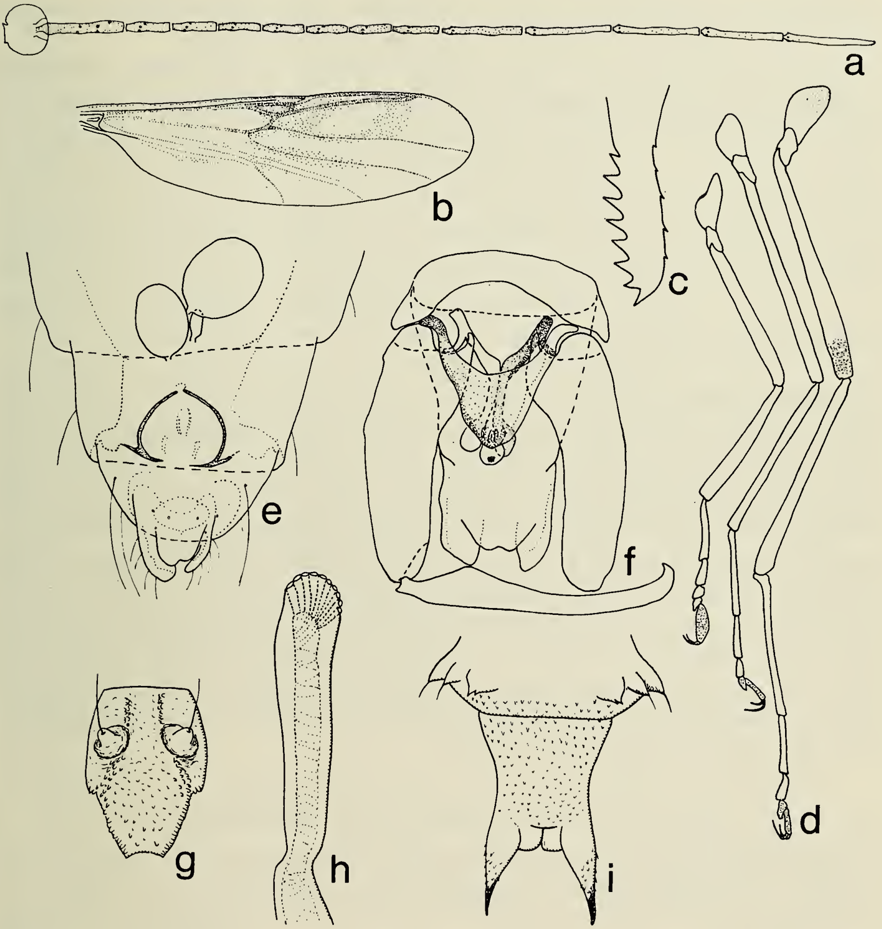

Fig. 2. *Clinohelea bimaculata*: a–e, female, f, male genitalia; g–i, pupa; a, antenna; b, wing; c, mandible; d, leg pattern; e, genitalia; g, operculum; h, respiratory horn; i, terminal segment.

Immature stages.—Larval head with lateral arms of epicranial suture obsolescent on anterior half of head, thus resembling larvae of the tribes Sphaeromiini and Palpomyiini. In the Ceratopogonini and Stilobezziini the lateral arms of the epicranial suture are complete to the bases of the antennae. Pupa without ventral membranous discs on abdominal segments.

Genus *Clinohelea* Kieffer

Clinohelea Kieffer, 1917:295. Type-species, *Ceratopogon variegatus* Winnertz, by original designation.

References.—Wirth, 1951b:321 (description and figures of pupa; Grogan and Wirth, 1975:275 (revision of North American species).

Diagnosis.—Moderately large, shining midges, usually with infuscated wing pattern. Antenna (Figs. 2a, 3a, 4a) elongate, segments slender and cylindrical. Fourth tarsomere of at least middle and hind legs deeply bilobed, each lobe ending in a stout blunt spine and smaller spines; front fifth tarsomere greatly inflated in both sexes (Fig. 2d), often bicolored (Figs. 3b, 4b); front claws equal, middle and hind claws very unequal in female; all claws equal in male; two radial cells present (Fig. 2b); aedeagus (Figs. 4e–g) with low anterior arch, distal portion broad, underlying membrane extending beyond tip; parameres (Fig. 2f) usually divided, each portion slender with an elongated bulbous tip.

Immature stages.—Larvae are aquatic; swimming. Glukhova (1977) figured the head, pharyngeal apparatus, and last two segments of the larva of the palaearctic species *C. unimaculata* (Macquart). Larval mandibles of this species especially long and slender, about a third as long as head; antenna short; labrum with one pair of long setiform sensilla; head hairs *o*, *q*, and *u* long and multiple; *p*, *s*, *t*, *w*, and *y* hairs long and single; pitlike sensilla *j*, *k*, *m*, *n*, *r*, and *z* present; epipharynx with two pairs of well-developed combs and lateral arms each with a comb of about ten strong teeth; anal segment and preanal segments subequal in length, the former with four long and two short perianal hairs. Pupae of *C. bimaculata* (Loew) were described by Wirth (1951b) and Grogan and Wirth (1975); see diagnosis under this species below.

Key to Potomac Valley Species of *Clinohelea*

1. Fifth tarsomere of front leg solid brown (Fig. 2d); wing with two spots, one centered over first radial cell, second near tip of costa (Fig. 2b) *bimaculata* (Loew)
– Fifth tarsomere of front leg with pale band (Figs. 3b, 4b); wing with one spot centered over first radial cell or entirely infuscated (Figs. 3d, 4c) 2
2. Fifth tarsomere of front leg with pale band twice as long as width of tarsomere (Fig. 3b) *curriei* (Coquillett)
– Fifth tarsomere of front leg with pale band much shorter than width of tarsomere (Fig. 4b) *pseudonubifera* Grogan and Wirth

1. *Clinohelea bimaculata* (Loew)
(Figs. 2, 4f)

Ceratopogon bimaculatus Loew, 1861:311 (female; Washington, D.C.).
Johannseniella bimaculata (Loew); Malloch, 1914:227 (combination; redescription).

Johannsenomyia bimaculata (Loew); Malloch, 1915a:333 (combination; key).

Clinohelea bimaculata (Loew); Kieffer, 1917:317 (combination; key; fig. tarsus; Wirth, 1951a:321 (pupa described, figured); Johannsen, 1952:164 (key; fig. tarsus); Wirth, 1965:136 (distribution); Grogan and Wirth, 1975:281 (male, female, pupa redescribed; figs.).

Female diagnosis.—Wing 1.65–2.68 mm long; with two infuscated areas, one centered over first radial cell, the second at tip of costa (Fig. 2b). Legs (Fig. 2d) mainly yellow, hind femur with dark subapical band; fifth tarsomere on front leg solid brown. Genitalia as in Fig. 2e.

Male.—Much smaller, but similar to female; genitalia (Fig. 2f) with breadth of aedeagus (Fig. 4f) subequal to its length.

Immature stages.—Larva unknown. Pupa: Length 3.5 mm; color pale brown. Operculum (Fig. 2g) narrow, 0.8 times as broad as long with a pair of rounded tubercles each bearing a long seta; surface with fine tubercles, those on lateral margin sharp and setose. Respiratory horn (Fig. 2h) moderately long and slender, about five times longer than broad with ten apical spiracles. Anal segment (Fig. 2i) about twice as long as broad; surface covered with fine tubercles; apicolateral processes about a third of total length of segment, with subapical fine tubercles; tips heavily sclerotized and sharply pointed, directed caudad.

Biology.—Wirth (1951a) reared this species from the margin of a small stream in Virginia. This species is a common inhabitant of wooded, swampy situations.

Distribution.—Michigan and Texas to New Hampshire and Florida.

Potomac Valley records.—D.C.: Washington, vi. (Coquillett), 3 females. MARYLAND: Montgomery Co., Glen Echo, vii, viii, 1922, 1923 (Malloch), 4 females. Prince George's Co., Beltsville, v.1922 (Malloch), 1 female; Patuxent Wildlife Res. Ctr., v–viii, 1975 (Grogan, malaise trap), many males, females. VIRGINIA: Alexandria, vii, 1951, 1952 (Wirth), 3 females; Alexandria, Dyke Marsh, vi.1952 (Wirth), 7 males, 24 females. Fairfax Co., Falls Church, vi,vii.1950, 1951, reared from stream margin (Wirth), 21 males, 36 females, some with pupae.

2. *Clinohelea curriei* (Coquillett)
(Figs. 3, 4g)

Ceratopogon curriei Coquillett, 1905:62 (female; British Columbia).

Palpomyia curriei (Coquillett); Malloch, 1914:219 (combination; description).

Clinohelea curriei (Coquillett); Johannsen, 1943:783 (combination; Wirth, 1965:136 (distribution); Grogan and Wirth, 1975:277 (redescribed; figs.; distribution; synonym: *nebulosa*).

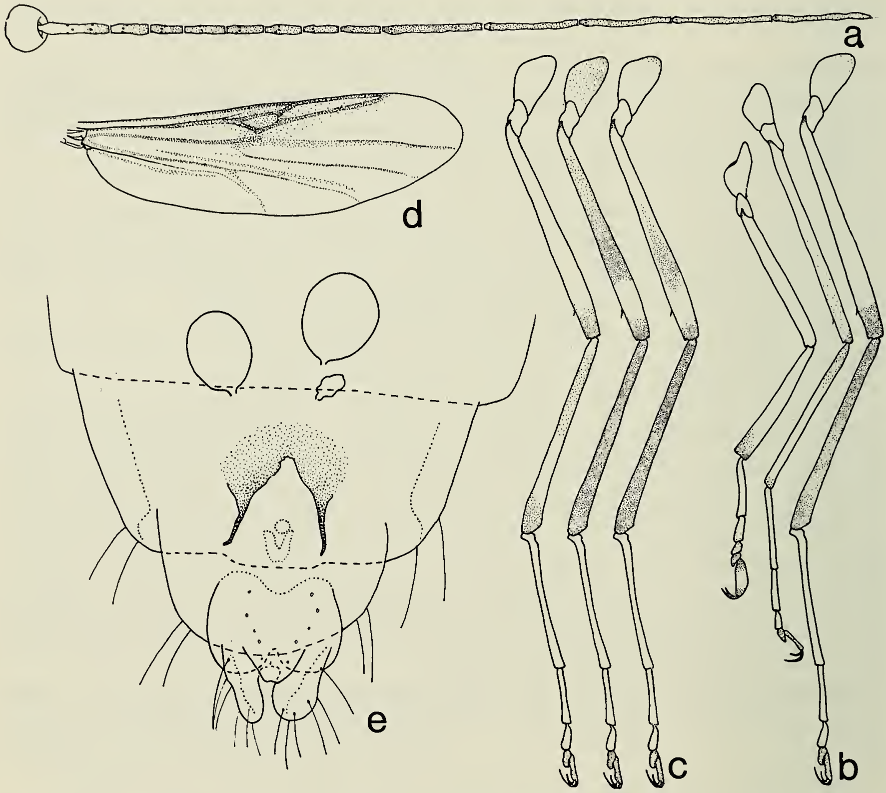

Fig. 3. *Clinohelea curriei*, female: a, antenna; b, leg pattern; c, variation in hind leg pattern; d, wing; e, genitalia.

Palpomyia nebulosa Malloch, 1915a:322 (female; Michigan).
Clinohelea nebulosa (Malloch); Johannsen, 1943:783 (combination); Wirth, 1965:136 (distribution).

Female diagnosis.—Wing 2.53–3.32 mm long; with one large infuscated area centered over first radial cell or entirely infuscated (Fig. 3d). Legs (Fig. 3b) yellowish, apex of front tibia and middle femerotibial area brownish, hind leg (Fig. 3c) usually with tibia and distal sixth of femur brown, occasionally femur also broadly brownish in midportion; fifth tarsomere of front leg brown with conspicuous median pale band twice as long as width of tarsomere. Genitalia as in Fig. 3e.

Male.—Smaller than female; genitalia similar to those of *C. bimaculata*; aedeagus as in Fig. 4g.

Immature stages.—Unknown.

Biology.—This species inhabits swampy habitats and is often found with *C. bimaculata*, although usually not as common.

Distribution.—Alaska and California to Newfoundland and Florida.

Potomac Valley records.—MARYLAND: Prince George's Co., Patuxent Wildlife Res. Ctr., v–viii.1975, malaise trap (Grogan), 2 females. VIRGINIA: Alexandria, vi.1952 (Wirth), 11 females; Alexandria, Dyke Marsh, 31.v.1954 (Wirth), 3 males, 5 females. Fairfax Co., Dead Run, 18.vi.1914 (Shannon), 1 female.

3. *Clinohelea pseudonubifera* Grogan and Wirth
(Figs. 4a–e)

Clinohelea sp. 1; Wirth, 1951a:321 (females; Virginia).
Clinohelea pseudonubifera Grogan and Wirth, 1975:280 (male, female; Maryland; figs.).

Female diagnosis.—Wing 2.03 mm long; with one large infuscated area centered over first radial cell (Fig. 4c). Legs (Fig. 4b) yellow; hind tibia, distal five-sixths of hind femur, and distal fifth of middle femur and all of middle and hind tibiae brown; fifth tarsomere of front leg brown with very short median pale band. Spermathecae as in Fig. 4d.

Male.—Smaller, but similar to female; genitalia similar to those of *C. bimaculata*; aedeagus as in Fig. 4e.

Immature stages.—Unknown.

Biology.—Nothing is presently known of the biology of this apparently uncommon species, known only from the original type series.

Distribution.—Ontario to North Carolina.

Potomac Valley records.—VIRGINIA: Fairfax Co., Falls Church, 4.vii. 1950 (Wirth), 2 females.

Genus *Heteromyia* Say

Heteromyia Say, 1825: plate 35. Type species, *Heteromyia fasciata* Say, by monotypy.
Pachyleptus Walker, 1856a:426. Type-species, *Pachyleptus fasciatus* Walker, by monotypy.

References.—Duret and Lane, 1955:35 (revision, key to Neotropical species); Wirth and Grogan, 1977b:177 (revision of North American species; new Neotropical species).

Diagnosis.—Large species with fasciate wings (Fig. 5g); front leg with femur short and greatly swollen, with conspicuous armature of 20–30 stout black spines, the tibia arcuate (Fig. 5a); claws of anterior four legs of

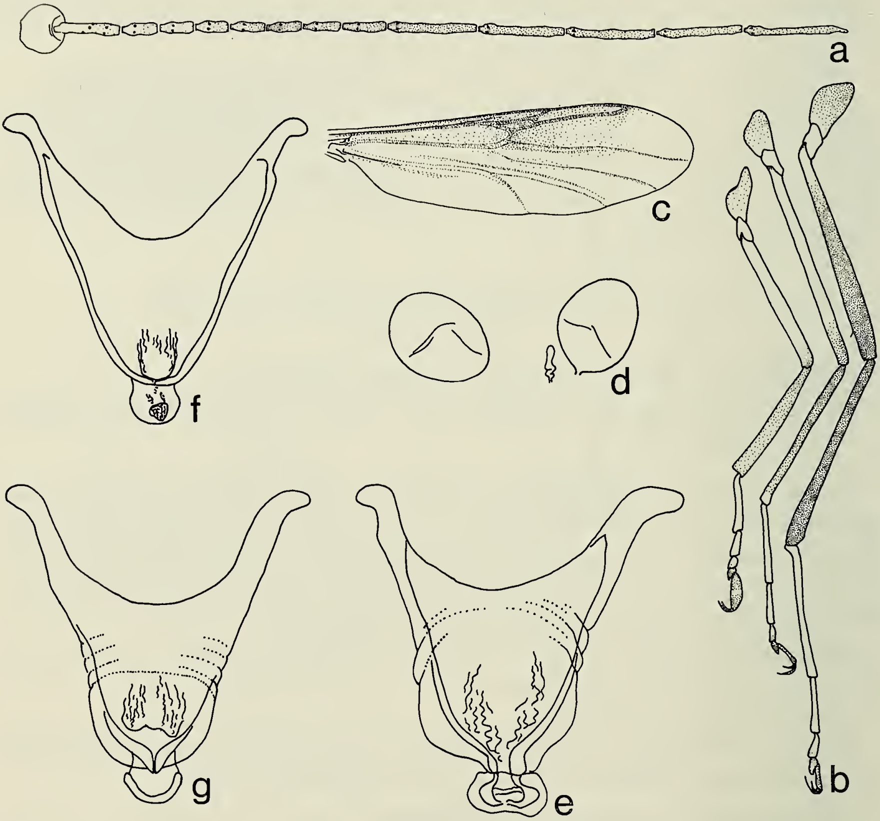

Fig. 4. *Clinohelea* spp.: a–e, *C. pseudonubifera*; f, *C. bimaculata*; g, *C. curriei*; a, female antenna; b, female leg pattern; c, wing; d, spermathecae; e–g, male aedeagi.

female short and equal with basal inner teeth; hind leg of female with a single long claw with short basal barb (Fig. 5h); claws of male small, equal; aedeagus (Fig. 5e) with short basal arch and broad distal body; parameres (Fig. 5f) separate, apices slender and clavate.

Immature stages.—Larva unknown. Pupa with respiratory horn subcylindrical, about six times as long as broad, with 12 spiracles borne at the apex which is not expanded (Fig. 6b); segmental spines of abdomen moderately strong and sharp, suberect; apicolateral processes (Fig. 6c, d) of abdomen quite long and tapering, sharp pointed, directed caudad, and bearing appressed spinulose vestiture.

Biology.—The larva are found in aquatic or semi-aquatic vegetation; rearings have been made from *Sphagnum* and *Cabomba*.

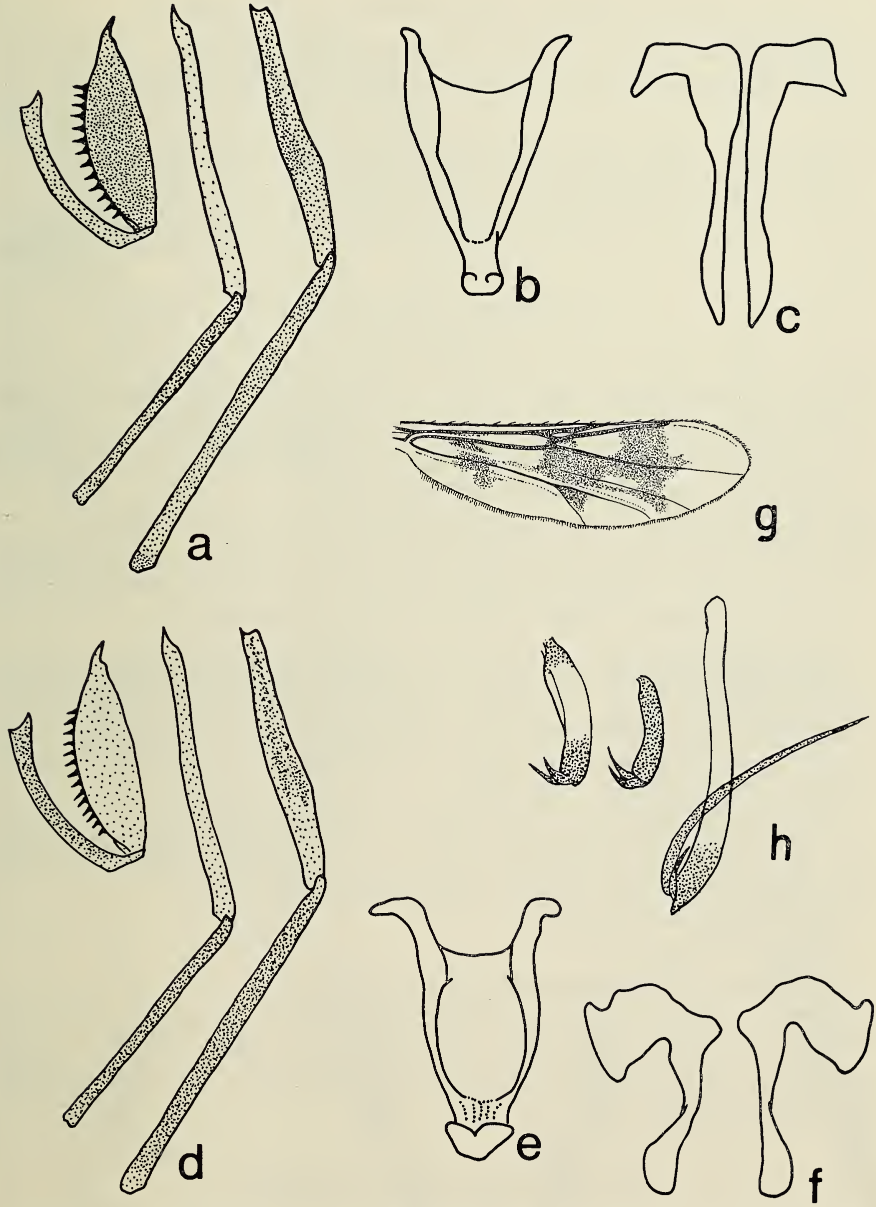

Fig. 5. *Heteromyia* spp.: a–c, g–h, *H. fasciata*; d–f, *H. prattii*; a, d, female leg pattern; b, e, male aedeagi; c, f, male parameres; g, wing; h, fifth tarsomeres and claws of female.

Key to Potomac Valley Species of *Heteromyia*

1. Abdomen with dense whitish pruinescence dorsally; mid and hind femora yellowish brown, rarely with faint subapical infuscation *fasciata* Say

– Abdomen without whitish pruinescence dorsally, but marked with conspicuous segmental pale and dark bands; mid and hind femora with variable but usually extensive infuscation except at apices *prattii* Coquillett

4. *Heteromyia fasciata* Say
(Fig. 5)

Heteromyia fasciata Say, 1825: plate 35 (no type locality; "of rather frequent occurrence"); Malloch, 1915a:360 (key); Kieffer, 1917:325 (key); Johannsen, 1943:783 (list); Johannsen, 1952:163 (figs.; key); Wirth, 1965:137 distribution; synonyms: *festiva*, *pratti*).

Ceratopogon festivus Loew, 1861:314 (male, female; Pennsylvania).

Heteromyia festiva (Loew); Malloch, 1915a:360 (combination; key); Kieffer, 1917:325 (key); Johannsen, 1943:783 (list); Johannsen, 1952:163 (key; variety of *fasciata*); Wirth, 1965:137 (synonym of *fasciata*).

Female diagnosis.—Wing length 2.71–3.49 mm. A large subshining species with brown legs, yellow on middle femur and distal third of hind femur (Fig. 5a); dorsum of abdomen with whitish pruinosity; wing fasciate (Fig. 5g); front and middle claws small and equal, hind claw greatly elongated with a smaller inner claw (Fig. 5h).

Male.—Similar to female but smaller and slightly darker; aedeagus (Fig. 5b) with narrow tip; parameres (Fig. 5c) with slender, slightly swollen distal portions and short, slightly expanded basal arms.

Immature stages.—Unknown.

Biology.—Unknown.

Distribution.—Massachusetts south to Florida.

Potomac Valley records.—MARYLAND: Indian Head, 28.vi.1932 (Bishop), 1 female. VIRGINIA: Alexandria, vi–vii.1952 (Wirth), 1 male, 12 females; Alexandria, Dyke Marsh, 31.v.1954 (Wirth), 3 males; St. Elmo, vi. (Pratt), 8 females.

5. *Heteromyia prattii* (Coquillett)
(Figs. 5, 6)

Heteromyia prattii Coquillett, 1902:88 (female; Virginia); Wirth, 1965:137 (synonym of *fasciata*).

Heteromyia pratti Coquillett: Malloch, 1915a:360 (key; Wisconsin record); Johannsen, 1943:783 (list); Johannsen, 1952:163 (key; variety of *fasciata*).

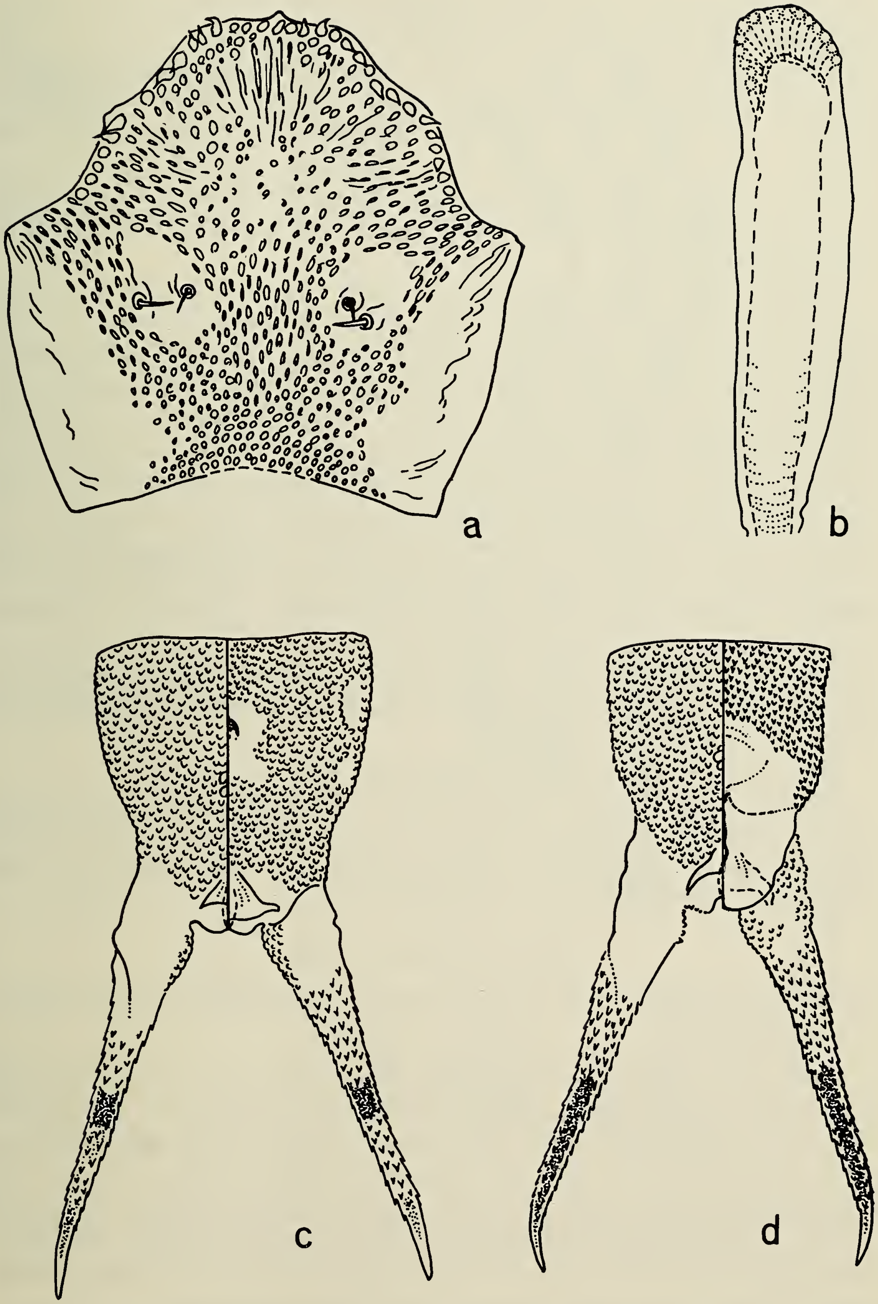

Fig. 6. *Heteromyia prattii*, pupa: a, operculum; b, respiratory horn; c, female terminal segment; d, male terminal segment.

Female diagnosis.—Very closely related to *H. fasciata* but a slightly larger and darker species lacking the whitish pruinosity on the dorsum of the abdomen. Wing length 2.95–3.77 mm. Legs (Fig. 5d) yellowish brown; proximal ⅔ of hind femur dark brown; middle and hind tibiae dark brown to blackish. Abdomen with conspicuous segmental alternating pale and dark bands.

Male.—Similar to female but smaller and slightly darker; aedeagus (Fig. 5e) with expanded tip; parameres (Fig. 5f) with expanded distal portions and broad basal arms.

Immature stages.—Larva unknown. Pupa (Fig. 6a–d) 7.0 mm long; brown with coarse shagreening. Operculum (Fig. 6z) as broad as long, surface with coarse pointed tubercles as figured, anterior end rounded, posterior portion with a pair of low rounded tubercles each bearing two short setae. Respiratory horn (Fig. 6b) 4.5 times as long as broad, spatulate and nearly straight, with 15 apical spiracles; surface smooth. Female terminal segment (Fig. 6c) 0.9 times as broad as long, covered with scattered small pointed tubercles as figured; apicolateral processes long and slender, 1.3 times as long as segment, moderately divergent, with sharp-pointed tips, covered densely except at base with small sharp spines and short setae. Male terminal segment (Fig. 6d) similar to female except for the well-developed genital processes which lack the spinose vestiture.

Biology.—Shahin Navai reared a male and a female of this species from pupae found in sphagnum moss in the floodplain of the Patuxent River in Prince George's County, Maryland.

Distribution.—Illinois east to Ontario and south to Florida.

Potomac Valley records.—MARYLAND: Prince George's Co., Patuxent Res. Ctr., 13.vi.1977 (Navai), 1 male, 1 female, with pupal exuviae, reared from sphagnum. VIRGINIA: Alexandria, St. Elmo, 9.vi. (Pratt), 1 female (lectotype); Alexandria, 11.vi– 6.vii.1952 (Wirth), 1 male, 12 females.

Genus *Neurohelea* Kieffer

Neurohelea Kieffer, 1925:112. Type-species, *Ceratopogon luteitarsis* Meigen, by monotypy.

Diagnosis.—Moderately large midges; body almost bare. Eyes bare and separated. Female antennal segments 3–10 oval, segments 11–15 elongated (Fig. 7a); male antenna with sparse plume. Palpus slender; third segment not swollen, without sensory pit. Mesonotum without anterior tubercle. All femora slender and unarmed (Fig. 7b); fifth tarsomere of front leg swollen in both sexes (Fig. 7c); female claws large, equal on all legs, with basal inner tooth. Wing (Fig. 7d) moderately broad, without infuscated pattern; media forking at r–m crossvein; two well-developed radial cells, costa extending beyond R4+5. Male genitalia (Fig. 7f) with spiculate membrane

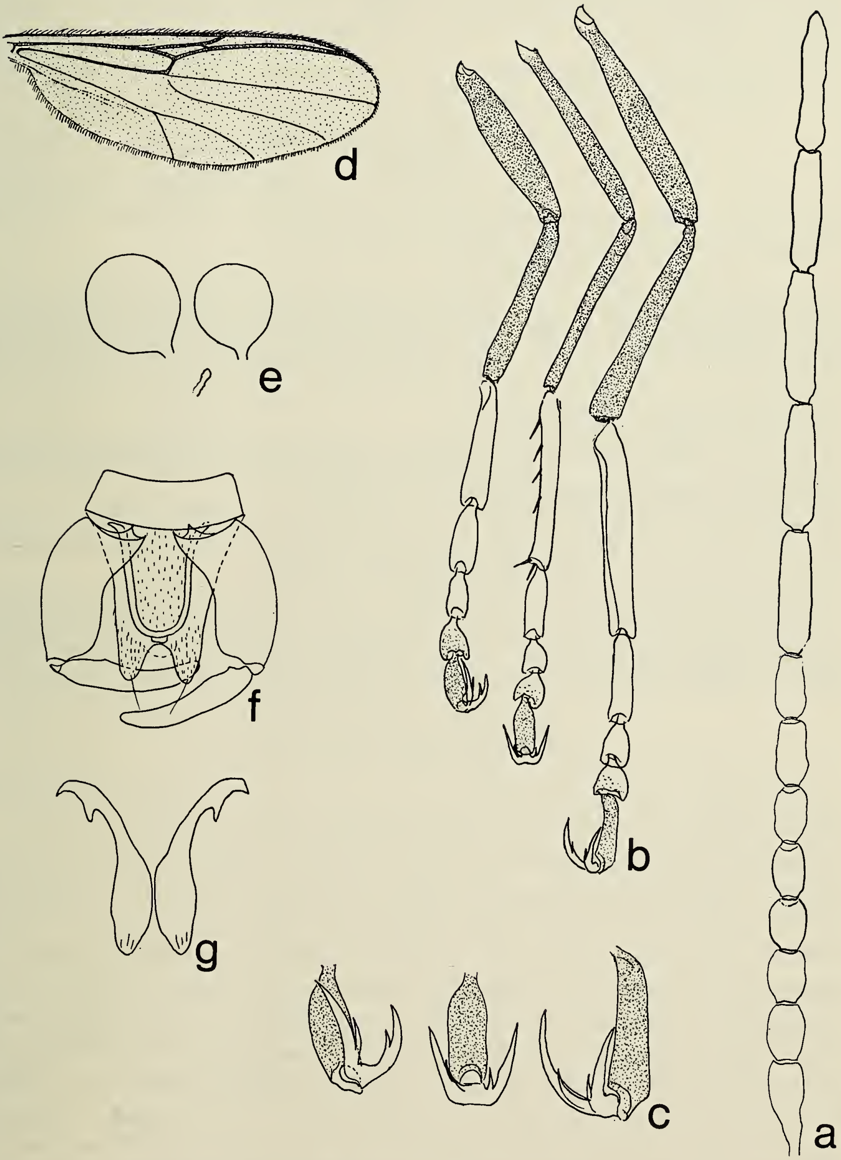

Fig. 7. *Neurohelea nigra*: a–e, female; f–g, male genitalia; a, flagellum; b, leg pattern; c, fifth tarsomere and claws; d, wing; e, spermathecae; f, genitalia, parameres removed; g, parameres.

on ventral face continuous to apex; aedeagus a sclerotized arch with rounded apex and parallel sides; parameres (Fig. 7g) separate, each forming a spatulate lobe distally.

Immature stages.—Unknown.

6. *Neurohelea nigra* Wirth
(Fig. 7)

Neurohelea nigra Wirth, 1952:208 (male, female; California; fig. wing, tarsus, antenna, spermathecae, male genitalia).

Diagnosis.—Wing 1.8 mm long. A uniformly shining brownish black species except proximal four tarsomeres yellowish; wing grayish hyaline, veins yellowish to brownish; halter brownish infuscated. Structural details as in Fig. 7.

Immature stages.—Unknown.

Biology.—The species was swept from vegetation in an *Osmunda* bog area and at the margin of a small stream in Virginia.

Distribution.—British Columbia and California (Wirth, 1965). Unpublished records in the USNM collection from Oregon, Washington, Tennessee, Virginia, North Carolina, and Georgia.

Potomac Valley records.—VIRGINIA: Alexandria, 2–17.vi.1951 (Wirth), from *Osmunda* fern bog and stream margin, 5 females. Fairfax Co., Falls Church, Holmes Run, 1.vi.1961 (Wirth), light trap, 1 female.

Tribe SPHAEROMIINI Newman

References.—Wirth, 1962a:272 (key to genera; revision of North American species); Debenham, 1974:15 (revision of Australian species).

Diagnosis.—Large, nearly bare, predaceous midges. Female antenna elongate, distal segments usually longer, cylindrical. Palpus five-segmented, usually rather short; third segment slender, without sensory pit. Female mandible with 7–12 strong teeth. Wing without macrotrichia; costa extending to more than ¾ wing length; media broadly sessile. Female tarsal claws large and straight to gently curved. Tarsi with fourth tarsomere cylindrical or cordiform; fifth tarsomere of female armed ventrally with stout spines (batonnets) (Fig. 8d). Female abdomen (Fig. 8a) without internal sclerotized gland rods or eversible glands. Two strongly sclerotized spermathecae, a rudimentary third often present (Fig. 8a). Male genitalia (Fig. 8b) usually long and slender; basistyle simple; dististyle usually long and slender (both structures fused in *Nilobezzia*); aedeagus simple with low basal arch, distal process short; parameres separate, slender, distal blades usually clavate and markedly curved ventrad.

Immature stages.—Larval head with lateral arms of epicranial suture usually obsolescent on anterior half of head, as in tribes Heteromyiini and Palpomyiini. Pupa often with membranous glandular discs present on ventral sides of several abdominal segments.

Key to the Known Pupae of Potomac Valley Sphaeromiini

1. Posterior margin of operculum attached 2
– Posterior margin of operculum free 3
2. Abdomen with ventral glandular discs
(*Jenkinshelea albaria* (Coquillett)
(*Probezzia* spp. (part)
– Abdomen without ventral glandular discs *Probezzia* spp. (part)
3. Abdomen with ventral glandular discs *Mallochohelea* spp.
– Abdomen without ventral glandular discs 4
4. Posterior margin of operculum truncate
Johannsenomyia argentata (Loew)
– Posterior margin of operculum convex
Sphaeromias longipennis (Loew)

Genus *Jenkinshelea* Macfie

Jenkinsia Kieffer, 1913:161. Type-species, *Jenkinsia setosipennis* Kieffer, by original designation. Preoccupied by Jordan and Evermann, 1896 (Pisces).

Jenkinshelea Macfie, 1934:177 (new name for *Jenkinsia* Kieffer). Type-species, *Jenkinsia setosipennis* Kieffer, automatic.

Reference.—Grogan and Wirth, 1977a:126 (revision of North American species).

Diagnosis.—Body slender, usually pollinose. Legs slender, unarmed; fifth tarsomere of female armed ventrally with several stout batonnets (Fig. 8d); female claws equal, each with blunt basal external tooth. Wing (Fig. 8c) broad in female with greatly expanded anal angle, narrow in male with normal anal angle; two radial cells, the second greatly elongated in female; female abdomen (Fig. 8a) with sternum fused with tergum on each of segments eight and nine forming subcylindrical structures; male genitalia elongate (Fig. 8b); aedeagus fairly short, apex usually rounded; parameres fused at base, divided distally, the tips usually slender, recurved, and bent ventrad.

Immature stages.—Larva as described for *J. albaria.* Pupa with respiratory horn very short, abdominal tubercles large, bent backward; abdominal segments six and seven with ventral glandular discs.

Biology.—*J. albaria* (Coquillett) has been reared from river margins in Virginia and Texas and a pond margin in Florida. *J. magnipennis* (Johannsen) has been reared from a lake margin in Ontario where pupae climbed up above the water line and secured themselves by their adhesive discs to the side of a boat. When Wirth brought pupae of *J. albaria* into the laboratory for rearing, they rapidly climbed up the glass walls of the vials, using their discs for adhesion and moving by moderately rapid, lateral, bending movements of the body. The discs secreted a fluid by which the pupa became fixed to the vial when movement stopped. When the pupae sometime later were forcibly pried loose from the vial, the pattern of the dried fluid on the glass marked the exact outline of the glandular discs.

7. *Jenkinshelea albaria* (Coquillett)
(Figs. 8, 9)

Ceratopogon albarius Coquillett (as *albaria*), 1895:308 (female; Florida).

Johannsenomyia albaria (Coquillett); Malloch, 1915a:335 (Illinois; synonym of *J. magnipennis* (Johannsen)).

Jenkinshelea albaria (Coquillett); Johannsen, 1943:783 (combination; eastern U.S.); Wirth, 1962a:1 (redescription; key; fig. male genitalia); Grogan and Wirth, 1977a:129 (redescribed, figures; distribution).

Johannsenomyia aequalis Malloch, 1915a:336 (male; Illinois); Johannsen, 1943:378 (New York); Wirth, 1962a:2 (synonym of *J. albaria*).

Female diagnosis.—Wing length 3.08 mm. Thorax grayish pollinose in dry specimens. Legs brown, usually with front femur, proximal 0.75 of middle and hind femora, front tibia, and broad subapical bands on middle and hind tibiae yellowish to pale brown; tarsomeres one and two pale; claws (Fig. 8b) with basal outer teeth. Wing (Fig. 8c) membrane milky whitish on proximal third, pale smoky brown on distal two-thirds; r-m crossvein dark brown. Halter knob white. Abdomen whitish except segments eight and nine brown, venter reddish brown. Genitalia as in Fig. 8a; eighth and ninth segments each with a pair of ventrolateral sclerotized spinelike tubercles at midlength.

Male.—Smaller than female, integument shining black, without grayish pollen; femora and tibiae entirely brown; halter brown. Genitalia as in Fig. 8b.

Larva (4th Instar).—Length 8–10 mm. Head long and slender (Fig. 9a); 2.5 times longer than broad; eye situated on epicranial suture; dorsum with chaetotaxy and sensilla as follows: two pairs of pits encroaching on anterior margin of postoccipital ridge; two pairs of setae near posterior margin of epicranial suture; *r* seta just laterad of eye; *m* pit anterior to eye; *q* seta anterior to eye and immediately laterad of epicranial suture; *s* and *k* pits anteriorad of *q* seta; *z* seta laterad of epicranial suture; *x* seta short; *w* seta apparently absent. Venter of head with chaetotaxy as follows: *y* pit opposite eye; single *u* and *v* setae on lateral margins opposite *s* and *k* pits; two pairs of *o* pits; *n* pit anterior to *o* pits; and *t* seta unbranched. Terminal seg-

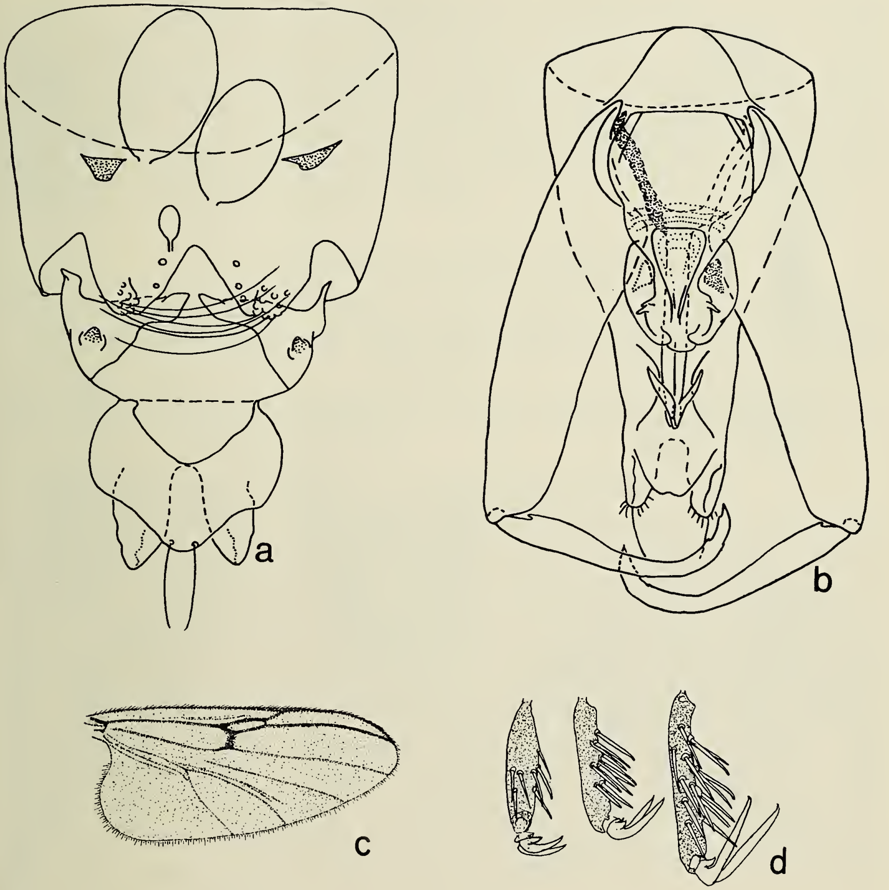

Fig. 8. *Jenkinshelea albaria*: a, female genitalia; b, male genitalia; c, female wing; d, female fifth tarsomere and claws.

ment of abdomen (Fig. 9b) about 3 times longer than broad; posterior end with four pairs of slender setae, the anterior two pairs half the length of the two posterior pairs.

Pupa.—Brown. Female operculum (Fig. 9d) about as long as broad, surface covered with small rounded tubercles; anterior end rounded, tip pointed; central portion with raised areas bearing a pair of tubercles, the posterior one with a single long seta; lateral margins greatly elevated; posterior margin attached. Male operculum similar to that of female but slightly narrower. Respiratory horn (Fig. 9c) 2.5 times longer than broad; surface smooth; apex with double row of 5–8 spiracles. Female terminal segment (Fig. 9e) about twice as long as broad; dorsum covered with

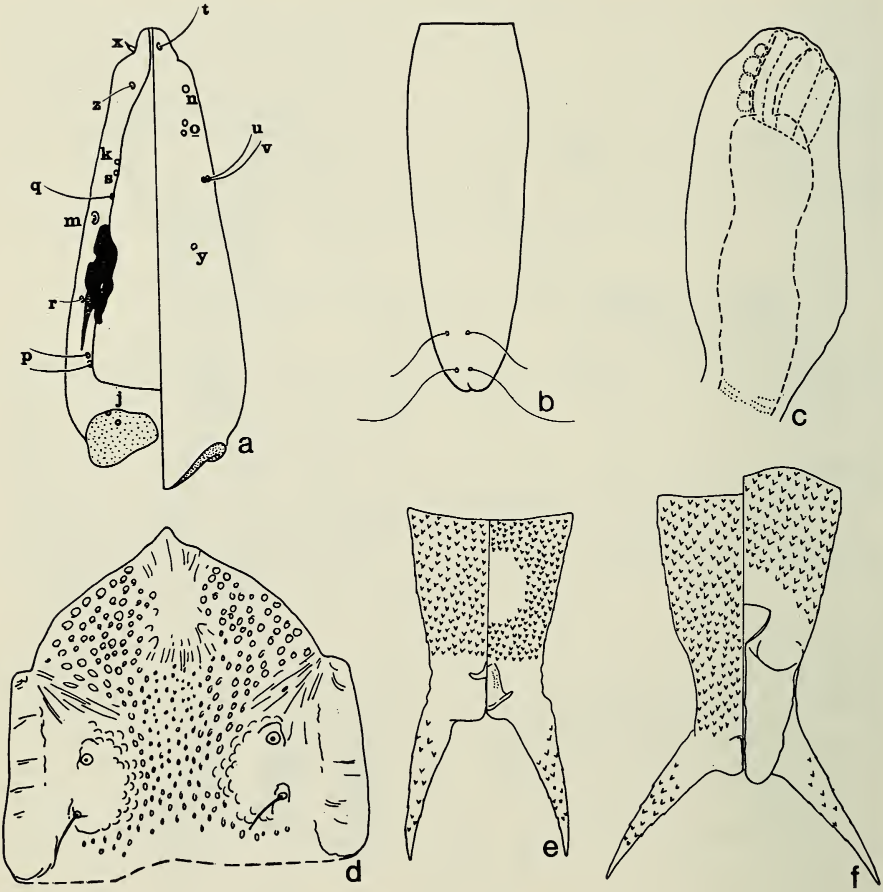

Fig. 9. *Jenkinshelea albaria*: a–b, larva; c–f, pupa; a, head capsule; b, terminal segment; c, respiratory horn; d, operculum; e, female terminal segment; f, male terminal segment.

small pointed tubercles; venter covered with small pointed tubercles except for a small circular central area; apicolateral processes moderately divergent, covered with small pointed tubercles. Male terminal segment (Fig. 9f) 1.7 longer than broad; dorsum covered with small pointed tubercles; venter covered with small pointed tubercles on distal half, genital processes tightly appressed and very slightly wrinkled; apicolateral processes greatly divergent, covered with small pointed tubercles.

Biology.—This species has been reared from river margins in Virginia and Texas and from a pond margin in Florida.

Distribution.—Ontario south to Florida, west to Texas and Illinois.

Potomac Valley records.—MARYLAND: Montgomery Co., Plummers Island, 24.ix.1902 (Barber and Schwarz), 16 females; 1.viii.1903 (Busck), 1 female; 8.vi.1914 (Schwarz and Shannon), at light, 2 females (male genitalia attached); 2.vii.1915 (Shannon), 1 female. VIRGINIA: Fairfax Co., Potomac River at Scott Run, 7.vi.1955 (Wirth and Jones), reared from sandy river margin, 200 males, females, with pupal exuviae and 3 larvae; 12.vii.1976 (Wirth and Grogan), 1 pupa.

Genus *Johannsenomyia* Malloch

Johannsenomyia Malloch, 1915a:332. Type-species, *Johannsenomyia halteralis* Malloch, by designation of Wirth, 1952:211; synonym of *J. argentata* (Loew).

Dicrohelea Kieffer, 1917:363. Type-species, *Palpomyia filicornis* Kieffer, by designation of Macfie, 1940:26.

Reference.—Wirth, 1962a:276 (revision; synonymy).

Diagnosis.—Slender, nearly bare midges, usually shining species. Legs long and slender; fifth tarsomere of female armed ventrally with numerous long, black, blunt spines (batonnets); fifth tarsomere of male hind leg armed with 2–3 pairs of ventral batonnets; claws of female equal on front legs, very unequal on middle and hind legs, the longer claw only slightly curved, each claw with short, stout, basal tooth on external side; wing with two radial cells; female abdomen more or less petiolate, eighth segment without sclerotization or ventral hair tufts; two large spermathecae present. Male genitalia rotated and appressed obliquely against apex of abdomen with sternal side facing caudad; aedeagus broad, with well-developed basal arch and broad, caplike tip; parameres separate, the distal portions approximate, basal portion of each slender and curved, distal portion expanded into a broad, platelike, laterally flattened tip.

Immature stages.—Larva undescribed. Pupa with respiratory horn 3–4 times as long as breadth of flaring portion; abdominal tubercles inconspicuous, not conical or angulate; abdominal sterna without glandular discs.

Biology.—Williams (1955) presented a very interesting account of the habits of the larvae of *J. argentata* on the sandy beach of Douglas Lake, Michigan, near the University of Michigan Biological Station. Beach sand from near the lake margin was mixed with lake water and poured into a white enamel pan where the larvae could be seen swimming about. One or two larvae were found per bucket of sand. Larvae were not numerous at the margin where the lake water met the sandy beach. When pupation time approached, submerged larvae swam to the water surface where they headed for the beach and rapidly burrowed into the sand. About ten days after pupation, adults of *J. argentata* emerged.

8. *Johannsenomyia argentata* (Loew)
(Figs. 10, 11)

Ceratopogon argentatus Loew, 1861:310 (Cent. 1, no. 5) (female; D.C.).
Johannseniella argentata (Loew); Malloch, 1914:226 (combination).
Johannsenomyia argentata (Loew); Malloch, 1915a:334 (combination; female redescribed; Illinois); Wirth, 1962a:277 (redescribed; figs.; distribution).
Sphaeromias argentatus (Loew); Kieffer, 1917:315 (combination).
Dicrohelea argentata (Loew); Johannsen, 1943:783 (combination; distribution); Williams, 1955:96 (larval habits; Michigan).
Johannsenomyia halteralis Malloch, 1915:338 (in part, type male; Illinois); Wirth, 1962a:277 (synonym of *J. argentata*; notes on type).

Female diagnosis.—Wing (Fig. 10a) length 2.5–3.0 mm. Subshining brownish black. Antenna brown, segments 3–10 annulate, with yellow proximal ends, antenna very elongate, 11th segment 12 times as long as broad. Legs (Fig. 10b) yellow, hind femur often with extensive distal infuscation leaving a prominent subapical yellow ring (Fig. 10c); hind tibia often with proximal half infuscated; fifth tarsomeres (Fig. 10f) black, with 4–5 pairs of batonnets. Wing uniformly brownish gray infuscated; halter brownish. Abdomen dark brown, dorsum with prominent silvery pruinosity; genitalia as in Fig. 10d; spermathecae (Fig. 10e) two, ovoid, unequal, without sclerotized necks, third spermatheca absent.

Male.—Similar to female but smaller, legs more extensively darkened, broad bases of front and middle femora more or less yellowish; abdomen shining brown above, without silvery pollen; fifth tarsomere (Fig. 10g) on hind leg with 2–3 pairs of black ventral batonnets. Genitalia (Fig. 10h) as figured; aedeagus with low basal arch, laterally flaring basal arms, and stout, caplike distal portion; parameres (Fig. 10i) each with apex flattened laterally and expanded dorsoventrally in a large, platelike lobe.

Immature stages.—Larva not described. Pupa: Respiratory horn (Fig. 11a) 2.5 times longer than broad; narrow proximally, broader distally; surface smooth; apex with 24–30 spiracles. Operculum (Fig. 11b) 1.25 times longer than broad; anterior portion and central area of posterior portion covered with small rounded tubercles; anterior end rounded; posterolateral margins parallel, surface smooth with two pairs of tubercles each bearing a moderately long seta; posterior end truncate. Female terminal segment (Fig. 11c) 1.4 times broader than long; anterior third of dorsum and venter covered with small pointed tubercles; apicolateral processes greatly divergent, surface smooth. Male terminal segment (Fig. 11d) 1.4 times broader than long; anterior half of dorsum and anterior fourth of venter covered with small pointed tubercles; apicolateral processes greatly divergent,

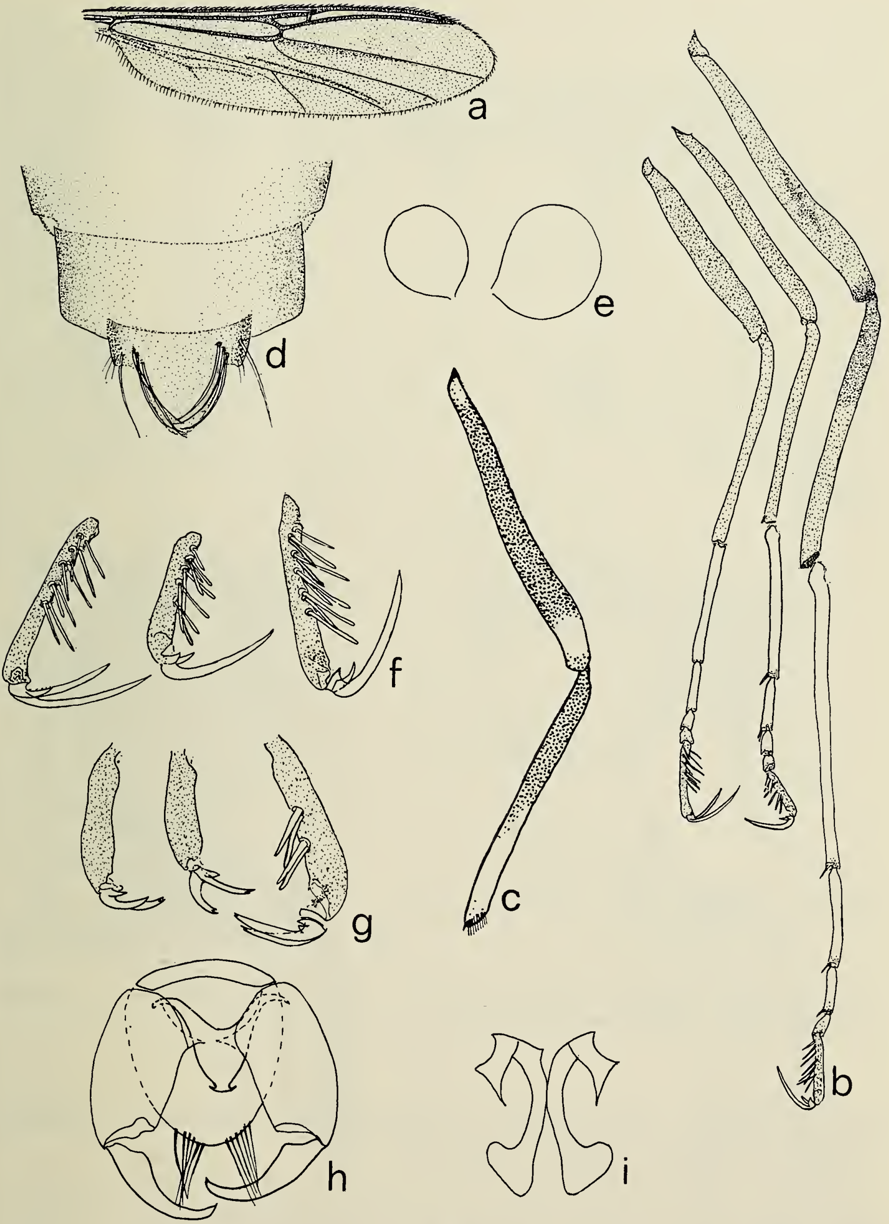

Fig. 10. *Johannsenomyia argentata*: a–f, female; g–i, male; a, wing; g, leg pattern; c, alternate hind leg pattern; d, terminal abdominal segments; e, spermathecae; f–g, fifth tarsomeres and claws; h, genitalia, parameres removed; i, parameres.

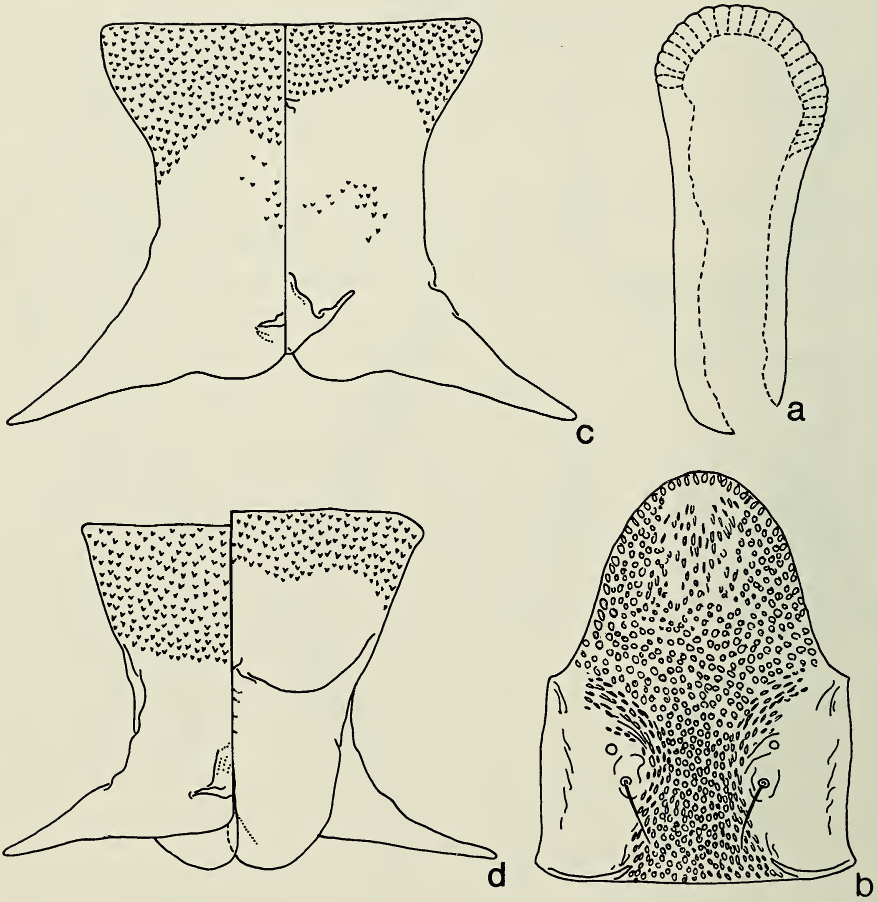

Fig. 11. *Johannsenomyia argentata*, pupa: a, respiratory horn; b, operculum; c, female terminal segment; d, male terminal segment.

surface smooth; ventral genital processes greatly appressed, extending beyond body, surface slightly wrinkled.

Biology.—Wirth and Jones reared this species from the sandy margin of the Potomac River at Scott Run, Virginia. Note Williams' observations on the habits of the larvae in the generic discussion above.

Distribution.—North Dakota to Ontario, south to Texas and Florida.

Potomac Valley records.—D.C.; Washington (Osten Sacken), 4 females (syntypes, in Museum of Comparative Zoology, Cambridge, Mass.). MARY-

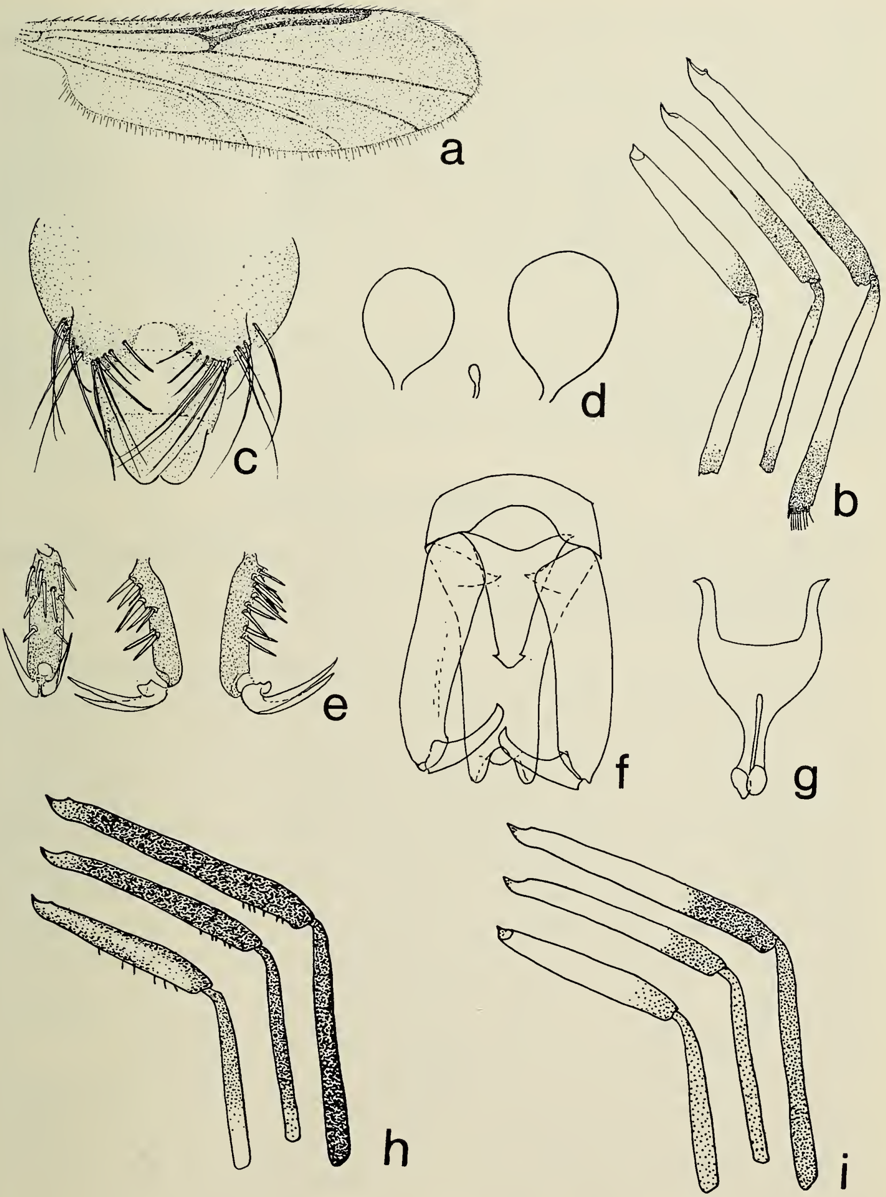

Fig. 12. *Mallochohelea albibasis*, a–g; *M. atripes*, h: a–e, female; f–g, male; a, wing; b, leg pattern; c, terminal abdominal segments; d, spermathecae; e, fifth tarsomere and claws; f, genitalia, parameres removed; g, parameres; h–i, female leg patterns.

LAND: Cabin John, 10.viii.1916 (Fouts), 1 female. Herzog Island, 23.viii. 1914 (Shannon), 1 female. Plummers Island, vi.1902, vi.1905, viii.1906 (Barber), 8 females; 11.viii.1907 (Fisher), 1 female; 28.vi.1914 (McAtee), 1 female; vi.1914, viii.1915 (Shannon), 6 females. VIRGINIA: Alexandria, 29.vi, 6.vii.1952 (Wirth), 4 males, 2 females. Fairfax Co., Dead Run, 22.vi. 1915 (Shannon), 4 females. St. Elmo, 30.vi (Pratt), 4 females. Great Falls, vi.1922 (Aldrich), 1 female; 21.vi.1931 (Melander), 2 females; 12.vi.1949 (Wirth), 2 females. Potomac River at Scott Run, 7.vi.1955 (Wirth and Jones), reared from river margin, 11 males, 10 females, some with pupal exuviae.

Discussion.—Wirth (1962a) recorded *J. annulicornis* Malloch from the Scott Run, Virginia series. Re-examination of the genitalia reveals that this specimen was misidentified, and is actually *J. argentata.* Males of *J. annulicornis* differ by the shape of the parameres.

Genus *Mallochohelea* Wirth

Mallochohelea Wirth, 1962a:278. Type-species, *Johannsenomyia albibasis* Malloch, by original designation.
Johannsenomyia Malloch of authors.

Reference.—Wirth, 1962a:278 (revision of North American species).

Diagnosis.—Body slender to moderately stout, nearly bare, integument usually shining. Femora (Fig. 12b, h, i) with or without ventral spines; fifth tarsomeres of female (Fig. 12e) armed ventrally with 5–8 pairs of stout, black, blunt spines (batonnets); female claws long, equal, bent at base, nearly straight distally, each claw with short basal tooth on external side. Wing (Fig. 12a) with two radial cells (rarely only one); anal angle not broadened; costa short, usually extending to about 0.8 of wing length. Female abdomen (Fig. 12c) without internal gland rods; eighth segment with pair of ventral hair tufts. Male genitalia (Fig. 12f) with long basistyle and dististyle; aedeagus with low basal arch, tapering distally to moderately broad, caplike tip; parameres (Fig. 12g) usually fused in midportion forming a rounded basal arch, the tips separate but contiguous.

Immature stages.—Larva: see *M. atripes* for description. According to Glukhova (1977) the larva of the Palaearctic species *M. inermis* (Kieffer) has the head moderately broad and tapering, the *o* and *u* hairs multiple; the epipharynx with one pair of combs and a toothed comb on the lateral arm. Pupa with respiratory horn very short (Figs. 13c–e; 14a), 1.5–2.0 times as long as broad; abdominal segments with prominent, angular, backward projecting, spinose tubercles; abdominal sterna six and seven with membranous glandular discs; apicolateral processes relatively short and pointed.

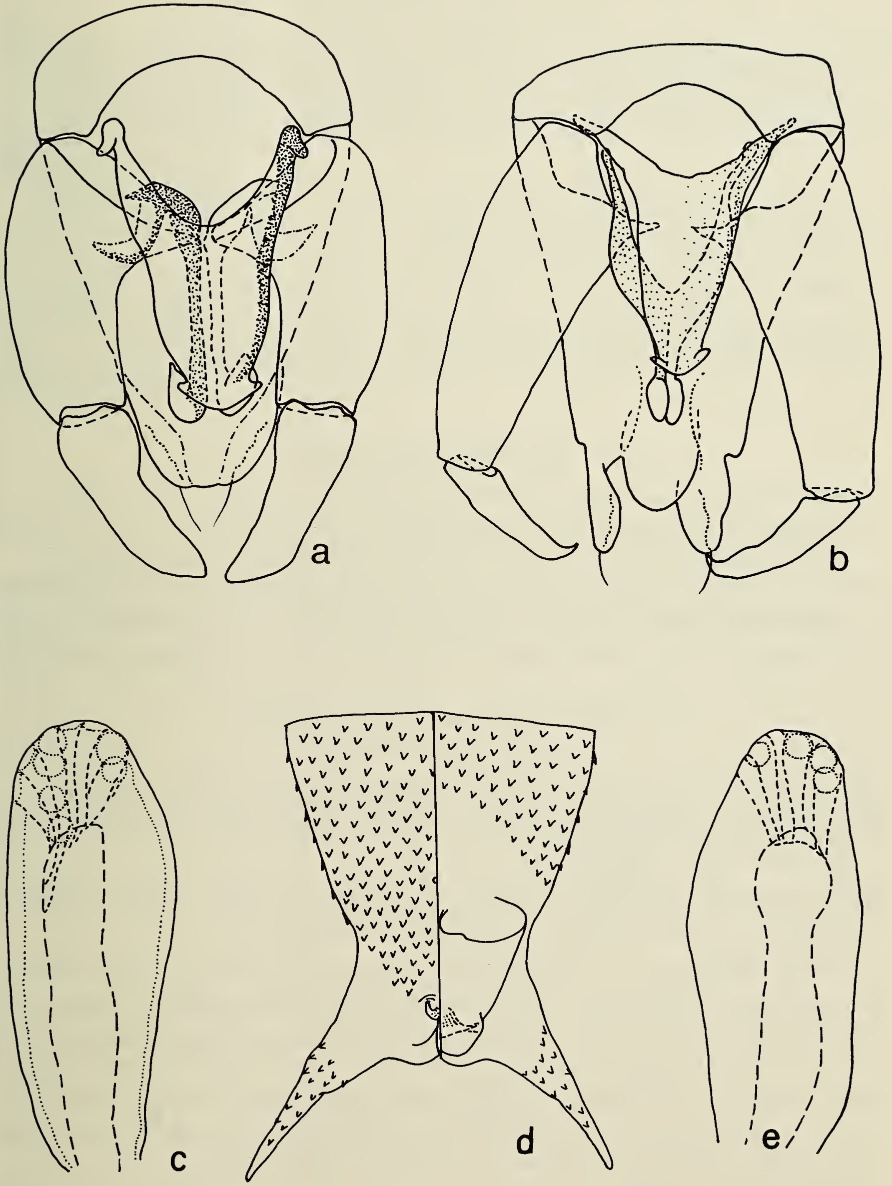

Fig. 13. *Mallochohelea atripes*, a; *M. albihalter*, b, e; *M. albibasis*, c–d: a–b, male genitalia; c–e, pupal respiratory horns; d, terminal segment of male pupa.

Key to Potomac Valley Species of *Mallochohelea*
(Primarily for Females)

1\. Femora and tibiae entirely blackish, at least on hind legs (Fig. 12h); antenna including scape, halter, and abdomen blackish; all femora armed (Fig. 12h); base of front femur and apex of front tibia paler *atripes* Wirth

– Femora and tibiae with conspicuous pale bands, except sometimes hind tibia entirely dark (Fig. 12i); antenna, halter and abdomen various; femora unarmed (Fig. 12i) 2

2\. Halter dark; wing whitish at base, infuscated on distal two-thirds. *albibasis* (Malloch)

– Halter pale; wing uniformly whitish to pale grayish hyaline *albihalter* Wirth

Key to Known Pupae

1\. Apicolateral processes with small pointed tubercles (Fig. 13d); respiratory horn with 5–10 spiracles (Fig. 13c, e) 2

– Apicolateral processes smooth, lacking small pointed tubercles (Fig. 14e, f); respiratory horn with 18–20 spiracles (Fig. 14d) *atripes* Wirth

2\. Respiratory horn with 5–6 spiracles (Fig. 13e) *albihalter* Wirth

– Respiratory horn with 10 spiracles (Fig. 13c) *albibasis* (Malloch)

9. *Mallochohelea albibasis* (Malloch)
(Figs. 12a–g, 13c–d)

Johannsenomyia albibasis Malloch, 1915b:315 (male, female; Illinois).

Mallochohelea albibasis (Malloch); Wirth, 1962a:379 (combination; redescribed; figs.; distribution).

Johannsenomyia halteralis Malloch, 1915a:338 (in part, allotype female; misident.); Wirth, 1952:212 (California; redescribed).

Female diagnosis.—A small slender species, wing 2.0 mm long. Thorax shining black. Wing (Fig. 12a) white at base, infuscated on distal two-thirds. Halter infuscated. Antenna entirely brown, eleventh segment 4.3 times as long as broad; face and palpus pale. Legs (Fig. 12b) yellow; front knee, extreme tip of front and middle tibiae, distal third of middle and hind femora, distal fourth to ¾ of hind tibia, and fifth tarsomeres blackish; fifth tarsomeres (Fig. 12e) with five pairs of batonnets. Abdomen pale at base, brownish black distally. Spermathecae (Fig. 12d) unequal, ovoid, with moderately long necks.

Male.—Marked as in female. Male genitalia as in Fig. 12f; parameres (Fig. 12g) with distinctly expanded tips.

Immature stages.—Larva unknown. Pupa with respiratory horn (Fig. 13c) 2.5 times longer than broad, surface smooth; apex with about 10 spiracles. Male terminal segment (Fig. 13d) 1.3 times longer than broad; dorsum covered with scattered small pointed tubercles; anterior third of venter covered with small pointed tubercles; genital processes short, greatly appressed; apicolateral processes moderately divergent, covered with small pointed tubercles.

Biology.—Unknown.

Distribution.—Northwestern Canada to Quebec, south to California and Alabama.

Potomac Valley records.—MARYLAND: Montgomery Co., Fairland, 12.v.1959 (Hubert), 1 female; Forest Glen, 12.vi.1966 (Wirth), 1 female. VIRGINIA: Fairfax Co., Falls Church, Holmes Run, 9.vi.1961 (Wirth), 1 female; Great Falls, 19.v.1915 (McAtee), 1 female.

10. *Mallochohelea albihalter* Wirth
(Figs. 12i, 13b, e)

Mallochohelea albihalter Wirth, 1962a:280 (male, female; figs.; Michigan).

Female diagnosis.—A small, moderately stout species, wing 2.0 mm long. Thorax and abdomen subshining brownish black. Head dark brown, including palpus and entire antenna; the latter short, distal segments not greatly elongated, eleventh segment 3.5 times as long as broad. Legs (Fig. 12i) yellow; extreme apex of front femur, distal fourth of middle and hind femora, extreme apices of front and middle tibiae, and distal fourth of hind tibia brownish black; tarsomeres 3–5 brownish; fifth tarsomeres with five pairs of batonnets. Wing uniformly whitish to pale grayish hyaline, veins yellowish white; halter whitish. Abdomen not pale at base; spermathecae unequal, ovoid, tapering to very short, sclerotized neck.

Male.—Color as in female, pale markings of legs not so extensive; distal antennal segments not greatly elongated. Genitalia (Fig. 13b) shorter and broader than in related species; aedeagus broad at base with short basal arch; sides slightly convex, tapering to rounded, caplike tip; parameres with fused midportion broad, anterior arms slender, distal stems slender with slightly expanded tip.

Immature stages.—Larva unknown. Pupa similar to that of *M. albibasis*; respiratory horn (Fig. 13e) with 5–6 spiracles.

Distribution.—Wisconsin to Quebec, south to Louisiana and Maryland.

Biology.—Unknown.

Potomac Valley records.—MARYLAND: Montgomery Co., Plummers Island, 10.v.1905 (Barber and Schwarz), 1 female; 8.vi.1914 (Schwarz and Shannon), 1 female.

11. *Mallochohelea atripes* Wirth
(Figs. 12h, 13a, 14)

Mallochohelea atripes Wirth, 1962a:281 (male, female; New Jersey; figs.).

Female Diagnosis.—A large slender species, wing 2.7 mm long. Thorax and abdomen shining black. Head black, face brown, palpus, pedicel and bases of antennal segments 3–10 yellow, apices of segments 3–10 and all of last five segments dark, the distal five very elongate, eleventh segment five times as long as broad. Legs (Fig. 12h) brownish black; front femur except apex and distal portion of front and middle tibiae more or less yellowish brown; tarsomeres one to four whitish; fifth tarsomere with five pairs of batonnets, the fifth, distal one removed toward claws and sharper than the others. Femora with stout, sharp, black ventral spines, ten on distal half of fore leg, and four or five on distal third of mid and hind legs. Spermathecae slightly unequal, ovoid, without sclerotized necks. Wing grayish hyaline, veins brown infuscated. Halter deeply infuscated.

Male.—As in female, with usual sexual differences; legs darker, only extreme base of front femur and apex of front tibia yellowish; femoral spines three to five on front leg, 0–1 on middle, and 2–3 on hind leg; fifth tarsomeres unarmed ventrally. Genitalia (Fig. 13a) approaching those of *Johannsenomyia*, parameters separate, slender with expanded, hooked tip; aedeagus short and broad, with spicules ventrally and on the membrane to ninth sternum; ninth tergum bilobed, dististyles well developed.

Immature stages.—Larva (fourth instar): Length 9–10 mm. Head elongate and tapering; head capsule (Fig. 14a) 2.5 times longer than broad; a prominent, elongate eye spot situated on epicranial suture. Dorsal chaetotaxy and sensilla of head as follows: two pairs of *j* pits just anterad of postoccipital ridge; two pairs of *p* setae near posterior margin of epicranial suture; *r* pit posterior to eye; *m* pit laterad of eye; *q* seta just anterad of eye; *s* seta single, anterior to *q* seta; *k* pit just anterior to *s* seta; *w* seta on lateral margin just posterior to *z* seta; *x* seta short. Ventral chaetotaxy of head as follows: *y* seta opposite eye; single *v* seta and branched *u* seta opposite *q* seta; anterior pair of *o* pits with seta; *n* pit opposite *o* pits; *t* pit lacking seta. Terminal segment (Fig. 14b) three times longer than broad; posterior end with four pairs of setae, the two posterior pairs longer and slightly stouter than anterior two pairs.

Pupa.—Operculum (Fig. 14c) 1.3 times longer than broad, surface covered with small rounded tubercles as figured; anterior margins with large rounded tubercles, anterior end pointed; central portion with a pair of small raised areas; posterior portion with a pair of raised areas each with two pairs of tubercles, the posterior pair bearing a single seta; posterior margin slightly convex and a median posteriorly projecting portion. Respira-

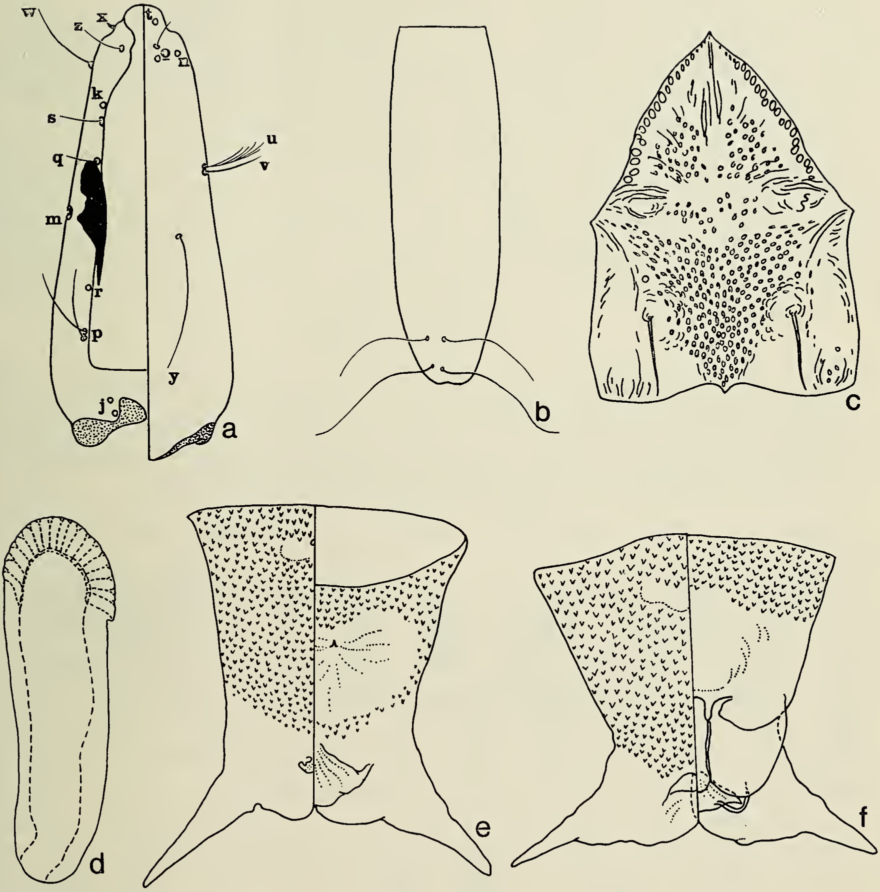

Fig. 14. *Mallochohelea atripes*: a–b, larva; d–f, pupa; a, head capsule; b, terminal segment; c, operculum; d, respiratory horn; e, female terminal segment; f, male terminal segment.

tory horn (Fig. 14d) three times longer than broad, surface smooth; apex with 18–20 spiracles. Female terminal segment (Fig. 14e) slightly longer than broad; dorsum covered with small pointed tubercles; venter covered with small pointed tubercles except for a broad circular central portion; apicolateral processes moderately divergent, surface smooth. Male terminal segment (Fig. 14f) similar to that of female, differing as follows: slightly broader than long; anterior third of venter covered with small pointed tubercles, genital processes very short, greatly appressed; apicolateral processes greatly divergent.

Biology.—Grogan recovered numerous larvae and pupae of *M. atripes* from algae-covered purslane taken in the pond at Knowles Marsh 1, Patuxent Wildlife Research Center. The larvae of this species were extremely active and swam near the surface of the water in which they were recovered.

Distribution.—Michigan to Ontario, south to Florida.

Potomac Valley records.—MARYLAND: Montgomery Co., Fairland, 10.vi.1959 (Hubert), 1 female. Prince George's Co., Patuxent Wildlife Res. Ctr., 2.vi.1958 (Scanlon), light trap, 200 females; 17.v.1976, 4.vi.1976 (Grogan), reared from pond weeds, 4 males, 1 female, 1 pupal exuviae, 1 larva. VIRGINIA: Fairfax Co., Falls Church, 5.vii.1958 (Wirth), 1 female.

Genus *Probezzia* Kieffer

Probezzia Kieffer, 1906:57. Type-species, *Ceratopogon venustus* Meigen, by designation of Coquillett, 1910:594 (synonym of *P. seminigra* (Panzer)).

Dicrobezzia Kieffer, 1919:127. Type-species *Ceratopogon venustus* Meigen, by original designation (synonym of *P. seminigra* (Panzer)).

References.—Wirth, 1951a:25; 1971:729 (revisions of North American species).

Diagnosis.—Body slender and nearly bare. Fourth tarsomeres (Fig. 15g) short, cordiform; female fifth tarsomeres (Fig. 15f) armed with numerous, blunt, strong, black spines (batonnets) ventrally; female claws long, bent at base, straight and flattened distally, each with external basal tooth. Wing (Fig. 15a) with a single long radial cell; costa in female reaching nearly to wing tip; membrane usually milky white with a major part covered with a broad smoky fascia. Female eighth sternum (Fig. 15e) with a pair of prominent submedian tufts of long fine setae on posterior margin. Male genitalia (Fig. 15d) with basistyle long and slender, dististyle short and pointed; aedeagus tapered with short anterior arch and caplike posterior tip; parameres (Fig. 15b) slender, parallel sided, and more or less fused in middle.

Immature stages.—Larva (*P. seminigra* (Panzer), after Glukhova, 1977): Head moderately broad, tapering; head hairs *o*, *s*, and *u* multiple; epipharynx with one pair of combs, no combs on lateral arms; last segment with four pairs of rather short hairs arranged subapically on each side rather than around the anus. Pupa with short slender respiratory horn (Figs. 17b, f; 18b, d) bearing 8–10 terminal spiracles; some species with some abdominal sterna provided with large, disclike, glandular areas; apicolateral processes (Figs. 17c, d, g, h, i; 18c, e, f) short and divergent, sharp pointed.

Biology.—Weerekoon (1953) found larvae of *P. seminigra* (Panzer) (as *venusta*) common in the bottom mud of Loch Lomond in Scotland, coming to the water surface at night and swimming to shore to pupate. He found their guts filled with red, semi-liquid matter which he believed came from

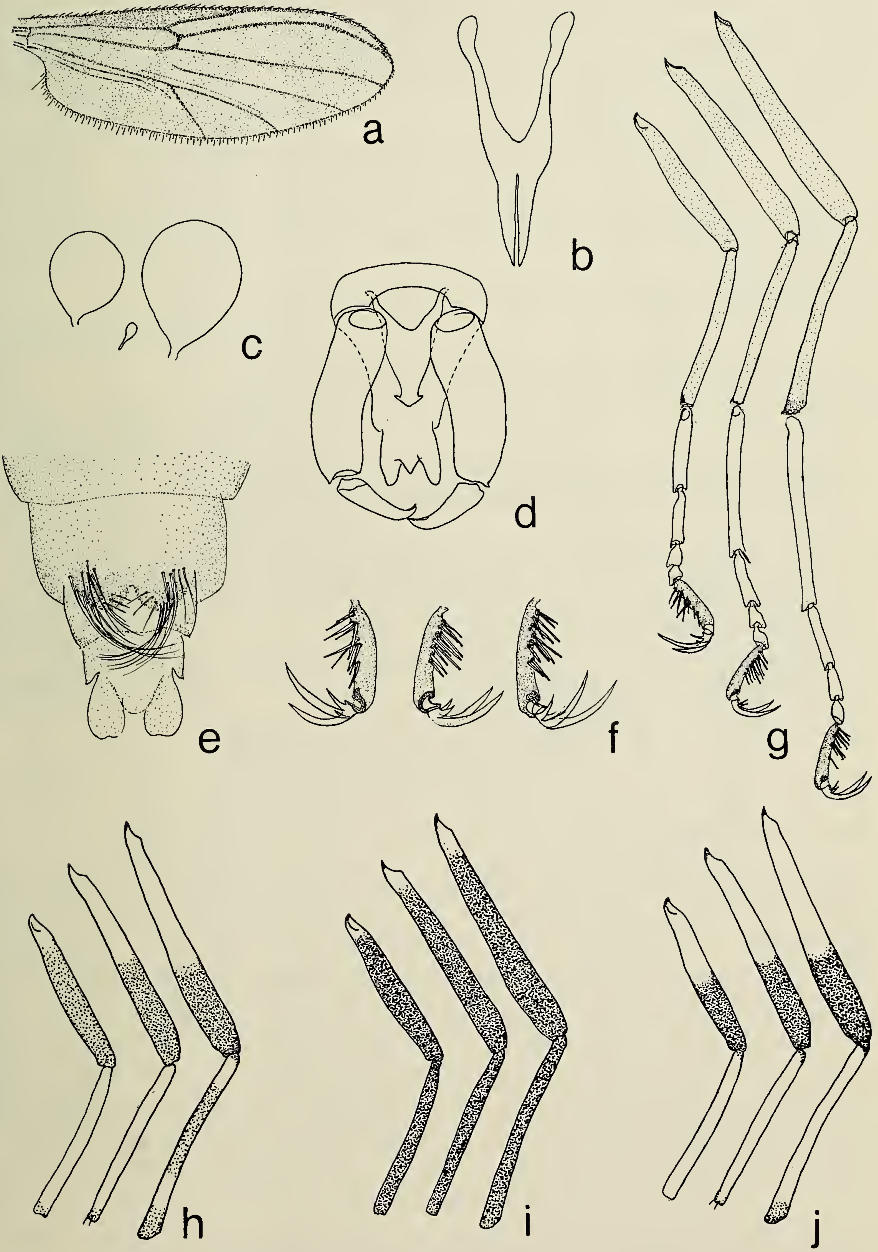

Fig. 15. *Probezzia pallida*, a–g; *P. albitibia*, h; *P. smithii*, i; *P. xanthogaster*, j: a, female wing; b, male parameres; c, female spermathecae; d, male genitalia; e, female genital segments; f, female fifth tarsomeres; g–j, female leg patterns.

feeding on animals containing hemoglobin, probably bloodworms of the family Chironomidae. As reviewed in the introduction, Downes (1971) gave details of the adult feeding and mating habits of *P. seminigra* (as *flavonigra* (Coquillett)) in Alberta.

Key to Potomac Valley Species of *Probezzia*

1. Wing entirely pale, veins and membrane whitish 2
– Wing whitish with broad dark band, veins in infuscated portion darkened 4
2. Mesonotum entirely yellowish or pale brownish *pallida* Malloch (female)
– Mesonotum entirely shining black or dark brown 3
3. Legs entirely pale except for black fifth tarsomere *pallida* Malloch (male)
– Legs with black markings on approximately distal third of femora and extreme tip on hind tibia (Fig. 15j); fifth tarsomeres black *xanthogaster* (Kieffer)
4. Wing with dark band covering middle third of wing and centering just distad of r-m crossvein, distal portion pale; broad bases of middle and hind femora pale (Fig. 15h) *albitibia* Wirth
– Wing with distal two-thirds dark; tibiae entirely and femora except extreme bases black (Fig. 15i) *smithii* (Coquillett)

12. *Probezzia albitibia* Wirth
(Figs. 15h, 16a, 17a–d)

Probezzia albitibia Wirth, 1971:732 (male, female; Virginia; figs.).

Female diagnosis.—Wing length 2.5 mm. Head blackish; antenna with pedicel pale brown and segments 3–10 yellowish white; segments 11–15 dark brown. Palpus yellowish to brown. Thorax shining black. Legs (Fig. 15h) with coxae dark brown; trochanters and bases of femora yellow; front femur dark brown except at extreme base, distal half of middle femur and distal third of hind femur dark brown; front and middle tibiae yellowish white with faint basal and aipcal brown rings; hind tibia dark brown with pale brown sub-basal band and yellow subapical band; tarsi whitish, fifth tarsomers blackish. Wing whitish including veins; a prominent dark brown tranverse band across wing about a fourth as wide as wing is long, centering just past level of r-m crossvein and mediocubital fork, veins in this area dark brown, basal and distal pale areas of wing subequal in extent. Halter yellowish white. Abdomen pale, usually third to fifth terga blackish.

Male.—Similar to female but wing with dark band much fainter and

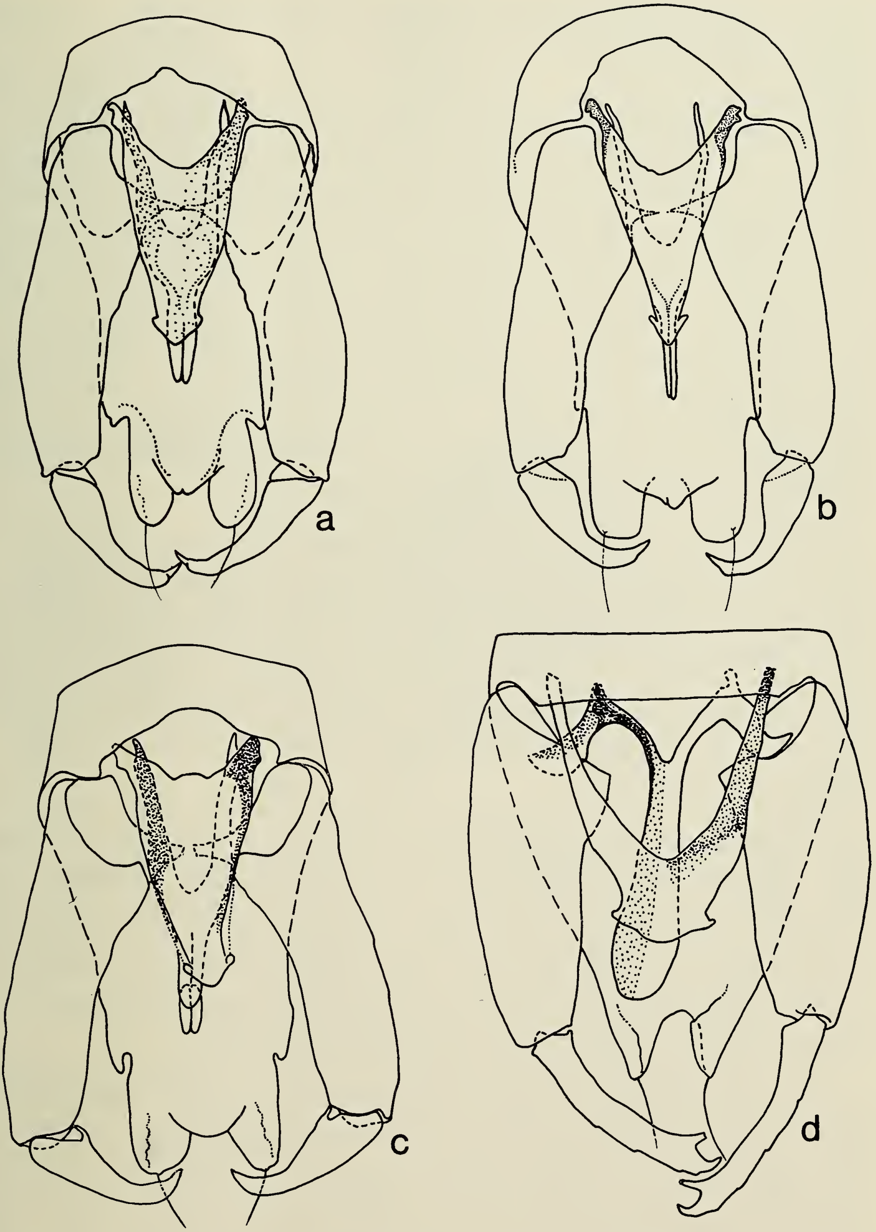

Fig. 16. *Probezzia* and *Sphaeromias* male genitalia: a, *P. albitibia*; b, *P. smithii*; c, *P. xanthogaster*; d, *S. bifidus*.

extending distally with decreasing intensity to wing tip; all tibiae infuscated except at extreme bases; abdomen pale at base, dark on distal half. Genitalia as in Fig. 16a.

Immature stages.—Larva unknown. Pupa with operculum (Fig. 17a) 1.3 times longer than broad, surface covered with small rounded tubercles as figured; anterior end pointed, posterior portion with two raised areas each with a pair of tubercles, the posterior one bearing a single long seta; posterior margin attached. Respiratory horn (Fig. 17b) four times longer than broad, surface smooth; apex with 4–8 spiracles. Female terminal segment (Fig. 17c) 1.3 times longer than broad; dorsum covered with small pointed tubercles as figured; venter covered with small pointed tubercles except for broad circular central area; apicolateral processes divergent, surface bare. Male terminal segment (Fig. 17d) 1.2 times longer than broad; dorsum and anterior fourth of venter covered with small pointed tubercles as figured; ventral genital processes short, appressed; apicolateral processes divergent, covered with scattered, small pointed tubercles.

Distribution.—Wisconsin to Quebec, south to Virginia.

Potomac Valley records.—D.C.: Washington, 14.vii.1924 (Malloch), 1 female. MARYLAND: Montgomery Co., Plummers Island, 11.vi (Barber), 1 female; 18.viii.1912 (Malloch), 1 female. Prince George's Co., Beltsville, Indian Creek, v.vi.1975 (Grogan, 1 female, 1 female, with pupal exuviae, reared from margin of a small, cold stream. VIRGINIA: Fairfax Co., Falls Church, Holmes Run, 2.vii.1961 (Wirth), 1 female; Potomac River at Scott Run, 4,7.vi.1955, reared from river margin (Wirth and Jones), 6 males, 3 females, with pupal exuviae.

Biology.—Wirth and Jones reared *P. albitibia* from the sandy margin of the Potomac River at the mouth of Scott Run, Fairfax County, Virginia, June 1955. Williams reared it from the beach at Douglas Lake, Michigan, July 1959. Wirth reared it from the edge of a sand bar in the Madawaska River in Algonquin Park, Ontario, June 1960; also from Fishing Brook, Hamilton Co., New York, June 1960, and from Dead Creek, Piercefield, St. Lawrence Co., New York, June 1963. Grogan reared this species from the margin of a small, cold stream (Indian Creek) at Beltsville, Maryland.

Notes.—The sexual dimorphism in leg markings in this species is unusual; in most species the leg markings are an important means of correlating males and females of the species. In the material of *albitibia* originally studied in 1971 it was noted that the series from Conewago Creek near York, Pennsylvania lacked the pale bands on the hind tibia; in the Potomac River series reared by Wirth and Jones some of the females also lacked these bands. The pupae were examined carefully but no characters were found to separate this series from typical *albitibia*, nor could other significant differences be found in females with these dark tibiae.

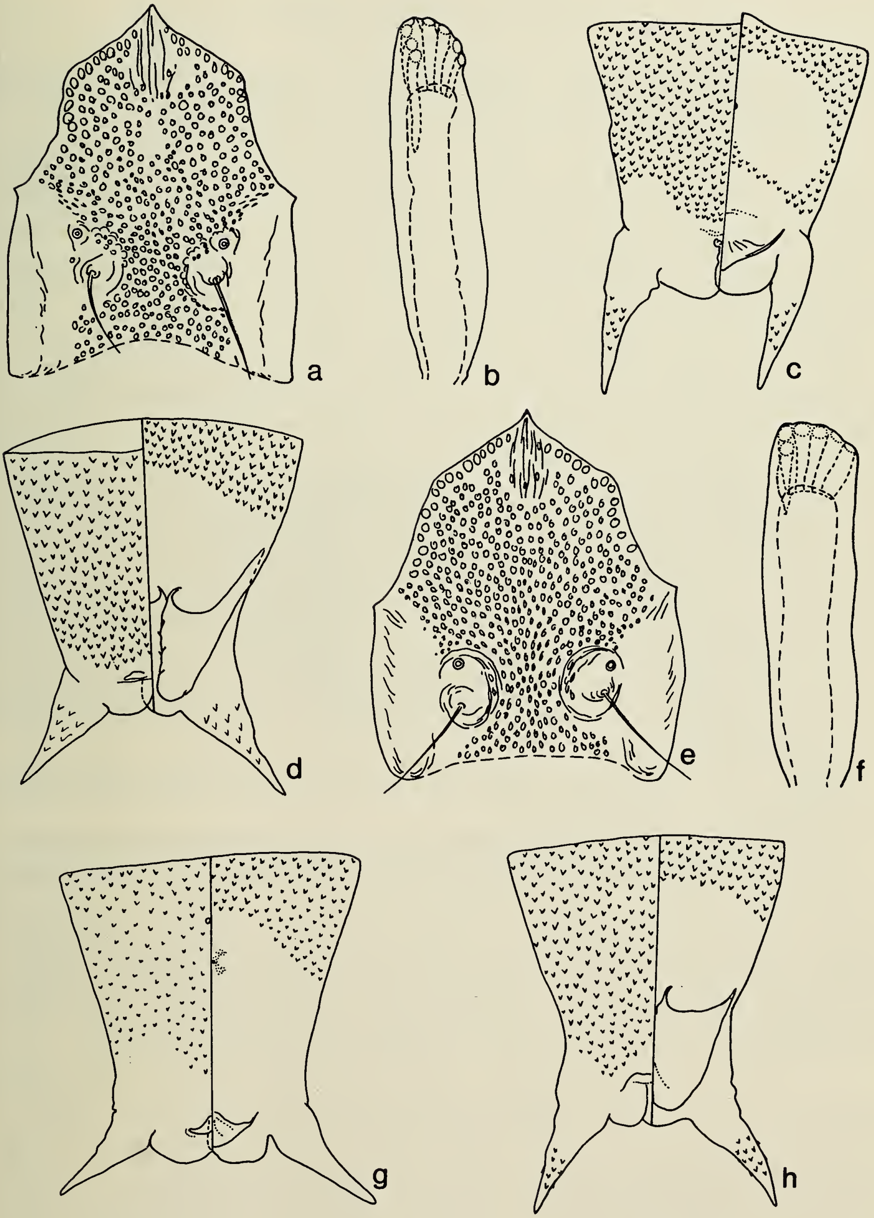

Fig. 17. *Probezzia* spp., pupa: a–d, *P. xanthogaster*; e–h, *P. pallida*; a, e, opercula; b, f, respiratory horns; c, g, female terminal segments; d, h, male terminal segments.

13. *Probezza pallida* Malloch
(Fig. 15a–g; 17e–h)

Probezzia pallida Malloch, 1914:138 (female; Illinois); Wirth, 1951a:30 (distribution; notes); Wirth, 1971:736 (notes; distribution).

Female diagnosis.—Wing (Fig. 15a) length 2.8 mm. A medium-sized, uniformly pale yellowish species; head brown, antenna yellow with last five segments brownish; legs (Fig. 15g) pale, fifth tarsomeres black (Fig. 15f).

Male.—Differing markedly from the female in its shining black thorax and darkened abdomen, but easily recognized by its entirely pale legs (except for the black fifth tarsomeres). Genitalia as in Fig. 17f–g.

Immature stages.—Larva unknown. Pupa with operculum (Fig. 17e) 1.2 times longer than broad, surface covered with small, pointed tubercles as figured; anterior end pointed, posterior portion with raised area bearing two pairs of tubercles, the posterior pair bearing a single long seta; posterior margin attached. Respiratory horn (Fig. 17f) four times longer than broad, surface smooth; apex with 6–8 spiracles. Female terminal segment (Fig. 17g) 1.25 times longer than broad; dorsum and anterior third of venter covered with scattered small pointed tubercles as figured; apicolateral processes greatly divergent, surface bare. Male terminal segment (Fig. 17h) 1.35 times longer than broad; dorsum and anterior fourth of venter covered with small pointed tubercles; ventral genital processes short, greatly appressed; apicolateral processes moderately divergent, covered with scattered small pointed tubercles.

Biology.—This species has been reared numerous times from the margins of medium size to large streams.

Distribution.—North Dakota to Ontario, south to Arizona and Florida.

Potomac Valley records.—MARYLAND: Montgomery Co., Glen Echo, 12.vii.1922 (Malloch), 1 female; Plummers Island, 11.vi (Barber), 1 female. Prince George's Co., Beltsville, 23.vi.1918 (McAtee), 1 female. VIRGINIA: Fairfax Co., Falls Church, Holmes Run, 30.vii.1960, 1.vii.1961 (Wirth), 2 females; Potomac River at Scott Run, 4,7.vi.1955 (Wirth and Jones), reared from river margin), 1 male, 2 females, with pupal exuviae.

14. *Probezzia smithii* (Coquillett)
(Figs. 15i, 16b, 18a–c)

Ceratopogon smithii Coquillett, 1901:600 (female; New Jersey).

Probezzia smithii (Coquillett); Malloch, 1914:138 (combination); Wirth, 1951a:29 (notes; distribution); Wirth, 1971:737 (notes; distribution).

Dicrobezzia smithii (Coquillett); Johannsen, 1943:785 (combination; distribution).

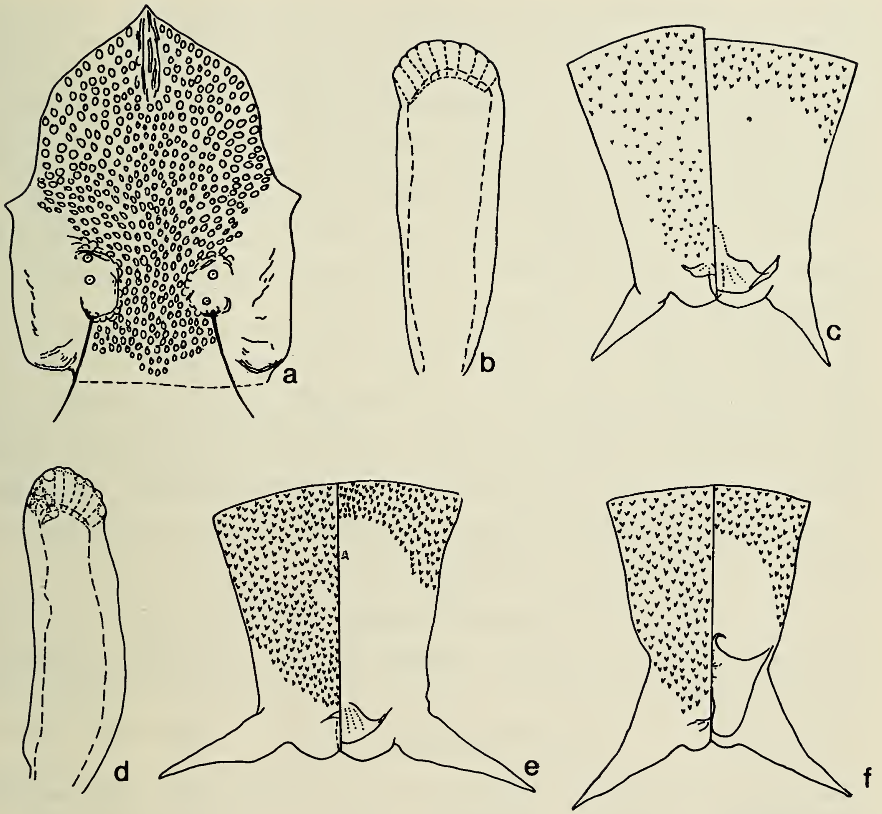

Fig. 18. *Probezzia* spp., pupa: a–c, *P. smithii*; d–f, *P. albitibia*; a, operculum; b, d, respiratory horns; c, e, female terminal segments; f, male terminal segment.

Female diagnosis.—Wing length 2.6 mm. A rather small black species; thorax and abdomen black; wing infuscated on distal two-thirds, the veins brown; halter whitish; antenna pale, last five segments brown; legs (Fig. 15i) black, except trochanters, extreme bases of femora and first four tarsomeres yellowish; abdomen usually extensively black dorsally.

Male.—Genitalia (Fig. 16b) with aedeagus wedge shaped, tapering distally to a narrow caplike tip, the forklike basal arch extending to about a fourth of total length; parameres with long, slender, anterior arms and distal tips in form of slender contiguous rods when viewed ventrally.

Immature stages.—Larva unknown. Pupa with operculum (Fig. 18a) 1.3 times longer than broad, surface covered with small rounded tubercles as figured; anterior end pointed; posterior portion with a pair of raised areas with three pairs of tubercles, the posterior one bearing a single long seta; posterior margin attached. Respiratory horn (Fig. 18b) three times longer than broad, surface smooth; apex with 9–12 spiracles. Female terminal segment (Fig. 18c) 1.2 times longer than broad; dorsum covered with scattered small pointed tubercles; anterior fourth of venter covered with small pointed tubercles; apicolateral processes divergent, surface bare. Male terminal segment nearly identical with that of *P. xanthogaster* (Fig. 18f).

Biology.—This species has been reared twice from river margins; the Potomac River as noted below, and by Jones from the Wolf River in Wisconsin, June 1954.

Distribution.—Kansas and Wisconsin to New Jersey, south to Louisiana and Florida.

Potomac Valley records.—D.C.: Washington, 7.ix.1907 (McAtee), 1 female; 15.vii.1924 (Malloch), 1 female. MARYLAND: Montgomery Co., Plummers Island, 8.vi.1914 (Schwarz and Shannon), at light, 1 male. VIRGINIA: Fairfax Co., Chain Bridge, 20.viii.1922 (Malloch), 1 female; Potomac River at Scott Run, 4,7.vi.1955 (Wirth and Jones), reared from river margin, 4 males, 4 females, with pupal exuviae.

15. *Probezzia xanthogaster* (Kieffer)

Ceratopogon elegans Coquillett, 1901:599 (female; New Jersey, preocc. Winnertz 1852).

Bezzia (*Probezzia*) *xanthogaster* Kieffer, 1917:329 (n. name for *elegans* Coquillett).

Dicrobezzia xanthogaster (Kieffer); Johannsen, 1943:785 (combination; distribution).

Probezzia xanthogaster (Kieffer); Wirth, 1951a:29 (combination; notes; distribution); Wirth, 1971:738 (notes; distribution).

Female diagnosis.—Wing length 2.5 mm. A rather small black and yellow species; thorax shining black; wing milky white including veins; halter white; antenna yellow, last five segment black; legs (Fig. 15j) yellow, coxae, distal third of all femora, extreme tip of hind tibiae, and fifth tarsomeres brownish black; abdomen yellowish (infuscation of front femur variable).

Male.—Genitalia (Fig. 16c) with aedeagus short with broad base, basal arch extending to less than a sixth of total length, and with slender caplike tip. Parameres with basal arms long and slender and placed closer together than usual, with distal tips stouter and more strongly bent in lateral view than usual.

Immature stages.—Larva unknown. Pupa with operculum nearly identical with that of *P. smithii* (Fig. 18a) except only two pairs of tubercles on raised posterior portions, the posterior pair bearing a single seta. Respiratory horn (Fig. 18d) 3.5 times longer than broad, surface smooth; apex with 8–12 spiracles. Female terminal segment (Fig. 18e) 1.3 times broader than long; dorsum covered with small pointed tubercles; apicolateral processes greatly divergent, surface bare. Male terminal segment (Fig. 18f) 1.2 times longer than broad; dorsum covered with small pointed tubercles; anterior third of venter covered with small pointed tubercles; ventral processes short, greatly appressed; apicolateral processes moderately divergent, surface bare.

Biology.—This species has been reared from the margin of Quaker Run, Allegany State Park, New York (Wirth, May 1963); margin of Independence River, Glenfield, Lewis Co., New York (Wirth, June 1963); pond margin, Letchworth State Park, New York (Wirth, June 1963); river margin, Genessee River, Portageville, New York (Wirth, June 1963); creek margin, Taughannock Falls, Tompkins Co., New York (Wirth, June 1963); margin Wolf River, Outagamie Co., Wisconsin (Jones, June 1954); and margin Wisconsin River, Sauk Co., Wisconsin (Jones, June 1954).

Distribution.—Wisconsin to Ontario, south to Illinois and Virgnia.

Potomac Valley records.—D.C.: Washington, v.1932 (Barber), 9 females. MARYLAND: Montgomery Co., Fairland, 10.vi.1958 (Hubert), 3 males; Plummers Island, 11.vi, 14.v.1914 (Shannon), 2 females. VIRGINIA: Alexandria, Dyke, 28.v.1915 (McAtee), 1 female. Fairfax Co., Holmes Run, Falls Church, 13.v, 10–14.vi.1961 (Wirth), 1 male, 3 females.

Genus *Sphaeromias* Curtis

Sphaeromias Curtis, 1829: plate 285. Type-species, *Sphaeromias albomarginatus* Curtis, by original designation (synonym of *S. fasciatus* (Meigen)).

Xylocrypta Kieffer, 1899:69. Type-species, *Ceratopogon fasciatus* Meigen, by original designation.

Diagnosis.—Large, stout, grayish pollinose species. Femora with numerous small, sharp, ventral spines; fourth tarsomeres simple, not cordiform; fifth tarsomeres (Fig. 19c) armed ventrally with numerous long, black, blunt spines (batonnets); female claws (Fig. 19c) large, equal, curved, not as long as fifth tarsomere, each with slender, sharp tooth at base on inner side. Wing (Fig. 19a) with two radial cells; costa long, extending nearly to wing tip. Eighth segment of female abdomen without sclerotization or hair tufts; two large spermathecae present. Male aedeagus (Fig. 19d) with well developed basal arch and broad, caplike tip; parameres (Fig. 19e) joined in a V-shaped notch at base, fused distally in a long tonguelike lobe, tip usually setose.

Immature stages.—Larva described under *S. longipennis.* Larva of *S. pictus* (Meigen) (after Glukhova, 1977) with head rather short and ovoid,

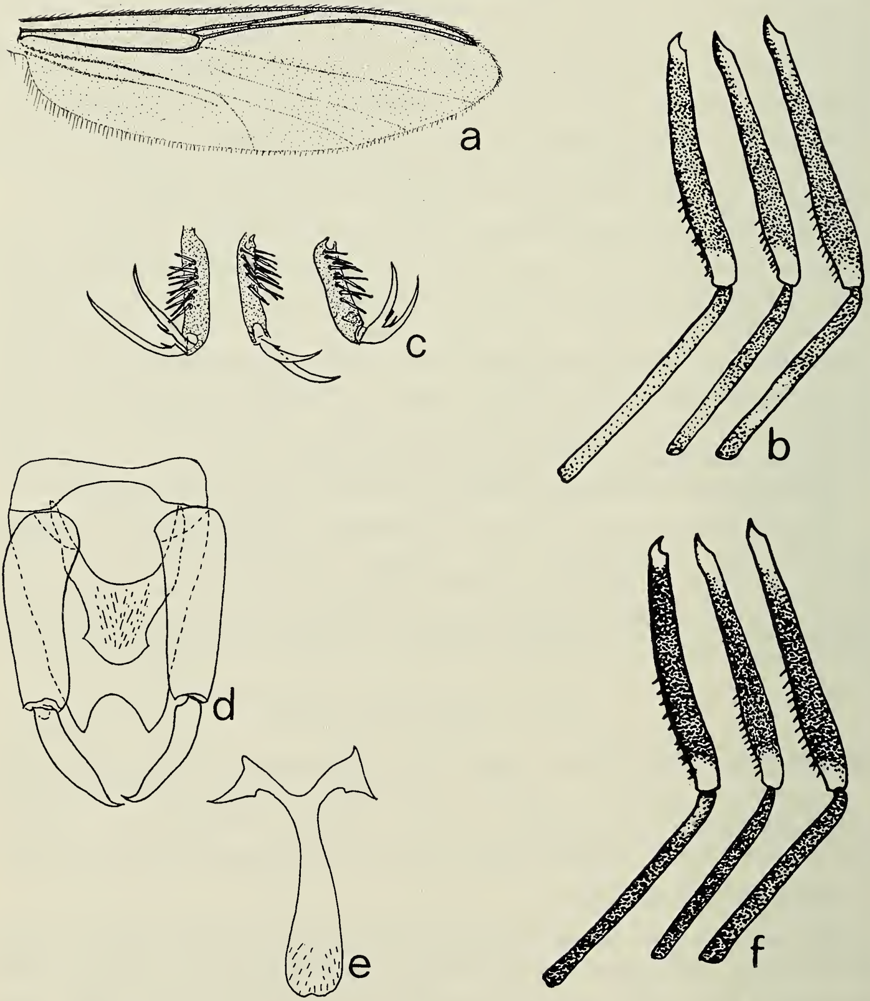

Fig. 19. *Sphaeromias* spp.: a–e, S. *longipennis*; f, S. *bifidus*; a, female wing; b, f, female leg patterns; c, female fifth tarsomere and claws; d, male genitalia, parameres removed; e, parameres.

slightly tapering, twice as long as broad; *o*, *s*, and *u* setae multiple; last segment with four pairs of short, slender, lateral setae and two minute pairs of perianal setae. Pupa (Fig. 20d) with respiratory horn elongate, tapering from broad, rounded apex; abdominal tubercles prominent, conical, and sharp-pointed; abdomen without ventral glandular discs.

Biology.—See discussion under S. *longipennis.*

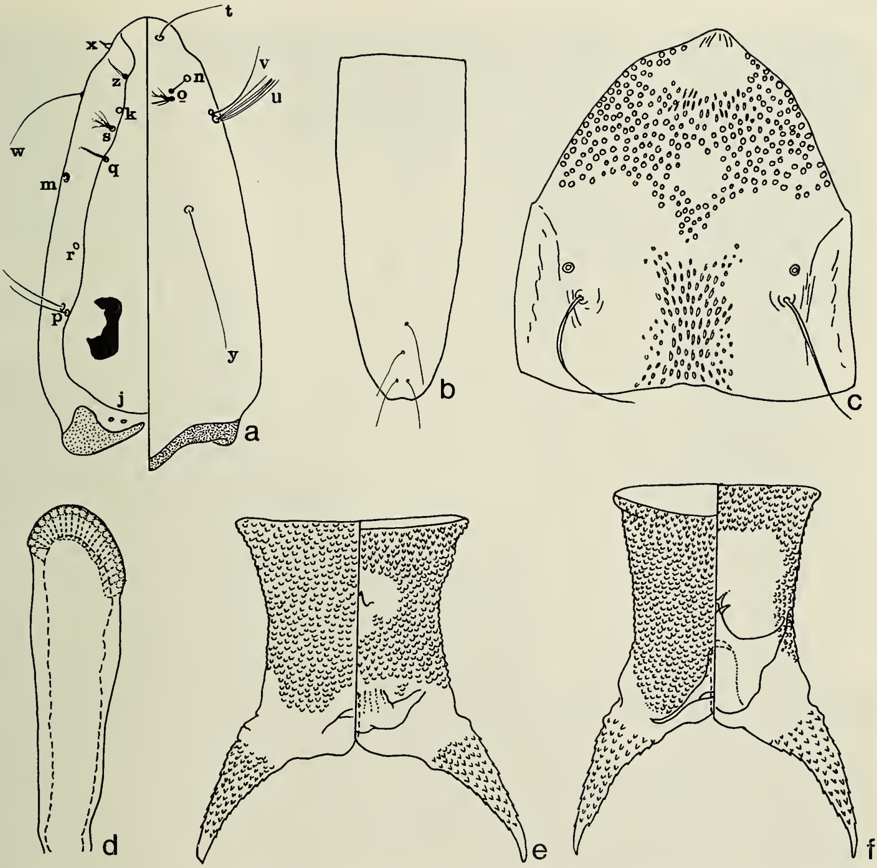

Fig. 20. *Sphaeromias longipennis*, a–b, larva; e–f, pupa: a, head capsule; b, terminal segment; c, operculum; d, respiratory horn; e, female terminal segment; f, male terminal segment.

Key to Potomac Valley Species of *Sphaeromias*

1. Tibiae of female entirely dark brownish black (Fig. 19f); male dististyle with bifurcate tip (Fig. 16d) *bifidus*, new species

– Female with front tibia and broad subapical bands on middle and hind tibiae light brown (Fig. 19b); male dististyle with pointed tip (Fig. 19d) *longipennis* (Loew)

Sphaeromias bifidus Wirth and Grogan, new species
(Figs. 16d, 19f)

Diagnosis.—Closely resembling *S. longipennis* (Loew), but slightly smaller, female wing length 3.94 mm; differing also as follows: Dististyle of

male genitalia with bifurcate tip; female with tibiae entirely dark blackish brown.

Allotype female.—Wing length 3.94 mm, breadth 1.15 mm. Head brown. Antennal pedicel dark brown; proximal eight flagellomeres with proximal halves light brown; flagellomeres with lengths in proportion of 25-15-15-15-15-16-17-19-42-40-39-45-58; antennal ratio 1.64. Palpus slender; segments with lengths in proportion of 8-14-19-10-11; third segment lacking sensilla; palpal ratio 3.17. Mandible with seven large teeth on inner margin. Thorax dark brown. Legs (Fig. 19f) dark blackish brown; bases and apices of femora and base of front tibia paler brown; tarsomeres 1–3 yellowish; femora armed ventrally with spines on distal halves; fifth tarsomere as in *S. longipennis* (Fig. 19c), armed ventrally with several batonnets; claws equal and with inner basal barbs. Wing hyaline, similar to that of *S. longipennis* (Fig. 19; anterior veins light brown, posterior veins extremely pale; costal ratio 0.95. Halter stem pale, knob white. Abdomen dark brown. Spermathecae ovoid, subequal with very short necks.

Holotype male.—Similar to female but smaller; with the usual sexual differences; proximal eight flagellomeres light brown, plume brown; femora with bases only light brown, front tibia entirely dark; femora with fewer spines. Genitalia as in Fig. 16d. Ninth sternum 4.5 times broader than long, base nearly straight and a slight caudomedian excavation; ninth tergum with nearly straight base, tapering abruptly distally to a rounded tip, cerci short, extending slightly beyond basistyle. Basistyle curved slightly, 2.4 times longer than broad; dististyle 0.75 times the length of basistyle; slightly curved, tip bifurcate. Aedeagus 1.2 times longer than broad; basal arch 0.75 of total length, membrane spiculate; basal arm straight, heavily sclerotized proximally, distal portion lightly sclerotized, tip broadened. Parameres fused; basal arm heavily sclerotized, doubly recurved with an anterior projecting portion; distal portion more lightly sclerotized, slender proximally, broader distally with rounded tip covered with fine setae.

Etymology.—The specific name *bifidus*, Latin for two-branched, refers to the distinctive bifurcate dististyle on the male genitalia.

Distribution.—Maryland; presently known only from the type locality.

Types.—Holotype, male, allotype, female, Patuxent Wildlife Research Center, Prince George's Co., Maryland, male 14–17 June, female 6–11 July, 1976, W. L. Grogan, Jr., malaise trap (Type no. 71,176, USNM).

Discussion.—Sphaeromias longipennis differs from *bifidus* as follows: male genitalia with pointed tip on dististyle and basal arch of aedeagus 0.6

←

Fig. 21. Sandy margin of Potomac River at the lower end of Plummers Island, a characteristic habitat of the stream-dwelling Sphaeromiini.

times length of aedeagus; females larger (wing length 4.2–4.9 mm), with front tibia and broad subapical bands on middle and hind tibiae pale brown.

Biology.—The two specimens of this unusual species were taken in a malaise trap from a swampy situation (Fig. 23) near stagnant water where sphagnum, skunk cabbage, and *Osmunda* ferns were plentiful and red maples and sweet gum are the predominant trees. It is likely that S. *bifidus* prefers such swampy situations whereas S. *longipennis* is normally found in open bodies of water such as ponds, lakes and streams. However, there is the possibility that these two species may occur together as two males of S. *longipennis* were taken in the malaise trap at the same site. These may have strayed from a nearby pond (Knowles Marsh no. 1) which contained large quantities of algae and other aquatic vegetation, the usual habitat of S. *longipennis* larvae. A female of S. *longipennis* was reared from this pond, thus lending further proof of this hypothesis.

The discovery of a new species of *Sphaeromias* in North America was entirely unexpected. It is more remarkable in view of the fact that Wirth (1962a) recently reviewed S. *longipennis* and reported it from most of North America. This species is usually extremely abundant wherever it is found and it inhabits a wide variety of aquatic habitats. At present it is impossible to determine the distribution of S. *bifidus*. However, it is likely that it may be chiefly an inhabitant of the southeastern Coastal Plain, an area poorly represented by ceratopogonids in the U.S. National Museum.

Sphaeromias longipennis (Loew)
(Figs. 19a–e, 20)

Ceratopogon longipennis Loew, 1861:313 (female; Pennsylvania).
Palpomyia (*Sphaeromyas*) *longipennis* (Loew); Kieffer, 1906:62 (combination).
Palpomyia longipennis (Loew); Malloch, 1914:219 (male, female, larva, pupa; habits; figs.; Illinois); Malloch, 1915a:323 (larva; figs.; habits; Illinois); Kieffer, 1917:319 (in key); Thomsen, 1935:295 (fig. male genitalia); Thomsen, 1937:75 (larva, pupa; figs.; New York).
Homohelea longipennis (Loew); Kieffer, 1917:364 (combination).
Sphaeromias longipennis (Loew); Johannsen, 1943:784 (combination, distribution); Wirth, 1952:214 (redescribed; California; distribution; figs.); Wirth, 1962a:278 (redescribed; figs.; distribution).

Female diagnosis.—A large robust species; wing length 4.2–4.9 mm.

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Fig. 22. Margin of Knowles Marsh no. 1 in floodplain of Patuxent River, Patuxent Wildlife Research Center, Prince George's County, Maryland.

Thorax dull grayish brown, mesonotum heavily overlaid with whitish pollen, also with sparse, erect, short, sharp spinules. Legs (Fig. 19b) yellowish, front femur with broad midportion and middle and hind femora with broad subapical bands blackish; tibiae with broad sub-basal bands and narrow apices black; narrow tips of tarsomeres 1–4 and all of fifth blackish. Wing and halter whitish. Abdomen densely whitish pollinose above. Legs with abundant sharp spines ventrally on femora, front and hind femora especially somewhat arcuate and swollen on distal portion.

Male.—As in the female with usual sexual differences; legs dark brown except bases of femora and four proximal tarsomeres pale. Male genitalia as in Fig. 19d, e.

Immature stages.—Larva (fourth instar) 15–17 mm long. Head capsule (Fig. 20a) twice as long as broad; eye kidney shaped, located mesad of epicranial suture; dorsum with chaetotaxy as follows: two pairs of small *j* pits just anterior to postoccipital ridge; two pairs of *p* setae opposite eye spot; *r* pit anterior to eye; *q* seta mesad of epicranial suture; *m* pit on lateral margin just posterior to *q* seta; *s* seta just anterior to *q* seta laterad of epicranial suture; *z* seta anterior to *k* pit; *w* seta on lateral margin nearly opposite *z* seta; *x* seta short. Venter of head with chaetotaxy as follows: *y* seta about halfway between *m* and *r* pits; *o* seta multiple; single *v* seta opposite *k* pit; *u* seta multiple, anterad of *k* pit; *t* seta single. Terminal segment (Fig. 20b) 2.6 times longer than broad; posterior end with four pairs of short, slender setae.

Pupa.—Operculum (Fig. 20c) slightly longer than broad; anterior margin slightly pointed, surface covered with small rounded tubercles as figured; central area with slightly elevated portions each bearing a single long seta and a pit just anterad of the seta; posterior margin slightly convex. Respiratory horn (Fig. 20d) 3.5 times longer than broad, surface smooth; apex with 20–30 spiracles. Female terminal segment (Fig. 20e) slightly longer than broad; dorsum covered with small pointed tubercles; venter covered with small pointed tubercles except for circular central portion; apicolateral processes moderately divergent, covered with small pointed tubercles. Male terminal segment (Fig. 20f) 1.3 times longer than broad; dorsum covered with small pointed tubercles; anterior fourth and lateral margins of venter covered with small pointed tubercles, genital processes short, greatly appressed; apicolateral processes covered with short pointed tubercles.

Biology.—Malloch (1914, 1915a) described all stages of *S. longipennis* from Illinois. He stated that the eggs are laid in groups on the leaves of

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Fig. 23. Malaise trap site in swamp adjacent to Knowles Marsh no. 1, Patuxent Wildlife Research Center, Prince George's County, Maryland.

plants in the water and covered with a gelatinous substance. The larvae were found in the Illinois River and in a nearby lake often submerged to a depth of as much as 8.5 ft. The pupae kept in rearing vials did not entirely leave the water as did related genera, but remained with the posterior half of the body submerged in the water. Thomsen (1937) found the larvae and pupae of S. *longipennis* in great numbers in blanket algae in Goodell Lake, New York. Wirth reared it from mud and sand at the margin of the Rideau River in Ottawa, Ontario, on 29 May 1960, where it was associated with *Jenkinshelea albaria*, *Johannsenomyia argentata*, *Probezzia pallida*, *Mallochohelea albihalter* Wirth and *M. smithi* (Lewis), and species of *Stilobezzia* and *Bezzia.* Grogan recovered larvae and pupae from debris along the margin of Black Lake, Ontario. Larvae were very active when placed in water and swam with just their head at the surface, the remainder of their body extending at an oblique angle into the water. Our larval and pupal descriptions are based on this material.

Distribution.—Minnesota to Ontario, south to Texas and Florida, also California.

Potomac Valley records.—D.C.: Washington, 30.vii.1907 (McAtee), 1 female; 15.vii.1914 (McAtee), 1 female. MARYLAND: Montgomery Co., Colesville, 17.vi.1975 (Wirth), 1 female; Potomac, 17.vii.1976 (Steiner), 1 female. Prince George's Co., Patuxent Wildlife Research Center, 17.v.1976 (Grogan), 1 female, reared; 1.vii.1976 (Grogan), 2 males, malaise trap. VIRGINIA: Alexandria, Dyke Marsh, 19.vi, 6.vii.1952 (Wirth), 3 males.

VI. Acknowledgments

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A NEW ASELLOTA (STENETRIIDAE) AND TWO, ONE NEW, ANTHURIDEA (ANTHURIDAE) FROM BERMUDA (CRUSTACEA, ISOPODA)

George A. Schultz

Abstract.—Three species are described from Bermuda. They are all from a single dredge haul from 90 m deep off the south shore of the island. One is placed in *Stenobermuda*, a new genus of Stenetriidae (Asellota), and the new species is the first hermaphrodite described in the family. The other two species are in Anthuridae (Anthuridea). One is a new species in the new genus *Anthomuda*, and the other is *Apanthura magnifica* Menzies and Frankenberg. The range of *A. magnifica* is thus extended to Bermuda from the southeastern coast of the United States.

Three species, two new, of isopod crustaceans were collected during dredging operations by the "North Star" two miles off Castle Roads on the south shore of Bermuda. The specimens were obtained from a bottom of sand and rocks at 90 m on 30 October 1976. One, an Asellota, is in a new genus of the family Stenetriidae. It is the first record of a hermaphrodite in that family. The other two species are in the Anthuridea in the family Anthuridae. *Apanthura magnifica* Menzies and Frankenberg (1966) is recorded for the first time from Bermuda.

Richardson (1902) described the isopods of Bermuda and they were reviewed more recently by Schultz (1969).

Stenobermuda, new genus

Description.—Eyes of few ocelli. Frontal margin of cephalon with rostrum; frontal processes short; anterolateral processes pointed. Squama present on peduncle of antenna 2. Body margins subparallel with coxal process showing somewhat from beneath edge of peraeonite I. Coxal processes on lateral edges of peraeonite IV and posterolateral edges of peraeonites VI and VII. Two free pleonal segments. Posterolateral notches in margins of pleotelson.

The type-specimen used in the description of the type-species of the genus is a hermaphrodite.

Etymology and gender.—The prefix "steno-" is from *Stenetrium* the name of the type-genus of the family. It means narrow and is combined with the name of the island where the specimen was found. The gender is feminine.

Type-species.—*Stenobermuda acutirostrata*, sp. nov.

Stenobermuda acutirostrata, new species

Figs. 1–11

Description.—Five ocelli. Rostrum elongate and acutely pointed. Frontal margin of cephalon with frontal processes short; anterolateral processes moderately long and acutely pointed. Anterolateral edges of peraeonites I–VI pointed. Coxal extensions can show from beneath lateral edges of peraeonite I. Peraeonite IV with large lateral coxal extensions. Peraeonites V and VI with large posterolateral extensions. Peraeonite VII with coxal extensions on rear border. Pleotelson about as long as peraeonites VI and VII combined; posterolateral notches well defined; posterior margin rounded and somewhat produced; light setation on lateral margins.

Antenna 1 with outer distal margin of peduncular segment projecting anteriorly about half length of second segment; 5 flagellar articles; first and apical articles very short with few aesthetascs and long setae. Sensory setae on peduncular segments. Maxilliped with 3 coupling hooks on narrow endite; distal 2 palp articles much narrower than proximal 3 articles; endite with convex outer border; apex acutely pointed.

Peraeopod I with propodus longer than wide; inner margin of manus with 6 moderately large setae and one large palmar seta; cutting edge beneath overlapping dactylus with moderately large setae on it. Dactylus with elongate unguis. Hair-like setae on margin of peraeopod I. Elongate setae on inner margin of subequal carpus and merus. Ischium and basis with few setae.

Male pleopod 1 with 4 long apical setae and other moderately long setae on lateral margins. Male pleopod 2 with spine longer than exopod projecting from near apex of exopod; endopod with elaborately structured apex.

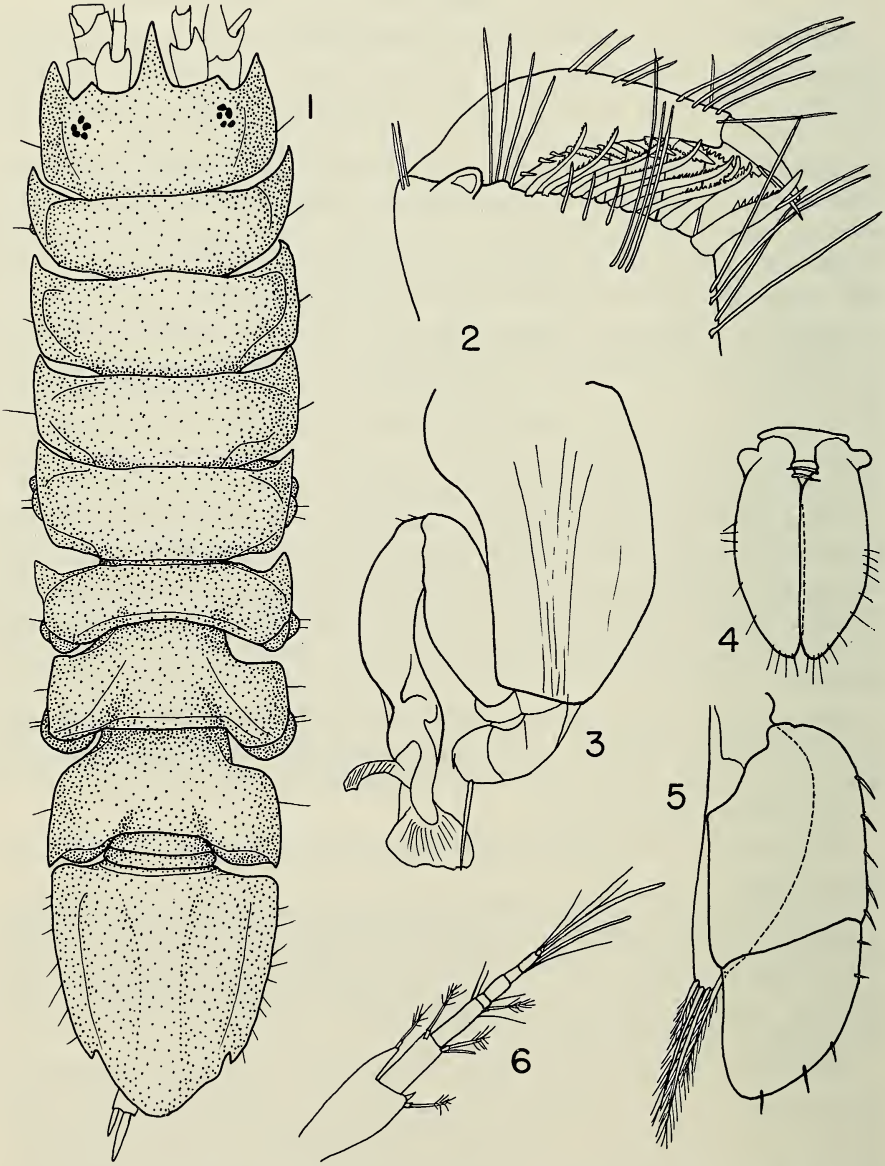
Pigmentation light if at all.

Measurements.—Holotype male (?) 4.8 mm long; allotype hermaphrodite 3.8 mm long.

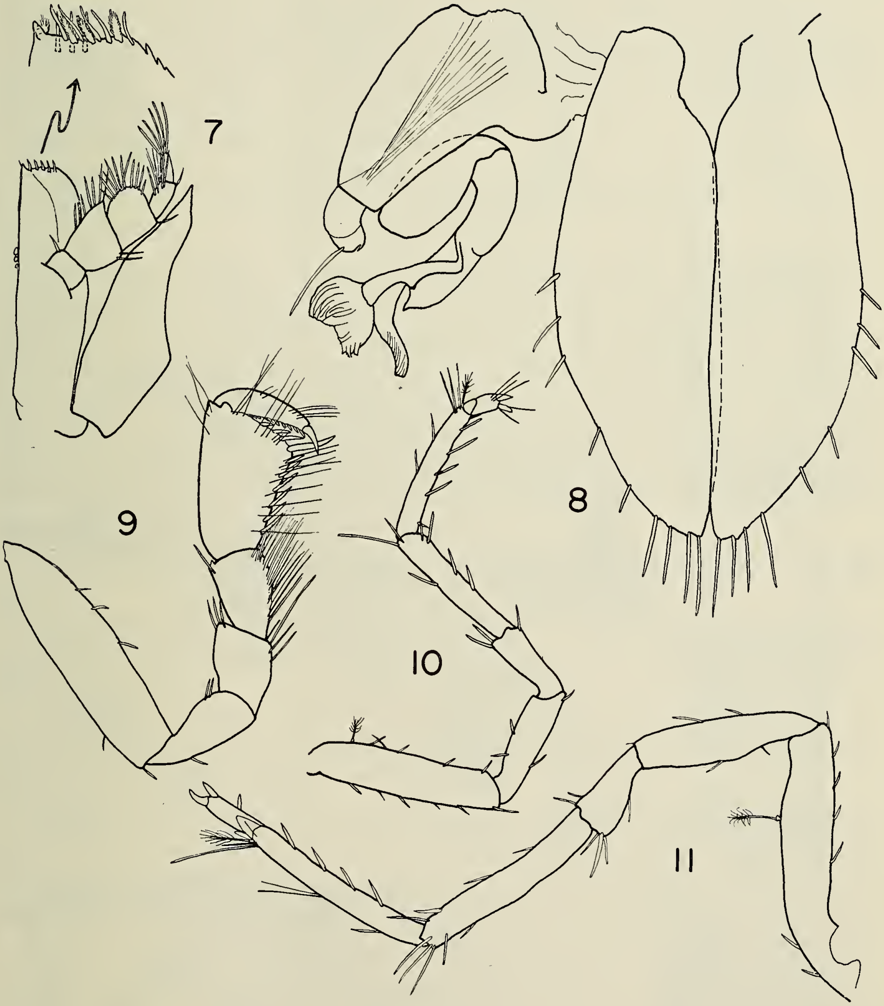
Derivation of species name.—The latin *acutus* means sharp and *rostratus* means beaked and combined they refer to the sharp rostrum on the specimen.

Disposition of types.—The type-specimens have been deposited in the National Museum of Natural History (holotype male [?] USNM 171265; allotype hermaphrodite USNM 171266).

Affinities.—The species is unique among the Stenetriidae because one specimen has both a marsupium and definite male pleopods 1 and 2 and is thus a hermaphrodite. The 4.8 mm long specimen has male pleopods 1 and 2, but no marsupium. It was not examined internally so its sex is still in doubt since it could be a non-gravid hermaphrodite. The species has no definite affinity to *Stenetrium stebbingi* Richardson (1902) also from Bermuda. The two species differ from each other in the configuration of the frontal margin of the cephalon among many other characters.



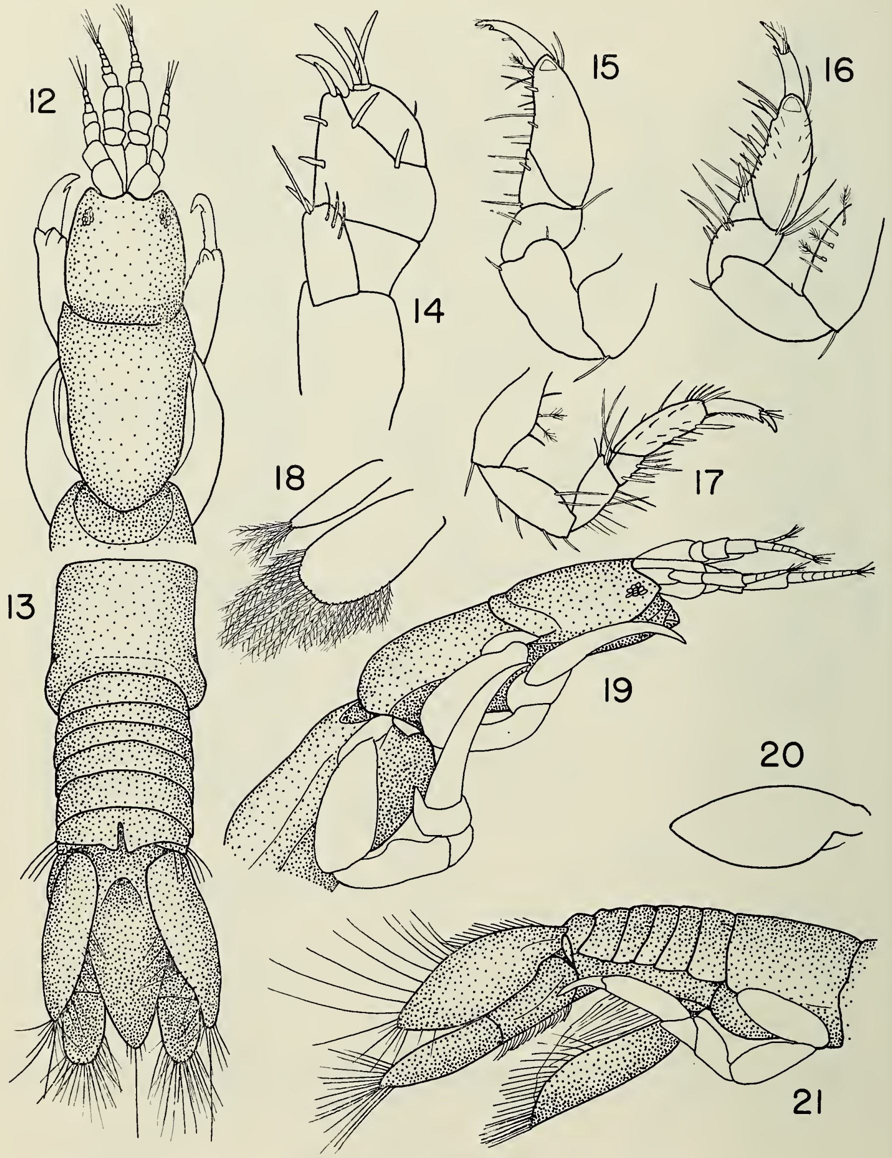
Figs. 1–6. *Stenobermuda acutirostrata*, holotype. 1, Holotype male (?) 4.8 mm long; 2, Peraeopod I; 3, Pleopod 2; 4, Pleopods 1; 5, Pleopod 3; 6, Antenna 1.



Figs. 7–11. *Stenobermuda acutirostrata.* 7, Maxilliped; 8, Pleopods 1 and 2 hermaphrodite 3.8 mm long; 9–11, Peraeopods I, II and VII respectively of male (?).

Anthomuda, new genus

Description.—(Based on females only) Eyes of several ocelli. Frontal margin of cephalon with rostrum and anterolateral processes weakly produced. Antenna with few flagellar articles. Mandibular palp with 3 articles. Apical segment of palp of maxilliped rounded and with long setae. Carpus of all peraeopods greatly or slightly underriding propodus. Peraeonite VII



Figs. 12–21. *Anthomuda stenotelson*, holotype female. 12, Anterior part of holotype female 8 mm long; 13, Posterior part; 14, Maxilliped; 15–17, Peraeopods I, II and VII respectively; 18, Operculate pleopod 1; 19, Anterior part lateral view; 20, Exopod of uropod; 21, Posterior part lateral view.

shorter than each of other 6 peraeonites. All 6 pleonal segments distinct. Pleopods 1 operculate. Telson with one statocyst. Pigmentation absent.

Etymology and gender.—The prefix "anth-" means flower and combined with the suffix "-muda" from Bermuda means roughly "flower of Bermuda." The gender is feminine.

Type-species.—*Anthomuda stenotelson*, sp. nov.

Anthomuda stenotelson, new species

Figs. 12–21

Description.—Eyed. Cephalon short with short medial and short antero-lateral processes. Antenna 1 with 4 flagellar articles; antenna 2 with 6 flagellar articles. Maxilliped with apical article of palp rounded with apparently 4 long medially pointing setae; endite small with one very long apical seta. Peraeopod I not especially large and not subchelate; with carpus only slightly underriding propodus; only few stout setae even on inner edges of segments of peraeopods. Peraeopod II like I, but much thinner. Pleopods 1 operculate. Exopod of uropod pointed; telson pointed with single statocyst.

Measurements.—Holotype female 8 mm long; paratype female 8.8 mm long.

Derivation of species name.—The Greek *steno* means narrow and *telson* means limit and combined they refer to the narrow last or limiting segment of the specimen.

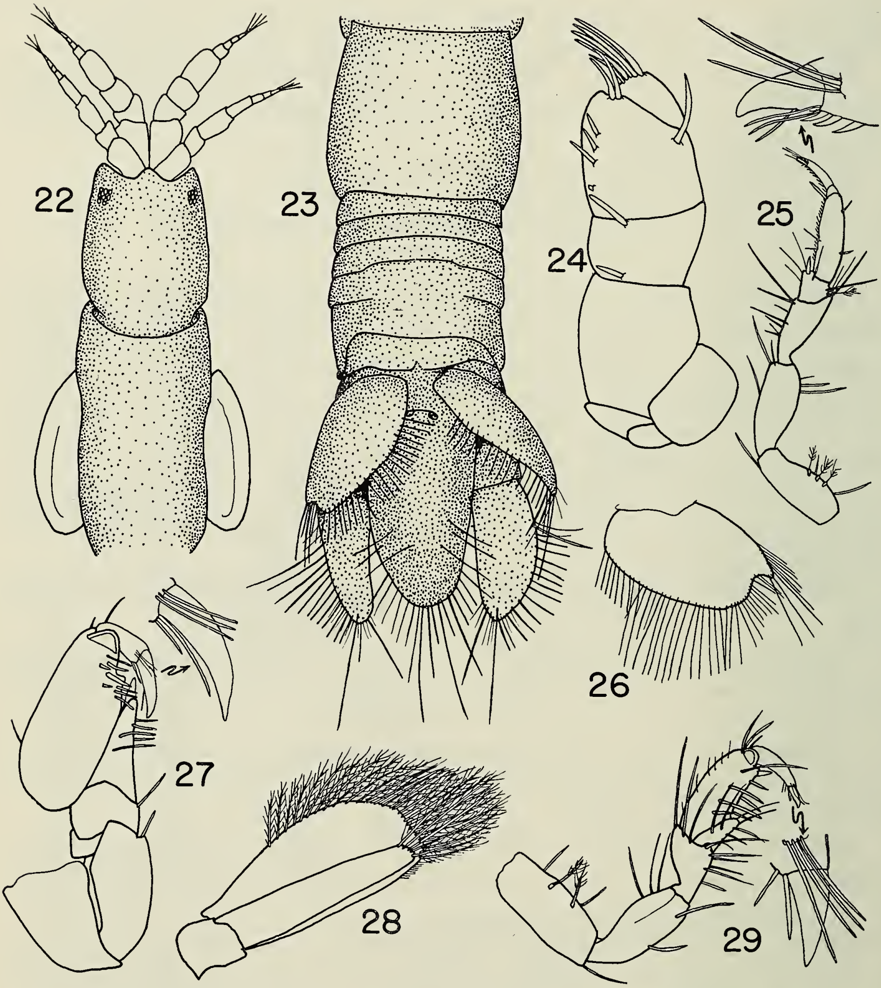
Disposition of types.—The type-specimens have been deposited in the National Museum of Natural History (holotype female USNM 171263; paratype female USNM 171264).

Affinities.—In Barnard's (1925) key the species would be placed in *Apanthura* Stebbing. Differences are present in the flagellar article number. In species of *Apanthura* according to Barnard antenna 1 has one or "obscurely 2–3" flagellar articles. The flagellum is "rudimentary" on antenna 2. For the new species described here there are only a few flagellar articles and they are quite distinct (Fig. 12). Peraeopod I of the new species has no stout seta at the palmar base and the unguis is not long (Fig. 15). The new species is in no way related to *Paranthura infundibulata* Richardson (1902), also from Bermuda, because among many other characters, the pleons of the two species are quite distinct.

Apanthura magnifica Menzies and Frankenberg

Figs. 22–29

Apanthura magnifica Menzies and Frankenberg, 1966:40, fig. 17A–L.—Howard and Dörjes, 1972:614.—Kruczynski and Myers, 1976:354, Fig. 1A–I, 2A–F.



Figs. 22–29. *Apanthura magnifica* Menzies and Frankenberg, female. 22, Anterior part of female 8.6 mm long; 23, Posterior part; 24, Maxilliped; 25, Peraeopod VII; 26, Exopod of uropod; 27, Peraeopod I; 28, Operculate pleopod 1; 29, Peraeopod II.

Description.—Eyed. Cephalon with short medial and short anterolateral processes. Antenna 1 with 4 flagellar articles; antenna 2 with 4 flagellar articles. Maxilliped with apical article of palp rounded and with apparently 5 long medially pointing setae; endite not seen. Peraeopod I subchelate with carpus well set beneath propodus; dactylus with large unguis. Peraeopod II much thinner than peraeopod I with carpus underriding propodus and with many long setae. Peraeopod VII much thinner than peraeopod II with carpus only slightly underriding propodus. Pleon with dorsal parts of segments 4 and 5 fused. Pleopods 1 operculate. Exopod of uropod with process on posterior margin; telson broadly rounded with paired statocysts.

Measurements.—Female 8.6 mm long.

Disposition of specimen.—The specimen has been deposited in the National Museum of Natural History (Female USNM 171262).

Range.—The species was collected off Sapelo Island, Georgia, at depths between 17.2 and 138 m, and on the Gulf coast of Florida at Dickerson Bay at depths of 2 to 5 m. Howard and Dörjes (1972) claim to have taken the species in the tidal flats at Sapelo Island. The range is here extended to Bermuda at a depth of 90 m.

Remarks.—The species as redescribed here and by Kruczynski and Myers (1976) has no endite on the maxilliped (p. 355, Fig. 1I), but what might be one is shown by Menzies and Frankenberg (1966:83, Fig. 17G). Barnard (1925:112, Fig. 1H) illustrated a maxilliped without an endite for the genus. The species as illustrated here has more flagellar articles on the antennae than is shown by Kruczynski and Myers. The flagella are more like those shown by Menzies and Frankenberg.

Acknowledgment

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A NEW SUBSPECIES OF *HOLOTHURIA LENTIGINOSA* MARENZELLER FROM THE WESTERN ATLANTIC OCEAN (ECHINODERMATA: HOLOTHUROIDEA)

John E. Miller and David L. Pawson

Abstract.—*Holothuria* (*Vaneyothuria*) *lentiginosa enodis* new subspecies is described from the Florida-Cuba area. The species is amphi-Atlantic in depths of 69–450 m. In southeast Florida, one population of the new subspecies is closely associated with a reef of the scleractinian coral *Oculina varicosa.* The common western Atlantic pearlfish, *Carapus bermudensis*, is an inquiline of this holothurian.

During the course of diving operations with the submersibles *Johnson-Sea-Link I* and *II*, staff members of the Harbor Branch Foundation, Inc. found a large population of an aspidochirote sea cucumber around a reef of the scleractinian coral *Oculina varicosa* Lesueur at a depth of 75–80 m. The reef is located off Fort Pierce, Florida. We first observed the population from the *Johnson-Sea-Link II* during August, 1977, and studies of ecology and reproductive biology were begun at that time. The holothurians are described here as a new subspecies of *Holothuria* (*Vaneyothuria*) *lentiginosa* Marenzeller. Some notes on its distribution and habitat preferences are included, together with some information on behavior in an aquarium of the pearlfish, *Carapus bermudensis* (Jones), which was found in association with the holothurians.

Holothuria lentiginosa s.l. has been reported from several localities in the eastern Atlantic (see below). In the western Atlantic, Deichmann (1940) first recorded the species off Cuba, and gave a brief description. She indicated that her specimens were similar to the eastern Atlantic form in many respects; the only difference she noted was that many of the tables in the body wall "have a smooth instead of a dentate margin" (p. 197). After examination of numerous specimens from off Florida, Deichmann's specimens, and material from the eastern Atlantic, we find that there are several consistent differences that warrant separation of the 2 populations at the subspecies level. They may be distinct species, but as they are obviously closely related and definitely allopatric, it would seem the wiser course to regard them as subspecies rather than species.

Order Aspidochirotida
Family Holothuriidae
Holothuria (*Vaneyothuria*) *lentiginosa* Marenzeller

Diagnosis.—Tentacles 20. Body more or less cylindrical, with flattened ventral surface; up to 50 cm long. Ossicles include delicate tables with spire of moderate height and disc with spinose to smooth margin. Spire ends in few teeth, forming irregular Maltese cross. Buttons with 2–5 pairs of perforations, either flat and relatively smooth or twisted. Color variable, pale ventrally, brownish to light reddish dorsally. Internally, one stone canal, one polian vesicle.

Type-specimen.—Monaco (according to Deichmann, 1940).

Type-locality.—Strait of Pico-Fayal, Azores, 130 meters (Marenzeller, 1893).

Remarks.—Rowe (1969) included 5 species under the subgenus *Vaneyothuria*, and noted in his remarks that perhaps 2 of the species are synonyms. Until now, only *H.* (*V.*) *zacae* Deichmann from the Gulf of California, southern California and the Galapagos Islands was known to possess large dark brown blotches in a double row along the dorsal surface.

H. (*V.*) *lentiginosa lentiginosa* Marenzeller
Fig. 4C–D

Holothuria lentiginosa Marenzeller, 1893:6, pl. I Fig. 1, pl. II Fig. 1a–b. —Herouard, 1929:53, 63.—Panning, 1934:82, Fig. 68; 1939:532, Figs. 5–6. —Cherbonnier, 1958:371; 1965:13, pl. II Figs. k–m.
Holothuria pardalis var. *lentiginosa.*—Bedford, 1899:143.
Vaneyothuria lentiginosa.—Deichmann, 1958:307 (in part).
Holothuria (*Vaneyothuria*) *lentiginosa.*—Rowe, 1969:151.

Diagnosis.—Dorsally light brown to light reddish, fading to paler color or whitish ventrally. Usually lateral margin of body carries 10–18 conspicuous retractile papillae. Discs of tables 50–100 μm in diameter, conspicuously dentate; tables with smooth discs rare. Buttons 45–60 μm long, strongly contorted, frequently with obliterated or incomplete perforations. Tentacles with extremely numerous small rods of 15 μm minimum length, and less numerous larger rods with coarse prickles along their length.

Distribution.—Azores (Marenzeller, 1893), Morocco (Herouard, 1929; Panning, 1939), Congo–Angola area, several localities (Cherbonnier, 1965), Sierra Leone (Cherbonnier, 1958).

Depth range.—100–250 meters.

Remarks.—This subspecies can vary in color to some extent. In Marenzeller's (1893) original description the color figure shows that the dorsal surface was light brown to pinkish with medium brown bases to the small papillae; the ventral surface was pinkish to dirty white. Herouard (1929) described the color as light brown dorsally with brown "points," and white ventrally, with chestnut-colored tubercles. Cherbonnier (1958) noted that the dorsolateral areas of his specimen were greenish-yellow, and he later (1965) described another group of specimens as having whitish-yellow ventral surfaces with scattered dark red spots, and dorsal surfaces brownish-

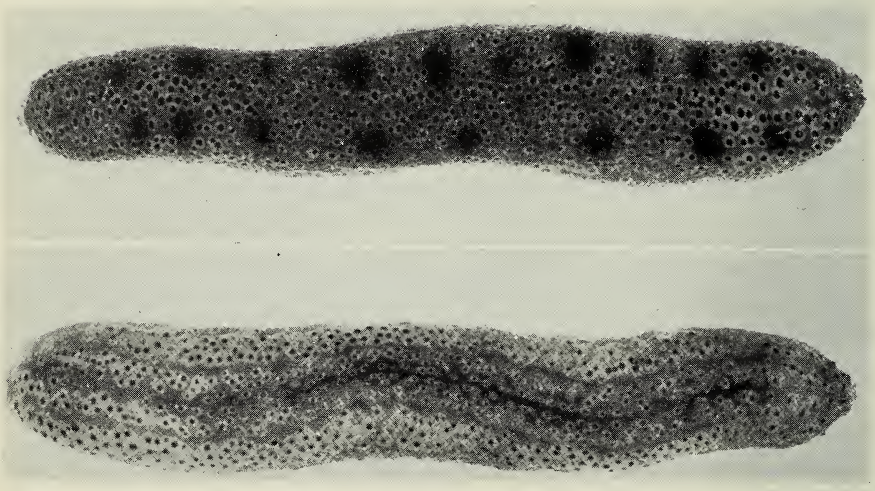


Fig. 1. *Holothuria* (*V.*) *lentiginosa enodis*. Dorsal (upper figure) and ventral (lower) aspects of a live specimen 195 mm long.

red with white spots. Further information on details of color can be obtained from the publications mentioned above.

Material examined.—*Dana* Sta. 4021, 8°56′W, 33°28′N, 205–235 m, 31 March 1930, 1 specimen (Panning, 1939). Coast of Morocco, collected by Mr. G. Belloc, October 1923, 1 specimen (identified by G. Cherbonnier).

H. (*V.*) *lentiginosa enodis* new subspecies
Figs. 1–3, 4A–B

Holothuria lentiginosa.—Deichmann, 1940:196, pl. 33 Figs. 1–7; 1954:391.
Vaneyothuria lentiginosa.—Deichmann, 1958:307 (in part).

Diagnosis.—Dorsally light to very dark brown with 2 longitudinal rows of 5–10 pairs of conspicuous dark brown blotches approximately 7–10 mm in diameter; ventrally usually white to light tan. Discs of tables 45–100 μm in diameter, slightly dentate to smooth. Buttons 45–105 μm long, irregular, often incomplete, but seldom strongly contorted. Rods in tentacles usually more than 200 μm long, with minute spines, often confined to extremities.

Type-specimens.—National Museum of Natural History, Smithsonian Institution Holotype USNM E17291, length 135 mm, R/V *Johnson* Cruise 053, Dive No. JSL 2053 10 April 1978, 27°32.8′N, 79°58.8′W, 79.3 m, silty sand, 14.2°C, collected by R. Jones. Paratypes USNM E17292, 5 specimens, length 150, 155, 130, 135, 110 mm, same locality data as holotype.

Paratypes, Harbor Branch Foundation—Smithsonian Institution Reference Museum, Fort Pierce, Florida, S.I.F.P. 71:064, 4 specimens, length 170, 130, 130, 100 mm, R/V *Johnson* Cruise 049, Dive No. 2279, 7 November 1977, 27° 32.8′N, 79°58.8′W, 76.1 m, silty sand, 21.8°C, collected by J. Miller.

Other material examined.—University of Miami, R/V *Gerda* Sta. 232, 25° 37′N, 79°21′W, 439–421 m, 29/30 January 1964, 1 specimen; R/V *Gerda* Sta. 568, 24°23′N, 82°53′W, 90 m, 12 April 1965, 1 specimen. Museum of Comparative Zoology, Harvard Cat. No. 2014, Cuba, Santa Clara Province, Bahía de Cochinosa, 200–255 fathoms, 1 specimen (all of the above identified as *H. lentiginosa* by E. Deichmann).

R/V *Johnson* Cruise 025, Dive No. JSL 2099, 16 September 1976, 27° 33.2′N, 79°58.8′W, 76.1 m, silty sand, 1 specimen, S.I.F.P. 71:065 collected by R. Avent; R/V *Johnson* Cruise 031, Dive No. JSL 2149, 23 November 1976, 27°32.8′N, 79°58.8′W, 77.7 m, silty sand, 1 specimen, S.I.F.P. 71:066 collected by F. Stanton; R/V *Johnson* Cruise 038, Dive No. JSL 2163A, 7 February 1977, 27°32.8′N, 79°58.8′W, 80 m, 1 specimen, S.I.F.P. 71:067 collected by F. Stanton; R/V *Johnson* Cruise 049, Dive No. JSL 2279, 7 November 1977, 27°32.8′N, 79°58.8′W, 76.1 m, silty sand, bottom temperature 21.8°C, 3 specimens, S.I.F.P. 71:068 collected by J. Miller; R/V *Johnson* Cruise 049, Dive No. JSL 2282, 9 November 1977, 27°32.8′N, 79°58.8′W, 80.1 m, silty sand, bottom temperature 3.6°C, 13 specimens, S.I.F.P. 71:069 collected by J. Reed.

R/V *Gosnold* Cruise 246, Sta. 697, 6 September 1974, 27°49.5′N, 79° 57.8′W, 69 m, 1 specimen, S.I.F.P. 71:070 collected by R. Avent.

Distribution.—Southwest Cuba (Deichmann, 1940), Florida Straits (University of Miami collections), southeast Florida (present study).

Depth range.—69–450 m.

Description.—Total length 15–30 cm, average 20 cm. Body 4–8 times as long as broad, cylindrical, with flattened sole. Mouth subterminal, directed ventrally and surrounded by ring of 35–50 papillae. Anus terminal, directed dorsally. Body wall thick, extremely rigid when contracted. Pedicels

Fig. 2. *Holothuria* (*V.*) *lentiginosa enodis* photographed from submersible *Johnson-Sea-Link II* on seafloor at type-locality. Note small scattered heads of *Oculina varicosa*. In right photograph, dark object at bottom is manipulator arm of submersible, used to collect the holothurians.

numerous, scattered over entire surface, dorsally as pointed papillate podia situated on low warts, ventrally as cylindrical locomotory podia. Radii indistinct. All podia fully contractile and capable of extension to length of 5–7 mm. Ventrolateral podia indistinguishable from others. Tentacles 20 (19 not uncommon), equal, shield-shaped, each frond composed of 9–12 fleshy lobes.

Dorsal body wall light to very dark brown with 2 longitudinal rows of conspicuous dark brown blotches approximately 7–10 mm in diameter (Fig. 1). Usually 5–7 pairs of spots, occasionally up to 10 pairs found. On living specimens a large papillate podium prominent in center of each spot. Ventral body wall usually white to light tan; a darker mid-ventral line runs from mouth to anus. Specimens with darker dorsal coloration also darker ventrally. Dorsal podia dark brown, with white ring around base; ventral podia light to dark brown with white sucking discs.

Calcareous ring moderately strong, radial pieces wider than interradials, each with small anterior notch (Fig. 3A); interradials with moderately sharp anterior projections. Posterior edge of ring undulating. Surface sculpture inconspicuous; 2 shallow depressions lie on radial pieces to left and right of midline.

Polian vesicle single, bulbous. Stone canal approximately 10 mm long, running anteriorly in dorsal mesentery and terminating in an elongate oval madreporite. Tentacle ampullae conspicuous, approximately 10 mm long. Gonad as one tuft of tubules on left side of dorsal mesentery, located approximately ⅓ of way along body cavity. Gonoduct opens immediately posterior to tentacles. Left respiratory tree forms well developed rete mirabile in posterior half of body cavity. Right tree extends to extreme anterior end of body cavity. Cuvierian tubules conspicuous.

Ossicles in body wall tables and buttons. Tables (Fig. 3C) with large disc with single central hole surrounded by 8–12 marginal holes. Margins with more or less conspicuous projections. Spire slightly tapering, with variable number (9–12) of short teeth. Dorsal tables slightly larger and more numerous than ventral. Buttons (Fig. 3B) without knobs, irregular, often incomplete, usually with 3 pairs of perforations, although 2 or 4 pairs occur frequently.

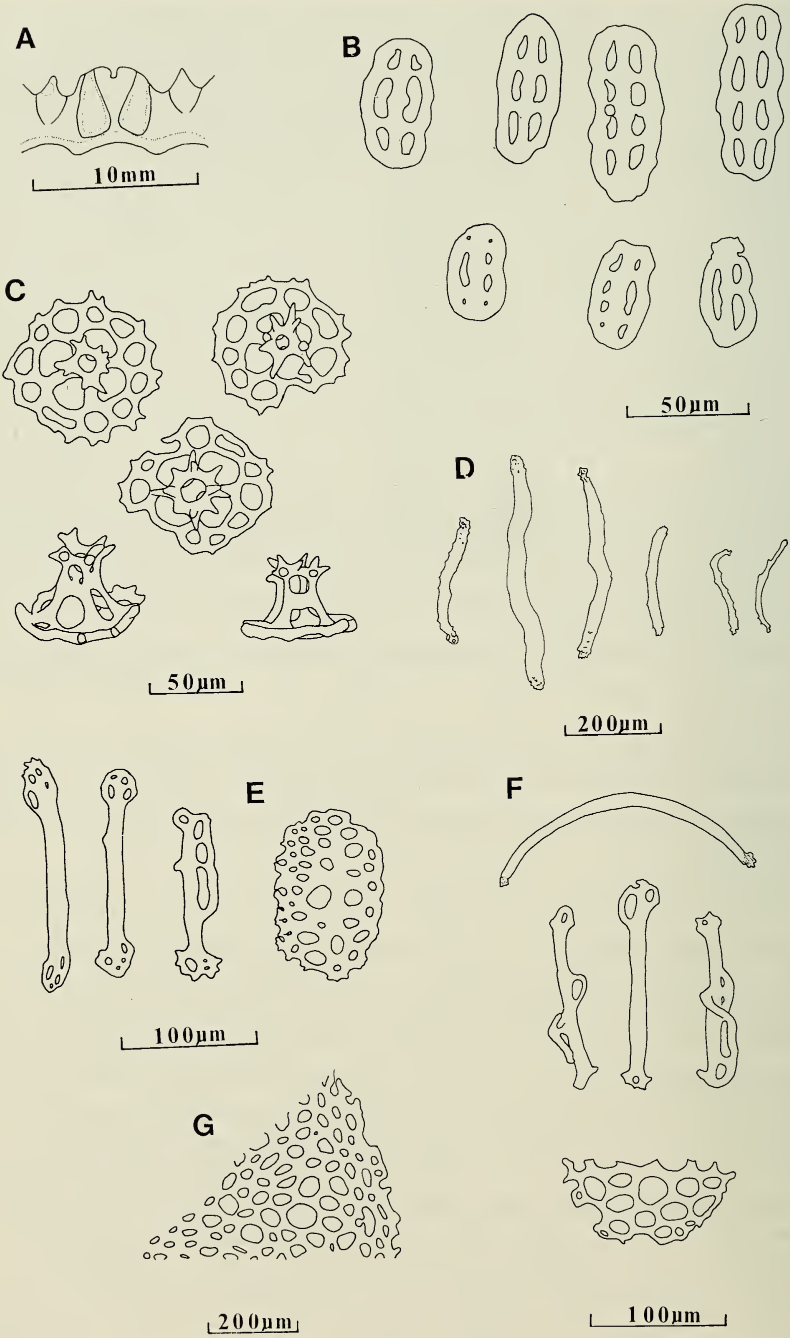
Dorsal podia contain tables, buttons, rudimentary end plates and straight to curved supporting rods with one or more terminal perforations (Fig. 3F). Ventral podia contain tables, buttons, well developed end plates and straight or curved supporting rods with more numerous perforations than those of dorsal feet (Figs. 3E, 3G).

Tentacles with straight to irregularly curved supporting rods bearing minute spines distally, and occasionally distal perforations; length of rods 200–450 μm, average 330 μm (Fig. 3D).

In 2 small specimens 47 mm and 65 mm long, tables almost invariably with smooth discs, average disc diameter being 60 μm and 70 μm respectively. Buttons very similar to those of adults, lengths 57 μm and 74 μm respectively (Fig. 4A–B).

Remarks.—Deichmann (1940:196) noted that the color of the specimens she examined from Cuba was "light brown, paler on the ventral side . . . ." She made no mention of a double row of dark blotches dorsally, and she surely would have done so had they been present in her specimens. We conclude that the color had faded somewhat in alcohol, as it has in the 2 specimens from the University of Miami. All of these specimens are now mostly uniformly whitish in alcohol, with traces of brownish color dorsally.

This new subspecies is distinguished from the typical subspecies in a variety of ways, but we do not consider the differences sufficient to warrant separation at the species level. In terms of external features, the most conspicuous difference lies in the color. Also important is the fact that the eastern Atlantic subspecies usually has prominent papillae along the ventrolateral edge. Such papillae are absent from western Atlantic forms, but we have observed that in aquaria some ventrolateral papillae are larger than others. The most consistent difference lies in the body wall ossicles.


A
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C
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G
200µm
100µm

Table 1. Dimensions of body wall ossicles in *H. lentiginosa.* Ossicles can vary greatly in size within a single specimen. Generally, ossicles from ventral body wall are slightly smaller than those from dorsal body wall. S.D. = standard deviation.

	Dorsal tables (diameter, μm)	Dorsal buttons (length, μm)
Holothuria (*V.*) *lentiginosa lentiginosa*		
Dana Sta. 4021 (Copenhagen Museum)	106	85
Coast of Morocco (Paris Museum)	95	59
Holothuria (*V.*) *lentiginosa enodis*		
Southeast Florida (R/V *Johnson*)	72 (59–99, S.D. 7.18)	59 (46–105, S.D. 13.18)
Cuba (MCZ Harvard No. 2104)	97	77
Florida Straits (Univ. of Miami, *Gerda* 232)	100	83
Florida Straits (Univ. of Miami, *Gerda* 568)	70	68

The tables are much less dentate in the western Atlantic form, and are often quite smooth (compare Figs. 3C and 4D). The buttons are much more contorted in the eastern Atlantic form (compare Figs. 3B and 4C). The tentacle rods are smaller and much more numerous in the eastern Atlantic form and the larger rods have coarser "prickles" along their length.

The *Oculina varicosa* habitat: The type-locality lies in 80 m of water off Fort Pierce, Florida. It is a large reef capped with luxuriant growth of the scleractinian coral *O. varicosa.* The reef consists of 3 major ridges running in an east–west direction and cresting at a depth of 64 m. Estimated dimensions are length 220 m, width 90 m. The southern (upcurrent Gulf Stream) boundary is composed of massive *Oculina* heads situated on a 30–45° slope. The slope on the northern (downcurrent) boundary is shallower, with scattered *Oculina* heads. The entire reef is surrounded by a bottom of silty sand littered on the north, east and west with coral debris and many small, unattached heads. The area adjacent to the southern boundary is free of any reef litter.

The pearlfish, *Carapus bermudensis*: Pearlfish of the genus *Carapus* have been reported several times in association with the shallow water sea cucumbers (e.g., Dawson, 1971; Smith and Tyler, 1969; Haburay *et al.*, 1974).

←

Fig. 3. *Holothuria* (*V.*) *lentiginosa enodis*, ossicles: A, Part of calcareous ring; B, Buttons from dorsal body wall; C, Tables in plan and profile view; D, Rods from tentacles; E, Perforated rods from ventral podia; F, Rods and plate from dorsal podia; G, Part of endplate from ventral podium.

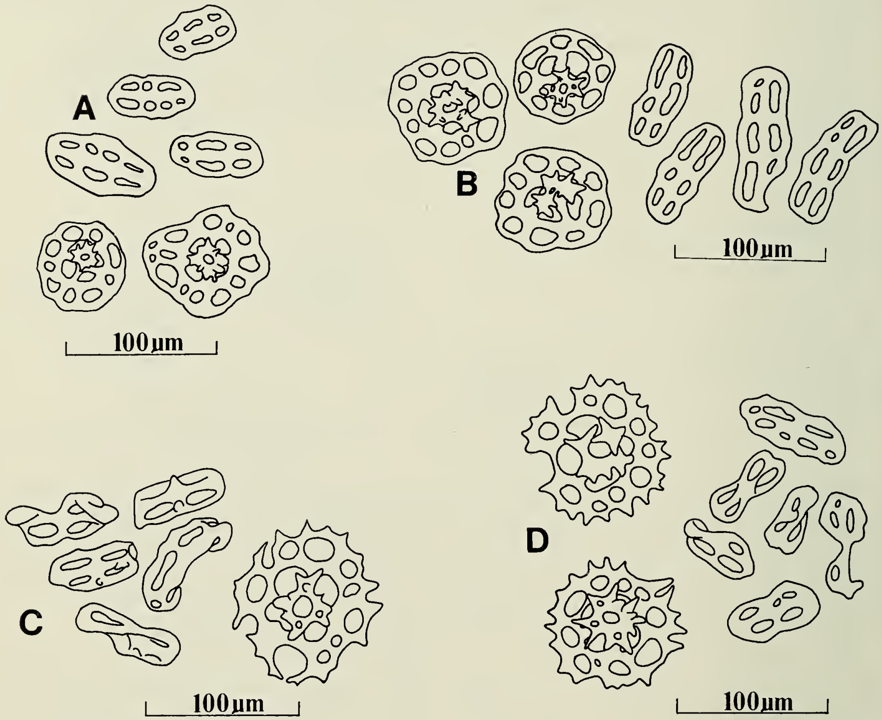

Fig. 4. *Holothuria* (V.) *lentiginosa enodis*, ossicles. A, Tables and buttons from 47 mm specimen; B, Tables and buttons from 65 mm specimen. *Holothuria* (V.) *lentiginosa lentiginosa*, ossicles; C, Table and buttons of specimen from *Dana* Sta. 4021 (Copenhagen Museum); D, Tables and buttons of specimen from Morocco (Paris Museum).

There are very few reports of occurrence in deep water holothurians. Cherbonnier (1965) noted that some specimens of *H.* (*V.*) *lentiginosa lentiginosa* contained *Fierasfer imberbis* (Linnaeus) (=*Carapus acus* (Brünnich)), but he offered no further information on his material.

Our material, collected alive by the submersible, has been retained alive in aquaria for many weeks. One of us (J.E.M.) observed that a pearlfish was present in a tank containing several specimens of *H.* (*V.*) *lentiginosa enodis.* The fish, total length 77 mm, was identified by Dr. D. M. Cohen of the National Marine Fisheries Service as *Carapus bermudensis* (Jones). During the 2 weeks following the discovery of the fish, some observations were made of its behavior. The fish emerged only in subdued light; during full daylight it would seek shelter inside the host. Head-first entry into the anus was effected after the fish tapped its way along the holothurian's dorsal surface until the anus was encountered. Active swimming was not frequently observed; more often than not the direction of movement was backwards and upwards. The fish spent much time suspended head down in the water, gently undulating its dorsal and anal fins to maintain its position. For the week prior to its death the fish remained outside its host and could not be persuaded to re-enter the host. It remained stationary in the corner of the aquarium or nestled head-down between the holothurian and the glass, with the attenuated body coiled in several "S"-turns. Occasionally the fish would mouth the sediment, but no ingestion was observed. The fish died (of starvation?) after 83 days in capitivity.

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ACROCIRRUS COLUMBIANUS AND *A. OCCIPITALIS*, TWO NEW POLYCHAETES (ACROCIRRIDAE) FROM THE NORTHEAST PACIFIC OCEAN

Karl Banse

Abstract.—Two new species of *Acrocirrus* from shallow water of southern British Columbia are described. They belong to the group of North Pacific species with compound neurosetae throughout.

In connection with a joint study of previous records and new collections of benthic polychaetes from Washington and British Columbia, specimens of *Acrocirrus* were found by the late Katharine D. Hobson and sent to the author for further identification. Eight species of this genus had been covered by Banse (1969). Two species were added since then: *Acrocirrus incisa* by Kudenov (1975) and *A. aciculigerus* by Kudenov (1976). Two new species are described herein. The types are deposited in the British Columbia Provincial Museum, Victoria (BCPM), and the National Museum of Natural History, Smithsonian Institution, Washington (USNM).

The new species from British Columbia belong to the group of *Acrocirrus* species distinguished *inter alia*, by having compound neurosetae throughout; even a heavy neuropodial hook on segment 14 is absent. With one possible exception (a doubtful record of *A. uchidai* Okuda by Hartman, 1976, from the Indian Ocean), this group is restricted to the North Pacific Ocean (see Banse 1969). Its six members can be distinguished as follows:

1. Segment 14 with single heavy acicular hook, or with several simple, slender hooks
   A. aciculigerus Kudenov; *A. frontifilis* (Grube); *A. heterochaetus* Annenkova; *A. incisa* Kudenov; *A. okotensis* Imajima; *A. trisectus* Banse.
– Segment 14 with only compound hooks in neuropodium, as in all other setigers 2
2. First gill-bearing segment dorsally not visible (Fig. 1d) *A. occipitalis* n. sp.
– First gill-bearing segment dorsally at least partly visible (as in Fig. 1a) 3
3. Neurosetae from fourth gill-bearing segment *A. crassifilis* Moore
– Neurosetae from third gill-bearing segment 4
4. Notosetae from second setiger *A. uchidai* Okuda
– Notosetae from third setiger 5
5. Usually one notoseta and two neurosetae per parapodium *A. columbianus* n. sp.

–	Several noto- and neurosetae per parapodium	6
6.	Upper face of prostomium smooth	*A. muroranensis* Okuda
–	Upper face of prostomium ridged	*A. validus* Marenzeller

Acrocirrus columbianus, new species
Fig. 1a, b

Diagnosis.—A slender *Acrocirrus* species with a posterior, mid-dorsal extension of the prostomium on segment 1. No large papilla on segment 2. Without parapodial cirri; with distinct neuropodia. Notosetae from segment 6. Neurosetae from segment 4, compound throughout. Without heavy neuropodial hook on segment 14. Parapodia usually with one notoseta and two neurosetae. Nephridia through segment 10 or 11, straight.

Etymology.—The species name refers to the region of the type-locality.

Material.—Holotype, British Columbia: Brochie Ledge, off Ogden Pt. breakwater, 4.5 to 7.5 m, in rocky habitat, from base of *Balanus nubilus* clump (apparently in burrows of unknown origin in the calcareous material), 8 February 1973, B. Cooke and P. Lambert coll., holotype (BCPM 977-233), 5 paratypes (BCPM 977-234), and 3 paratypes (UNSM 55731).

Description.—The well-preserved type-material consists of slender, mature males and females some of which are entire, and a few smaller, immature specimens. The holotype, a mature female, has about 47 setigers and is approximately 2.4 cm long and 0.15 cm wide. The posterior third, although complete, seems to be recently regenerated as it is markedly thinner than the anterior part of the body.

The prostomium (Fig. 1a) is divided into an anterior and a posterior part, the latter bearing the two pairs of eyes which vary appreciably in size. The left palp is missing, the right one is regenerating. The prostomial posterior border is demarcated by a deep furrow and extends mid-dorsally on segment 1. Segments 1 and 2 are clearly visible dorsally and laterally. Segment 2 carries the first of the four pairs of gills but lacks a large papilla. Segment 3 has a conspicuous papilla below the gill.

The body segments are clearly demarcated; they lack annuli or wrinkles as described for other species, e.g., *A. validus* Marenzeller by Okuda (1934). The neuropodia are conspicuous (Fig. 1b), especially so in the thorax. In the depicted, fifth parapodium some interramal, epidermal papillae could be seen; there may be a few similar papillae ventrad to the neuropodium which, however, could not be clearly distinguished. In both sexes, a large colorless papilla is distinct below the parapodia on segments 11 (sometimes 10) through 13 (position indicated by broken line in Fig. 1b). There are no modifications of the parapodia themselves at the transition from thorax to abdomen, and specialized hooks are lacking on segment 14.

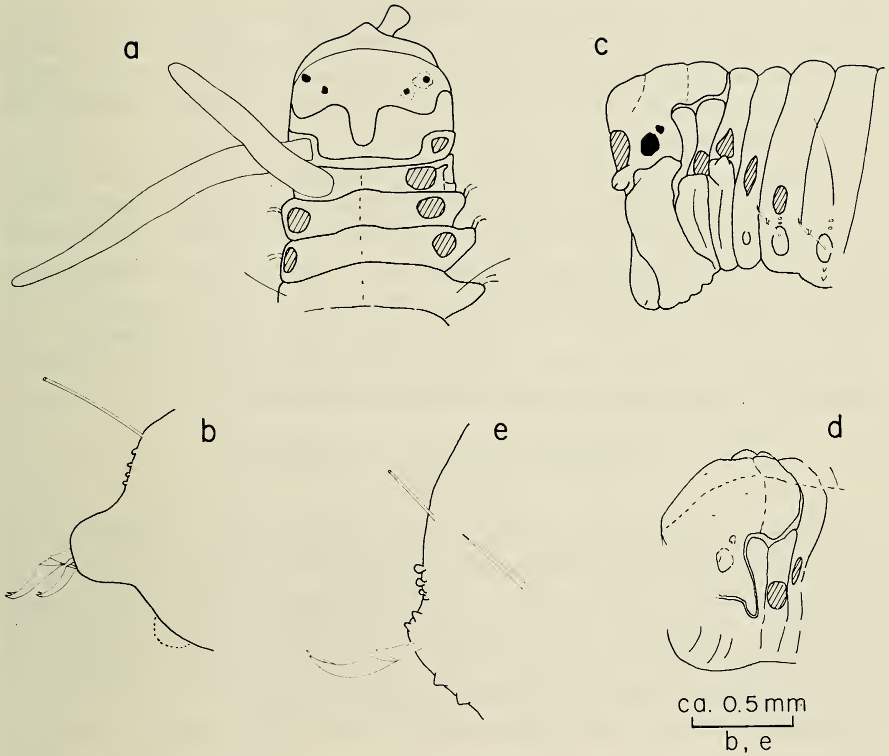

Fig. 1. *Acrocirrus columbianus*: a, Holotype, anterior end, dorsal view; scars of lost gills hatched; b, Parapodium from segment 8; note that epidermal papillae were difficult to make out; the position of the ventral papillae on segments 11–13 indicated by broken line; setae sketched. *Acrocirrus occipitalis* (holotype): c, Anterior end, side view; scars of missing appendages hatched; d, Anterior end, seen from the left side and above; ventral parts sketched; the broken line is the imaginary mid-dorsal line; e, Parapodium from segment 16; setae sketched (notoseta broken-off), notopodial aciculae indicated.

Neurosetae start on segment 4 (third gill-bearing segment), and notosetae on segment 6. Usually, notosetae occur singly, and neurosetae in pairs in each parapodium. In both sexes the cutting edges of the blades of the neurosetae face posteriorly through segment 12 (setiger 9) and anteriorly in all succeeding setigers.

Females have gonads present from segments 11 and 12 (2 specimens) through 27 (regenerating holotype) and 32 (1 specimen); the egg size is about 0.15 mm. Males have gonads from segments 11 and 12 (2 specimens each) through segments 39, about 43 and about 49, in one specimen each respectively; these segments were missing in the fourth animal. The nephridia in a dissected male are straight and extend into segment 10 or 11.

The color in life is dark brown, especially anteriorly. Some of the preserved animals are yellowish, others are brownish to greyish in the thorax, from numerous scattered small, black (in transparent light) pigment spots of varying size; the abdomina of these specimens appear dusted. The cirri are unpigmented.

Discussion.—*A. columbianus* belongs to the group of six *Acrocirrus* species which is characterized by having compound neurosetae throughout. Diagnostic characters of the new species have been summarized in the preceding key. In addition it may be noted that *A. columbianus* is similar to *A. validus* in respect to the form of the prostomium (see the interpretation of Okuda's [1934] description in Banse 1969) but is distinguished by the slenderness of its body and the straight, short nephridia. Both *A. columbianus* and *A. muroranensis* have markedly slender bodies.

Acrocirrus occipitalis, new species
Fig. 1c–e

Diagnosis.—A relatively thick *Acrocirrus* species with a mid-dorsal, apparent extension of the prostomium to the posterior border of segment 2. No large papilla on this segment. Without parapodial cirri; with distinct neuropodia. Notosetae from segment 6. Neurosetae from segment 5, compound throughout. Without heavy neuropodial hook on segment 14. Parapodia usually with one notoseta and one neuroseta.

Etymology.—The species name refers to the dorsal, posterior extension of the prostomium.

Material.—British Columbia: mouth of Brundige Inlet, 54°36.8′N, 130°50.4′W, less than 29 m, rock reef, 22 June 1974. P. Lambert coll., holotype (BCPM 974-236-21).

Description.—The holotype is well-preserved, lacking only palps and gills; it has about 82 setigers, and is almost 2 cm long and up to about 0.1 cm wide. The prostomium appears to extend dorsally to the anterior border of the second gill-bearing segment (segment 3, cf. Fig. 1c), which has not previously been observed in this genus. A faint epidermal demarcation (Fig. 1c, d) running across this extension suggests that the cause might be subepidermal, e.g., an elongated brain as in *Nephtys* or *Pisione*. As a consequence of this extension and the extruded proboscis, the first segment is visible only laterally while the second segment can be seen laterally and ventrally. In side view, the postero-lateral corner of the prostomium is partly hidden by an extension of the ventral lip (cf. Fig. 1c and d). The ventral lip and the lateral and ventral parts of segments 1 and 2 are whitish suggesting glandular tissue which on segment 3 extends upward to the usual papilla present below the second gill.

The body is almost circular in cross-section in the first five or so setigers. Thereafter in the anterior half of the body, the dorsal side becomes high and arched, with the neuropodia occupying the lower corners of the arch. While the ventral side is flat, relatively narrow, and almost smooth, the dorsum is mostly triannulate. Each annulus, faintly biannulated in itself, is crossed by longitudinal ridges so that the dorsal surface in places appears divided into irregular rectangles (similar [but smaller] as in *A. validus*, Fig. 8 in Okuda [1934]). The epidermis is finally roughened and seems to be sticky (in contrast to, e.g., *A. trisectus*, cf. Banse 1969). In the posterior half of the body the dorsum is not much higher than the body is wide, and the segments are essentially simple annuli.

On segment 4, a rudimentary neuropodium is found on the left side only (Fig. 1c). Well-developed neuropodia begin on segment 5, each usually having one compound seta, except the anterior abdominal segments where occasionally two setae emerge. As usual in the genus, the direction of the blades changes between segments 12 and 13. There is no modification of these segments. Approximately three papillae with triangular outline (cf. Fig. 1e) occur below the thoracic and anterior abdominal neuropodia which are lacking in the posterior half to third of the body. About three round papillae can be seen between the neuro- and notopodia. Notosetae—usually single—start on segment 6. Their length does not exceed the body width even in the narrow, posterior body section. The color of the preserved animal is yellowish, with some darkening in the thorax, except the glandular region mentioned above.

Discussion.—*A. occipitalis* is to be included into the group of *Acrocirrus* species which possess only compound neurosetae. Among them, the new species is close to *A. crassifilis* on account of the starting segments of neuro- and notosetae (see Banse 1969). It is distinguished from this species by the usually single setae per parapodial ramus as well as by the form of the dorsal, apparent posterior extension of the prostomium. In fact this extension differentiates the new species from all other known species of the genus. However, a similar dorsal, "prostomial" extension is present in *Macrochaeta papillosa* Ehlers as redescribed in Banse (1969) but was observed in less detail than here. That species possesses also other similarities to *Acrocirrus*, i.e., the close proximity of the origin of the palps and the pads below them. It is included among *Macrochaeta*, however, on account of the usually papillose epidermis and its small size.

Acknowledgments

It is a pleasure to thank Dr. A. E. Peden in Victoria, B.C. for the loan of the material, and Drs. D. P. Henry, Seattle and M. H. Pettibone, Washington, for advice regarding the style of the manuscript. The preparation of the manuscript was partly supported by Grant No. 04-7-158-44021 from the National Oceanic and Atmospheric Administration to the Washington Sea Grant Program. Also this assistance is gratefully acknowledged. Contribution No. 1047, from the Department of Oceanography, University of Washington.

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STUDIES ON SPIROBOLOID MILLIPEDS. XII. THE STATUS OF *SPIROBOLUS NORONHENSIS* POCOCK, 1890, AND SOME RELATED SPECIES (PACHYBOLIDAE)

Richard L. Hoffman

Abstract.—A new genus, *Atlanticobolus*, is proposed for the single species *Spirobolus noronhensis* Pocock, which is known only from the original collection made on Ilha Fernando de Noronha in the 1880s. This species is a dwarfed member of the family Pachybolidae. It is closely related to several spiroboloids described from West Africa, particularly to three which are referable to the genus *Amblybolus* Keeton, 1964 (=*Tonkouibolus* Demange & Mauries, 1975, syn. nov.!). Affinity of *Atlanticobolus* and *Amblybolus* with *Centrobolus* (Cook, 1897) is suggested.

Spirobolus noronhensis must qualify as one of the least-known species of millipeds: to the best of my knowledge it has not been mentioned in the literature since the name was published almost 90 years ago. The description provided scarcely more than ordinal characters, and since the type material originated on a small island off the Brasilian coast it had long been my presumption that some small well-known synanthropic milliped probably bore the name *noronhensis.*

When I was able to study the original material in the British Museum collection during the summer of 1977, I was agreeably surprised to discover that Pocock's enigmatic little species has apparently not been either previously or subsequently described, and that, moreover, it is not referable to any of the currently recognized spiroboloid genera.

A survey of the literature disclosed some obviously related species, some interesting biogeographic implications, and (as usual in diplopod taxonomy) suggestive leads to be followed up by someone having the opportunity for revisionary work on these small spiroboloids. For the present I must be content to record the pertinent details about the identity of *noronhensis* and some inferences about related forms extracted from reliable literature sources. Anything further would probably have to be preceded by a revision of the entire order.

I am very much obligated to Keith H. Hyatt, Esq., for permission to work in the collection of the British Museum (Natural History). This research was supported by grant BMS 75-04860 from the National Science Foundation.

Family Pachybolidae Cook

Following the traditional classification of spiroboloids first proposed by Brolemann in 1913–1914 and variously modified in recent years, those species in which the posterior gonopods are basically oriented parallel to the median body axis and joined medially by a distinct sternal remnant are referable to the suborder Trigoniulidea and its single family Pachybolidae. Earlier classifications admitted three trigoniulid families, but these were distinguished on the basis of rather tenuous and subjective characters of the gonopods, and may be better disposed for the present as subfamilies.

Spirobolus noronhensis is manifestly a pachybolid in this broad sense, but is representative of a rather distinct group of species unified by small body size, reduced segment number, and somewhat simplified form of the gonopods. Almost certainly this group deserves formal recognition as a tribe or subfamily, the more so since its known components are distributed in a way suggestive of a cohesive, amphiatlantic, geographic pattern. Aside from the several genera here accounted, a possibly related taxon is the South African genus *Centrobolus*, in which the posterior gonopod is prominently articulated near midlength, and in which some species are known with as few as 38 segments. In those which have been studied for the character, however, the posterior gonopod sternum is present, and at least in the species that I have seen, the side of the head is not modified as an antennal groove as in *Amblybolus* and its near relatives. Still, *Centrobolus* should certainly be taken into account when the status of these "amblybolines" *vis-à-vis* other pachybolids is eventually estimated.

In addition to the four species definitely known to be members of this group, it seems highly probable that at least some of the small spiroboloids described from Cameroun by C. O. von Porat in 1893 and 1894 will be found referable to *Amblybolus* or a related new genus. The several species recorded from central Africa under the generic name *Brachyspirobolus* are similarly small and one has only 36–38 segments, but the form of the gonopods is quite different from that of the West African species (notably the posterior gonopod lacks articulation at midlength) and no especially close relationship can be asserted.

The two genera which I now recognize in this section of the Pachybolidae may be easily distinguished by the following contrast:

Temporal region of head capsule deeply depressed laterally, forming an antennal cavity the dorsal edge of which produces a sharp rim just laterad to the ocellaria; apex of telopodite of posterior gonopod complex in structure, with a short basal process on medioposterior side, a terminal flagelliform process, and a terminal laminate lobe; no sternal remnant between these gonopods *Amblybolus* Keeton

Temporal region of head depressed as a shallow antennal cavity but without a sharply defined dorsal rim laterad to ocellaria; apex of telopodite of posterior gonopod with basal process but otherwise apically simple and laminate, with a small reflexed acicular process; posterior gonopods with a small sternal sclerite *Atlanticobolus* gen. n.

Genus *Amblybolus* Keeton

Amblybolus Keeton, 1964, Pilot Register of Zoology, card 5. Type-species, *A. mitis* Keeton, 1964, by original designation.

Tonkouibolus Demange & Mauries, 1975, Bull. Mus. Nat. Hist. Natur., Zool., 201:392. Type-species, *T. flagellatus* Demange & Mauries, 1975, by original designation. New synonymy!

Comparison of the excellent illustrations and descriptions given by the above-cited authors leaves no doubt that the two generic names are based on closely related species. In fact, one is at some pains to distinguish the two species, and future studies may show them to be only geographic races of a single species. MM. Demange and Mauries probably were unaware of Keeton's paper because of the unorthodox method of its publication.

The most obvious distinction between the three species of *Amblybolus* appears in the anterior gonopods, particularly in the form of the coxal lobes, as noted in the following key. All three have the coxae of the posterior gonopods medially in contact (no trace of sternum remains) and share the same general form of the apical modifications of the telopodite. The authors of both generic names emphasized the remarkable excavation of the head to accommodate the antennae, and in both cases suggested that their new genera probably represented a valid family-group.

Because of a delay in publication, the formal proposal of the names *Tonkouibolus* and *flagellatus* did not appear until December, 1975, but both were validated by brief indications in a paper (printed in July, 1975) in which *T. levieuxi* was described.

The three species now referable to *Amblybolus* may be distinguished by the following key based upon their gonopod structure:

1. Apex of coxal endite lobes of anterior gonopods spiniform and projecting distad beyond end of median sternal lobe *flagellatus*
– Apex of coxal endite lobes rounded, about equal in length to median sternal lobe 2
2. Coxal endite lobes apically notched; posterior lobes of telopodite large, extending nearly to reflexed inner edge of coxa *levieuxi*
– Coxal endite lobes not notched apically; posterior lobes of telopodite smaller, widely separated from inner posterior edge of coxa *mitis*

Amblybolus mitis Keeton

Amblybolus mitis Keeton, 1964, Pilot Register of Zoology, card 6, figs. 1–9. Male holotype and 64 paratypes (U.S. Nat. Mus.) from Monrovia (type locality), Mount Coffee, Muhlenberg Mission, and Bushrod Island, Montserrado Co., Liberia.

Amblybolus flagellatus (Demange & Mauries), comb. nov.

Tonkouibolus flagellatus Demange & Mauries, 1975, Bull. Mus. Nat. Hist. Natur., Zool., 201:392 (July).—1975, Ann. Mus. Roy. Afr. Centr., Sci. Zool., 212:114, figs. 170–173. Male holotype (Mus. hist. nat. Paris) from Mont Tonkoui, north of Man, Ouest Province, Côte d'Ivoire.

Amblybolus levieuxi (Demange & Mauries), comb. nov.

Tonkouibolus levieuxi Demange & Mauries, 1975, Bull. Mus. Nat. Hist. Natur., Zool., 201:392, figs. 11–13. Male holotype and seven paratypes (Mus. Nat. Hist. Natur.), from Teke, 30 km north of Abidjan, Côte l'Ivoire.

Atlanticobolus, gen. nov.

Type-species.—Spirobolus noronhensis Pocock, 1890.

Diagnosis.—Body small, length less than 35 mm, typically with 37 segments. Lateral side of head excavated as a shallow antennal socket but lacking an acutely edged overhang laterad to ocellaria. Clypeus with 2–2 widely separated setiferous pits. Antennae short and robust, apically with four small sensory cones. Ocellaria small, rounded. Collum of normal spiroboloid form, the lateral end symmetrically rounded, not subtended by projection from second segment. Segments virtually smooth, without scobinae, metazona slightly enlarged. Leg length less than half the body diameter; males with tarsal pads on legs back to 25th segment; prefemora with small setiferous apical foveola near end on ventral side; coxae of legs 4–6 of males with low rounded apical knobs. Epiproct short, blunt, posterior edge scarcely produced.

Anterior gonopods of typical spiroboloid form, sternum medially arcuate and prolonged as a triangular median lobe; coxae large, apically truncate, attaining same level of sternal apex, not prolonged mesad on posterior side, the telopodite broadly in contact with posterior extension of sternum (Fig. 2). No trace of proximal coxal apodemes. Telopodites of moderate size, almost entirely concealed by coxal in anterior aspect, partly overlapped laterally by reflexed lateral edge of coxa. Small rounded apical lobe present.

Posterior gonopods of pachybolid form, approximately "C"-shaped and flattened in one plane, oriented parallel to median body axis; proximal ends of coxae medially in contact, with a small displaced sternal remnant still evident (Fig. 3, S); interior of coxa with diffuse basal gland and internal

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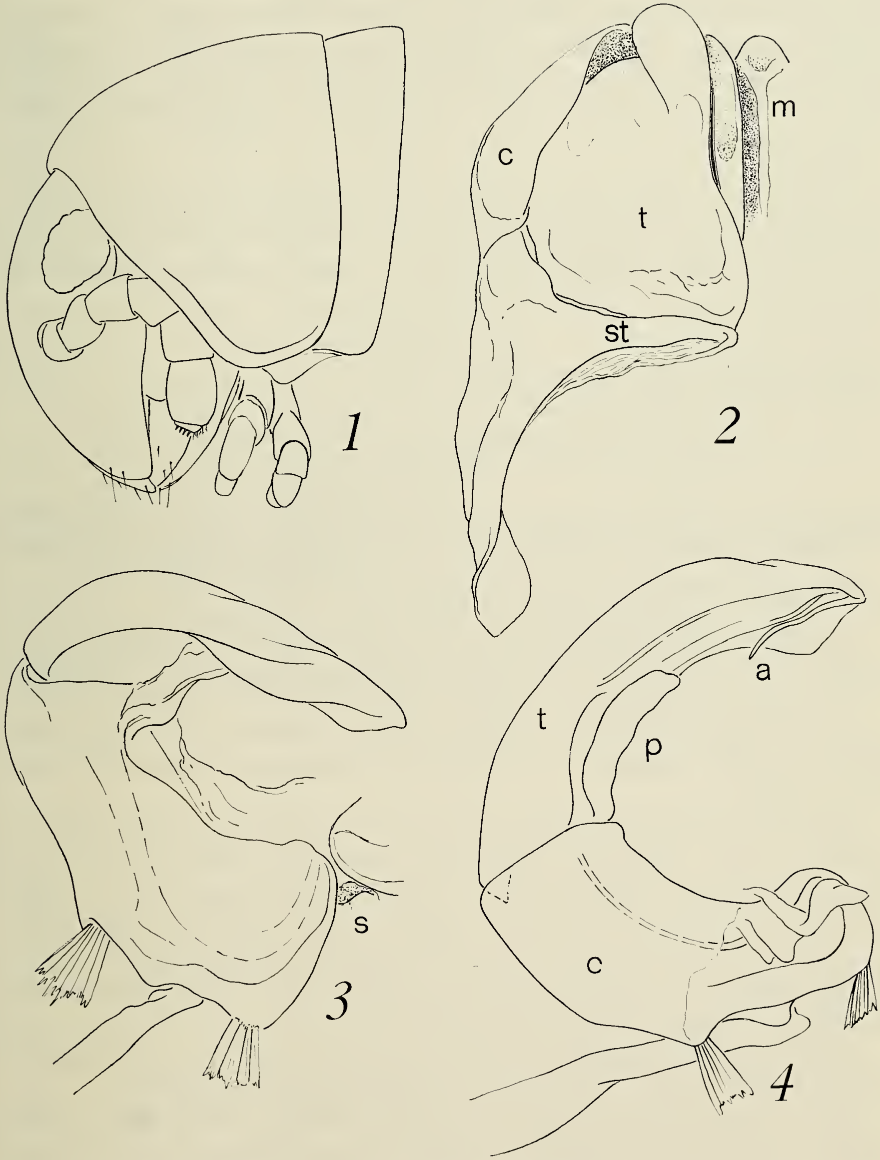
Figs. 1–4. *Atlanticobolus noronhensis* (Pocock), lectoparatype male. 1, Head and first two body segments, lateral view, showing shape of collum and antenna; 2, right side of coleopods (anterior gonopods), posterior view; 3, right phallopod (posterior



gonopod), oblique caudolateroventral view; 4, left phallopod, mesal view. Drawings made at different magnifications. Abbreviations: a, retrorse terminal process of posterior telopodite; c, coxa; m, median lobe of sternum; p, basal process of posterior telopodite; s, sternum; st, posterior median extension of sternum of coleopod; t, telopodite. Condition of the material did not permit accurate tracing of the prostatic groove beyond the posterior coxa.

duct but lacking an enlarged globose chamber. Coxa and telopodite separated by a prominent articulation at about midlength, most distinct and flexible on mesal side; base of telopodite with a large flattened, partially moveable process on inner side, remainder of segment thin, laminate, apically acute and slightly expanded, with a long, slender, reflexed acicular process (Fig. 4, A).

Remarks.—This genus is monobasic and its type species is so far known only from an isolated oceanic island east of Brasil. It is somewhat improbable that a spiroboloid genus would be endemic to such a locality, and introduction either through commerce or ocean current (Fernando de Noronha lies directly astride the South Equatorial Current) must be considered a strong possibility. Yet the species itself remains to be discovered on the African continent or in South America.

Atlanticobolus noronhensis (Pocock), comb. nov.

Figs. 1–4

Spirobolus noronhensis Pocock, 1890, Journ. Linnean Soc. London, Zool., 20:525. Numerous syntypes [Brit. Mus. (Nat. Hist.) Reg. No. 1888-85] from Ilha Fernando de Noronha, Brasil, H. N. Ridley *leg.*

Diagnosis.—With the characters of the genus. Specific characters will be sought in the gonopod structure should additional species be forthcoming.

Lectotype.—Adult male, 27 mm in length, 2.5 mm in diameter, with 37 segments. Segments 1–35 of virtually the same diameter. W/L ratio about 9.2%. Original coloration not evident, the specimen bleached from long preservation.

Head relatively large, moderately convex in front, general appearance as shown in Fig. 1. Accurate ocellus count impossible owing to loss of most pigment and some decalcification. Clypeal setiferous pits 2-2, all widely separated. Antennae of moderate length, articles short and robust, partly concealed by anterior edge of collum, 6th largest, suboval in shape, 7th very small and flattened, with four minute sensory cones. Gnathochilarium and mandibles without special modification.

Collum smooth and polished, lateral ends symmetrically rounded, anterior edge set off by a faint submarginal groove up to level of ocellaria.

Body segments almost smooth, metazona ventrally with horizontal striae nearly up to level of ozopores, mesozona with striae oblique, the uppermost becoming transverse and about four or five such fine parallel striae cross dorsum of each segment. No transverse sulci or sutures evident. Ozopores located at about midlength of the slightly elevated metazona. No scobinae. Epiproct short, apically rounded, not completely covering paraprocts.

Sterna smooth. Legs short, each about half as long as body diameter;

podomeres each with a single apical seta, that of prefemora set in a small subapical foveola; legs back as far as 25th body segment with tarsal pads along entire ventral length of tarsi. Legs of 4th–6th pairs with low rounded coxal lobes. Sympleuron of 7th segment simple, without raised or flared median transverse crest.

Genitalia as defined under the generic heading and of the form shown in Figs. 2–5.

Lectoparatype.—Largest female in the type series, 32 mm in length, 3.2 mm in diameter, with 37 segments. Antennae slightly smaller than in male; other external structural features agree closely with those of male.

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TANAIDACEANS AND ANTHURIDEAN ISOPODS COLLECTED ON THE PRESIDENTIAL CRUISE OF 1938

Noboru Nunomura

Abstract.—Descriptions and illustrations are given of the following Tanaidacea and Anthuridea: *Anatanais normani*, Magdalena Bay, Lower California, Mexico; *A. marmoratus*, Galápagos Is.; *A.* sp., Cocos I.; *Tanais stanfordi*, Clipperton I.; *Paranthura californiae*, new species, Magdalena Bay; *P. algicola*, new species, California (specific locality unknown); and *Colanthura squamosissima*, Magdalena Bay.

In July and August 1938, an inspection and collecting cruise aboard the U.S.S. Houston was carried out by President Franklin D. Roosevelt. The principal collecting localities on this cruise were off Lower California, Cocos Island, Clipperton Island, the Galápagos Islands, and Old Providence Island. A report on the isopods other than Anthuridea has been recently published by Bowman (1977). A preliminary study of the Tanaidacea and Anthuridea was undertaken by Dr. K. H. Barnard, South African Museum, in 1939, but for various reasons was never published. Recently this material was placed at my disposal for re-examination by Dr. Waldo L. Schmitt, Smithsonian Institution.

Order Tanaidacea
Family Tanaidae
Anatanais normani (Richardson)
Figs. 1–2

Tanais normani Richardson, 1905a:369–370, figs. 11–13; 1905b:14–16, figs. 16–18.—Fee, 1926:10.

Anatanais normani.—Shiino, 1951:33–34, fig. 1.—Greve, 1974:115–118, fig. 1.

Description.—Body almost cylindrical, length about 5–6× width. Peraeonal somites with a few lateral setae. Abdomen 6-segmented, about ¼ total length; 4th and 5th pleonal segments narrower than preceding segments, but less so than stated by Richardson, lateral margins prominent, strongly convex, almost angular, each with 3–5 setae. Transverse sutures between pleonal segments very indistinct. Anterior margin of cephalon between eyes triangular. Body color creamy white all over at time of my observation, but according to Dr. Barnard's notes on fairly recently preserved specimens, "As preserved the specimens have the grey stippling usual in littoral tanaids, with a dark transverse band on the front of the head between the black eyes."

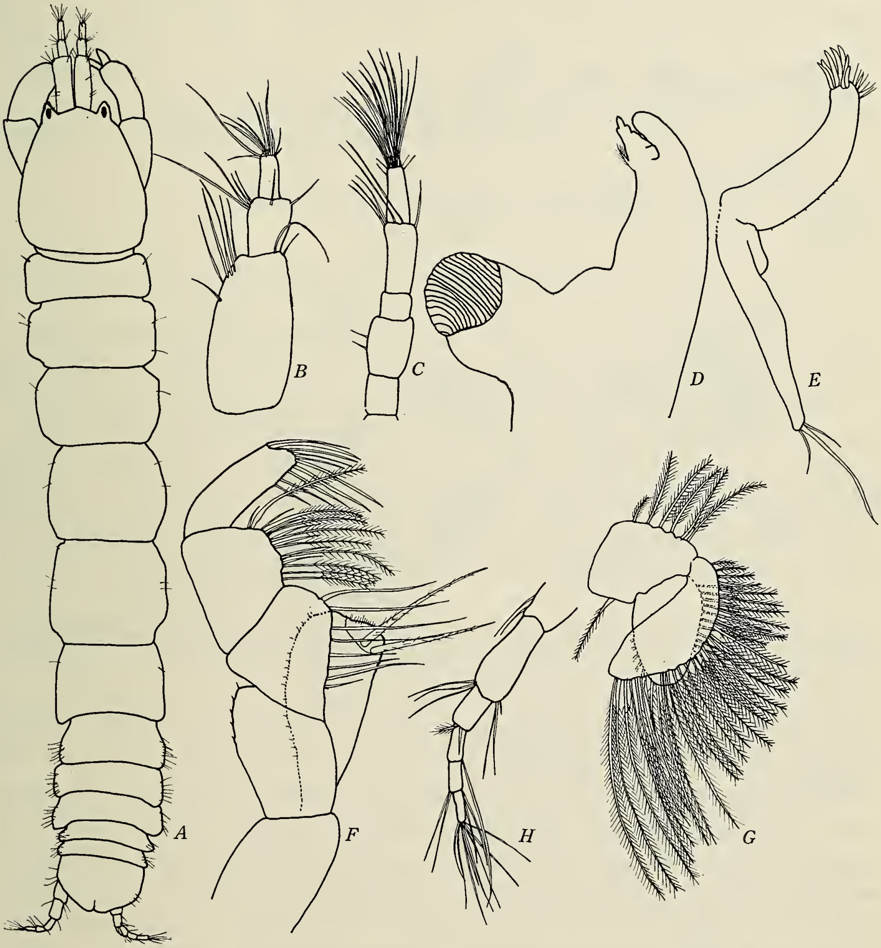

Fig. 1. *Anatanais normani*, female. *A*, Dorsal view of female; *B*, First antenna; *C*, Second antenna; *D*, Mandible; *E*, First maxilla; *F*, Maxilliped; *G*, Pleopod I; *H*, Uropod.

First antenna short, 3-segmented; 1st segment large, robust. Second antenna nearly as long as 1st antenna; 6-segmented.

Mandible without palp; pars incisiva with rounded apex; lacinia mobilis with dentate cutting margin and a plumose seta; pars molaris stout. First maxilla endite with about 7 stout terminal spines of varying length; epipodite with 3 apical setae. Maxilliped with 4-segmented palp, 1st segment wthout setae, 2nd segment with single row of about 8 setae, 3rd segment with double

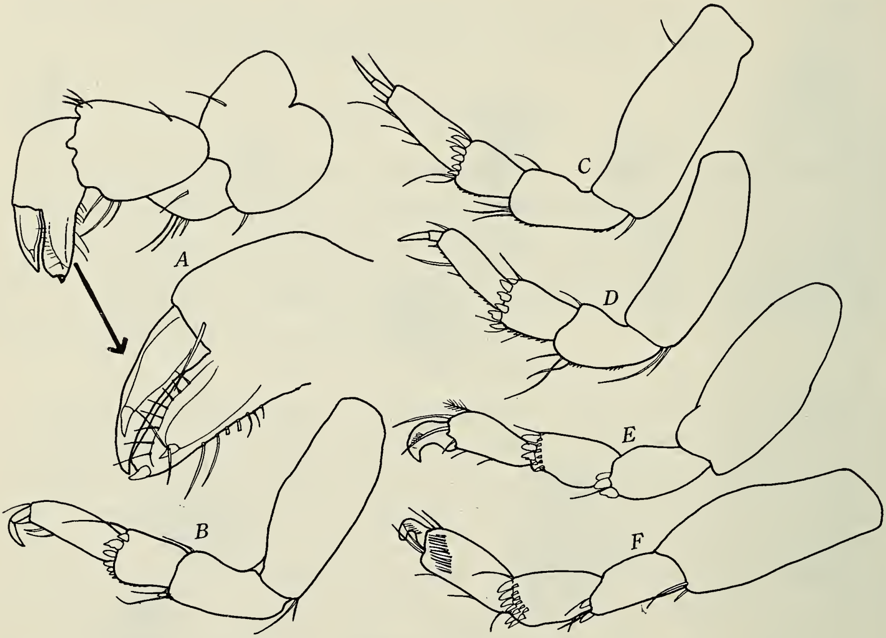

Fig. 2. *Anatanais normani*, female. *A*, Cheliped; *B–E*, Peraeopods II–V; *F*, Peraeopod VII.

row of setae, 4th segment with single row of about 10 setae; endite with 2 long setae, fringed with fine hairs.

Cheliped (peraeopod I) not so powerful in female, 5-segmented, sparsely setose; basi-ischium with triangular excavation at base; merus short, triangular; carpus stout and broad, with a small protuberance on distal margin; propodus smaller than carpus; dactylus slightly narrower and shorter than thumb. Peraeopods II–IV similar in shape; basis large, rectangular; carpus with 5 to 6 stout distal spines on posterior margin; dactylus elongate. Peraeopods V and VI similar in shape; merus with 3 stout spines at distal corner; dactylus strongly curved into hook with sharp apex. Peraeopod VII resembling peraeopod VI but with subapical row of about 12 fine setae on posterior surface of propodus.

Pleopods in 3 pairs; propodite broad with several long plumose setae on outer margin and only a single seta on inner margin; exopodite crescent-shaped, with many long plumose setae on outer margin; endopodite linguiform with similar long setae. Uropod uniramous, composed of 6 segments.

Remarks.—The present specimens from Magdalena Bay agree well with Richardson's original description and Greve's supplementary description of the type-specimens. But some minor differences are found: (1) 6-segmented 2nd antenna as in the specimen from Japan (Shiino, 1951), and (2) shape of mandible.

Material.—3♀♀ (2.6–4.4 mm); 2 sexually undetermined specimens (already dissected, but according to Dr. Barnard's note, up to 5 mm), Lower California, Mexico, 10–15 fathoms, 18 July 1938.

Anatanais marmoratus Nordenstam

Figs. 3–4

Anatanais marmoratus Nordenstam, 1930:526–529, figs. 1–2.

Description.—Body almost cylindrical, about 5× as long as wide. Abdomen 6-segmented, about ¼× body length. Anterior margin of cephalon triangular between eyes. Eyes well developed, composed of 8–10 ocelli.

First antenna similar in shape in both sexes, 4-segmented; 1st segment largest, about 3× as long as wide and slightly longer than the remaining segments combined; terminal segment small, bearing a tuft of setae. Second antenna as long as 1st, composed of 6 segments; 1st and 3rd segments similar in length; 2nd, 4th and 5th also equal in length and longer than 3rd; terminal segment small, bearing a tuft of setae.

Mandible without palp; pars incisiva with rounded tip; right mandible with with dentate lacina mobilis, that in left mandible small and not dentate; pars molaris rather stout. First maxilla endite with about 10 sharp terminal spines. Maxilliped with 4-segmented palp; 1st segment with 1 or 2 setae; 2nd segment with about 4–5 inner setae and several outer setae; 3rd segment with about 7–8 plumose setae and a few simple setae; 4th segment with 10 setae; basis endite with a stout seta and a few simple setae.

Cheliped (peraeopod I) rather powerful in male, but not in female, 5-segmented and setose in both sexes; merus and carpus short, triangular; propodus as long as carpus in male but a little shorter than carpus in female; thumb shorter than remaining part of propodus, cutting edge armed with several setae. Peraeopod II elongate; basi-ischium 4× as long as wide; merus and carpus rectangular, ⅓× longer than basi-ischium; propodus 1½× longer than carpus; dactylus and its claw ⅔× longer than propodus. Peraeopods II and III similar in shape; basi-ischium stout, especially in peraeopod II; merus rectangular with 2 stout setae; carpus rectangular with 4 stout setae and 1 to 2 long setae; propodus slightly longer than carpus. Peraeopods V–VII similar in shape; basi-ischium stout; merus rectangular with a few stout setae and a simple seta; carpus oblong, with a row of several setae in peraeopod VII only.

Pleopods in 3 pairs, normal in shape; propodite broad with several long

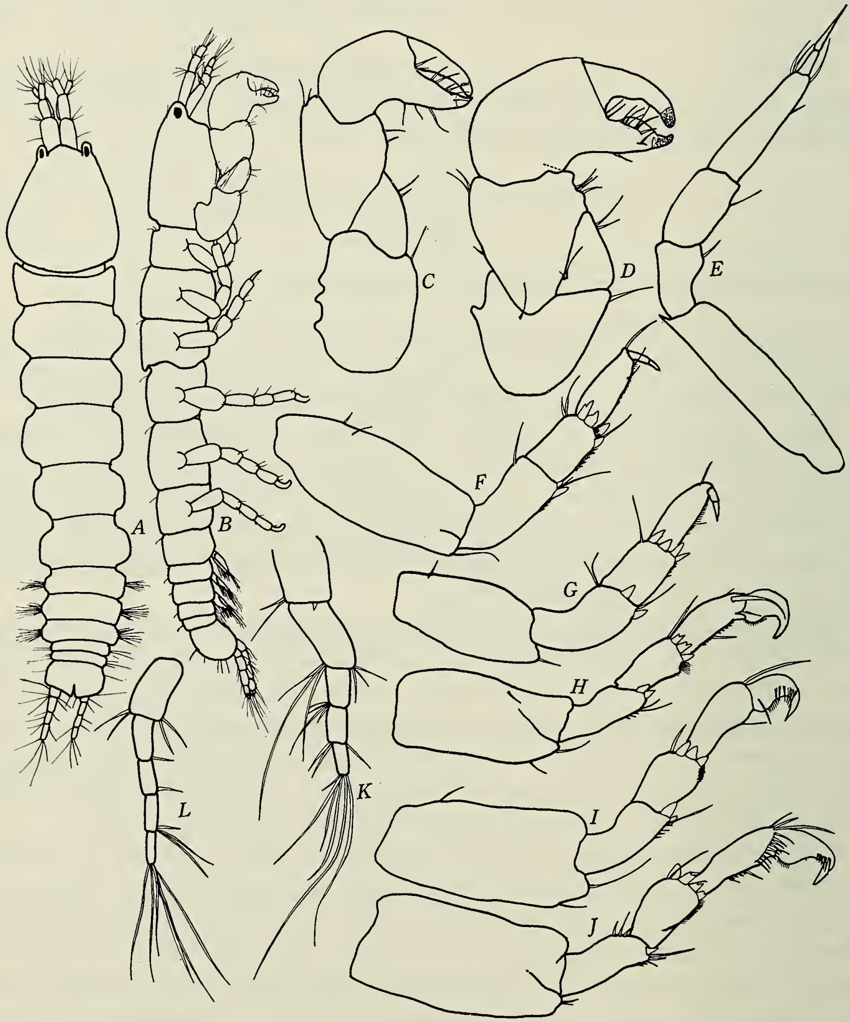

Fig. 3. *Anatanais marmoratus*. *A*, Dorsal view of young specimen; *B*, Lateral view of young specimen; *C*, Cheliped of female; *D–J*, Cheliped to peraeopod VII of male; *K*, Uropod of male; *L*, Uropod of female.

plumose setae on outer margin; exopodite crescent-shaped with many long plumose setae on outer margin; endopodite linguiform with similar long hairs on outer margin and a simple seta and a plumose seta on inner margin. Uropod uniramous, composed of 5 segments.

Material examined.—1♂ (body length unknown), 2 immature, 1 juv.,

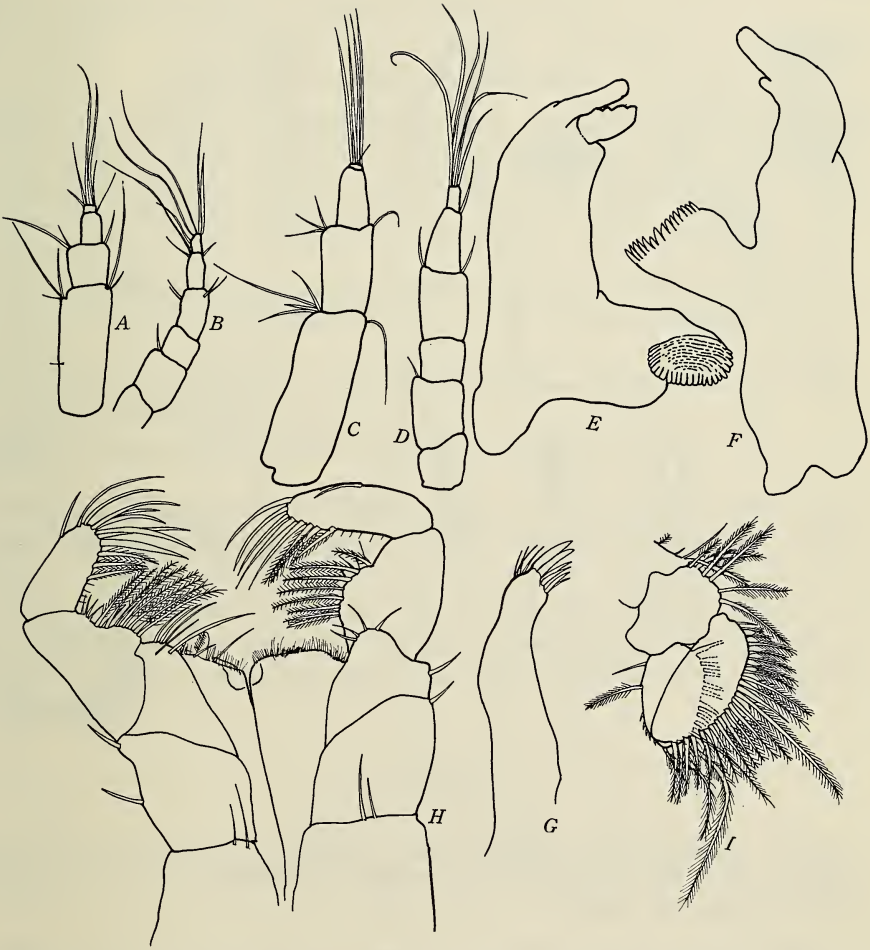

Fig. 4. *Anatanais marmoratus.* *A*, First antenna of female; *B*, Second antenna of female; *C*, First antenna of male; *D*, Second antenna of male; *E* and *F*, Mandible of male; *G*, First maxilla of female; *H*, Maxilliped of male; *I*, First pleopod of male.

Sulivan Bay, James Island, Galápagos Islands, shore collecting, 24 July 1938.

Remarks.—The present specimens from Galápagos agree fairly well with Nordenstam's original description but in some features differences are found: (1) only 5 segments in the uropod (6–8 in original), but in some tanaids, however, there is a tendency for young animals to have fewer segments in the uropod; (2) second antenna with unsegmented flagellum.

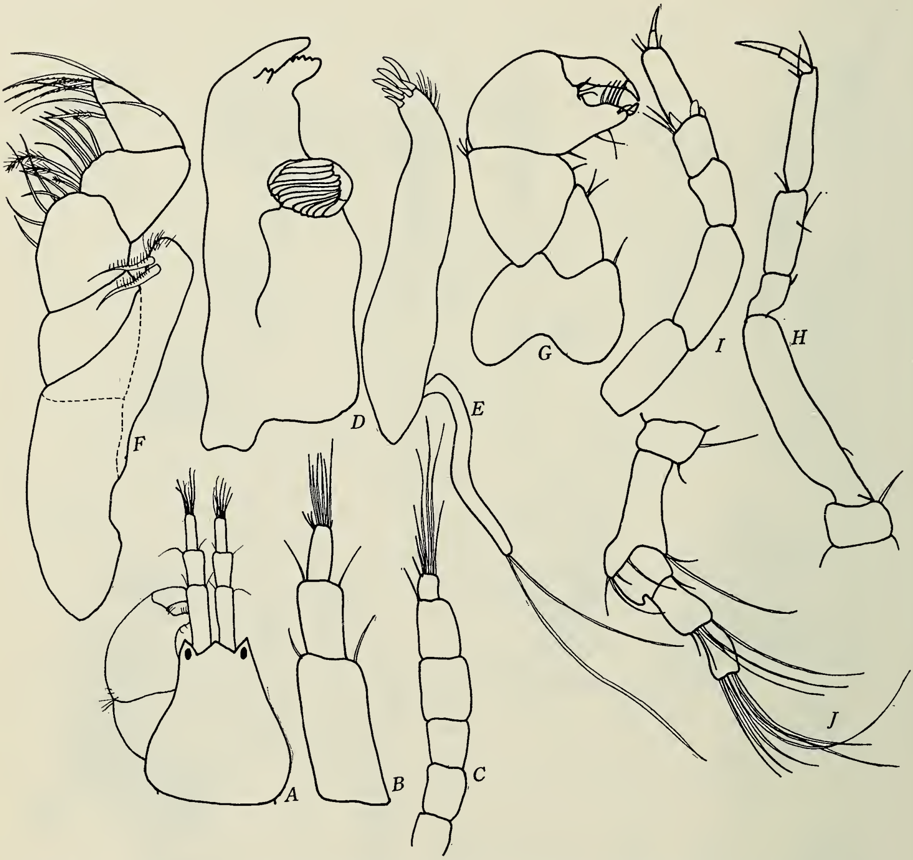

Fig. 5. *Anatanais* (?) sp., copulatory male. *A*, Cephalon; *B*, First antenna; *C*, Second antenna; *D*, Mandible; *E*, First maxilla; *F*, Maxilliped; *G*, Cheliped; *H*, Second peraeopod; *I*, Third peraeopod; *J*, Uropod.

Anatanais (?) sp.
Fig. 5

Two problematic specimens were collected from Chatham Bay, Cocos Island, by bottom sampling, 3 Aug. 1938. One of them is a copulatory male, in which 7 pleonal segments were counted (this specimen was strongly shrivelled at the time of my observation), and the other is perhaps a female with a 6-segmented pleon. According to Dr. Barnard's note the latter specimen is possibly in a protogynous copulatory male instar.

Copulatory male specimen: First antenna 3-segmented. Second antenna 6-segmented, with several long apical setae. Mandible with stout pars incisiva, dentate lacina mobilis, and pars molaris. Maxilliped with 4-segmented palp and a basis endite. Cheliped rather stout. Second and 3rd peraeopods rather slender. Uropod 5-segmented.

Tanais stanfordi Richardson

Tanais stanfordi Richardson, 1901:565, Figs. 1–8.—Stephensen, 362, Figs. 1–5.—Miyadi, 1938:241, Fig. 2 [after Stephensen].—Miller, 1940:317.—Lang, 1956:255–256, Figs. 1–5; 1958:538, pls. 1–2.—Shiino, 1965:177–184, Figs. 1–4.—Kussakin and Tzareva, 1974:219–222, Fig. 2.—Gardiner, 1975:127–138, Figs. 1–3.

Tanais fluviatilis Giambiagi, 1923:248–253, 8 Figs. (unnumbered).—Van Name, 1936:418–419, Figs. 258–259.—Mañé-Garzón, 1943:2–5, Fig. 1a, pl. 1.

Tanais sylviae Mello Leitao, 1941:203–207, 5 figs. (unnumbered).—Mañé-Garzón, 1943:6–10, Fig. 1b, 2, pl. 2.

Tanais herminiae Mañé-Garzón, 1943:10–14, Fig. 1c, pl. 3.

Material examined.—13♂♂ (2.9–3.8 mm), 93♀♀ and young (1.4–3.8 mm). Washed from bucket of algae collected in lagoon, Clipperton Island, 21 July 1938.

Remarks.—Originally described from Clipperton Island. Nothing need be added to the descriptions of this species, made quite adequately by so many researchers. A full summary of its distribution is given by Gardiner (1975: Table 1).

Order Isopoda
Suborder Anthuridea
Family Paranthuridae
Paranthura californiae, new species
Figs. 6–7

Description.—Body not very elongate, about 8× as long as wide. First to 6th peraeonal somites subequal in length, 7th about ⅗ length of others. Body creamy white all over at the time of my observation, but Dr. Barnard wrote in his notes, "As preserved, creamy white, with sparse pigment speckles, mostly in transverse lines across the middle segments of the peraeon, a more or less distinct dark patch in front of head between the black eye." Eyes mediocre with 14 to 17 ocelli. Anterolateral angles of cephalon exceed the rostral projection. Four pairs of oostegites. Without dorsal pit. Demarcation of pleonal somites visible dorsolaterally but indistinct in medial part.

First antenna with 6 distinct segments; first segment large, oblong; 2nd and 3rd segments rectangular; 4th segment small; 5th segment rectangular; terminal segment bearing several aesthetascs. Second antenna longer than the first, with 6 distinct segments; 1st segment small, triangular; second

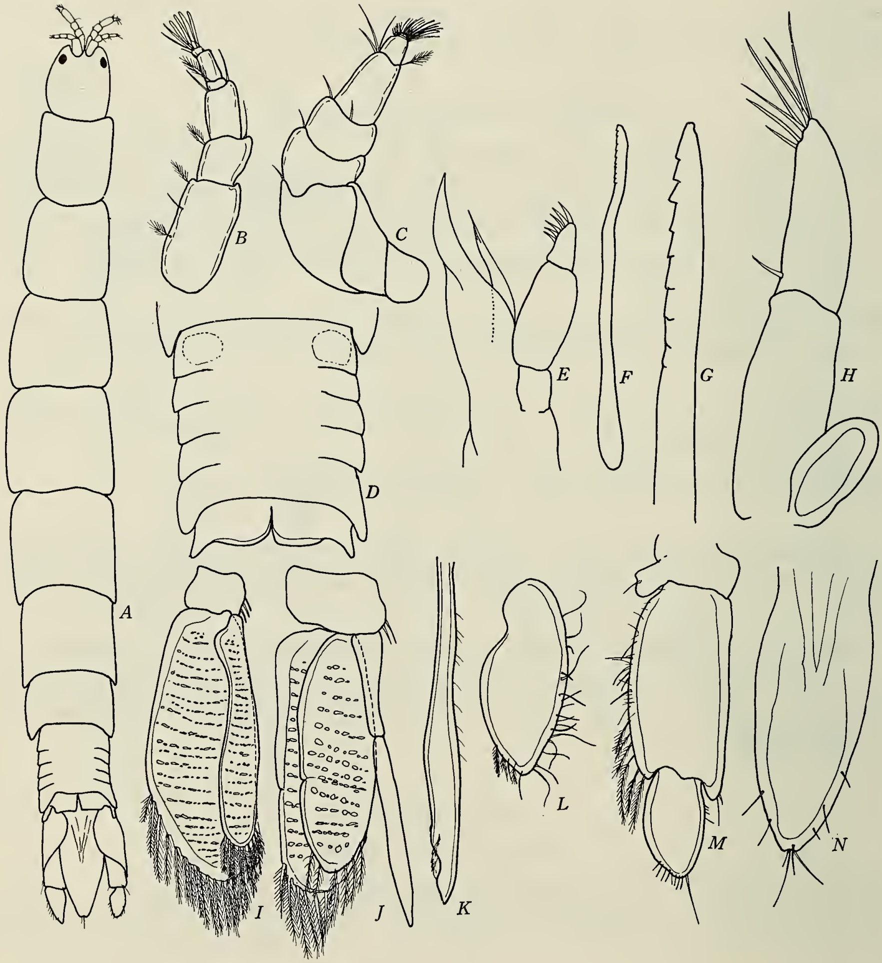

Fig. 6. *Paranthura californiae*. *A*, Dorsal view; *B*, First antenna; *C*, Second antenna; *D*, Abdomen; *E*, Mandible; *F*, First maxilla; *G*, Apical part of same; *H*, Maxilliped; *I*, First pleopod of female; *J*, Second pleopod of male; *K*, Apical part of stylus of the same; *L*, Exopod of uropod; *M*, Endopod of uropod; *N*, Telson. (*A–I* and *L–N*, female holotype; *J* and *K*, male allotype.)

segment biggest, grooved; terminal segment with tuft of setae at tip. There is no sexual difference in the morphology of both antennae.

Mandible with acute apex and 3-segmented palp; 2nd segment without seta; terminal segment bearing a row of 6–7 setae on inner border. First maxilla slender with 9–14 saw-like teeth on inner border of apical part. Maxilliped with 2 slender free segments; basal segment without rudimentary

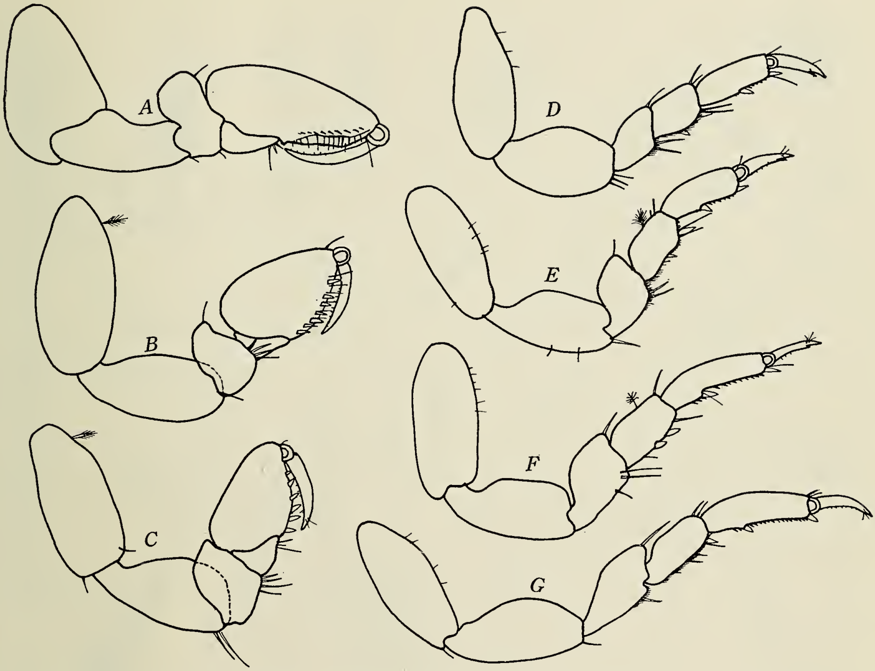

Fig. 7. *Paranthura californiae*, female holotype. *A–G*, First to seventh peraeopods.

endite found in some species of the genus; terminal segment somewhat tapering, with about 7 setae at the tip.

Peraeopods I–III subchelate. Peraeopod I big, armed with about 12 setae in a row on inner border of propodus. Peraeopods II and III each with 6–7 toothed setae on inner border of propodus. Peraeopods IV–VII ambulatory; basis and ischium oblong; merus triangular; carpus with 2 stout spines at inner part; propodus with a stout spine and 12–16 small and sharp spines.

Second pair of pleopods in male with spearhead-shaped long stylus. Endopod of uropod elongate; basal segment about twice as long as broad. Exopod of uropod ovate and slightly elongate, outer margin slightly sinuous distally, apex subacute. Telson ovate-lanceolate, slightly more than twice as long as broad, margin somewhat sinuate near base, apex rounded with a tuft of setae arising from a small indentation, dorsal surface evenly convex without sculpturing.

Material examined.—Station 3-38. Magdalena Bay, Lower California, Mexico, 18 July 1938. Dredging inside northern point of entrance to bay, 10–15 fm: ♀ holotype, 7.3 mm (USNM 82557); ♂ allotype, 5.3 mm (USNM 171242); 12♀ paratypes, 2.7–8.3 mm, 11 deposited in National Museum of

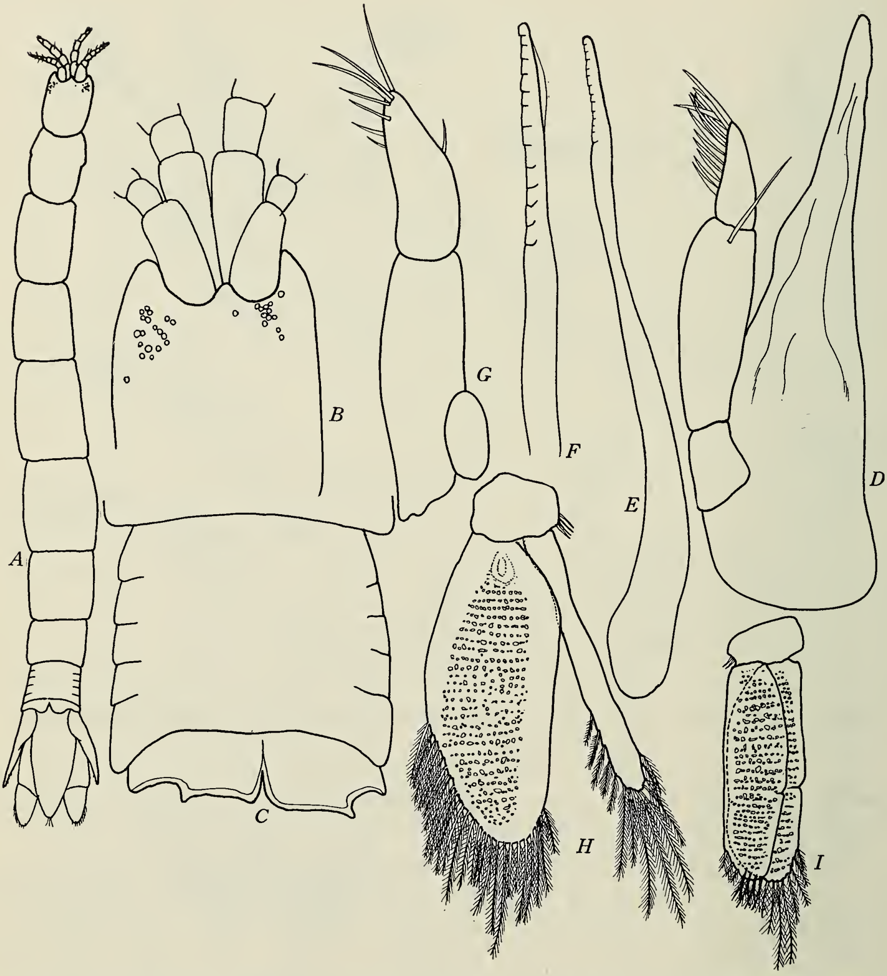

Fig. 8. *Paranthura algicola.* Female holotype, *A*, Dorsal view; *B*, Anterior part of cephalon; *C*, Abdomen; *D*, Mandible; *E*, First maxilla; *F*, Apical part of same; *G*, Maxilliped; *H*, First pleopod; *I*, Second pleopod.

Natural History (USNM 171243), and 1 deposited in Osaka Museum of Natural History (OMNH-Ar-1747).

Remarks.—The present new species is not a very distinct form in the genus. It very closely resembles *P. elegans* Menzies, 1951, from California. The former is separated, however, from the latter by the following features: (1) shape of both antennae, especially fewer segments in first antenna; (2) shape of anterior part of cephalon; (3) fused medial part of pleonal segments; (4) shape of posterior part of sixth pleonal somite; (5) less nu-

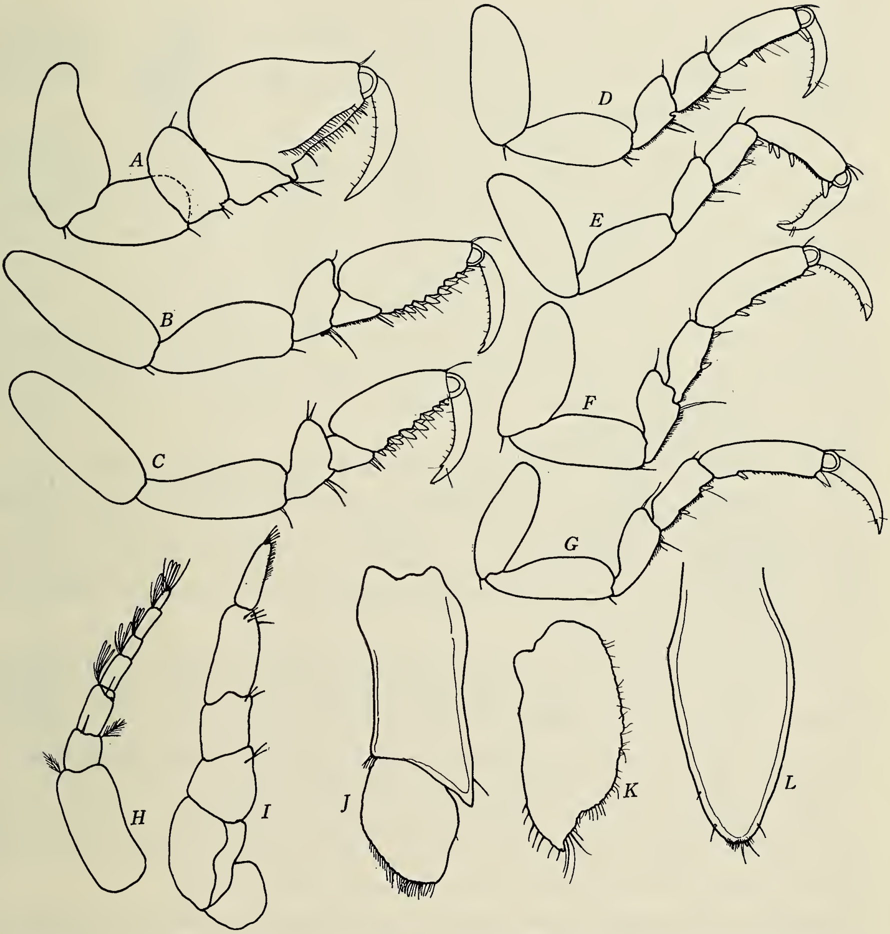

Fig. 9. *Paranthura algicola.* Female holotype, *A–G*, First to seventh peraeopods; *H*, First antenna; *I*, Second antenna; *J*, Endopod of uropod; *K*, Exopod of uropod; *L*, Telson.

merous setae on inner border of mandibular palp; and (6) indistinctly serrated border of telson.

Paranthura algicola, n. sp.
Figs. 8–9

Description.—Body elongated, about 10× as long as wide. First to 3rd and 6th peraeonal somites all subequal in length. Fourth and 5th somites equally long, ¾× third. Seventh somite about half length of 6th. Body color creamy white, as preserved in alcohol. Each eye consists of 12–19 distinct round ocelli, which are scattered separately. Anterolateral angles of cephalon exceed rostral projection. Fourth to 7th peraeopods with pairs of oostegites. Without dorsal pit. Demarcation of pleonal somites visible in dorsal view but indistinct in medial part.

First antenna with 7 distinct segments, and a small indistinct segment between 3rd and 4th segments; first segment biggest and oblong; terminal 5 segments each with 2 or 3 aesthetascs on distal corner. Second antenna 6-segmented and a little longer than the 4th. (All these observations are based only on female specimens; antennae of male is unknown).

Mandible with acute apex and 3-segmented palp; 2nd segment oblong bearing a long seta near distal end, terminal segment with row of 12 setae on inner border. First maxilla slender, with about 13 saw-like teeth on inner border of apical part. Maxilliped with 2 free segments; basal segment without rudimentary endite.

Peraeopods I–III subchelate. Peraeopod I big, propodus with row of about 12 setae. Propodus of peraeopods II and III with 6 to 8 stout spines on inner border. Peraeopods IV–VII ambulatory; basis and ischium oblong; merus triangular; carpus rectangular with 1 or 2 stout spines; propodus with 1–4 stout spines and 10–20 small denticles on inner margin. First and 2nd pleopods as in Fig. 8*H–I*.

Endopod of uropod obliquely oval, about as long as broad, inner margin short. Exopod broadly oval, with slight longitudinal fold, outer margin indented. Telson ovate-lanceolate; dorsal surface evenly but only slightly convex, about twice as long as broad, apex rounded with many small setae.

Material examined.—♀ holotype, 10.0 (USNM 82264) and ♀ paratype, 5.5 mm (OMNH-Ar-1748), from "rocky beach," California, washed from algae, 24 November 1916. This material was not derived from the Presidential Cruise, but is included at the request of Dr. Schmitt.

Remarks.—The present new species is most closely allied to *Paranthura elegans* Menzies from California but differs from the latter in the following features: (1) scattered eye ocelli; (2) coalescence of medial part of pleonal somites; and (3) shape of posterior border of sixth pleonal somite.

Colanthura squamosissima Menzies
Fig. 10

Colanthura squamosissima Menzies, 1951:114–118, Figs. 14–16.

Description.—Body not very elongate, about 8× as long as wide. First and 2nd peraeonal segments subequal in length. Third to 5th segments much longer than the preceding ones and subequal in size to one another. Sixth segment as long as each of the first 2 segments. Seventh segment almost completely supressed, very small. Seventh pair of peraeopods lacking. Four

Fig. 10. *Colanthura squamosissima*. *A*, Dorsal view; *B*, Anterior part of cephalon; *C*, Sixth pleonal somite; *D*, First antenna of male; *E*, First antenna of female; *F*, Second antenna of male; *G*, Second antenna of female; *H*, Mandible; *I*, First maxilla; *J*, Maxilliped; *K–P*, First to sixth peraeopods; *Q*, Second pleopod of male; *R*, Apical part of stylus of same; *S*, Exopod of uropod; *T*, Endopod of uropod; *U*, Telson (*A–C*, *E*, *G–P*, *S–U*, female; *D*, *F*, *Q–R*, male).

pairs of oostegites. Pleonal sutures rather distinct but not clearly visible dorsally as figured in Menzies' original description (Menzies, 1951); 6th pleonal segment fairly big. Eyes rather large, with about 11–16 distinct ocelli. Body color whitish yellow in alcohol. Anterolateral angles of cephalon exceed rostral projection. Head with small median process between the 1st antennae. Telson thin, without statocyst.

First antenna with 10 segments, segments of terminal half each bear many brushlike aesthetascs in male; 1st antenna of female has 5 segments. Second antenna longer than 1st, no distinct difference by sex.

Mandible without palp. First maxilla with about 10 saw-like teeth on inner border of apical part. Maxilliped with only 1 free segment.

Peraeopods I–III subchelate. Peraeopod I big, armed with about 12 setae in a row near basal part of margin. Peraeopods II and III slenderer than peraeopod I; propodus with about 8 stout spines on inner margin. Peraeopods IV–VI ambulatory; basis and ischium oblong; merus triangular; carpus rectangular with 2 or 3 stout spines; propodus rectangular with 2 or 3 stout spines and many denticles on inner margin.

Male second pleopod with rather long stylus, apical part of which bears a thin hooklike structure. Uropod with broad ovate exopod arching over telson and with sinuately-margined endopod. Telson spatulate, without statocyst.

Material examined.—1♂ (3.8 mm in body length), 3♀♀ (4.1–5.4 mm in body length) and 2♀♀ (body length undetermined, because of lacking cephalon); Magdalena Bay, Lower California; July 18, 1938.

Acknowledgments

I wish to express my sincere gratitude to Dr. Saburo Nishimura, Kyoto University, for reviewing the manuscript; to the late Dr. Waldo L. Schmitt, who served as Naturalist during the Presidential Cruise of 1938, for giving me the opportunity to study such an important and interesting collection, and to Professor Emeritus Sueo M. Shiino, Mie University, for many useful suggestions on the systematics of tanaids. Last but not least I wish to thank Dr. Thomas E. Bowman, National Museum of Natural History, for his helpful cooperation. Contributions from the Osaka Museum of Natural History, No. 214.

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c/o Mr. Hasegawa, 11, 2-Ku, Tarômaru, Toyama, 930-11 Japan.

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TWO NEW SPECIES OF *QUANTANTHURA* FROM BRASIL (CRUSTACEA, ISOPODA, ANTHURIDAE)

Brian Kensley and Maria Luise Koening

Abstract.—Two new species of the anthurid isopod genus *Quantanthura* are described. *Q. menziesi* was taken from 31 stations ranging from Cape Orange in the north to Cape Santo Agostinho in the south, in depth ranges from 1.4–94.0 m. *Q. brasiliensis* was recorded from only two stations, one close to Rio de Janeiro, and one further north, in 21 and 166 m. This is only the second record of the genus, and the first from the Atlantic. The genus *Quantanthura* is redefined.

The present work is based on dredged material collected chiefly by the Department of Oceanography of the Federal University of Pernambuco, Brasil. Since 1965 several oceanographic surveys of the Brasilian continental shelf have been carried out, between Amapá (latitude 04°40′N) and São Paulo (latitude 24°23′S), by the Directory of Hydrography and Navigation (Diretoria de Hidrografia e Navigação) and by the Superintendent of Development of the North-east (Superintendência de Desenvolvimento do Nordeste) (see Fig. 1). Further oceanographic and ecological data are obtainable from Cavalcanti & Kempf (1970), Kempf (1970), Coelho & Koening (1972), and Mabesoone, Kempf, & Coutinho (1972).

Type-material has been deposited in the National Museum of Rio de Janeiro, and the United States National Museum.

Family Anthuridae

Quantanthura Menzies & George

Diagnosis.—Eyes present or absent. Antennular flagellum of 5–7 articles. Antennal flagellum of 9 articles. Mandibular palp 3-segmented; lacinia, molar, and incisor well developed. Maxilliped 6-segmented, third segment very short; endite present. Pereopod 1 larger than pereopods 2 and 3, propodus broad. Pereopods 4–7 with rectangular carpus, not underriding propodus. Pleopod 1 exopod operculiform. Pleonites 1–5 fused, pleonite 6 free. Telson indurate, with 2 basal statocysts. Marsupium of 4 pairs of oostegites.

Remarks.—Menzies & George (1972) indicated that some species of both *Anthelura* and *Ananthura* should be placed in *Quantanthura*. The genus *Ananthura* (type-species *A. sulcaticauda*) has been synonymised with *Anthelura* by Kensley (1978). *Anthelura* differs from *Quantanthura* as here

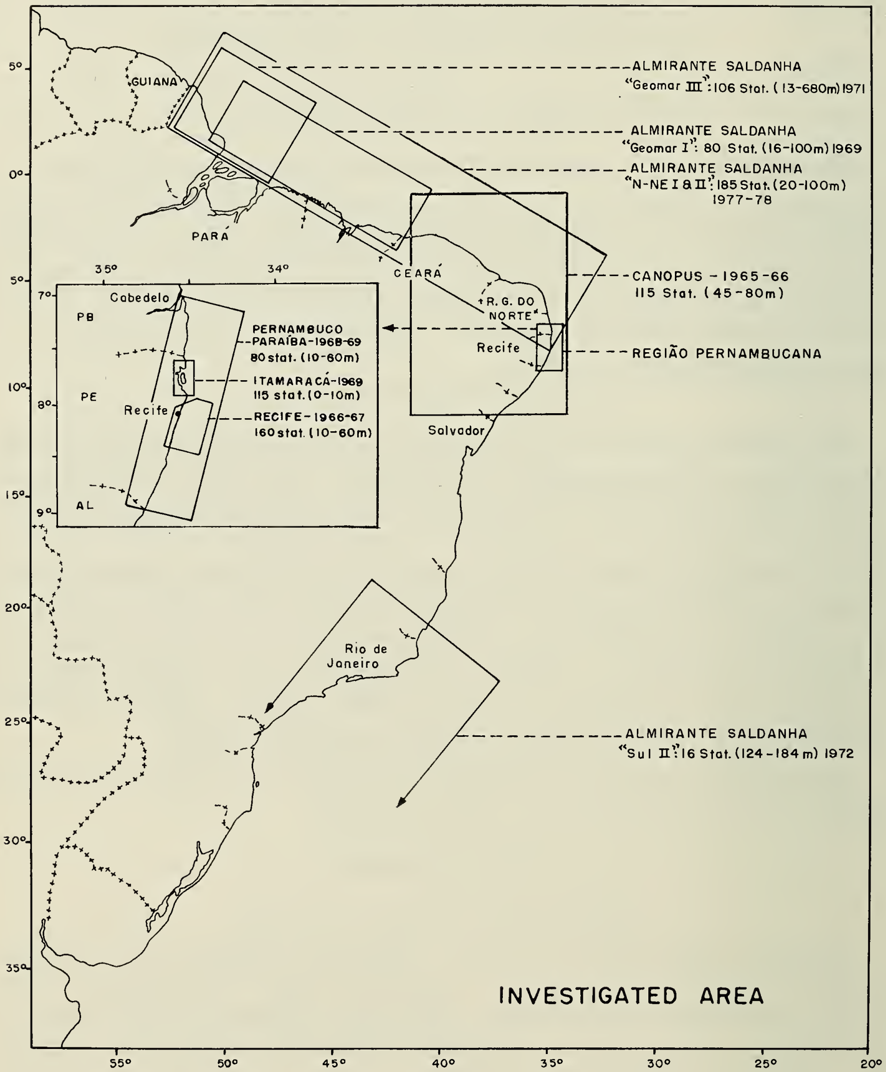

Fig. 1. Map showing oceanographic survey areas.

defined in 2 major generic characteristics, viz. in having a 5-segmented maxilliped, and in having pleonites 1–6 free.

Quantanthura menziesi, new species

Figs. 2, 3

Description.—♀. Integument, except for uropods and telson, hardly indurate. Cephalon with tiny dorsolateral eyes; rostrum short, not extending

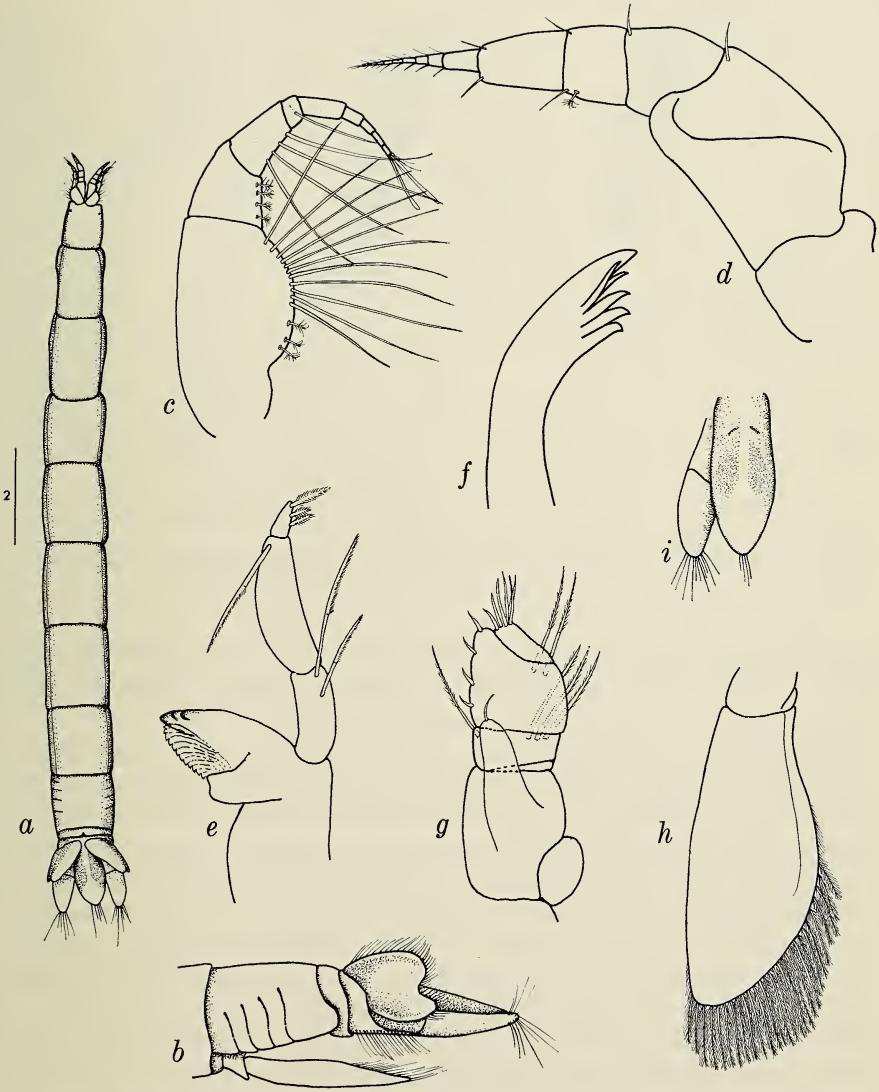

Fig. 2. *Quantanthura menziesi*: a, Female in dorsal view; b, Pleon in lateral view; c, Antennule; d, Antenna; e, Mandible; f, Apex of maxilla; g, Maxilliped; h, Pleopod 1 exopod; i, Telson and uropodal basis and endopod.

beyond square anterolateral corners. Cephalon and pereonites 1 and 2 with dorsolateral keel, becoming obsolete on posterior pereonites. Body proportions: $C < 1 < 2 > 3 < 4 = 5 = 6 > 7$. Pleonites 1–5 fused, sutures laterally visible; pleonite 6 free, with small middorsal notch in posterior margin.

Fig. 3. *Quantanthura menziesi*: a, Pereopod 1; b, Pereopod 2; c, Pereopod 7.

Telson dorsally convex, with low proximal middorsal rounded ridge, flattened in distal third to rounded apex; 2 slit-like statocyst openings visible at about proximal third; ventral surface gently convex.

Antennular peduncle 4-segmented, basal segment broadest and longest, with several elongate simple setae; fourth segment small, set obliquely into apex of third; flagellum of 5 articles, terminal article with 2 aesthetascs. Antennal peduncle 5-segmented, second segment longest, dorsally grooved to accommodate antennule; flagellum of 9 articles, each with distal group of setae protected by basal flange. Mandibular palp 3-segmented, basal segment two-thirds length of second segment, with 2 distal elongate fringed setae; second segment with single distal elongate fringed seta; terminal segment one-quarter length of middle segment, with 3 fringed spines on distal half; incisor of 3 cusps; lacinia margin with 12 serrations; molar bluntly lobed. Maxilla with 6 distal spines. Maxilliped 6-segmented, second segment longest, third segment very narrow, wedge-shaped, fourth segment with 3 elongate distally fringed setae on outer surface, fifth segment with 4 short setae on mesial margin, 2 elongate fringed setae on outer surface, sixth segment narrow, set obliquely into fifth, with 5 distal setae; thin-walled endite present on inner surface, with few distal setae. Pereopod 1 unguis half length of dactylus; propodal palm almost straight, bearing fringe of tiny square scales and single row of simple setae; carpus triangular, distally rounded, posterior margin scalloped, armed with close-set short scales and finely-fringed setae. Pereopods 2 and 3 similar, unguis one-third length of dactylus; posterior margin of propodus, carpus, and merus bearing short blunt scales. Strong posterodistal sensory spine on propodus and carpus. Pereopods 4–7 similar, unguis one-fifth length of dactylus; propodus with 2 finely-fringed spines and strong sensory spine at posterodistal corner; carpus broad, 5-sided, not underriding propodus, with 2 sensory spines on posterior margin, and 5 or 6 finely-fringed distal spines. Brood pouch formed by 4 pairs of oostegites on pereonites 2–5. Exopod of pleopod 1 indurate, operculiform, with numerous distal plumose setae; endopod one-third width of exopod and only slightly shorter, with 7 or 8 distal plumose setae. Uropodal exopod with deep notch distally, fringed with setae; endopod extending slightly beyond telsonic apex, distally rounded.

Etymology.—The species is named for the late Dr. Robert J. Menzies, in recognition of his assistance to the second author.

Material.—Holotype: Salinópolis, 00°29′S, 47°24′W, 21 m, sta. SALD 2533, ♀ 16.2 mm, National Museum of Rio de Janeiro.

Paratypes.—Natal, sta. SALD 1656, 05°41′S, 35°05′W, 23 m, ♀ 16.8 mm; Cape Santo Agostinho, sta. REC 154, 08°21′S, 34°45′W, 37 m, ♀ 14.5 mm; São Luis, sta. SALD 1743A, 00°51′S, 43°41′W, 75 m, ♀ 17.0 mm; Camocim, sta. SALD 1723, 02°00′S, 41°01′W, 73 m, ♀ 17.6 mm, USNM 171259; Tocantins Mouth, sta. SALD 2443, 00°39′N, 47°13′W, 43 m, ♀ 16.3 mm USNM 171260; Tocantins Mouth, sta. GM III 148, 01°47′N, 47°49′W, 60 m, 7♀♀ 17.0 mm, USNM 171261.

Additional material.—Cape Orange, sta. GM III 182, 04°40′N, 50°40′W, 78–80 m, ♀; Cape North, sta. GM III 189, 03°50′N, 49°55′W, 69–77 m, ♀; sta. GM III 190, 03°42′N, 49°49′W, 86–92 m, ♀; sta. GM III 191, 03°34′N, 49°43′W, 82–94 m, ♀. Amazon Mouth, sta. SALD 177 3A, 02°28′N, 48°13′W, 85 m, ♀; sta. SALD 2447, 02°24′N, 48°24′W, 85 m, ♀; sta. SALD 2471, 02°16′N, 47°47′W, 84 m, 2♀♀. Tocantins Mouth, sta. SALD 2438, 00°48′N, 47°05′W, 70 m, ♀; sta. GM I 45, 01°32′N, 47°34′W, 67 m, ♀; sta. GM III 218, 02°09′N, 47°25′W, 92 m, ♀. Salinópolis, sta. SALD 1804B, 01°00′S, 45°21′W, 21 m, 3♀♀; sta. SALD 2533, 00°29′S, 47°24′W, 21 m, 2♀♀. Cape Gurupi, sta. GM I 33, 00°11′S, 46°49′W, 29 m, 2♀♀; sta. GM I 34, 00°21′S, 46°58′W, 30 m, 2♀♀; sta. GM I 42, 01°28′S, 46°51′W, 80 m, ♀. Turiaçu, sta. SALD 1751, 00°37′S, 44°40′W, 44 m, ♀; sta. GM I 29, 00°38′N, 45°52′W, 75 m, ♀. São Luis, sta. SALD 1872, 01°20′S, 43°33′W, 50 m, ♀. Tutoia, sta. SALD 1731, 02°30′S, 41°51′W, 24 m, 2♀♀; sta. SALD 1817A, 02°07′S, 42°26′W, 73 m, ♀. Camocim, sta. SALD 1721, 02°25′S, 40°50′W, 24 m, ♀; sta. CAN 06, 02°11′S, 39°53′W, 60–65 m, ♀. Cape Bacopari, sta. SALD 1655, 06°04′S, 34°59′W, 25 m, ♀. Ponta de Pedras, sta. PB/PE 23, 07°33′S, 34°41′W, 20 m, ♀; sta. ITA 39, 07°46′S, 34°47′W, 1.4 m, 2♀♀.

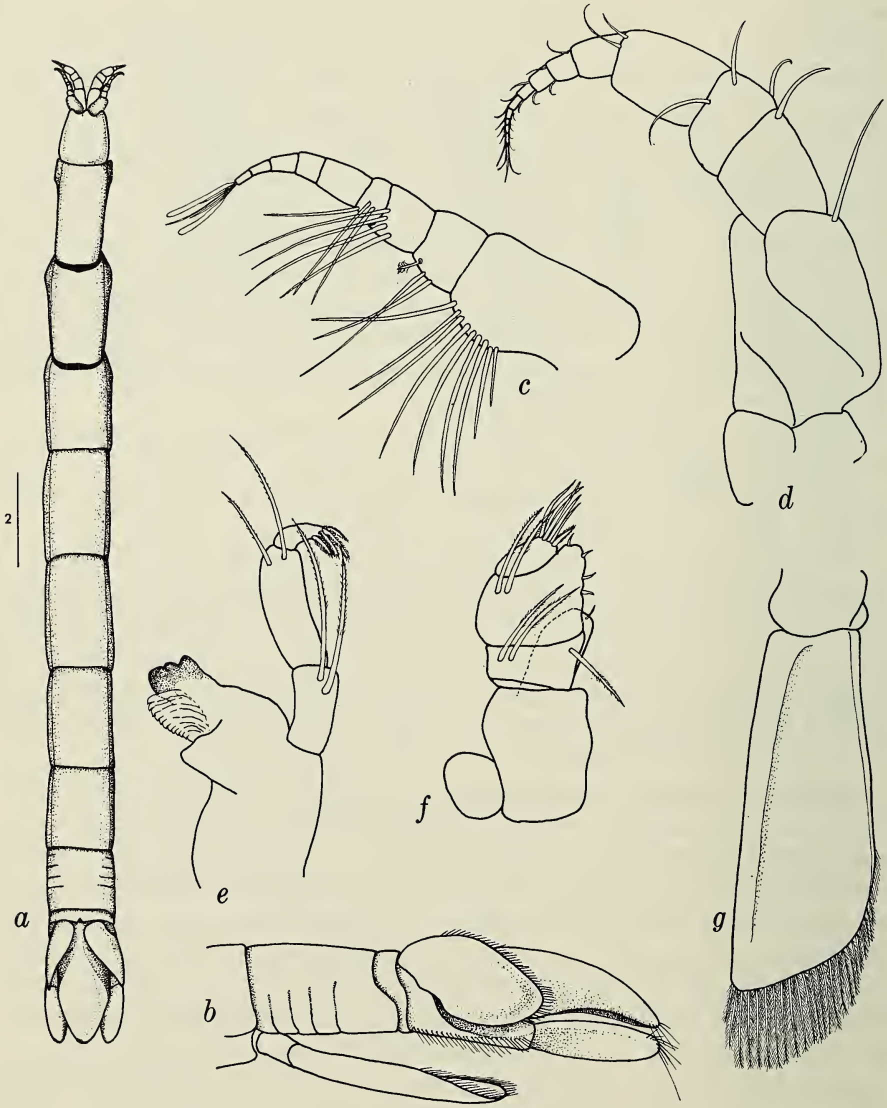

Fig. 4. *Quantanthura brasiliensis*: a, Female in dorsal view; b, Pleon in lateral view; c, Antennule; d, Antenna; e, Mandible; f, Maxilliped; g, Pleopod 1 exopod.

Quantanthura brasiliensis, new species
Figs. 4, 5

Description.—♀. Integument, except for uropods and telson, hardly indurate. Cephalon lacking eyes; low rounded rostrum not extending beyond

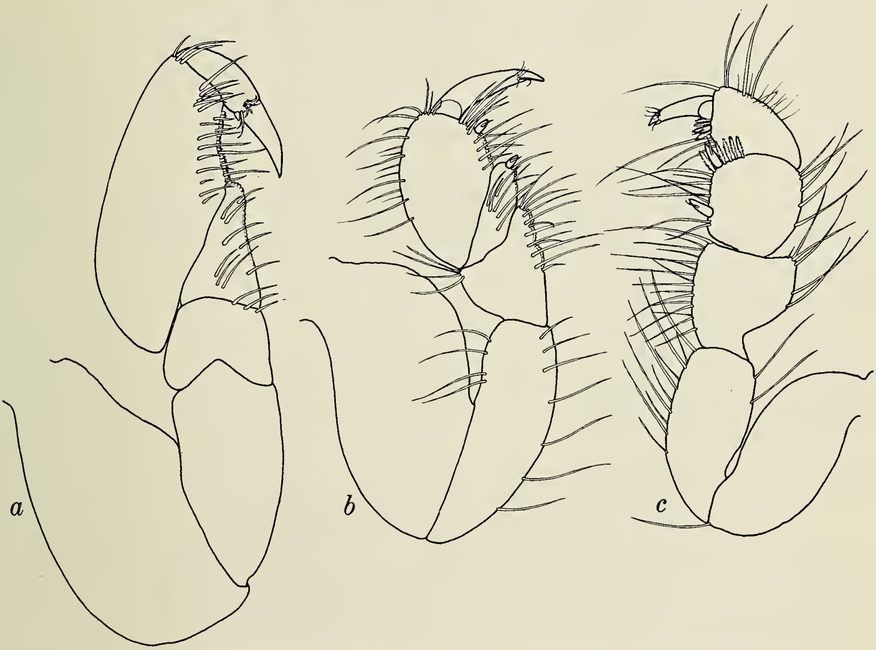

Fig. 5. *Quantanthura brasiliensis*: a, Pereopod 1; b, Pereopod 2; c, Pereopod 7.

anterolateral corners. Body proportions: C < 1 = 2 > 3 < 4 < 5 > 6 > 7. Pleonites 1–5 fused, sutures visible laterally; pleonite 6 free, with small middorsal notch in posterior margin. Telson with short proximodorsal ridge, distal two-thirds strongly convex, apex rounded; two proximal statocysts with slit-like openings; ventral surface gently concave.

Antennular peduncle 4-segmented, basal segment longest and broadest, with several elongate simple setae on ventral surfaces of all 4 segments; flagellum of 5 articles with 2 distal aesthetascs. Antennal peduncle 5-segmented, second segment strongly grooved to accommodate antennule; flagellum of 9 articles. Mandibular palp 3-segmented, first and second segments with 2 elongate finely fringed setae each; terminal segment with 4 distal fringed spines; incisor of 3 cusps; lacinia with 11 or 12 serrations; molar bluntly rounded. Maxilla with 6 distal spines. Maxilliped 6-segmented, third segment narrow, wedge-shaped, fourth segment with 3 elongate setae; sixth segment short, set obliquely in outer distal angle of fifth segment, with 5 simple setae and 1 short fringed seta; thin-walled endite on inner surface tipped with single seta. Pereopod 1 unguis almost half length of dactylus, with tiny supplementary spine at base; propodal palm gently concave, with border of short fringed scales and several setae;

Table 1. Comparison of species of *Quantanthura.*

	Q. globitelson	*Q. menziesi*	*Q. brasiliensis*
Proximodorsal ridge of telson	Weakly defined, rounded, extending about half telsonic length	Relatively strong, rounded, extending about two-thirds telsonic length	Weakly defined, rounded, extending about one-third telsonic length
Telsonic apex	Narrowly rounded	Narrowly rounded	Broadly rounded
Eyes	Absent	Present	Absent
Basal antennular segment	Elongate setae absent	Numerous elongate setae present	Numerous elongate setae present
Mandibular palp segments	1 and 2 subequal	2 longer than 1	2 longer than 1
Pereopod 1, propodal palm	Convex	Slightly convex	Concave
Pereopod 2 unguis	One-sixth length of dactyl	One-third length of dactyl	One-third length of dactyl
Pleopod 1 exopod, anterior surface	Ridge near mesial margin	Ridge absent	Ridge near mesial margin
Uropodal exopod	Broadly ovate, outer margin sinuous	Notched	Ovate, outer margin not sinuous

carpus triangular, distally rounded, with border of rounded scales becoming obsolete proximally. Pereopod 2 unguis one-third length of dactylus; propodus with squat posterodistal sensory spine, several elongate simple setae on anterior and posterior margins; carpus narrow, posterior margin rounded, with squat sensory spine and several simple setae; merus with scalloped posterior margin and several simple setae. Pereopods 4–7 with elongate simple setae on propodus, carpus, merus, and ischium; propodus with posterodistal sensory spine and 3 fringed spines; carpus rectangular, not underriding propodus, with 2 strong sensory spines on posterior margin, 5 or 6 distal fringed spines. Pleopod 1 exopod indurate, operculiform, with strong groove on outer (anterior) surface near mesial margin, numerous distal plumose setae. Uropodal exopod ovate, fringed with setae, apex rounded, folding over telson and fitting into hollowed proximal area of telson and uropodal basis, reaching distal margin of basis; endopod narrowly ovate, distally rounded.

Etymology.—The specific name derives from Brasil, the country of origin of both species of *Quantanthura* described here.

Material.—Holotype: Piauí, sta. SALD 1730, 02°37′S, 41°27′W, 21 m, ♀ 21.9 mm, National Museum of Rio de Janeiro. Paratype: San Sebastião, sta. SUL II DG-04, 24°23′S, 44°34′W, 166 m, ♀ 17.3 mm, National Museum of Rio de Janeiro.

Discussion.—Menzies & George (1972) placed *Anthelura truncata* (Hansen, 1916) from abyssal depths in the Davis Straits in *Quantanthura*, but the descriptions provided by Hansen (1916), Barnard (1925), and Menzies (1962) do not give sufficient details to place this species with certainty. The pleonal structure appears to be similar to *Quantanthura* as here defined, but pleonite 6 is not delineated. Hansen's figure of the maxilliped (1916, pl. 15, Fig. 2g) indicates by a dotted line a possible narrow wedge-shaped third segment as is seen in *Quantanthura*, but no endite is shown.

Quantanthura globitelson was recorded from the abyssal depths of the Peru-Chile Trench of the eastern Pacific, while both the present species are from shallow water in the western Atlantic. The main differences between *Q. globitelson* and the 2 new species are summarised in Table 1. As *Q. brasiliensis* was recorded from only 2 stations, speculation on the distribution of both species is difficult. Considerng the number of stations sampled between depths of 20 and 100 meters, it is possible that *Q. brasiliensis* has a deeper distribution than *Q. menziesi*, and/or it is a rarer species.

Acknowledgments

The authors are indebted to Professor Laurinaldo Barreto Cavalcanti, head of the Department of Oceanography of the Federal University of Pernambuco, for permission to study the material here described. We also thank the Brasilian National Research Council for financial aid; Professor Petrônio Alves Coelho for helpful suggestions, and Dr. Thomas E. Bowman of the Smithsonian Institution, Washington, D.C. for reading the MS and for his valuable criticisms.

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A NEW GENERIC NAME FOR THE HUNDRED-PACE VIPER

Howard K. Gloyd

Abstract.—The genus *Deinagkistrodon* is established for the species now known as *Agkistrodon acutus.*

Studies on the Asian species of the genus *Agkistrodon* (*sensu lato*) with which I have been involved for several years indicate that the group should be divided among four genera, *Agkistrodon* (*sensu stricto*), *Calloselasma*, *Hypnale*, and a monotypic genus for which a name is proposed below.

Calloselasma of Cope (1860) was revived by Chernov (1957) for the species long known as *Agkistrodon rhodostoma*, an action with which I concur. *Calloselasma* was also used by Campden-Main (1970) and Burger (1971). Recently I resurrected *Hypnale* for the three small snakes that are restricted to Sri Lanka and peninsular India (Gloyd 1977). Most of the other Asian forms remain in the genus *Agkistrodon* but one, *acutus*, is distinctively different and requires a new generic name, for which I propose.

Deinagkistrodon, new genus

Diagnosis.—A large pit viper attaining a length of almost a meter and a half; tip of snout with an acute, blunt-pointed protuberance formed by the greatly elongated rostral and internasals; scales of the middorsal and upper lateral rows strongly tuberculate in adults; scales of the lowermost row near the tip of the tail higher than wide; dorsal process on the palatine bone high; reproduction presumably oviparous.

The range of *Deinagkistrodon acutus*, the type species, includes east central China, northern Vietnam, and Taiwan.

Burger (1971) lumped two species, *acutus* and *rhodostoma*, together in *Calloselasma*, an action with which I cannot agree. In *rhodostoma* the dorsal scales are smooth, the scales of the lowermost row near the tip of the tail are not higher than wide, and the dorsal process on the palatine bone is more acute and pointed. The protuberance on the snout of *acutus* is unique among pit vipers that have large scales on the crowns of their heads.

The partitioning of the genus *Agkistrodon* (*sensu lato*) results in the grouping of the species as follows:

Agkistrodon: *bilineatus*, *blomhoffii*, *caliginosus*, *contortrix*, *halys*, *himalayanus*, *intermedius*, *monticola*, *piscivorus*, and *strauchi*.
Calloselasma: *rhodostoma*
Deinagkistrodon: *acutus*
Hypnale: *hypnale*, *nepa*, and *walli*

Keys to the genera and the many taxa (several species are polytypic) will be included in a monograph on the group that is nearing completion.

The name *Deinagkistrodon* (from the Greek *deinos* = "terrible") is chosen in reference to the fear and awe with which this very dangerous snake is held in many parts of its range, and the common belief that after being bitten a human victim can walk only 100 paces before collapsing in death.

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I am deeply indebted to my friend and colleague, Dr. Roger Conant, for his kind assistance and encouragement in completing this paper. This contribution includes results of a study supported by the National Science Foundation (G2896, G8702, and G19400).

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A NEW *PLATYMANTIS* (AMPHIBIA: RANIDAE) FROM NEW IRELAND, WITH NOTES ON THE AMPHIBIANS OF THE BISMARCK ARCHIPELAGO

Walter C. Brown and James I. Menzies

Abstract.—A new species of *Platymantis, P. magnus,* is described from New Ireland, Bismarck Archipelago, and its probable relationship to other platymantids in the Bismarck, Solomon, and Fiji Islands is discussed. Lists of amphibians recorded from New Ireland and New Britain are also given.

Zweifel (1960) noted the apparent impoverished nature of the amphibian fauna of the Bismarck Archipelago when the number of known species (8) was compared with the Solomon Islands to the southeast (16 species at that time, now 24) and New Guinea to the southwest (123 species). He suggested that more species, but not a large number, might be added as a result of further exploration. He further suggested that a more recent geologic origin of the Bismarck group might account for the impoverished fauna.

It is of interest, therefore, to summarize briefly the history of our knowledge of this faunal element in the Archipelago prior to 1960 and of additions to our knowledge since 1960. Werner (1900) listed a total of 5 species of amphibians, all 5 from New Britain, one each from Mioka and New Lanenburg (=Duke of York), small islands at the east end of New Britain, and none from New Ireland or New Hanover. Actually, he placed *Pelodryas militarius* Ramsay, for which the type locality is New Ireland, in the synonymy of *Hyla dolichophis* Boulenger, but failed to note this in his distributional summary. Zweifel corrected this in his 1960 paper.

Sternfeld (1920) referred a specimen from New Ireland to *Cornufer punctata,* but from his brief description we suspect that it was an example of *Platymantis papuensis schmidti.*

Hediger (1934, p. 537 ff) also listed 5 species of amphibians for New Britain with some differences. His list did not include *Hyla brachypus* or *Platymantis boulengeri,* but he recognized *Hyla* (=*Litoria*) *militaria* and *Hyla* (=*Litoria*) *infrafrenata* as distinct species and included *Rana* (=*Discodeles*) *bufoniformis.*

Zweifel (1960), as noted above, recognized 8 species on New Britain, including *Discodeles guppyi* and a new *Platymantis, P. gilliardi.* He listed only one species, *Hyla* (=*Litoria*) *infrafrenata militaria,* as occurring on New Ireland.

More intensive field work in the Bismarcks since 1960 has added greatly to our knowledge and indicates that the amphibian fauna may not be as impoverished as it appeared in 1960. Tyler (1965), with a sample of the population on New Britain, transferred *brachypus* from *Hyla* to the microhylid genus, *Oreophryne*, and in 1967 he added a second species of this family, *Sphenophryne mehelyi*. Brown and Tyler (1968) described 3 new species of *Platymantis* and Zweifel (1975) another 2, all from New Britain. It is therefore not surprising that recent field work by one of us (Menzies) and Fred Parker on New Ireland has not only added to the species known from that island but also revealed another new species of *Platymantis*. Further exploration of the forested mountains, especially of New Ireland, will doubtless reveal populations of additional species. Although no comment can be made, at this stage, on the validity of some of the names, the species presently recorded from New Britain and New Ireland are:

New Britain

Oreophryne brachypus
Sphenophryne mehelyi
Litoria infrafrenata militaria
Litoria thesaurensis
Litoria bicolor
Discodeles guppyi
Platymantis akarithymus
Platymantis boulengeri
Platymantis gilliardi
Platymantis macroceles
Platymantis mimicus
Platymantis nexipus
Platymantis papuensis schmidti
Platymantis rhipiphalcus
Rana papua novaebritanniae

New Ireland

Litoria infrafrenata militaria
Litoria thesaurensis
Platymantis magnus, new species
Platymantis papuensis schmidti
Rana papua novaebritanniae

Platymantis magnus, new species

(Fig. 1)

Holotype.—CAS 143640, adult female, collected at Madina High School, 88 km southeast of Kavieng, New Ireland, September 25, 1976, by J. I. Menzies.

Paratypes.—New Ireland: same locality as holotype, CAS 143639, UPNG 5626, 5628–30, MCZ 92671–73; Kavieng area: AMNH 98079, UPNG 4856, 5599–5600, PMAG 13233, BMNH 1977436, USNM 205190; Lamerika area: UPNG 5625.

Diagnosis.—This species differs from the other three large species of

Fig. 1. *Platymantis magnus* from Kavieng, New Ireland. Photograph by Fred Parker.

the genus (*P. boulengeri*, *P. solomonis*, and *P. vitianus*) which lack greatly dilated finger disks in the following combination of characters: (1) its very large size is indicated by snout–vent length of mature specimens (Table 1), closest to that of *P. vitianus* (but females not reaching maturity before attaining more than 80 mm snout–vent length whereas females of *P. vitianus* may reach maturity between 60 and 65 mm snout–vent length); (2) the slightly more narrow head relative to tibia length, which readily distinguishes it from *P. vitianus* and *P. boulengeri* (Table 2); (3) the diameter of the eye relative to snout length or head breadth, which distinguishes it from *P. solomonis* (Table 2); (4) the somewhat larger typanum relative to the eye, which distinguishes it from *P. solomonis*; (5) the somewhat longer tibia relative to the snout–vent length, which tends to distinguish it from all three species (Table 2); (6) the relatively smooth skin of the abdomen, which distinguishes it from *P. boulengeri* and *P. vitianus*; (7) color pattern, marked by a wide dark transverse bar across the lips at the anterior corner of the eye, the light and dark mottling of the dorsal and lateral surfaces, and the light and dark transverse bands on the limbs (Fig. 1). *Platymantis magnus* also differs in voice characters from other species in the area (Fig. 2); the call is suggestive of the yelp of a young puppy.

Description.—A very large *Platymantis*, snout–vent length 58.5–64.4 mm for 4 mature males and 82.5–99.1 for 6 mature females; head about as

Table 1. Range of snout–vent length (mm) for species of *Platymantis* in the Bismarck Archipelago. Number of specimens in parentheses.

Species	Snout–vent length (mm)	
	Male	Female
P. akarithymus	18.5–24.2 (5)	—
P. boulengeri	—	66.0–79.7 (6)
P. gilliardi	33.2–34.2 (2)	40.9–48.7 (2)
P. macroceles	—	30.2 (1)
P. mimicus	27.0–40.4 (4)	45.1 (1)
P. nexipus	—	47.1 (1)
P. papuensis schmidti	29.8–39.9 (13)	39.8–60.1 (13)
P. rhipiphalcus	28.4 (1)	—
P. magnus	58.5–64.4 (4)	82.5–99.1 (6)

broad as long in males but broader than long (104–118%) in females; snout rounded to round-pointed, its length 39–58% of head breadth and 42–44% of head length; upper jaw slightly protruding; canthus rostralis rounded to sharp-rounded; lores only moderately oblique, concave; diameter of eye 26–34% of head breadth and 69–79% of snout length; diameter of tympanum 56–73% of diameter of eye; a fold dorsal and posterior to tympanum; lateral surfaces and posterior surfaces tuberculate and the lateral surfaces with several scattered short folds; dorsal surfaces nearly smooth on largest females but with scattered short folds within dark bars on other specimens (Fig. 1); fingers slender, without webs; tips of fingers bluntly rounded (Fig. 1), not or scarcely dilated, 1st and 2nd without a circummarginal groove, 3rd and 4th in some instances with a shallow groove between dorsal and ventral surfaces; 1st finger longer than the 2nd and about equal to the 4th when adpressed; fingers with large, round-pointed subarticular tubercles; three very large metacarpal tubercles; hind limbs relatively long, length of tibia 49–56% of snout–vent length and 110–143% of head breadth; toes with small basal webs; tips of toes not or slightly dilated, depressed, with circummarginal groove between dorsal and ventral surfaces; subarticular tubercles strongly protruding, round-pointed; outer and inner metatarsal tubercles prominent, the outer round, the inner about twice as long as broad; venter nearly smooth; posterior thighs with small, low granules.

Measurements of holotype (mm).—Snout–vent length, 93.3; head length, 34.9; head breadth, 37.3; snout length, 15.4; eye diameter, 11.8; tympanum diameter, 7.4; interorbital distance, 8.0±; internasal distance, 7.7; 3rd finger length, 14.5; hind limb length, 135± (stiff); tibia length, 46.3.

Color in preservative.—Dorsum light gray to slate-gray or grayish brown, marked by darker patches or bars especially at the position of the short folds;

Table 2. Range of snout–vent length (mm) and ratios for *P. magnus* and three related large species of *Platymantis*; number of specimens in parentheses.

	Platymantis magnus	*Platymantis solomonis*	*Platymantis vitianus*	*Platymantis boulengeri*
Snout–vent length at maturity: (Male)	58.5–64.4 (4)	45.0–49.0 (6)	46.1–59.4 (4)	—
(Female)	82.5–99.1 (6)	60.0–87.0 (13)	64.5–96.4 (17)	66.0–79.7 (8)
Eye diameter / Snout length	0.69–0.79 (8)	0.83–1.01 (17)	0.67–0.84 (17)	0.70–1.00 (6)
Eye diameter / Head breadth	0.26–0.34 (16)	0.33–0.42 (17)	0.30–0.36 (17)	0.23–0.27 (6)
Tibia length / Snout–vent length	0.50–0.56 (16)	0.45–0.50 (17)	0.47–0.50 (18)	0.43–0.45 (6)
Third finger length / Head breadth	0.38–0.42 (8)	0.30–0.37 (17)	0.35–0.45 (17)	0.25–0.29 (6)
Tympanum diameter / Eye diameter	0.56–0.74 (16)	0.42–0.58 (17)	0.50–0.60 (17)	0.63–0.75 (6)
Head breadth / Tibia length	0.67–0.85 (16)	0.79–0.88 (17)	0.84–0.90 (18)	0.95–1.11 (7)
Head breadth / Snout–vent length	0.35–0.43 (16)	0.37–0.42 (17)	0.40–0.44 (18)	0.43–0.49 (8)

lateral surfaces darker or more heavily mottled; hind limbs marked by light and dark transverse bands, the darker bands wider; lips marked by wide, dark, transverse bars, the most prominent one beneath the anterior part of the eye; venter dirty white to grayish or light brown, more blotched anteriorly than on the belly.

Ecological note.—The present series was collected from garden and cocoa plantation areas in the lowlands as well as caves in the same region. The caves appear to be used primarily as a hiding place during daylight hours. Although calling males were observed on the ground under leaves or on low stumps or rocks, no egg-deposition sites have been discovered. Other habitats occupied by this species have yet to be determined.

Etymology.—The term *magnus* refers to the large size of the species.

Range.—At present, this species is known only from northern New Ireland.

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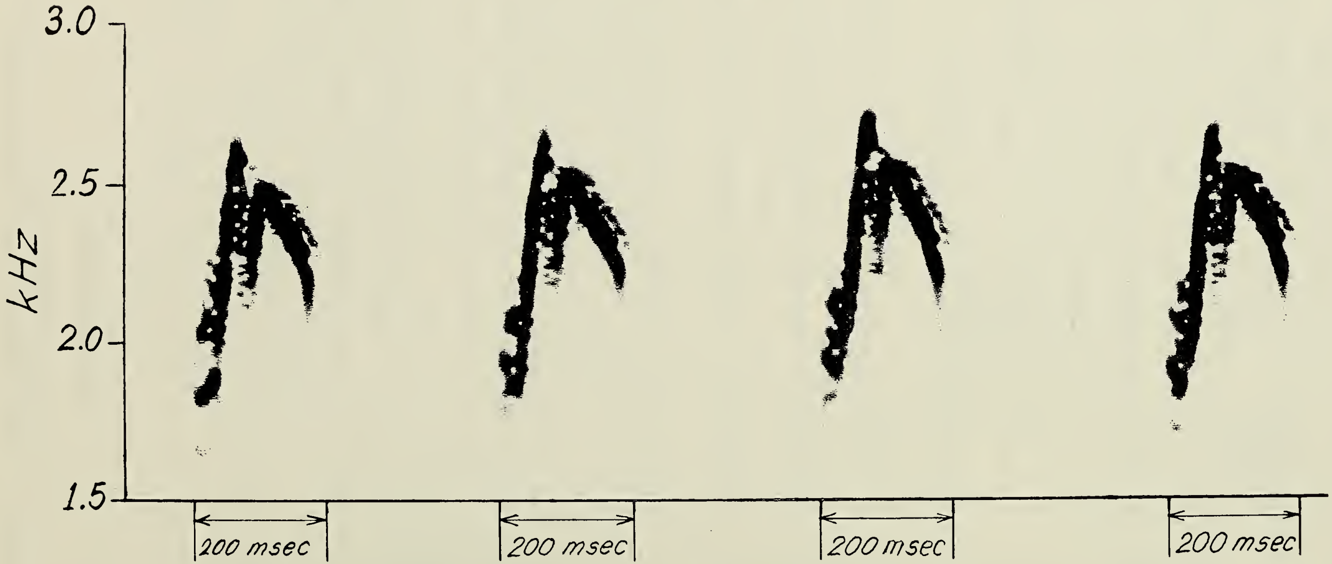

Fig. 2. Audiospectrogram of call of *Platymantis magnus*, recorded at Madina, New Ireland. Air temperature was 26.5°C. The typical call consists of a single note at intervals followed by a short series of similar notes (up to 6) then a pause for a few minutes. Each note is in fact a double note, the first lasting about 90 msecs and the second about 100 msecs.

Ernest E. Williams, Museum of Comparative Zoology (MCZ), Richard G. Zweifel, American Museum of Natural History (AMNH), Alan E. Leviton, California Academy of Sciences (CAS), Biology Department, University of Papua New Guinea (UPNG), and Harry Sakulas, National Museum and Art Gallery, Papua New Guinea (PMAG) for the loan of critical material. We also thank Fred Parker, Wildlife Division, Department of Natural Resources, Papua New Guinea, for the photograph. For the senior author this study is a part of the Pacific Islands research project under the auspices of National Science Foundation Grant GB-41947, and American Philosophical Society Grant 7796.

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THE FOSSIL RECORD OF THE GLAREOLIDAE AND HAEMATOPODIDAE (AVES: CHARADRIIFORMES)

Storrs L. Olson and David W. Steadman

Abstract.—*Paractiornis perpusillus* Wetmore, a putative pygmy haematopodid from the lower Miocene of Nebraska, is shown to be a member of the Glareolidae and provides the first fossil record for the family as well as the first record from the New World. The fossil oystercatcher *Palostralegus sulcatus* Brodkorb, from the middle Pliocene Bone Valley Formation of Florida, proves to be correctly assigned to the Haematopodidae, but the genus *Palostralegus* is here considered a synonym of *Haematopus.* A humerus from the lower Pliocene Yorktown Formation in North Carolina is referred to *Haematopus* and is the earliest and only other Tertiary record of the family.

We have recently had an opportunity to examine the three specimens that presently make up the fossil record for the families Glareolidae and Haematopodidae. Although both these families are included in the suborder Charadrii of the Charadriiformes, within that group they are not closely related and it is only through an accident of history that we are forced to consider them together here.

Glareolidae

The Recent members of this family are entirely Old World in distribution, occurring in Africa, southern Europe, Asia, and Australia. Two subfamilies are recognized, the Glareolinae, or pratincoles, which are short-legged, aerially adapted forms with a swallow-like aspect, and the Cursoriinae, or coursers, which are long-legged and terrestrial. No fossils have previously been assigned to this family. We have found, however, that the fossil *Paractiornis perpusillus* Wetmore 1930, originally proposed as a new genus of diminutive Haematopodidae, actually pertains to the Glareolidae.

The type and only specimen of *Paractiornis perpusillus* is a left tarsometatarsus (MCZ 2191) lacking only the area of the intercotylar knob (Figs. 1b, d; 2b, c). It was collected 22 August 1929 by Erich M. Schlaikjer at Carnegie Hill, Agate fossil quarry, Sioux County, Nebraska, from the Harrison Formation, Arikareean land mammal stage, lower Miocene. Although Wetmore (1930:154) stated that the similarity between the type of *Paractiornis* and modern oystercatchers was "so close that the differences listed are seen only on careful scrutiny," to our eyes the differences were so great that from the beginning of our examination of the specimen we did not doubt that *Paractiornis* was incorrectly assigned to the Haematopodidae.

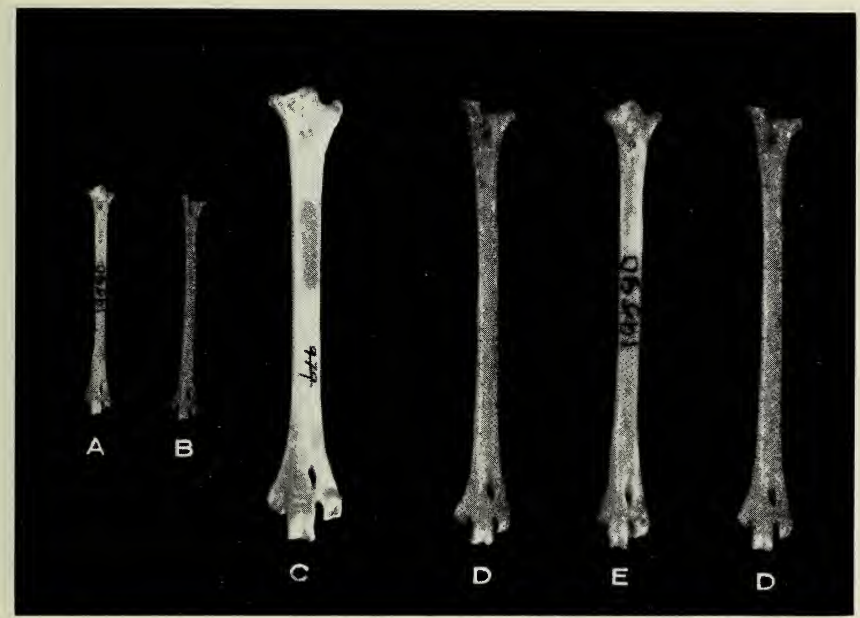

Fig. 1. Left tarsometatarsi in anterior view. *a* and *e*, *Glareola maldivarum*; *b* and *d*, *Paractiornis perpusillus*, holotype; *c*, *Haematopus palliatus*. *a–c* = 1×; *d–e* = 2×. *d* = stereo pair.

As seen in Fig. 1, there is a great difference in size between the large and heavy-bodied modern Haematopodidae (all in the genus *Haematopus*), and *Paractiornis*, which was quite small and slender (the figures of *Paractiornis* in Wetmore 1930 are 2×, not 1× as stated in the caption). The proportions of the tarsometatarsus are also very different. In *Haematopus* the tarsometatarsus is stouter and the ends are much more expanded antero-posteriorly and latero-medially relative to the shaft than in *Paractiornis*. The outer hypotarsal ridge in *Haematopus* is much shorter than the inner ridge, whereas in *Paractiornis* these ridges are of about equal length, with a closed canal between them that is lacking in *Haematopus*. The ridge extending from the hypotarsus is nearly centered on the shaft in *Paractiornis* but is shifted more medially in *Haematopus*. The inner trochlea in *Haematopus* is rotated posteriorly farther towards the midline of the shaft and has a much larger and more posteriorly protruding wing. The outer trochlea is higher relative to the middle trochlea in *Haematopus* than in *Paractiornis*. The distal foramen is proportionately larger in *Paractiornis*. These differences are quite sufficient to remove *Paractiornis* from the Haematopodidae and it only remains to be seen with which group of shorebirds it can properly be affiliated.

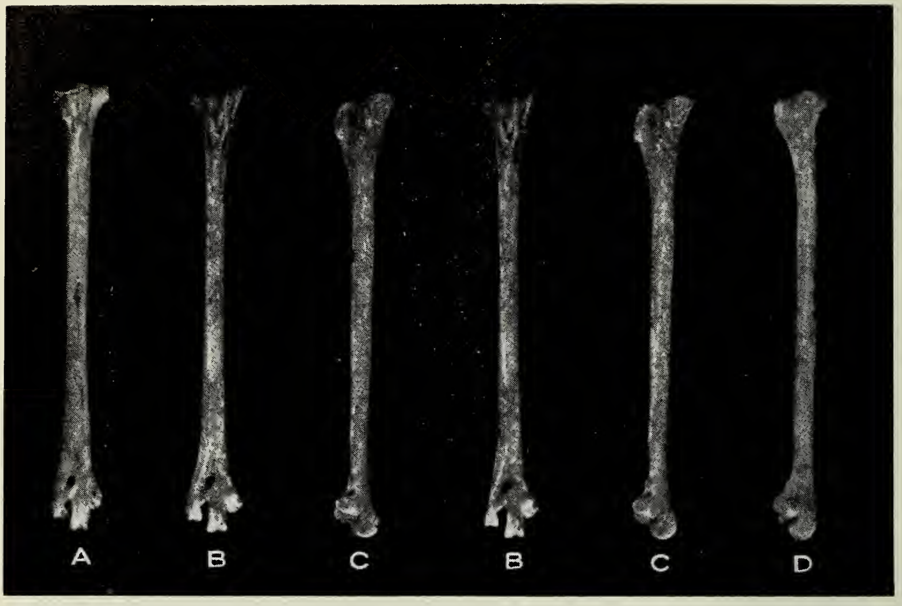

Fig. 2. Holotype left tarsometatarsus of *Paractiornis perpusillus* (*b* and *c*, stereo pairs) compared with *Glareola maldivarum* (*a* and *d*). *a–b* = posterior views; *c–d* = medial views. All figures 2×.

Paractiornis has none of the peculiarities of the tarsometatarsus of the Jacanidae (Olson, 1976). The distinctive, stout tarsometatarsus of the Thinocoridae has not the least resemblance to that of *Paractiornis*. The tarsometatarsus of the Chionididae is most similar to that of the Haematopodidae but is shorter and stouter and differs from *Paractiornis* in as many ways as does *Haematopus*. *Paractiornis* differs greatly from the Burhinidae, in which all three trochleae are more nearly in a single plane both proximo-distally and antero-posteriorly, the anterior surface of the shaft is more excavated, the shaft is almost triangular in cross section instead of square, and the distal foramen is very weakly developed. The Rostratulidae differ from *Paractiornis* in having the inner trochlea more elevated and more rotated inward towards the midline of the shaft, the inner trochlea with a larger wing, and the hypotarsus in medial view more abruptly set off from the shaft and less excavated on the medial side.

In the Charadriidae, the typical plovers (*Charadrius*, *Pluvialis*, etc.) differ greatly from *Paractiornis* in having the middle trochlea much more elongate, the inner and outer trochleae more elevated relative to the middle trochlea, and the inner trochlea more reflected. Among the lapwings, which are considered monogeneric by Bock (1958), but for which many generic names are available, great variation exists in the conformation of the distal end of the tarsometatarsus. *Vanellus vanellus* is most similar to typical plovers, whereas "*Lobivanellus*" *miles* represents the greatest departure by having the middle trochlea in posterior view short, stout and square proximally, the inner trochlea more distally located and not nearly as reflected, and the outer trochlea more distally positioned. The possible taxonomic implications of this go beyond the scope of this paper but we believe that the inclusion of all the lapwings in a single genus, *Vanellus*, is probably an oversimplification. The modern lapwings are considerably larger, with much more slender and elongate tarsometatarsi, than *Paractiornis.* In none of these forms does the hypotarsal configuration agree with that of *Paractiornis.*

Paractiornis differs from the Scolopacidae and Phalaropodidae in having the distal foramen conspicuously larger, and the inner trochlea in medial view shorter and more rounded, lacking a posteriorly expanded wing. Even with the great variation in the Scolopacidae, there is still no genus in this large family that bears a close similarity to the combination of overall proportions of the tarsometatarsus and the positions of the trochleae in *Paractiornis.*

The Recurvirostridae differ markedly from *Paractiornis* in the greatly elevated inner trochlea with a well-developed wing, the relatively smaller distal foramen, the very elongate proportions, and in much greater size. *Dromas* (Dromadidae) differs in the same ways except that the inner trochlea is not as elevated as in the Recurvirostridae. Also, the external side of the hypotarsus is more excavated than in *Paractiornis.*

In the only remaining family of Charadrii, the Glareolidae, we find a very close agreement between *Paractiornis* and the modern forms of the genus *Glareola* (subfamily Glareolinae). In the Cursoriinae, the tarsometatarsi of *Cursorius* and *Rhinoptilus* are much longer and more slender than in *Paractiornis*, the distal foramen is smaller, and the outer trochlea is relatively smaller. The hypotarsi of *Cursorius* and *Rhinoptilus* differ considerably from each other and from *Paractiornis* as well, the ridges in *Cursorius* being shorter, and in *Rhinoptilus* longer, than in the fossil. *Pluvianus* differs from *Paractiornis* in having the inner trochlea much more medially flared, the distal foramen larger, and the hypotarsus with a very short outer ridge and a very long inner ridge tapering gradually into the shaft.

The only genus in the Glareolinae besides *Glareola* is the Australian *Stiltia.* Peter Ballmann (*in litt.* to Olson, 24 April 1978) informs us that the tarsometatarsus from a skeleton of *Stiltia isabella* in the Rijksmuseum van Natuurlijke Historie in Leiden measures 48 mm, or about 50% longer than in *Paractiornis* or *Glareola pratincola*, the latter being of about the same body size as *Stiltia. Paractiornis* agrees exactly with the modern forms of *Glareola* in proportions, in the positions of the trochleae (particularly the lack of elevation and rotation of the inner trochlea), in the large distal foramen, in the lack of a distinct wing on the inner trochlea, in the conformation of the hypotarsus, and in the excavation of the medial side of the hypotarsus.

Lengths (in mm) of the various tarsometatarsi of *Glareola* compared are as follows: *Paractiornis perpusillus*, 30.8+ (slightly damaged); *Glareola pratincola*, 32.7–34.9 (n = 2); *G. maldivarum*, 31.3; *G. nordmanni*, 38.2; *G. lactea*, 20.9–21.5 (n = 3); *G. nuchalis*, 20.3–22.6 (n = 4). *Paractiornis* differs from the similarly-sized *G. maldivarum* in having the inner trochlea more medially expanded, but this condition is matched in a specimen of *G. nordmanni*. It differs slightly from the specimens of modern *Glareola* in having the middle trochlea in medial view placed more anteriorly, extending somewhat beyond the line of the shaft, but in this respect it is closely approached by the smaller species *G. lactea* and *G. nuchalis*.

On comparing *Paractiornis perpusillus* with the Recent forms of *Glareola*, it is difficult to recognize any features in the fossil that may be used to separate it generically, the greatest difference being that the distal foramen is relatively larger than in any of the specimens of modern *Glareola* available to us. However, because of the considerable age of *Paractiornis*, it would be unwise to assume that the remainder of the skeleton was as similar to *Glareola* as is the tarsometatarsus. Furthermore, as Ballman (pers. comm.) is currently studying much more extensive fossil material of Glareolidae from the Miocene of Germany that may affect the status of *Paractiornis*, we tentatively retain *Paractiornis perpusillus* as an extinct genus and species closely allied to *Glareola*.

Because pratincoles are birds of open inland country, *Paractiornis perpusillus* now fits in much better with what is known of the ecological conditions of the early Miocene in Nebraska (Webb, 1977) than it did when it was considered a stunted oystercatcher. *Paractiornis* does present a zoogeographical anomaly in that the Glareolidae are otherwise unknown in the New World. However, as the species of *Glareola* are highly aerial and several of the modern species are migratory, tending to wander rather great distances, such a range extension is within reason. It is evident that glareolids once inhabited North America, from which they have disappeared since the early Miocene. It is to be hoped that the discovery of additional fossil specimens will allow us to determine more precisely when this took place.

Haematopodidae

The oystercatchers, Haematopodidae, are a nearly cosmopolitan group of large shorebirds that are usually malacophagous residents of coasts and

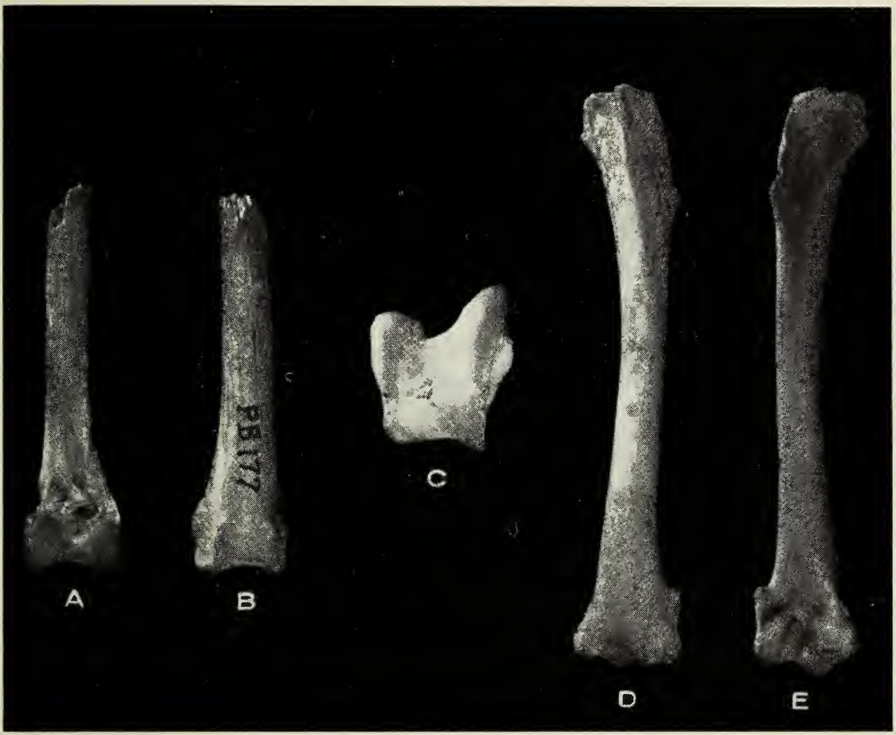

Fig. 3. *a–c*, *Haematopus sulcatus*, holotype right tibiotarsus (*a* = anterior, *b* = posterior, *c* = distal). *d*, *Haematopus* sp., right humerus USNM 215799 from Lee Creek, North Carolina, Yorktown Formation, Lower Pliocene. *a* and *b* = 1.5×; *c* = 2×; *d* and *e* = 1×.

estuaries, although there are inland populations inhabiting wet meadows, rivers, and lakeshores in Europe, Asia, and New Zealand. The species-level systematics of the group is excessively complex and poorly understood, but all of the forms are morphologically quite similar and are placed in the single genus *Haematopus*.

Haematopus sulcatus (Brodkorb)

With the removal of *Paractiornis* from the Haematopodidae, only a single recorded fossil remains for the family, apart from subfossil and archeological specimens of modern species (Brodkorb, 1967). This is the distal end of a right tibiotarsus (Brodkorb collection no. 177) from the middle Pliocene Bone Valley Formation (probably Hemphillian land mammal stage) near Brewster, Polk County, Florida (Fig. 3a–c). Brodkorb (1955) described this specimen as a new genus and species, *Palostralegus sulcatus*. We compared the type with all other families of Charadrii and confirmed that it is correctly referred to the Haematopodidae. This is particularly evident on the basis of the intercondylar sulcus in distal view being narrow, sharply perpendicular to the external condyle but sloping gradually into an anteriorly elongated internal condyle (Fig. 3c). In other Charadrii the internal margin of this sulcus is more perpendicular to the internal condyle.

Further comparison of the type with 25 skeletons representing five Recent forms of *Haematopus* reveals several inconsistencies with the generic diagnosis of *Palostralegus* (Brodkorb, 1955:20). The deeply excavated intercondylar sulcus of *Palostralegus* reported by Brodkorb is closely approached by certain individuals of *H. ater* and *H. leucopodus*. The ossified supratendinal bridge in the fossil also was supposed to distinguish it from *Haematopus*. We find, however, that in Recent *Haematopus* the tendinal bridge may be variably ossified within and between species. In a pair of *H. palliatus* taken together in Florida, the bridge is ossified in the male and unossified in the female. On the other hand, the bridge is ossified in all our specimens of *H. leucopodus*, and unossified in all specimens of *H. ater*. In any case, the condition of the supratendinal bridge is evidently worthless as a generic character. In the fossil the tendinal groove above the supratendinal bridge is deeper than in Recent species but not narrower as stated by Brodkorb (1955). The width of this "groove" cannot always be determined in Recent forms because in many specimens no impression whatever is apparent on the shaft. The internal ligamental prominence, said by Brodkorb (1955: 20) to be "slightly higher and slightly better developed" in the fossil, is extremely variable in size, shape and position in the Recent forms.

Re-examination of the supposed specific characters of *P. sulcatus* given by Brodkorb (1955:21) proves many of them to be invalid. The width through the condyles is not less than in *H. palliatus* or *H. bachmani* (Table 1). The external ligamental prominence, said to be "situated higher on shaft and more pronounced" in *P. sulcatus*, is indeed more pronounced than in *H. palliatus* or *H. bachmani*, but not more so than in *H. ater*, *H. ostralegus*, or *H. leucopodus*. The position of this structure on the shaft of the fossil is the same as in living forms. The internal condyle is deeper in the fossil than in *H. ostralegus* or *H. leucopodus*, as stated, but is not deeper than in *H. palliatus*, *H. bachmani*, or *H. ater*. The groove for M. peroneus profundus, supposedly deeper in the fossil than in *H. palliatus* or *H. bachmani*, is in fact equalled in depth by certain individuals of *H. palliatus*, *H. ater*, and *H. leucopodus*.

Characters given by Brodkorb which seem to be valid for the species *P. sulcatus* are the stout shaft (see Table 1), the more pronounced tendinal groove, and the deep intercondylar sulcus. These characters, however, seem insufficient to separate the species at the generic level from *Haemat-*

Table 1. Measurements (mm) of Haematopodidae; means in parentheses.

	Humerus				Tibiotarsus		
	Length from distal end to distal end of scar for M. pectoralis	Least width of shaft	Least depth of shaft	Distal width	Least width of shaft	Least depth of shaft	Distal width
Haematopus sulcatus	—	—	—	—	4.3	3.6	8.3
PB 177							
Haematopus sp.	62.6	6.2	4.6	14.9	—	—	—
USNM 215799							
H. ostralegus	51.8–52.5	5.0–5.1	3.6–4.0	11.6–12.2	3.3	2.9	8.4
(1♂, 1♀)							
H. palliatus	58.7–61.3	5.4–5.6	3.9–4.1	13.1–13.5	3.8–3.9	3.1	7.8–8.7
(2♂, 2♀)	(59.5)	(5.5)	(4.0)	(13.4)	(3.9)	(3.1)	(8.2)
H. bachmani	54.8–60.2	5.3–6.0	3.8–4.4	12.8–14.1	3.7–4.0	3.2–3.4	8.3–9.4
(1♂, 2?)	(57.8)	(5.7)	(4.2)	(13.6)	(3.8)	(3.3)	(8.9)
H. ater	57.8–61.9	5.6–6.2	3.9–4.6	14.3–15.5	3.6–4.3	3.0–3.6	8.8–10.3
(3♂, 6♀, 2?)	(59.8)	(5.9)	(4.2)	(15.0)	(4.0)	(3.3)	(9.6)
H. leucopodus	51.5–56.3	5.1–5.5	4.0–4.3	13.2–13.7	3.8–4.0	2.9–3.0	8.6–9.1
(3♂, 2♀)	(53.8)	(5.3)	(4.1)	(13.5)	(3.9)	(2.9)	(8.8)

opus. Therefore, *Palostralegus* Brodkorb 1955 becomes a synonym of *Haematopus* Linnaeus 1758 and its only species should now be known as *Haematopus sulcatus* (Brodkorb).

Haematopus sp.

Further to extend the Tertiary history of oystercatchers, we report here a second fossil specimen referable to *Haematopus.* This is a right humerus (USNM 215799) lacking the proximal end (Fig. 3d–e). It was received from Peter J. Harmatuk on 10 April 1975 and was collected from lower Pliocene deposits of the Yorktown Formation at Lee Creek, south side of Pamlico River, near Aurora, Beaufort County, North Carolina (see Olson, 1977). Microfossils in a matrix sample from this specimen were considered as being "probably lower Yorktown" (Thomas G. Gibson, pers. comm.).

The specimen differs from living species of *Haematopus* only in having a shallower olecranal fossa and tricipital groove. However, it is closely approached in this character by *H. leucopodus* and certain individuals of *H. ostralegus* and *H. palliatus.* In addition, the fossil has a narrow but distinct crescentic groove on the distal surface of the bicipital crest, lacking in all the forms examined except *H. leucopodus.* The fossil has a more rounded (less elongated) anterior articular ligament than observed in other specimens except certain individuals of *H. ater.*

The brachial depression is more deeply excavated, especially in its distomedial portion, than in any of the specimens examined except certain individuals of *H. ater* and *H. ostralegus.* In size the fossil is very slightly larger than in the largest species of Recent *Haematopus* examined (*H. ater*) and it is considerably more robust and larger than in *H. palliatus*, the form occurring in the same area today (see Table 1).

As the present specimen differs so little from Recent *Haematopus*, its assignment to that genus is justified. It provides the earliest record for *Haematopus* and the Haematopodidae and strengthens our contention that the specimen from Bone Valley should also be included in this genus. Because the humerus from North Carolina cannot be compared directly with *Haematopus sulcatus*, which is based on a tibiotarsus, the specimen does not warrant any further refinement of its nomenclatural status and we list it simply as *Haematopus* species.

Comparative Material Examined

For species-level comparisons, skeletons of the following taxa from the collections of the National Museum of Natural History (USNM) were examined: *Glareola maldivarum* 1, *G. nordmanni* 1, *G. lactea* 3, *G. nuchalis* 4, *G. pratincola* 2; *Haematopus ostralegus* 2, *H. palliatus* 4, *H. bachmani* 3, *H. ater* 11, *H. leucopodus* 5.

In addition, the following genera and species were used in determining the familial identity of the fossils studied in this paper: *Jacana jacana, Nycticryphes semicollaris, Rostratula benghalensis, Vanellus vanellus, V. miles, V. chilensis, V. albiceps, V. coronatus, V. cayanus, V. crassirostris, V. tectus, V. armatus, V. tricolor, V. senegallus, Pluvialis dominica, Charadrius vociferus, Bartramia longicauda, Numenius minutus, Limosa fedoa, Tringa flavipes, Tringa solitaria, Actitis macularia, Catoptrophorus semipalmatus, Heteroscelus incanum, Aphriza virgata, Limnodromus griseus, Capella gallinago, Philohela minor, Limnocryptes minimus, Calidris canutus, C. melanotos, Micropalama himantopus, Tryngites subruficollis, Philomachus pugnax, Recurvirostra americana, Himantopus mexicanus, Steganopus tricolor, Phalaropus fulicarius, Dromas ardeola, Burhinus vermiculatus, Rhinoptilus africanus, Cursorius temminckii, Pluvianus aegyptius, Attagis malouinus, Chionis alba.*

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A NEW SPECIES OF THE ENDEMIC SOUTH AMERICAN GENUS *AEGLA* FROM PARANÁ, BRAZIL (CRUSTACEA: ANOMURA: AEGLIDAE)

H. H. Hobbs III

Abstract.—The genus *Aegla* is widely distributed in streams, lakes, and salt marshes of temperate South America: Argentina, Bolivia, Brazil, Chile, Paraguay, and Uruguay (Schmitt, 1942; Bahamonde and Lopez, 1961). Currently there are 34 recognized species and subspecies of the genus, seven species having been described recently (Hebling and Rodrigues, 1977; Buckup and Rossi, 1977).

Shortly prior to his death, Dr. Waldo L. Schmitt asked if I would be interested in conducting a study of a collection of aeglids that he had amassed anticipating the preparation of a revision of his earlier monograph. Among the specimens lent to me were two lots containing representatives of the species described below that had been donated to the Smithsonian by Dr. Paulo Sawaya, Departmento de Zoologia, Universidade de São Paulo.

Aegla schmitti sp. nov.
(Figs. 1–2)

Description.—Moderately large species, attaining carapace length up to 38.0 mm (see Table 1).

Carapace slightly convex, front moderately wide. Rostrum variable, from short and lingulate to long and slender, tapering, triangular in cross section, distinctly carinate, ridge-roofed, generally exceeding eyestalk by 1–1.5 times length of cornea; carina extending posteriorly to merge with general surface of carapace at level of protogastric lobes; crest of rostral carina somewhat blunt, supporting 2 rows of corneous scales extending from level of epigastric prominences to anterior extremity of rostrum; scales closely situated and alternating from caudal end of rows to slightly anterior to level of posterior margin of orbits where forming single irregular row continuing to apex of rostrum. Rostrum sometimes slightly dorsally inclined at apex (Fig. 2*f*), but usually straight. Subrostral process (Fig. 2*f*) pronounced, conical, directed ventrally or anteroventrally.

Epigastric prominences generally low, with few small scales on summit; anterior margin of protogastric lobes only slightly raised yet furnished with one or more small distinct corneous scales. Areola somewhat variable but generally long and narrow, widening near posterior margin; lateral sutures of cardiac area converging posteriorly.

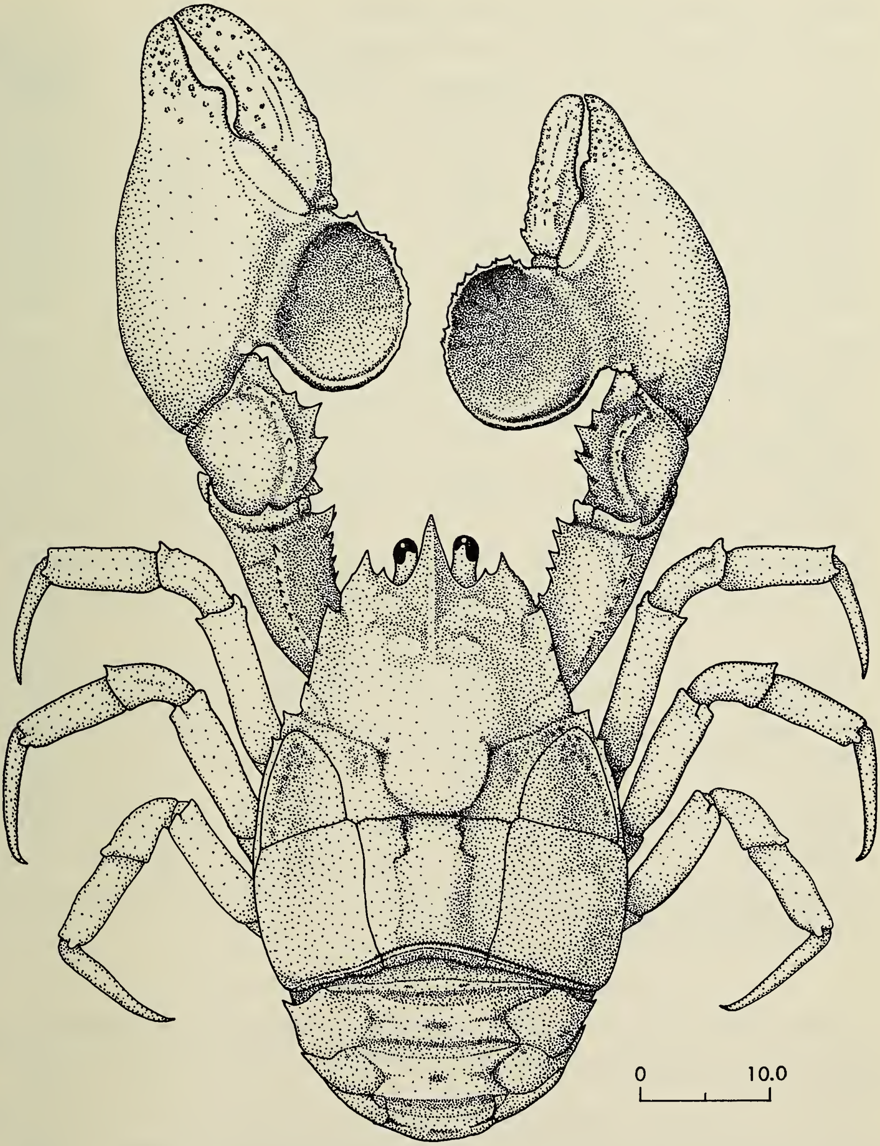


Fig. 1. *Aegla schmitti*, holotypic male (scale in mm).

Orbits moderately wide and deep, orbital spines prominent and separated from acute anterolateral spine by small to moderately wide (less than one-half width of orbital sinus) extraorbital sinus.

Anterolateral spine of carapace acuminate, reaching at least midlength

Table 1. Measurements (mm) of *Aegla schmitti*.

	Holotype	Male paratypes Range	(N = 21) Mean	Female paratype
Carapace				
Total length (CL)	31.4	25.8–38.0	31.8	24.8
Postorbital length (PCL)	26.7	21.3–30.9	26.2	20.3
Width (WC)	26.9	20.8–30.7	26.3	20.0
Length of rostrum (R)	5.0	4.4–11.9	6.2	4.6
Width of front (F)	9.4	7.8–11.7	9.9	7.7
Distance between orbital spines (D)	7.0	5.7– 8.2	7.2	5.9
Chelae				
Palm width (WP)				
Right	20.9	13.0–23.0	17.3	–
Left	21.0	12.2–21.6	15.8	–
Palm length (LP)				
Right	22.3	15.3–28.5	20.7	–
Left	27.7	17.0–32.1	22.0	–
Palm thickness (TP)				
Right	6.7	5.1–10.7	7.2	–
Left	8.9	5.3–11.3	7.9	–
Ratios				
CL/R	6.3	3.2–7.4	5.1	5.4
PCL/R	5.3	2.6–6.4	4.2	4.4
CL/WC	1.2	1.0–1.5	1.2	1.2
OS = D/2	3.5	2.8–4.1	3.6	3.0
EOS = (F-D)/2	1.2	0.8–1.9	1.4	0.9
OS/EOS	2.9	1.9–3.9	2.6	3.3
WC/F	2.9	2.2–3.1	2.7	2.6
LP/WP*	1.1	1.0–1.3	1.2	–
LP/TP**	3.3	2.0–4.9	2.9	–

* Cheliped with larger expanded palmar lobe.

** Larger of two chelipeds.

of cornea and commonly beyond. Anterolateral angle of first hepatic lobe acutely spined; second and third lobes plainly indicated but lacking distinct spines.

Chela broadly ovate and inflated; large chela with palm thick and swollen toward lateral margin. Movable finger with definite lobe on proximomesial margin, often supporting short spines or tubercles, additional ones extending distally along mesial border (Figs. 2*d*, *e*, *h*, *j*). Mesial margin of palm with extremely well developed, conspicuous, dorsally excavate, subdisciform lobe on one, and occasionally both chelae; margin of lobe distinctly cristiform upturned, or at least serrate, and furnished with small spines and scales (Fig. 1).

Carpus of first pereiopod with ridge dorsal to spined mesial margin well developed and bearing 4–9 conical tubercles (often acute conical spines) raised to or above general level of carpus; distomesial lobe of carpus broadly conical, with single small coreous spine situated near apex; ventral surface armed with 1, sometimes as many as 4, acute, conical spines. Merus with longitudinal row of moderately stout to slender spines dorsally (6–13), that situated on distal margin or that immediately proximal to it largest; remaining spines somewhat evenly spaced and regressing in size proximally; anterolateral lobe of merus with single small spine ventrally; ventral surface usually with 4 spines on mesial and 1 or 2 on lateral border. Ischium with single, well developed spine or tubercle on dorsal surface; mesial margin of ventral surface (Fig. 2*b*) with 3–5 spines, distalmost largest. Distal end of merus of second, third, and fourth pereiopods usually with small spinule (sometimes lacking, often 2) ventrolaterally.

Anteroventral angle of epimeron of second abdominal somite (Fig. 2*g*) armed with spine; posteroventral angle rounded; lateral border straight, or at most only slightly concave.

Sternal plate (Fig. 2*i*) between chelipeds with anterolateral angles produced; anteriormost part of sternite terminating in 2, sometimes one, corneous spinule.

Pubescence weak: setae virtually lacking on dorsal side of carapace, abdomen and chelae, unevenly and sparsely placed on ventral surface of latter; setae moderate on gnathal appendages, second, third, and fourth pereiopods and sternites; telson, uropods and epimera margined with closely spaced setae.

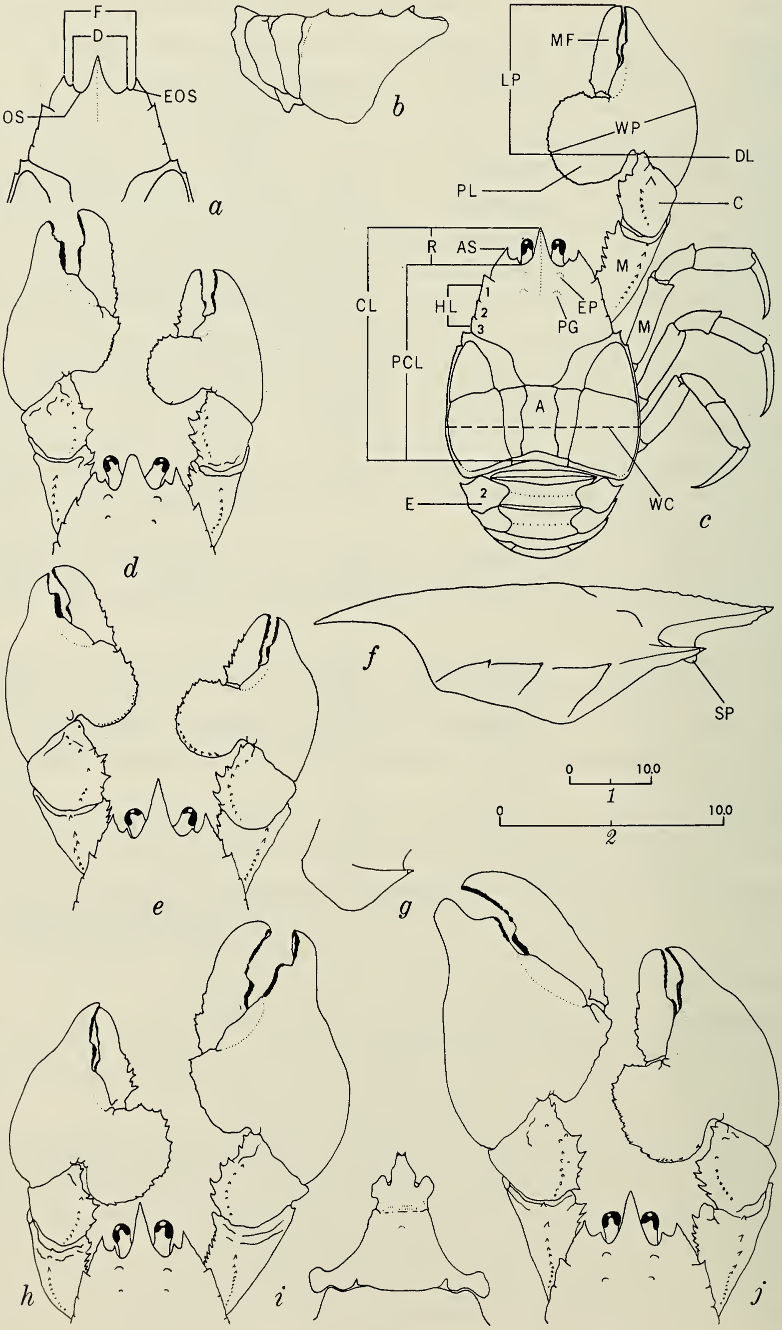
Disposition of types.—The male holotype (USNM 171276), 19 paratypic males and a single paratypic ovigerous female are deposited in the National Museum of Natural History (Smithsonian Institution). One male paratype is housed in the Museu de Ciências Naturais da Fundação Zoo-Botânica do Estado do Rio Grande do Sul, Porto Alegre, Brazil and a paratypic male is deposited in the Museu Nacional, Rio de Janeiro, Brazil.

Type-locality.—"Da dazenda Natal Cecone" (ranch of Mr. Natal Cecone), Curitiba, Brazil (no other data available).

Range.—This species is known from the type-locality and from Rio Bariguy, on the outskirts of Curitiba, Paraná, Brazil.

Size.—The largest specimen examined is a male with a carapace length of 38.0 mm (postorbital carapace length 30.9 mm). The smallest specimen examined is the lone female (ovigerous) (without chelae) having a carapace length of 24.8 mm (postorbital carapace length 20.3 mm).

Table 1 summarizes measurements obtained from the 23 specimens examined. Ringulet (1948) indicated the worth of working with numerical values to show relationships; the following ratios are listed in the table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(see Figs. 2*a*, *c*): CL/R, PCL/R, CL/W, OS(=D/2), EOS(=(F−D)/2), OS/EOS, WC/F, LP/WP, LP/TP.

Life history.—The date of the collection from Rio Bariguy is unknown; however, specimens from the type-locality were collected on 29 April 1943. Among the latter was a female carrying more than 200 eggs (see above), each approximately 1 mm in diameter.

Variation.—Like all aeglids, *A. schmitti* is quite variable. Of 18 males having both chelae, 14 possessed enlarged *left* chelae, 11 supported an expanded palmar lobe on the *right* chelae, and 5 exhibited enlarged lobes on both. Thus, the males of *A. schmitti* generally possess chelae and palmar lobes of unequal size; *left* chelae significantly larger ($P > 0.05$) than right and *right* palmar lobe significantly larger and more deeply excavate ($P > 0.05$) than left; this is consistent for specimens examined from both populations (Figs. 1 and 2*d*, *e*, *h*, *j*; Fig. 2*h* shows one of few specimens with large right chela and expanded left palmar lobe).

Relationships.—Due to the extremely broad and deeply excavate palmar lobe, this species is quite distinct from any other species of the genus *Aegla* (see Fig. 1).

Aegla schmitti has its closest affinities with *A. castro* Schmitt, and also with *A. o. odebrechtii* Müller and *A. o. paulensis* Schmitt; however, *A. schmitti* is a much larger animal than its relatives. These species share an enlarged, expanded, and noticeably excavate palmar lobe that is clearly most well developed in *A. schmitti*. This aeglid differs from *A. o. odebrechtii* and *A. o. paulensis* in that the anterodorsal angle of the epimeron of the second abdominal somite in the latter two species is rounded and not produced in a spine as it is in the former. In addition to attaining a larger size and possessing a more prominent palmar lobe on cheliped, it differs from *A. castro* in that the spine on the distomesial lobe of the carpus is distinctly smaller.

Symbionts.—The only symbionts observed on this aeglid are turbellarians

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Fig. 2. *Aegla schmitti*: *a*, Dorsal view of anterior region of carapace; *b*, Ventral view of ischium of left cheliped of holotype; *c*, Dorsal view illustrating terms and measurements used in species description; *d*, *e*, *h*, *j*, Anterior region and chelipeds of male paratypes showing variations; *f*, Lateral view of carapace of holotype; *g*, Lateral view of second abdominal epimeron of holotype; *i*, Sternum of third and fourth thoracic somites of holotype. *A*, areola; *AS*, anterolateral spine; *C*, carpus; *CL*, total carapace length; *D*, distance between orbital spines; *DL*, distomesial lobe of carpus; *E*, epimeron; *EOS*, extraorbital sinus; *EP*, epigastric prominence; *F*, "front," distance between anterolateral spines; *HL*, hepatic lobes; *LP*, length of palm; *M*, merus; *MF*, movable finger; *OS*, orbital sinus; *PCL*, postorbital carapace length; *PG*, protogastric lobe; *PL*, palmar lobe; *R*, length of rostrum; *SP*, subrostral process; *WC*, width of carapace; *WP*, width of palm. Scale in mm; scale 1: *d*, *e*, *h*, *j*; scale 2: *b*, *f*, *g*, *i*.

belonging to the genus *Temnocephala*, although, based on Dioni's (1967) observations, numerous other organisms most assuredly contribute to the epizootic community. Many egg cases of worms are found scattered over the exoskeleton, being particularly abundant around the eyestalks, antennae, suborbital process, sternal plate, and ventral side of the abdomen.

Etymology.—I am pleased to name this species in honor of the late Dr. Schmitt who contributed greatly to our knowledge of these unique freshwater crustaceans and who initiated me to a study of the aeglids.

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REASSESSMENT OF NORTHERN GEOGRAPHIC LIMITS FOR DECAPOD CRUSTACEAN SPECIES IN THE CAROLINIAN PROVINCE, USA; SOME MAJOR RANGE EXTENSIONS ITEMIZED

Gary N. Herbst, Austin B. Williams, and Billy B. Boothe, Jr.

Abstract.—Trawl samples taken in 1977 from the Cape Hatteras–Cape Lookout, North Carolina, area, together with other collections from the Carolinas during the past 15 years, have added about 70 species to the known decapod crustacean fauna of the region. Significant northward extensions of range for selected species are given. Recomputation of northern range limits given by Williams in 1965 confirms that Cape Lookout marks a zone of greater zoogeographic change than does Cape Hatteras. The area as a whole is characterized by thermal barriers, but variable substrates off Cape Lookout support a more diverse warm water fauna there.

Introduction

Many decapod crustaceans recently collected in the vicinity of a thermal front north of Cape Hatteras, North Carolina, represent significant northward extensions of ranges for species with Caribbean affinities. These extensions, combined with others reported since 1965 or known from unreported studies, are sufficiently numerous to warrant reevaluation of Williams's (1965a) summary and recomputation of his Table 1.

During 1977, a group from the University of Wisconsin under the direction of J. J. Magnuson collected trawl samples aboard the Duke University NSF sponsored vessel, R/V *Eastward*, as part of a study of this thermal front. We acknowledge funding of the immediate project by National Science Foundation Biological Oceanography Grant No. OCE77-08531 to the University of Wisconsin. The efforts and generosity of many individuals during the past 15 years have resulted in specimens and records that contribute to an increased knowledge of the Carolinian fauna. Much of such material has come through auspices of the Duke University Marine Laboratory from sampling aboard the R/V *Eastward* and *Beveridge*, and the University of North Carolina Institute of Marine Sciences from the R/V *Machapunga*, M/V *Ensign* and *Seven Brothers*, as well as miscellaneous collecting. Some information still to be reported in detail has come from the South Carolina Wildlife and Marine Resources MARMAP Program.

Material and Methods

The samples collected during the June and August, 1977, cruises of R/V *Eastward* (Nos. E-2-77 and E-5-77), consisted of 15-minute bottom trawls with a 9.14-m (30-ft) semi-balloon otter trawl having a 9.45-m headrope and an 11.6-m footrope. The body of the trawl was made of 3.8-cm nylon stretch mesh and the cod end liner of 0.6-cm nylon stretch mesh.

In June, 152 samples were collected east of Cape Lookout, N.C., and from the Cape Hatteras vicinity at depths of 28–40 m. In August, 176 samples were collected from the same areas.

Decapod crustaceans collected were fixed in 14% formalin, later preserved in 70% ethanol, and stored in either the University of Wisconsin-Madison Zoological Museum. or the National Museum of Natural History, Washington, D.C.

Results

Species not previously known from North Carolina shelf waters and representing major range exensions are listed in Table 1.

Apart from a single collection made in 1876 off the Massachusetts coast (USNM 58087), *Tozeuma serratum* A. Milne Edwards was not known to occur north of the Gulf of Mexico. During both June and August, *T. serratum* was commonly collected off the Cape Lookout and Cape Hatteras area.

Periclimenes iridescens Lebour, *Processa hemphilli* Manning and Chace, and *Pylopagurus holthuisi* Provenzano were regularly found in trawl samples at Cape Lookout and Cape Hatteras during both June and August. *Periclimenes pedersoni* Chace was regularly collected at Cape Lookout, while other species listed in Table 1 were represented in fewer than six samples (<5% of samples), or had been previously collected by others.

Two incomplete female specimens of *Processa* (carapace length 5.88 and 5.25 mm including rostrum) are closest to *P. guyanae* Holthuis in the keys to species of *Processa* given by Manning and Chace (1971) and Hayashi (1975). The smaller, more complete specimen lacks the left second leg but agrees with most other key characters for *P. guyanae* and with its original description (Holthuis, 1959). An exception is found in proportional lengths of distal articles of the fifth leg; the smaller specimen has the propodus 2.2 times the length of the dactyl rather than 4 times as in *P. guyanae.* Distal articles of the antennal peduncles are missing in both specimens, and in the larger specimen, identified by inference, most of the legs are missing.

The 13 species listed in Table 1 represent northern range extensions of forms having Caribbean affinities. Breeding populations of at least six of these species in North Carolina waters are suggested by the presence of gravid females.

Since Williams (1965a) computed the range limits for species of decapod crustaceans occurring in Carolinian shelf waters, 71 additional species have been recognized from the region (Williams, 1965b, 1974a, b; Williams *et al.*,

Table 1. Major range extensions.

Species	Range Extension	Bottom temp. °C	Specimen data	Previous northern limits and citation or USNM record
Periclimenes iridescens Lebour	NE C. Hatteras 35°32.9′N, 75°11.9′W 32 m 12 Aug. 1977 Eastward #33110	15.3	1 male	Off Panama City, Florida (Chace, 1972)
Periclimenes pedersoni Chace	E C. Lookout 34°35.5′N, 75°05.5′W 35 m 3 Aug. 1977 Eastward #32687	24.9	2 females ov.	Off West Florida, Bahamas (Chace, 1972)
Alpheus floridanus Kingsley	SE C. Hatteras 35°01.5′N, 75°30.8′W 38 m 13 Aug. 1977 Eastward #33202	25.3	1 male 1 female ov.	Northern Gulf of Mexico (Chace, 1972)
Tozeuma serratum A. Milne Edwards	NE C. Hatteras 35°32.1′N, 75°11.8′W 32 m 10 Aug. 1977 Eastward #33002	17.3	1 male 1 female ov.	Mass. Coast USNM 58087 Gulf of Mexico (Chace, 1972)
Processa aff. *P. guyanae* Holthuis	E C. Lookout 34°38.2′N, 75°09.0′W 33 m 4 Aug. 1977 Eastward #32701	26.0	2 females	Off Surinam (Holthuis, 1959)

Table 1. Continued.

Species	Range Extension	Bottom temp. °C	Specimen data	Previous northern limits and citation or USNM record
Processa hemphilli Manning and Chace	NE C. Hatteras 35°32.1′N, 75°11.8′W 32 m 10 Aug. 1977 Eastward #33002	17.3	1 male 5 females ov.	Off Southwest Florida (Manning & Chace, 1971)
Cancellus ornatus Benedict	ESE C. Fear 34°43.0′N, 70°40.0′W 90–110 m 27 Apr. 1965 Eastward #1087	—	1 female ov.	Off East Coast, Florida (Mayo, 1973)
Pylopagurus holthuisi Provenzano	NE Oregon Inlet 35°01.7′N, 75°11.2′W 33 m 9 Aug. 1977 Eastward #32943	13.7	1 male	Off South Carolina USNM 102503
Iridopagurus carribensis (A.M.E. & Bouvier)	E C. Lookout 34°36.5′N, 75°06.7′W 30 m 3 Aug. 1977 Eastward #32685	25.7	1 male	Off South Carolina (Williams, 1965) (de St. Laurent-D., 1966)
Raninoides loevis (Latreille)	SE C. Hatteras 35°03.2′N, 75°35.1′W 30 m 24 Oct. 1977 Eastward #33844	19.8	1 male C.L. 29.6 C.W. 16.2 mm	Gulf of Mexico (Bullis & Thompson, 1965) USNM 121663

Table 1. Continued.

Species	Range Extension	Bottom temp. °C	Specimen data	Previous northern limits and citation or USNM record
Coelocerus spinosus A.M.E.	SE C. Hatteras 35°03.2′N, 75°30.3′W 27 m 13 Aug. 1977 Eastward #33186	25.2	1 male juv.	East Coast, Florida USNM 169203
Hemus cristulipes A.M.E.	E C. Lookout 34°37.1′N, 76°13.0′W 38 m 1 June 1977 Eastward #31701	23.6	1 male	Gulf of Mexico (Bullis & Thompson, 1965) USNM 101581
Speocarcinus carolinensis Stimpson	E C. Hatteras 35°03.5′N, 75°25.7′W 36 m 14 Aug. 1977 Eastward #31730	23.1	1 female ov.	Off Charleston, South Carolina (Williams, 1965)

Table 2. Northern geographic ranges of decapod crustaceans found in the Carolinas.

Family	No. of species	North Cape Cod	Cape Cod	Middle Atlantic	Cape Hatteras	Cape Lookout	Cape Fear
Penaeidae	16	–	–	5	8	1	–
Sergestidae	2	1	–	–	1	–	–
Pasiphaeidae	3	1	–	–	2	–	–
Palaemonidae	16	2	2	1	4	6	1
Gnathophyllidae	1	–	1	–	–	–	–
Alpheidae	12	–	–	2	3	7	–
Ogyrididae	2	–	–	2	–	–	–
Hippolytidae	12	1	3	2	–	5	1
Processidae	6	–	–	–	3	3	–
Pandalidae	1	–	–	–	–	1	–
Crangonidae	1	1	–	–	–	–	–
Stenopodidae	1	–	–	–	–	–	1
Palinuridae	1	–	–	–	1	–	–
Scyllaridae	4	–	1	1	1	1	–
Callianassidae	4	1	1	–	–	1	1
Axiidae	2	–	–	–	–	2	–
Laomediidae	1	–	–	–	–	1	–
Upogebiidae	1	1	–	–	–	–	–
Paguridae	26	3	2	3	7	9	2
Galatheidae	6	–	1	1	1	3	–
Porcellanidae	8	–	2	1	3	1	1
Albuneidae	3	–	–	–	2	1	–
Hippidae	2	–	1	–	–	–	1
Dromiidae	4	–	–	–	4	–	–
Homolidae	1	–	1	–	–	–	–
Latreillidae	1	–	1	–	–	–	–
Dorippidae	5	–	1	–	1	2	1
Calappidae	9	1	1	1	3	3	–
Leucosiidae	9	–	1	1	4	3	–
Raninidae	4	–	–	–	1	2	1
Portunidae	18	2	5	4	2	5	–
Cancridae	2	2	–	–	–	–	–
Majidae	41	3	4	2	13	17	2
Parthenopidae	9	–	2	1	2	4	–
Xanthidae	27	2	3	–	8	12	2
Goneplacidae	7	–	–	–	5	1	1
Pinnotheridae	10	–	6	1	–	1	2
Grapsidae	7	1	1	1	1	3	–
Ocypodidae	4	–	3	1	–	–	–
Palicidae	2	–	–	–	2	–	–
No. species limit	—	22	45	30	82	95	17
Percent total	—	7.6	15.5	10.3	28.2	32.6	5.8

1968; Williams and Wigley, 1977; Guinot, 1969a, b, c; Pérez Farfante, 1969, 1971a, b, 1977; Pérez Farfante and Bullis, 1973; Manning and Chace, 1971; Chace, 1972; Mayo, 1973; USNM unpublished data). In addition, 30 other range extensions of less than 100 mi are known in the Cape Lookout–Cape Hatteras area (Herbst unpublished data). (Detailed distributional records for some species in the Carolinian Province from off Cape Fear to Cape Canaveral are also to be documented in forthcoming reports [South Carolina Wildlife Marine Resources Department, MARMAP Program]). Incorporating these new data, the northern geographic limits for the 291 decapod crustacean species known to reside in Carolinian shelf waters are grouped by family and listed in Table 2. Only verified records compared with identified material are included in this analysis.

Results indicate that the Cape Lookout–Cape Hatteras area is a major geographic barrier to 60.8% of the Carolinian decapod fauna (177 species). A secondary barrier is found at Cape Cod, Mass., where 46.4% of the fauna (45 of 97 species) that traverses the Cape Lookout–Cape Hatteras barrier reaches its northern limit.

Discussion

Williams (1965a) determined the northern range limits of the Carolinian decapod fauna, then represented by 220 species, and concluded that the Cape Lookout vicinity was an area of greater zoogeographic change in northward distribution of decapod crustaceans than that at Cape Hatteras. However, there was doubt as to whether this change was evidence for a real barrier region or a consequence of the greater collecting effort in the Cape Lookout vicinity. Our results are almost identical with those of Williams, thereby supporting his earlier findings.

Temperature has been thought to be a major factor limiting the distribution of animals in the Cape Lookout–Cape Hatteras region (Cerame-Vivas and Gray, 1966; Bowman, 1971; Briggs, 1974). At Cape Hatteras, southerly flowing cold Virginian water is diverted eastward by the northerly flowing Gulf Stream which is frequently less than 10 km from shore (Stefansson and Atkinson, 1967; Parker, 1976). Occasionally, this cold water spills past Cape Hatteras and moves inshore and southward as far as Cape Lookout where it is either diverted eastward by the shoals or moves inshore into Onslow Bay (Cerame-Vivas and Gray, 1966; Stefansson *et al.*, 1971; Hunt *et al.*, 1977). Species living in the Cape Hatteras vicinity would be occasionally exposed to intrusions of cold Virginian water. Evidence for at least temporary tolerance to cold water of decapod species having northern range limits there is indicated by the presence of some of these species in stable, cool Virginian water (June temperatures of less than 14°C) just north of Cape Hatteras.

These species include such tropical forms as *Solenocera atlantidis* Burkenroad, *Porcellana sayana* (Leach), *Dardanus insignis* (Saussure), *Iliacantha intermedia* Miers, *Portunus spinicarpus* (Stimpson), *Stenocionops furcata coelata* (A. Milne Edwards), *Mesorhoea sexspinosa* Stimpson, and *Euryplax nitida* Stimpson.

It is possible that a barrier in the Cape Lookout vicinity may be formed by the southernmost penetration of cold Virginian water, but Menzies *et al.* (1966), working on a submerged reef southeast of Cape Lookout, stated that the reef area is beyond the influence of cold shelf waters.

Sediment type and stability may be other factors influencing decapod crustacean distribution in the area near both capes. The Cape Lookout vicinity is characterized by a great diversity of bottom types including *Lithothamnion* reefs (Menzies *et al.*, 1966; Cain, 1972), tropical coral (MacIntyre and Pilkey, 1969), offshore scallop beds (Schwartz and Porter, 1977), and a virtual mosaic of sand grades. In contrast, the bottom type near Cape Hatteras is characterized by shifting fine sand and silt, with only a few small patches of coarse sand and shell fragments (Newton *et al.*, 1971; Hunt *et al.*, 1977). More species requiring specific physical habitats might therefore be expected to occur near Cape Lookout than near Cape Hatteras, giving the appearance of selective barriers to distribution at the capes. Vernberg and Vernberg (1970), working in the Cape Lookout–Cape Hatteras region similarly suggested that factors other than temperature (substrate and depth) may limit the northern distribution of species with southerly affinities.

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THE ADULT MALE OF *HARBANSUS BRADMYERSI* KORNICKER, 1978, AND A KEY TO SUBFAMILIES OF THE PHILOMEDIDAE (OSTRACODA: MYODOCOPINA)

Louis S. Kornicker

Abstract.—The adult male of *Harbanus bradmyersi* Kornicker, 1978, the type-species of the genus *Harbansus*, is described and illustrated, and sexual dimorphism discussed. A key is presented to subfamilies of Philomedidae.

In a recent paper (Kornicker, 1978) I proposed a new genus *Harbansus* with 10 species (2 left in open nomenclature). Adult males of members of the genus do not eat, and consequently die soon after mating. Therefore, they are not well represented in collections. Adult males of only *H. paucichelatus* (Kornicker, 1958) and *H. dayi* Kornicker, 1978 are known; they were described in the previous paper. A single adult male of *H. bradmyersi*, the type-species of the genus, was received too late for inclusion, and is described herein.

A key to the subfamilies of Philomedidae in the previous paper (p. 12) is incorrect in the last couplet; therefore, a new key to subfamilies is included herein.

I thank Mr. Brad Myers for the specimen described here, and Dr. Thomas E. Bowman, Mr. Brad Myers, and Mrs. Anne C. Cohen for criticizing the manuscript.

Key to the Subfamilies of Philomedidae

Bristles on list of caudal infold broad, spinous, frondlike; sensory bristle of 1st antenna of adult male with long filaments concentrated on bulbous segment occupying about proximal ⅕ or less of the bristle (proximal edge of bulb projecting backward); 3rd joint of exopodite of 2nd antenna of adult male shorter than 2nd; end joint of 6th limb with relatively slight posterior projection Pseudophilomedinae

Bristles on list of caudal infold slender, usually bare (except *Euphilomedes ferox* Poulsen, 1962); sensory bristle of 5th joint of adult male with long filaments concentrated along an elongate widened segment occupying proximal ⅓–⅔ of bristle (proximal edge of widened part not projecting backward); 3rd joint of exopodite of 2nd antenna of adult male much longer than 2nd joint; end joint of 6th limb with considerable posterior projection (except for genus *Igene* Kornicker, 1975, and some species of *Euphilomedes* Poulsen, 1962) Philomedinae

Harbansus bradmyersi Kornicker, 1978
Figs. 1–3, Pls. 1, 2

Harbansus bradmyersi Kornicker, 1978:24, Figs. 12–14, Pls. 3–6.

Holotype.—USNM 151989, adult female.

Type-locality.—Station C-2, continental shelf off Oxnard, California, depth 18.3 m.

Material.—USNM 157201, 1 adult male, sample hand-collected by diver off Oxnard, Ventura County, California, Nov. 1974, depth 40–60 m.

Distribution.—The species has been collected off Oxnard, Laguna Beach and Santa Catalina Island, California. Females have been collected from depths of 10.7–27.4 m (Kornicker, 1978:24).

Sexual dimorphism.—Sexual dimorphism in the genus *Harbansus* has been discussed by Kornicker (1978:15). The following comments concern differences in dimorphism in the 3 species of which both adult males and females are known (*H. paucichelatus, H. dayi, H. bradmyersi*).

First antenna: The 3rd and 4th joints of the 1st antennae of the adult females bear 1 and 2 ventral bristles, respectively. Equivalent bristles are present on the adult male of *H. dayi*, but are missing on the adult males of *H. paucichelatus* and *H. bradmyersi.* The c- and f-bristles are extremely long only on the male of *H. dayi.*

Second antenna: The distribution of natatory hairs and ventral spines of some exopodial bristles on males and females of the 3 species are tabulated below (+ present, – absent):

	Female		Male	
	Natatory hairs	Ventral spines	Natatory hairs	Ventral spines
H. pauchichelatus	+	+	+	+
H. dayi	–	+	+	–
H. bradmyersi	–	+	+	+

Description of adult male (Figs. 1–3, Pls. 1, 2).—Carapace elongate with rostrum broader than that of female, and with projecting caudal process; valve highest anterior to middle; dorsal margin more convex than ventral.

Ornamentation.—Each valve with 3 faint lateral ribs (Fig. 1); upper rib sloping downward slightly towards anterior end; anterior end of upper rib extending onto rostrum but not projecting past valve edge; horizontal middle rib ventral to central adductor muscle attachments; lower rib near ventral margin; surface with large shallow fossae (Pl. 1a–c) and sparsely distributed bristles, some divided (Pl. 1b, c); about 15 bristles forming row along ventral margin; bottom of fossae and area between fossae with

Fig. 1. *Harbansus bradmyersi*, adult male, USNM 157201: Lateral view of whole specimen, length 0.83 mm.

pustules with central pore (Pl. 1a, b); 2 narrow ribs present along each side of dorsal hinge (Pl. 1a, d); anterior margin of rostrum with minute nodes (Fig. 1); pair of bristles present on valve edge at inner end of incisur.

Infold: Infold of rostrum with 4 long spinous bristles (Pls. 1e, f, 2a, b); anteroventral infold with small bristle below inner end of incisur (Pls. 1f, 2c); ridge on infold of caudal process with 5 frondlike bristles (Pl. 2d, e); 1 short bristle present on posterior infold dorsal to caudal process; 5 bristles present along inner margin of infold of ventral margin in vicinity of caudal process.

Selvage: Broad lamellar prolongation with marginal fringe present along anterior and ventral margins of valves; prolongation divided at inner end of incisur.

Size: USNM 157201, length 0.83 mm, height 0.43 mm.

First antenna (Fig. 2a): 1st joint bare. 2nd joint with 1 long spinous dorsal bristle distal to middle. 3rd joint small with 2 dorsal bristles. 4th joint with 1 spinous dorsal bristle. 5th joint triangular, wedged ventrally between 4th and 6th joints; sensory bristle with abundant filaments on bulbous proximal part (complete filaments not shown in illustrated limb) and stem with 4 or 5 marginal filaments. Medial bristle of long 6th joint with short marginal spines. 7th joint: a-bristle spinous, about same length as bristle of 6th joint; b-bristle about twice length of a-bristle, with 3 marginal filaments and 2 spines at tip; c-bristle longer than sensory bristle of 5th joint, with 8 marginal filaments and 2 spines at tip. 8th joint: d- and e-bristles

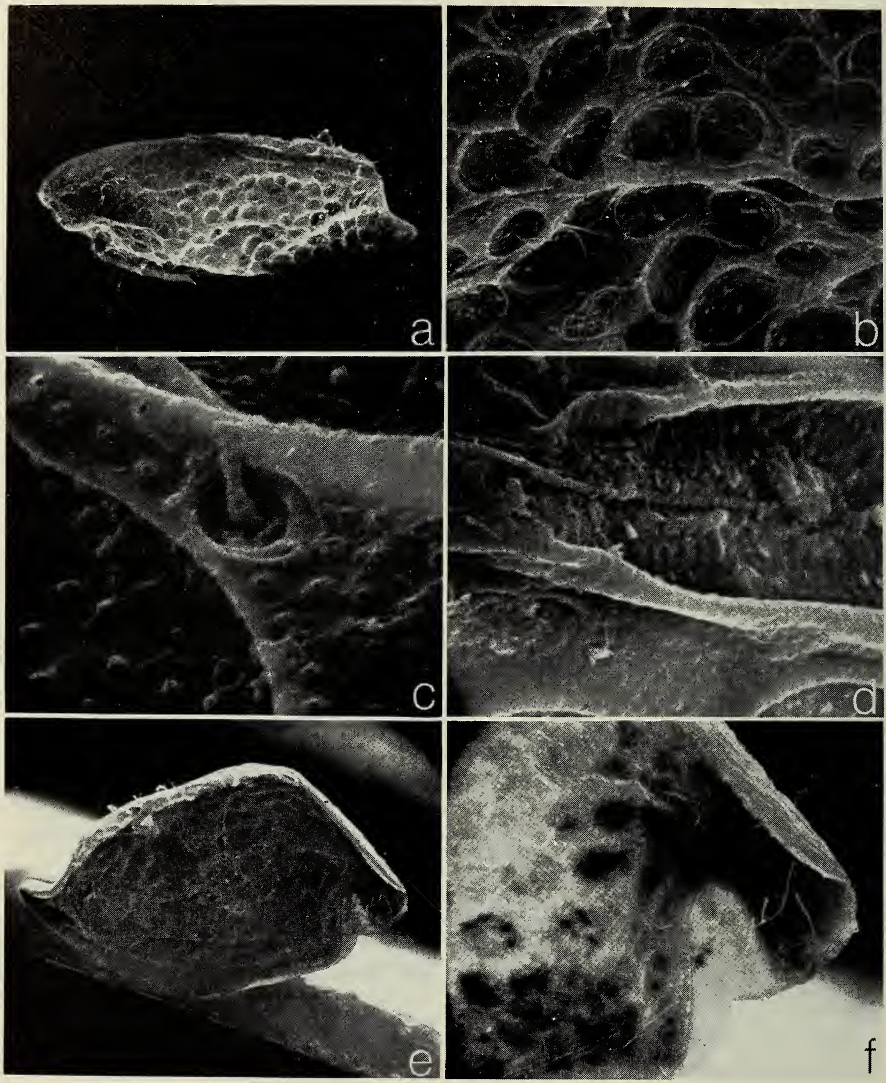

Plate 1. *Harbansus bradmyersi*, adult male, USNM 157201: a, Oblique dorsal view of left valve with narrow strip of dorsal part of right valve attached, × 120; b, Fossae near middle of a, × 500; c, Bristle just below middle of b, × 5,000; d, Dorsal view of anterior end of hingement, from a, × 2,000; e, Inside view of right valve, × 80; f, Rostrum and incisur shown in e, × 300. Magnifications given are those at which the micrographs were made on SEM; these have been reduced 43% for publication.

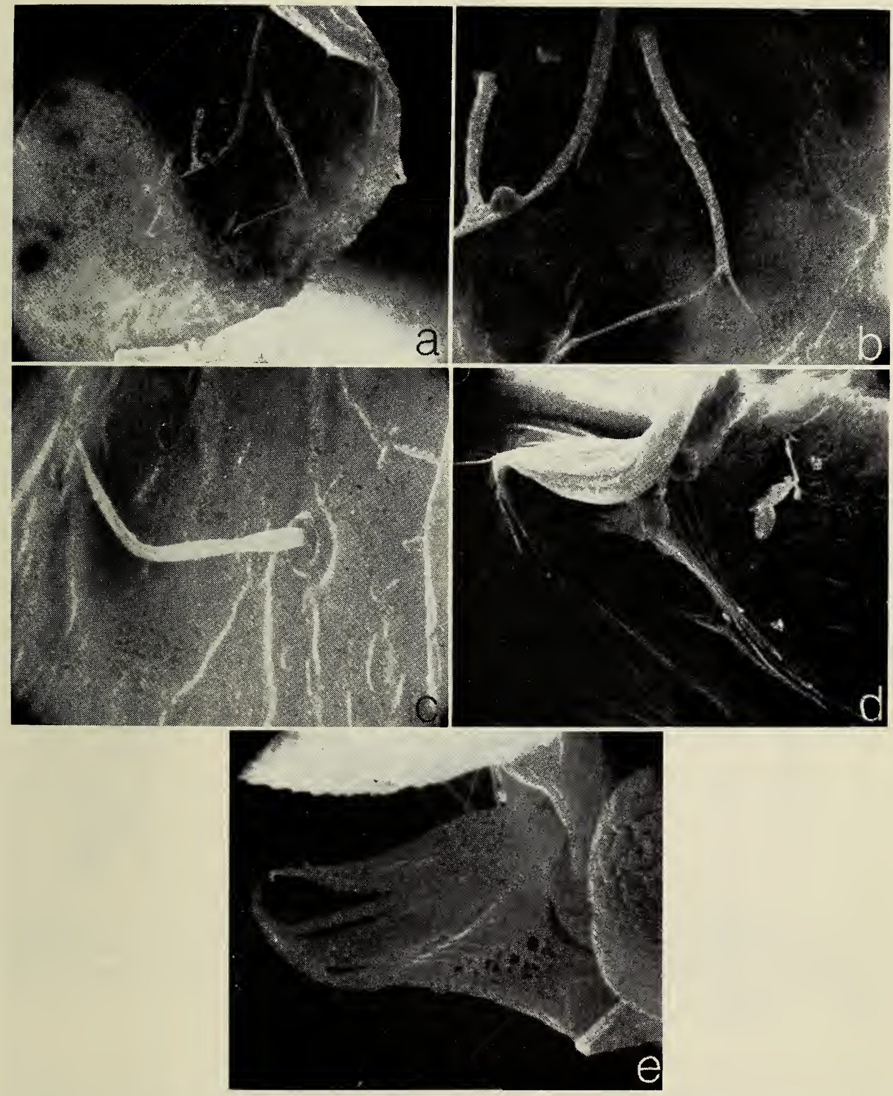

Plate 2. *Harbanus bradmyersi*, adult male, USNM 157201: a, Bristle on rostral infold, from Plate 1f, × 680; b, Detail of bristles shown in a, × 1,650; c, Bristle near inner end of incisur, from Plate 1f, × 3,200; d, Inside view of caudal process, from Plate 1e, × 480; e, Detail of bristle on infold of caudal process, from d, × 3,200. Magnifications given are those at which the micrographs were made on SEM; these have been reduced 43% for publication.

Fig. 2. *Harbansus bradmyersi,* adult male, USNM 157201: a, Right 1st antenna, medial view, only proximal ends of filaments of sensory bristle shown; b, c, Endopodites of left and right 2nd antennae, medial views; d, Left mandible, medial view; e, Left maxilla, medial view; f, Detail of exopodite of maxilla shown in e.

slightly shorter than c-bristle, bare with blunt tips; f-bristle slightly shorter than c-bristle, with about 9 marginal filaments and 2 spines at tip; g-bristle about same length as c-bristle, with about 5 marginal filaments and 2 spines at tip.

Second antenna (Fig. 2b, c): Protopodite bare. Endopodite 3-jointed: 1st joint short with 3 short anterior bristles; 2nd joint elongate with 2 long proximal bristles; 3rd joint elongate, reflexed, with 2 short bristles near sclerotized beaklike tip, and faint proximal process on inner concave margin. Exopodite: 1st joint elongate with minute terminal recurved medial bristle;

Fig. 3. *Harbansus bradmyersi*, adult male, USNM 157201: a, Tip of 5th limb; b, Right 6th limb, medial view; c, Tip of 7th limb; d, Posterior of body showing right lamella of furca, right Y-sclerite, and both copulatory limbs; e, Anterior of body showing right lateral eye, medial eye, bellonci organ, and upper lip.

2nd joint slightly larger than 3rd joint; bristle of 2nd joint with 3 proximal hairs on dorsal margin followed by about 6–10 stout spines on ventral margin, and also natatory hairs on both margins; bristles of joints 3–8 longer than bristle of 2nd joint, with more proximal hairs on dorsal margin than on bristle of 2nd joint, with ventral spines decreasing from 6 on bristle of 3rd joint to 2 on bristle of 8th joint, and with natatory hairs on both margins; 9th joint with 2 bristles (dorsal bristle shorter than ventral bristle and with slender marginal spines followed by natatory hairs; ventral bristle with natatory hairs); joints 2 to 7 or 8 with faint spines along dorsal margin, but no basal spines; segments of bristles bearing stout spines longer than segments of bristles having natatory hairs.

Mandible (Fig. 2d): Coxale endite not observed. Basale: medial surface with 2 short bristles near ventral margin (1 proximal, 1 near middle); ventral margin with 1 long spinous subterminal bristle; dorsal margin with 3 long bristles (2 terminal, 1 distal to middle); lateral surface with 2 spinous bristles with bases on or near ventral margin. Exopodite spinous, reaching just past middle of dorsal margin of 1st endopodial joint, with 1 long and 1 short bristle. 1st endopodial joint with medial spines and 3 ventral bristles (2 long, 1 short). 2nd endopodial joint with medial spines; ventral margin with bristles forming 2 distal groups, each with 2 bristles; middle of dorsal margin with 5 bristles. 3rd endopodial joint with 2 long claws, 2 ventral bristles, and 1 small dorsal bristle.

Maxilla (Fig. 2e, f): Limb reduced; exopodite relatively well developed with 3 ringed bristles; coxale with ringed distal bristle; remaining bristles of limb weakly developed, unringed.

Fifth limb (Fig. 3a): Endites and exopodite weakly developed. Endite I with 2 weak bristles; endite II with 3 or 4 weak bristles; endite III with 1 ringed bristle and 5 weak unringed finger-formed bristles. Exopodite: 1st joint with 2 finger-formed bristles; 2nd joint obscure; outer lobe of 3rd joint with 2 ringed bristles; inner lobe of 3rd joint with 3 unringed bristles (these could be on 2nd joint); end joint with 5 ringed bristles. Epipodial appendage with 40 hirsute bristles.

Sixth limb (Fig. 3b): Endite I with 3 short spinous bristles; endite II narrow, with 2 long spinous bristles; endite III with 5 spinous bristles; endite IV separated from end joint by marginal indentation, with 5 spinous terminal bristles. End joint with 4 spinous anterior bristles separated by space from 2 stout hirsute bristles. 1 bristle in place of epipodite. Limb hirsute.

Seventh limb (Fig. 3c): Each limb with 4 terminal bristles, 2 on each side; each bristle with 4 bells; terminus with comb with 5 teeth opposite 2 minute pegs.

Furca (Fig. 3d): Each limb with 6 claws; claw 3 shorter and weaker than claw 4; each claw with rows of teeth of fairly equal length along posterior margin; long hairs present medially at bases of claws; faint minute spines present on lamella between claws 5 and 6 and following claw 6.

Bellonci organ (Fig. 3e): Elongate with about 7 faint sutures in proximal half; tip rounded.

Eyes (Fig. 3e): Medial eye small, pigmented. Lateral eye 2 or 3 times diameter of medial eye, pigmented, with about 13 ommatidia.

Upper lip (Fig. 3e): Helmet shaped.

Genitalia (Fig. 3d): Each limb elongate, lobate, with bristles on each lobe, terminal lobe with sclerotized process with marginal teeth.

Y-sclerite (Fig. 3d): Branching distally (typical for family).

Ectozoa: Minute ovoid objects of unknown affiliation attached to inner side of valves near caudal process (Pl. 2d, e).

Remarks.—The sloping upper rib on the carapace of the adult male of *H. bradmyersi* resembles that of the female *Harbansus* species B described by Kornicker (1978:49). Carapace microstructures (revealed by SEM micrographs of the adult male *H. bradmyersi* and *Harbansus* species B) also are similar. The adult male described herein is referred to *H. bradmyersi* rather than to *Harbansus* species B because it was collected near Oxnard, California, where females of *H. bradmyersi* had been collected, and because its small size indicates that it is *H. bradmyersi. Harbansus* species B is known only from 1 specimen from Santa Rosa Island, California; additional collections from Santa Rosa Island might show that *Harbansus* species B is conspecific with *H. bradmyersi.*

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REDESCRIPTIONS AND ILLUSTRATIONS OF SOME PRIMNOID OCTOCORALS FROM JAPAN

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Abstract.—Seven species of the octocoral family Primnoidae from Japanese waters are described and illustrated, based on original material described by K. Kinoshita in the Zoological Institute, Tokyo University, and on a specimen in the Seto Marine Biological Laboratory. These descriptions and figures of *Arthrogorgia ijimai*, *Calyptrophora kerberti*, *C. japonica*, *Narella megalepis*, *N. irregularis*, *N. horrida*, and *N. biannulata* amplify the original ones and clarify the status of the species involved.

Introduction

The descriptions and illustrations of Japanese primnoid octocorals presented in this paper were prepared many years ago by Professor H. Utinomi for a projected revision of the subfamily Calyptrophorinae to be under our joint authorship. Regrettably, the pressure of other work and a change in my professional affiliation precluded the completion of this project, which was to include several new species from diverse parts of the world in addition to those already known at the time. Present circumstances and research commitments make it most unlikely that this joint undertaking ever can be completed as planned. In order that Prof. Utinomi's descriptions and exquisite drawings not be lost to science, I have edited them for press as he originally prepared them, with only such minor changes as were required to accommodate the present format of the *Proceedings*. It is with the deepest regret, and with the sincerest apologies to Prof. Utinomi, that I am unable to add my own observations to his outstanding contribution to our knowledge of the primnoid octocorals.

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Systematic Descriptions

Arthrogorgia ijimai (Kinoshita)

Fig. 1

Calyptrophora ijimai Kinoshita, 1907:234.
Arthrogorgia membranacea Kükenthal & Gorzawsky, 1908a:626.—Kükenthal & Gorzawsky, 1908b:29, pl. 2, figs. 10–11.
Calyptrophora (*Arthrogorgia*) *ijimai*.—Kinoshita, 1908a:59, pl. 4, fig. 28; pl. 6, fig. 54.—Kinoshita, 1909:7, pl. 1, fig. 1.
Arthrogorgia ijimai.—Kükenthal, 1919:477.—Kükenthal, 1924:320.

Calytrophora ijimai.—Nutting, 1912:16, fig. 2–3.—Broch, 1935:26, figs. 15–16.

Description.—Two specimens (holotype and paratype), preserved in the collection of the Zoological Institute, Tokyo University, were re-examined. As the holotype was fully described by Kinoshita (1908:59), the following description of the paratype may be useful as supplement.

The colony is 8 cm in height and arises off the first branch 7 mm above the base. The undivided, erect branchlets issue alternately along the sides of the main stem and first branch at intervals of about 5 or 6 mm, forming an angle of about 30°–40° to the axis. Thus the colony is not branched exactly in one plane, although flabellate. The cortex of the stem and main branch is peculiarly modified to form a membranous expansion connecting the proximal portion of twigs; it is entrely covered on both sides with somewhat modified cortical scales. The axis is cylindrical, longitudinally striated and 2 mm in diameter at its base. It is brown in color, becoming paler distally, and has a metallic luster throughout.

All the zooids facing downward are arranged in whorls of mostly 4 or 5, rarely 3. In 3 cm of axial length there are usually 11–13 whorls, about 2 mm apart. The zooids (Fig. 1, *a*, *b*) are 1.5 to 2.5 mm long including the buccal spines, measured parallel to the axis. They are formed of two pairs of large, spinose, abaxial body scales, two pairs of small, adaxial body (buccal) scales (and rarely one or a pair of inner lateral marginals), and the usual eight operculars. Between the body scales and the cortical scales, about 1 mm apart in large zooids, there are 2 or 3 transverse rows of infrabasals (usually abaxial in 2 or 3 pairs, lateral in 2 pairs and adaxial in 2 or 3 pairs, alternately arranged). The tentacles contain small, flat rods which are transversely disposed in the proximal part, becoming more or less longitudinal distally.

The basal and buccal body scale pairs are always open adaxially and connected abaxially with a simple or sinuous sutural line. The basal pair (Fig. 1, *d*) bears on its free edge a pair of long, slender, finely serrated spines, reaching 2 mm in length[1]; the inner articulating ridge connecting the bases of these spines is prominent and straight. The buccal pair (Fig. 1, *c*) bears two pairs of short marginal spines of which the frontal (dorsal) one is always stronger than the lateral. In the holotype, however, there are often found a pair of additional spinelets between the usual larger spines in the well-developed basal scales, and also two pairs of additional spinelets (each one between larger spines) on the buccal scales. Both basal and buccal scales are sculptured externally with tubercles, particularly around the nucleus. Normally there are two pairs of adaxial buccal scales and rarely one or a pair of vestigial inner lateral marginals between the abaxial buccal pair and operculars (Fig. 1, *b*, *c*).

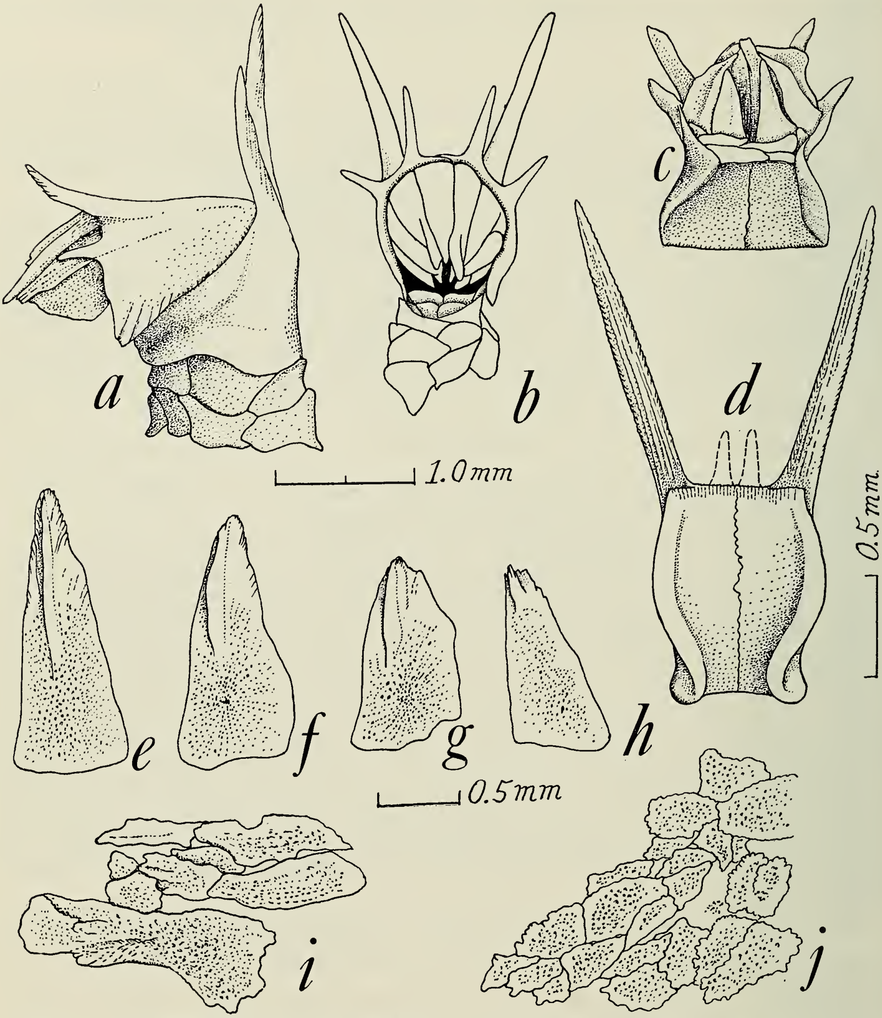

Fig. 1. *Arthrogorgia ijimai* (Kinoshita): *a*, Typical zooid, side view; *b*, Same, adaxial view (1.0 mm scale applies to *a*, *b*); *c*, Buccal part of zooid, from adaxial side; *d*, Inner face of basal scale pair (0.5 mm scale at right applies to *c*, *d*); *e*, Abaxial; *f*, Outer lateral; *g*, Inner lateral; *h*, Adaxial opercular scales, from inside; *i*, Scales of twig rind, outer face; *j*, Scales of membrane, outer face (0.5 mm scale at bottom applies to *e*–*j*).

The operculum is prominently protruding and consists of eight, tall triangular scales, each with more or less sharp apex and a moderately developed inner keel which is not so high as in other Calyptrophorines. The abaxial operculars are the largest and the adaxials the smallest, about two-thirds as long as the abaxial ones (Fig. 1, *e*–*h*).

The branches and stem are covered with a thin layer of comparatively small, flattened, irregular scales, which overlap one another. These cortical scales are mostly elongate or polygonal in outline, thin and sculptured with minute warts more or less radially arranged; those on the twig rind are rather elongate and have slightly raised margins, while those on the membrane are mostly polygonal and flattened throughout (Fig. 1, *i–j*).

Scale measurements (length × breadth or length only).
Basal scales (without spines): 1.3 × 0.8 mm.
Distal spine of basal scales: 1.5 mm long.
Buccal scales (without spines): 1.0 × 1.2 mm.
Spines of buccal scales:
1.0 mm long (dorsal), 0.5–0.6 mm long (lateral).
Adaxial buccal scales: 0.3 × 0.47 mm.
Adaxial operculars: 0.6 × 0.28 mm.
Inner laterals: 1.0 × 0.4 mm.
Outer laterals: 1.2 × 0.38 mm.
Abaxial operculars: 1.3 × 0.4 mm.

Occurrence.—(Holotype) Otaba Bank in Sagami Bay, 550 fathoms. 20 May 1905. K. Aoki coll. (Paratype) Okinose Bank in Sagami Bay, 400 fathoms. 15 Feb. 1907. K. Aoki coll.

Distribution.—This species has been recorded only from Japanese waters, *i.e.* Sagami Bay (Kinoshita; Kükenthal & Gorzawsky); south of Omae-saki (*Albatross* stations 5079, 5080), 475–505 fathoms; off Joga-sima, Sagami Bay, 614 fathoms (Nutting), N.E. of Sagalien, Ochotsk Sea, 54°53′N, 144° 00′E, 515 m (Broch).

Remarks.—A comparison of all previous descriptions given by Kinoshita, Kükenthal & Gorzawsky, and Broch with that here presented, suggests that this species shows a considerable variation in number and arrangement of the infrabasal scales, irrespective of the size as well as the height of zooid. The presence, though occasional, of marginal scales in the inner lateral rows which has been overlooked by previous authors, is also of much interest, since it shows a clear affinity to other described species of this genus, such as *Arthrogorgia kinoshitai* and *A. otsukai* (Bayer, 1952).

Calyptrophora kerberti Versluys
Fig. 2

Calyptrophora kerberti Versluys, 1906:105, figs., 134–139.

Calyptrophora (*Paracalyptrophora*) *kerberti.*—Kinoshita, 1908:63, pl. 4, fig. 29.—Kinoshita, 1909:8, pl. 1, fig. 2.

Calyptrophora kerberti.—Nutting, 1912:59.—Kükenthal, 1919:472.—Kükenthal, 1924:318, fig. 173.

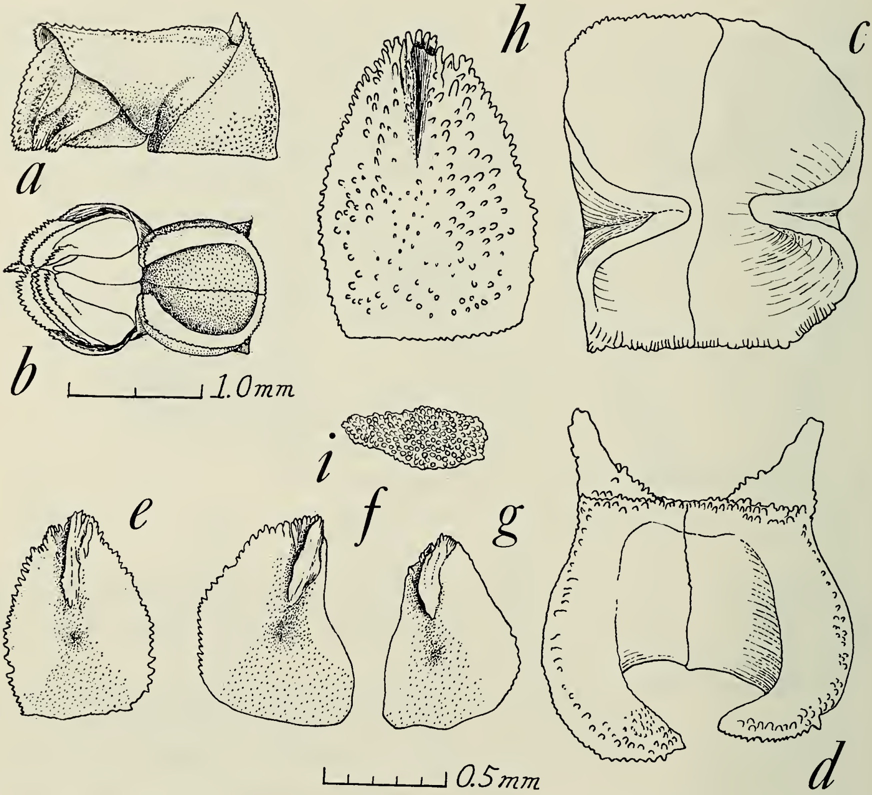

Fig. 2. *Calyptrophora kerberti* Versluys: *a*, Typical zooid, side view; *b*, Same, adaxial view (1.0 mm scale applies to *a*, *b*); *c*, Buccal scale pair, inner face; *d*, basal scale pair, inner face; *e*, Abaxial; *f*, Outer lateral; *g*, Inner lateral opercular scales, from inside; *h*, Abaxial opercular scale from another zooid, from outside; *i*, Rind scale, outer face (0.5 mm scale applies to *c–i*).

Description.—The present material, in the collection of the Zoological Institute, Tokyo University, corresponding to Ex. 6 given in Kinoshita's paper (1908a:65), is 10.5 cm high and 10 cm wide. The colony is dichotomously branched in two planes facing each other, and both planes of branching are strongly convex outward especially in the middle part. The axis is cylindrical, colored black with greenish metallic sheen, and not so distinctly striated as in the other species. The zooids, many of which are broken off, face downward in whorls of 4 to 6, usually 5; there are about 11–12 zooid whorls in 3 cm of axial length. These whorls are, at least in the distal part, regularly arranged but toward the base they are irregular and the zooids are sometimes isolated.

Each zooid (Fig. 2, *a*, *b*) is pillow-shaped, usually 2 mm long parallel to the axis and the intervals between them are about 0.5–2 mm. The two pairs of body scales, basal and buccal, are articulated at a right angle dorsally and the former scale is about half as long as the latter excluding the terminal spines. Both sclerite pairs are open adaxially and do not form complete rings. The basal pair (Fig. 2, *d*) is thick and bears a pair of short, broad spines about 0.3–0.5 mm long at its distal end, and a strongly tuberculated articulating ridge at the apical margin of the inner face. The buccal pair (Fig. 2, *c*) is plain on its free margin without any process, but is slightly keeled and serrated outside along the abaxial suture. The operculum is high and projects prominently from the buccal pair, so that its distal end almost touches the bark of the axis.

The opercular scales (Figs. 2, *e–h*) are roughly triangular in shape, each with a strong but short inner keel; the outer margins are strongly serrate, and the outer surface is tuberculate. The abaxials are the largest, about 0.9 mm long and 0.5 mm wide and the adaxials the smallest, about 0.6 mm long and 0.4 mm wide. The adaxial buccal (marginal) scales are usually absent, but vestigial scales often are present. Kinoshita recognized a considerable variation in the number of adaxial buccal scales, from 0 to 5 in six examples. Rind scales (Fig. 2, *i*) are irregular in outline but mostly elongate, with tubercles on both faces, up to 1 mm long.

Occurrence.—Sagami Bay, 400–450 fathoms. 5 Aug. 1893. Prof. K. Mitsukuri coll.

Distribution.—Known only from Japan. Versluys' original specimens from Hilgendorf's collection are probably from Sagami Bay.

Calyptrophora japonica Gray
Fig. 3

Calyptrophora japonica Gray 1866:25, fig. 1.—Gray, 1870:42, fig. 13.—Wright & Studer, 1889:50.—Versluys, 1906:113, pl. 10, figs. 27–29.—Kinoshita, 1908a:66, pl. 4, figs. 30–35.—Kinoshita, 1909:9, pl. 1, figs. 3–4.—Nutting, 1912:58.—Kükenthal, 1919:475.—Kükenthal, 1924:319.—Aurivillius, 1931:304.—Stiasny, 1951:28.

not *Calyptrophora japonica* Nutting, 1908, p. 578 (=*C. clarki* Bayer, 1951: 40).

Description.—Two specimens from Sagami Bay were examined. One of them, corresponding to Ex. 6 shown in Kinoshita's paper (1908a:66, pl. 4, fig. 34), is a small colony situated on a pebble, about 10 cm in total height, bearing branches about 6 cm long. The colony is dichotomously branched, normally in "lyre," or better, "bipectinate" form. The axis is round in cross section in the proximal portion, while hgher up it is flattened in the plane of branching; it is greenish brown with a metallic sheen proximally, lightening distally.

Zooids on branches occur in whorls of 5 to 7, mostly 6, and face upward;

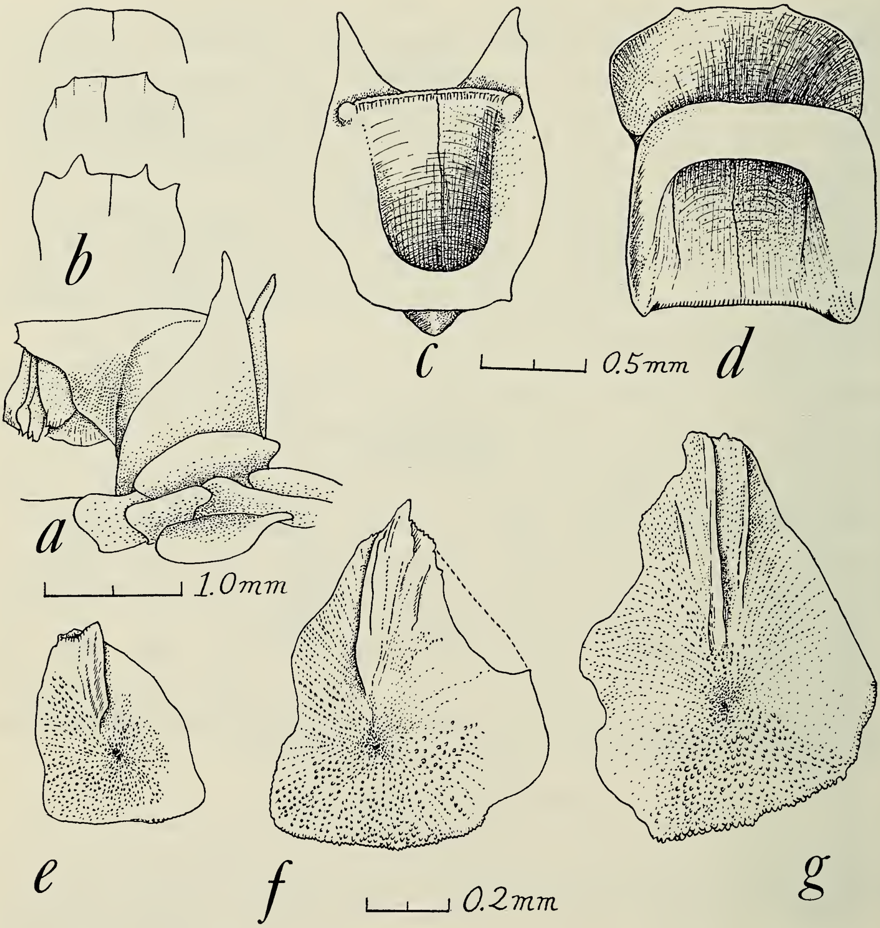

Fig. 3. *Calyptrophora japonica* Gray: *a*, Zooid, side view; *b*, Outline of free margin of buccal scale showing variation (1.0 mm scale applies to *a*, *b*); *c*, Basal scale ring, inner face; *d*, Buccal scale ring, inner face (0.5 scale applies to *c*, *d*); *e*, Adaxial; *f*, Outer lateral; *g*, Abaxial opercular scales, from inside (0.2 mm scale applies to *e*–*g*).

in 3 cm of branch length there are 12 whorls. On the main stem lower than the base of branches, however, they face downward throughout the length of 2 cm. In one branch of another specimen, a few downward-facing zooids exist between normally upward-facing ones. Each zooid, about 2 mm long, including the buccal spines, is surrounded by two pairs of large sclerites fused to form complete rings.

The basal ring (Fig. 3, *c*) bears distally a pair of short and broad spines which are only about 0.3–0.6 mm long. The buccal ring (Fig. 3, *d*) bears often 4 slightly or distinctly projecting, short processes on the free edge; sometimes it is plainly margined, showing no process (Fig. 3, *b*). The strength of these processes is subject to considerable variation, as described in detail by Versluys (1906) and Aurivillius (1931). Both the basal and buccal scales are apparently smooth externally, except for the bases of the terminal processes, which are slightly ridged. Normally there is one pair of abaxial infrabasal scales between the basal ring and the rind scales; when intact, they are transversely oval scales, up to twice as large as the adjacent rind scales and curved to fit the zooid base (Fig. 2, *a*).

The operculum is well developed and formed of eight roughly triangular scales, bearing each a prominent inner keel running from the somewhat laciniate distal end (Fig. 3, *e–g*). The rind scales are thick, very variable in shape, though mostly oblong, up to 0.7 mm in length. They are slightly depressed on the upper face and thickly covered with coarser warts on the under face.

Occurrence.—One colony in the collection of the Zoological Institute, Tokyo University: Okinose Bank in Sagami Bay, 330 fathoms; January 1899.

A fragment in the collection of the Misaki Marine Biological Station of Tokyo University: Yodomi near Okinose in Sagami Bay, 400 fathoms; 12 Dec. 1898.

Distribution.—Japan (type-locality): Sagami Bay; West of Kyushu, 160–640 meters (Gray, Kinoshita, Nutting, Aurivillius). Fiji Islands, 1,100 meters (Wright & Studer). Off Bourbon, Indian Ocean (Wright & Studer, Stiasny). Malay Archipelago, 400–1,301 meters (Versluys).

Narella megalepis (Kinoshita)
Fig. 4

Stachyodes megalepis Kinoshita, 1908a:47, pl. 3, figs. 21–22; pl. 6, fig. 50.—Kükenthal, 1919:458.—Kükenthal, 1924:310, fig. 169.
?*Stachyodes megalepis*.—Nutting, 1912:59.

Description.—The specimen referable to this species is only a small fragment, namely an incomplete branch 63 mm in length and 6 mm in diameter including whorls of zooids. The type colony is, according to the original description, dichotomously branched in one plane, almost penniform. The axis is brownish yellow, with a golden luster and a little flattened in the plane of branching (1 × 0.7 mm in cross section).

Zooids occur in whorls of 9–10 (according to Kinoshita, 5–8) closely set; 12 (according to Kinoshita, 9–11) whorls of zooids occur in 3 cm of axial length. The zooid body (Fig. 4, *a–c*) is surrounded by three pairs of large scales, of which the breadth *in situ* is almost the same. None of the pairs meet adaxially; the free edges of all three pairs are more or less reflexed,

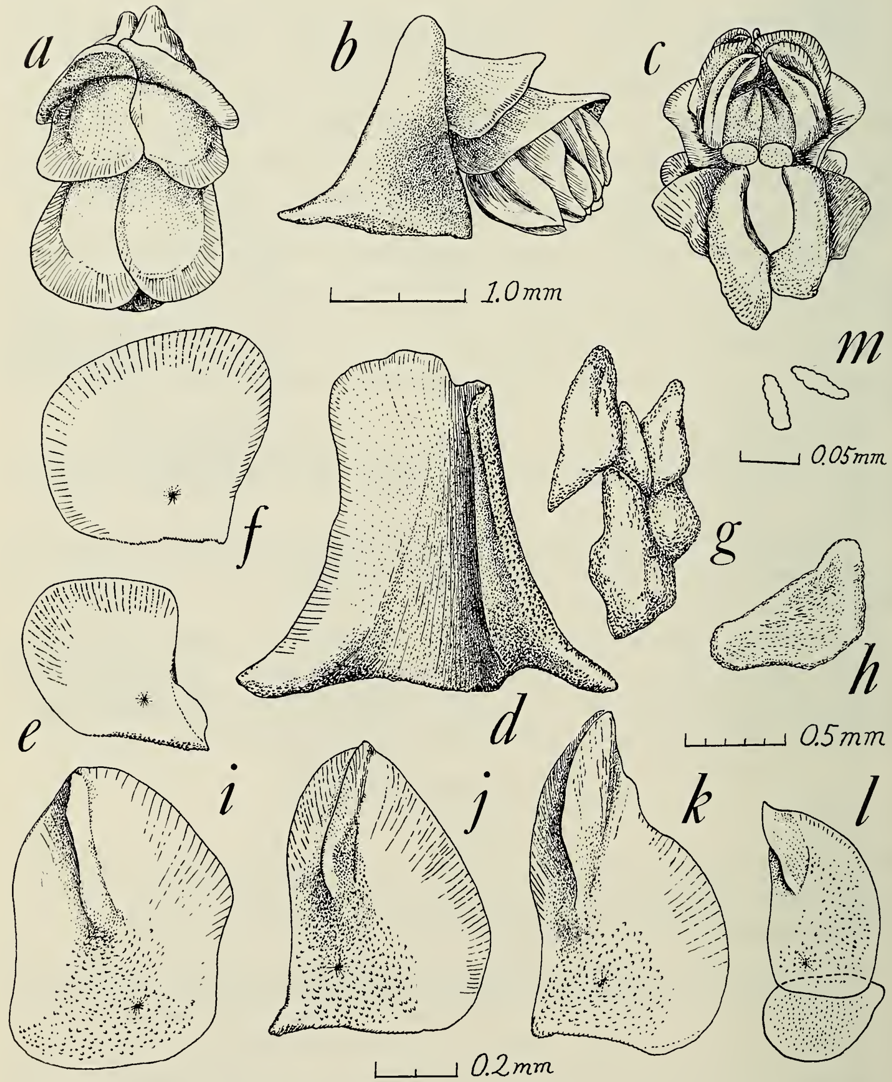

Fig. 4. *Narella megalepis* (Kinoshita): *a*, Zooid, abaxial view; *b*, Same, side view; *c*, Same, adaxial view (1.0 mm scale applies to *a–c*); *d*, basal body scale; *e*, Medial scale; *f*, Buccal scale, inner face in all; *g*, Scales of stem rind, inner face; *h*, Rind scale, outer face (0.5 mm scale applies to *d–h*); *i*, Abaxial; *j*, Outer lateral; *k*, Inner lateral; *l*, Adaxial operculars with adaxial buccal scale (0.2 mm scale applies to *i–l*); *m*, Spicules from tentacle (0.05 mm scale applies only to *m*).

plainly rounded, and have faint radial striae all around the margins. Basals (Fig. 4, *d*) are roughly trapezoidal in face view; the basal edges of the two scales together are hoof-shaped, or very rarely ring-formed. Medial and buccal pairs are rather thin and roughly oval or round, the former a little smaller than the latter (Fig. 4, *e*, *f*). A pair of small adaxial buccals is present (Fig. 4, *c*, *l*).

The operculum is very high; each scale is broad, with a very high keel on the inner face and corresponding groove on the outer; the abaxials are largest, oval, and the rest roughly triangular with a blunt point and square-cut base (Fig. 4, *i–l*). The tentacles contain very small flat rods (Fig. 4, *m*).

The rind scales are mostly polygonal, more or less elongated parallel to the axis; the inner face is furnished with prominent warts around the edges by which they come into contact with the adjoining scales; the outer face is slightly depressed and covered with weak warts, no wrinkles being evident.

Scale measurements (length × breadth).

Basal scales: 1.8 × 1.6 mm; 2.2 × 1.8 mm; 2.3 × 2.2 mm.
Medial scales: 0.8 × 0.8 mm; 1.0 × 1.0 mm.
Buccal scales: 1.0 × 1.0 mm; 1.2 × 1.2 mm.
Adaxial buccals: 0.35 × 0.4 mm; 0.4 × 0.45 mm.
Adaxial operculars: 0.44 × 0.4 mm; 0.7 × 0.35 mm.
Inner laterals: 0.7 × 0.5 mm.
Outer laterals: 0.88 × 0.5 mm.
Abaxial operculars: 0.74 × 0.6 mm; 1.1 × 0.8 mm.

Occurrence.—An unlabelled specimen (probably from Sagami Bay) in the collection of the Zoological Institute, Tokyo University.

Distribution.—Known only from the type-locality, Sagami Bay.

Remarks.—In lacking small interior spicules on the zooidal wall below the adaxial buccal scales pairs, this specimen does not agree exactly with the original description. As in many species of *Calyptrophora*, the adaxial scales may be subject to considerable variation, so that these may be of no specific importance. The identity of specimens collected by the *Albatross* from off the southwest of Kyushu, which were referred by Nutting (1912:59) to *Stachyodes megalepis*, was questioned by Kükenthal and then Aurivillius. However, this question cannot be answered because of the incompleteness of Nutting's description.

Narella irregularis (Kinoshita)
Fig. 5

Stachyodes irregularis Kinoshita, 1907:233.—Kinoshita, 1908a:49, pl. 3, figs. 23–24; pl. 6, fig. 52.—Kinoshita, 1909:4, pl. 18, fig. 4.—Kükenthal, 1919: 459.—Kükenthal, 1924:311.

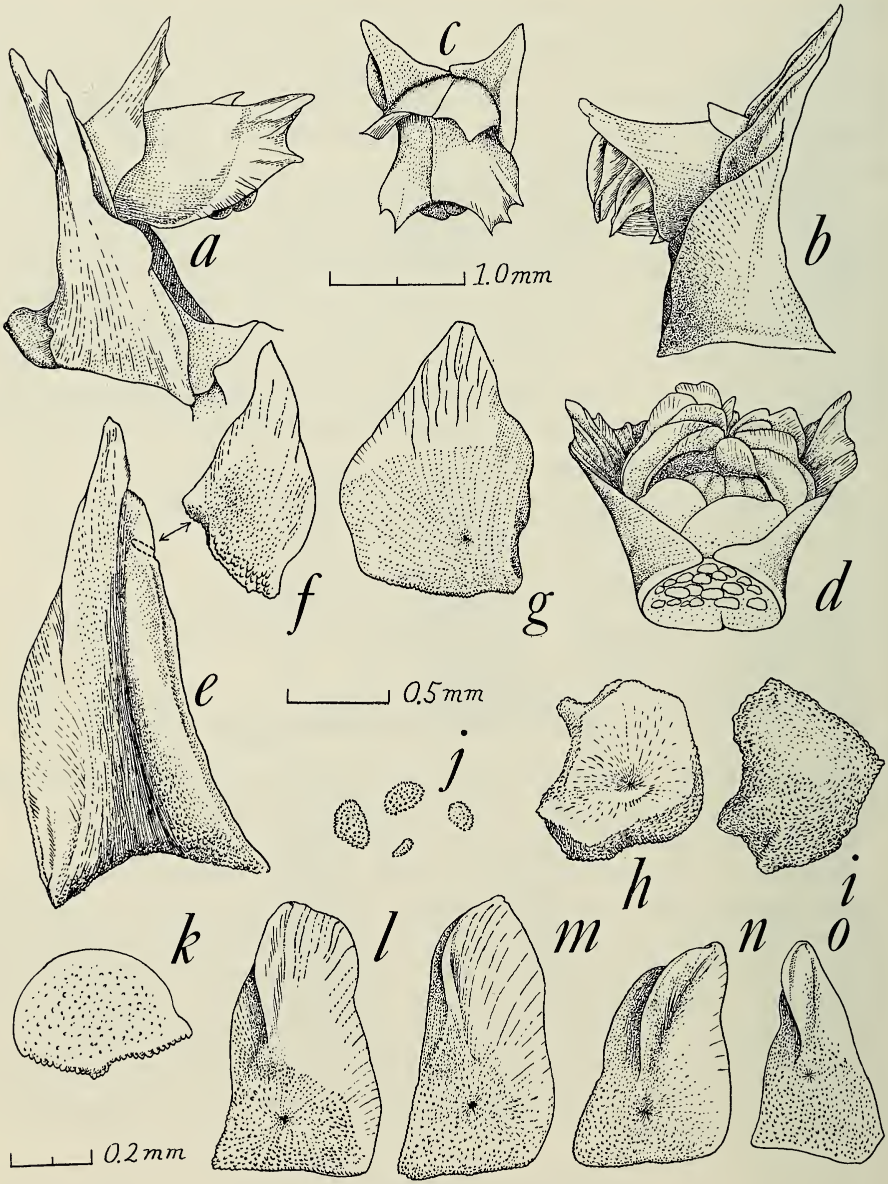

Fig. 5. *Narella irregularis* (Kinoshita): *a, b*, Two zooids from side; *c*, Another zooid from above (1.0 mm scale applies to *a–c*); *d*, Buccal part of zooid, from adaxial side; *e*, Basal body scale; *f*, Medial scale; *g*, Buccal scale, from inside (*e–g*); *h*, Scale of twig rind, from outside; *i*, Same, from inside (0.5 mm scale applies to *d–i*); *j*, Adaxial marginal scales on zooid wall; *k*, Adaxial buccal scale, from outside; *l*, Abaxial; *m*, Outer lateral; *n*, Inner lateral; *o*, Adaxial opercular scales, from inside (0.2 mm scale applies to *j–o*).

Description.—Kinoshita's type-specimen preserved in the collection of the Zoological Institute, Tokyo University, here re-examined, consists of two fragments, the larger about 140 mm in height. The colony is regularly branched dichotomously in one plane. The axis is longitudinally grooved, dull yellow-colored with golden luster, and nearly round in cross section. Zooids occur in whorls of 4–6 and there are 13–14 whorls in 3 cm of axial length.

All zooids (Fig. 5, *a–c*) are facing downward, wholly white (but labelled as "gelblich rose," probably the color in life); mostly 1.5–2.3 mm long, rarely up to 3 mm, parallel to the axis, and 2.3–3.0 mm in height. The basal scale pairs are exceedingly tall, so that the operculum is very far from the surface of the rind (the distance may be about 0.5–1.0 mm); they are very variable in shape but mostly an elongate triangle, about 0.8–1.2 mm wide at base and not closely joined adaxially but often merely placed in contact; their apex is sharply or broadly pointed and slightly upturned, and in the upper part of the inner face there are one to three ridges running parallel to and close to the free edge (Fig. 5, *b*, *e*). Medials also are variable, but the smallest of all three pairs, 0.6–1.0 mm long; they are roughly triangular and roundly or acutely pointed (Fig. 5, *f*). The buccal pairs are mostly almost pentagonal, about 1.0–1.3 mm long; often furnished also with one or more short processes on the free edge and several low inner keels near the edge; the baso-adaxial corners are sharply pointed and come close together, but leave a slight space between. There is a pair of large, oval, adaxial buccal scales, 0.4–0.5 mm wide (Fig. 5, *d*, *k*), below which a number of tiny, granular, adaxial body scales, only 0.06–0.12 mm wide, are scattered irregularly in the zooidal wall (Fig. 5, *d*, *j*).

The operculum is high and formed of eight roughly triangular scales, 0.5–1.0 mm high. Each bears a very high keel on the inner face and corresponding groove on the outer face (Fig. 5, *l–o*).

The rind scales are rather large, up to 1 mm wide, polygonal, thick plates closely fitted together; their outer face is mostly concave with slight radiating striae, while the inner face and margins are thickly covered with warts.

Occurrence.—(Holotype) North of Uzi-sima, Satuma Province, Kyushu, 75 fathoms; 3 May 1908. K. Kinoshita coll.

Distribution.—Known only from the type-locality mentioned above.

Narella horrida (Versluys)

Fig. 6.

Stachyodes horrida Versluys, 1906:101, pl. 8, fig. 24.—Kükenthal, 1919:465. Kükenthal, 1924:315.

Description.—A fragment of a colony, preserved in the collection of the Seto Marine Biological Laboratory of Kyoto University, is referable to this

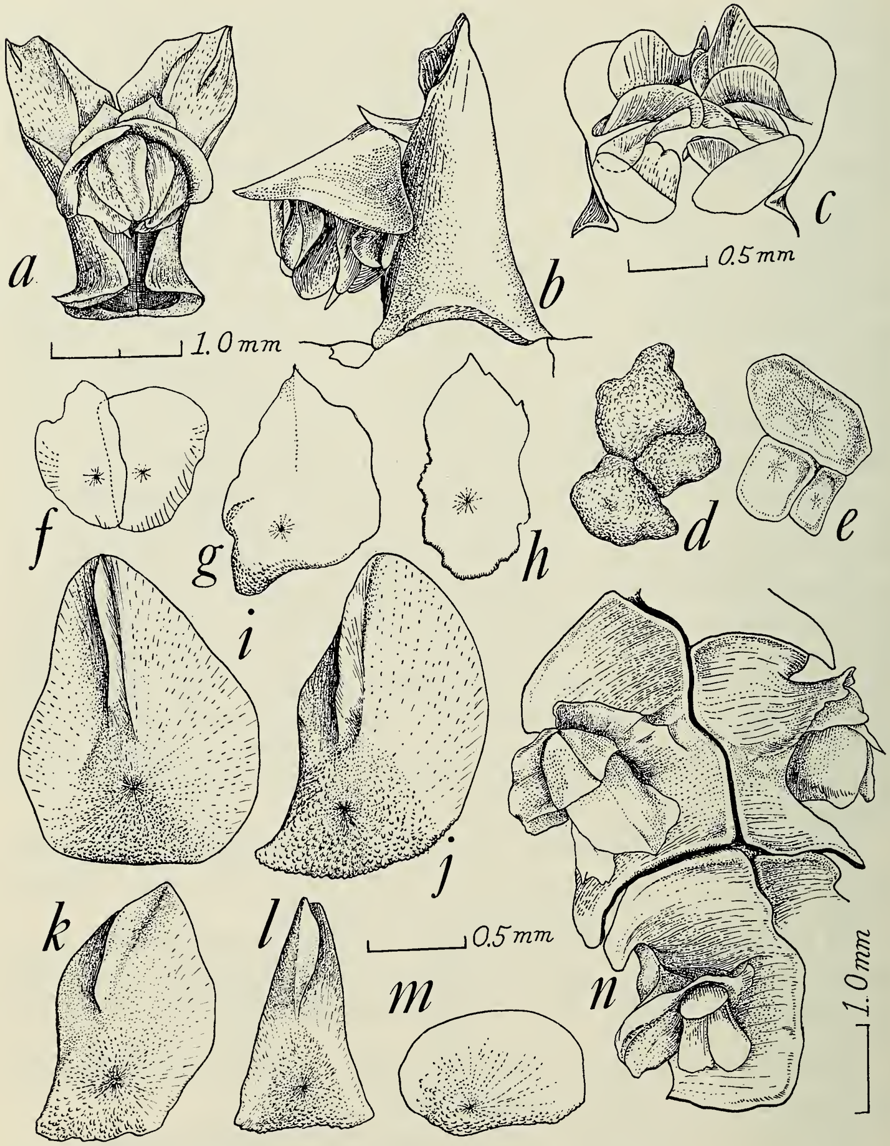

Fig. 6. *Narella horrida* (Versluys): *a*, Zooid, from below; *b*, Same, from side (1.0 mm scale applies to *a*, *b*); *c*, distal part of zooid, from adaxial side (0.5 mm scale applies only to *c*); *d*, Rind scales, from inside; *e*, Same, from outside; *f–h*, Medial scales, showing the variation in shape, inner face; *i*, Abaxial; *j*, Outer lateral; *k*, Inner lateral; *l*, Adaxial opercular scales, all operculars from inside; *m*, Adaxial buccal scale (0.5 mm scale applies to *f–m*); *n*, Three "arcade polyps" with abnormally expanded rind scales coalesced with basal body scales of adjacent zooids (1.0 mm scale applies only to *n*).

species. It consists only of two major branches, about 16 cm in height, lacking the proximal and distal portions. It is apparent that this is part of a colony dichotomously branched in one plane.

The axis is longitudinally grooved and shows a brownish-yellow color with golden luster; it is a little flattened perpendicuarly to the plane of branching, oval in section, in the lower part measuring 3 × 4 mm and in the distal part 1.2 × 1.4 mm. In the proximal part there are a couple of specimens of the barnacle *Balanus* (*Solidobalanus*) *hawaiensis* Pilsbry, the base of which is covered with coenenchyma and scales. The downward-facing zooids are 2.0–2.5 mm long (measured parallel to the branch), arranged in whorls of 6–8, of which 10–11 occur in 3 cm of axial length.

The zooid body (Fig. 6, *a*, *b*) is tall and formed of the usual three pairs of thick scales. Of these, only the basal scales meet adaxially to form a ring; the apex on each side is sharply or broadly pointed and outwardly projecting; the outer face is fairly smooth, while the inner face is sometimes furnished with one or a few short keels terminating in small processes; the basal edge is not broadly expanded. The medials are the smallest of all body scales; their shape varies to a great extent, though not so elongated as shown by Versluys (Fig. 6, *f–h*). The buccals are large, rounded quadrangular and plainly margined. A prominent pair of adaxial buccals is present; they are markedly projecting beyond the base of adaxial operculars and elliptic in outline (Fig. 6, *c*, *m*). Below these, additional smaller spicules may often be found in the wall of the zooid. The operculum is rather high; the scales are broad, the largest abaxial almost oval, the smallest adaxial elongate triangular, and each bears a developed high but short keel on the inner face (Fig. 6, *i–l*).

The rind scales are mostly rather thin and semi-translucent as compared with those of other species of the genus, polygonal, about 0.5–1.0 mm in diameter, no elongate ones ordinarily being found; the outer face is smooth, slightly concave with raised margins and the inner face is granular (Fig. 6, *d*, *e*). On the stem, the formation of the so-called "arcade polyps" is found in places. It is infested with polychaete worms where the rind scales become abnormally coalesced with the basal body scales of adjacent zooids to form a common plate around the base of each zooid. In such abnormal polyps, the zooidal scales except basals are mostly smaller and highly divergent in shape as well as in the development of each (Fig. 6, *n*).

Scale measurements (length × breadth).

Basal scales: 2.0 × 1.0 mm; 2.3 × 1.3 mm; 3.0 × 1.5 mm.
Medial scales: 0.8 × 0.4 mm; 1.0 × 0.7 mm; 1.2 × 0.58 mm.
Buccal scales: 1.18 × 0.88 mm; 1.3 × 1.1 mm; 1.5 × 1.4 mm.
Adaxial buccal scales: 0.28 × 0.46 mm; 0.35 × 0.5 mm; 0.35 × 0.6 mm.
Adaxial operculars: 0.46 × 0.28 mm; 0.5 × 0.35 mm; 0.56 × 0.38 mm.
Inner laterals: 0.58 × 0.35 mm; 0.6 × 0.4 mm; 0.7 × 0.45 mm.

Outer laterals: 0.67 × 0.46 mm; 0.8 × 0.35 mm; 0.8 × 0.6 mm.
Abaxial operculars: 0.7 × 0.53 mm; 0.8 × 0.5 mm; 0.88 × 0.6 mm.

Occurrence.—A fragment in the collection of the Seto Marine Biological Laboratory of Kyoto University (unlabelled as to locality and date). Probably from Southern Kyushu, as deduced from the occurrence of the epizoic barnacle.

Distribution.—(Type-locality) Kei Islands, Lat. 5°28′04″S, Long. 132° 00′20″E, 204 meters (*Siboga* station 251).

Remarks.—Versluys emphasizes the dwarfish and strongly pointed medial scales as one of the leading characters of the type-specimen of *Stachyodes horrida.* In the present specimen, however, these scales show a pronounced divergence in shape, although they are invariably the smallest of all the body scales. In other respects, the specimen appears to be indistinguishable from the type.

Narella biannulata (Kinoshita)
Fig. 7

Stachyodes biannulata Kinoshita, 1907:233.—Kinoshita, 1908a:53, pl. 4, figs. 26–27; pl. 6, fig. 53.—Kinoshita, 1909:5, pl. 18, fig. 5.—Kükenthal, 1919: 465.—Kükenthal, 1924:315.

Description.—Kinoshita's paratypes, here re-examined, consist of two fragments, one of which is a perfect specimen, about 20 cm in height and the other is a part of the colony without base, about 12.5 cm in height. The colony is dichotomously branched in one plane and somewhat curved to one side. The axis is feebly flattened in the plane of branching and almost round in section in the proximal part of the stem; it is longitudinally grooved and of a yellowish brown color with metallic luster. Twelve to 14 whorls of zooid (Fig. 7, *a*) occur in 3 cm of axial length; each whorl contains 5–7 downward-facing zooids.

The zooids, mostly 2 mm long, are formed of three pairs of peculiar large scales, of which two except the medial pair meet adaxially to form a ring. The free edges of all three pairs are plainly rounded and prominently upturned, and the inner face near the edge is sometimes longitudinally ribbed or granulated. The basal scale is quadrilateral or trapezoidal in face view and its basal portion toward the stem usually projects basad and distad along the stem; the outer face is usually wrinkled and often forms a crest-like keel along the abaxial suture (Fig. 7, *b*, *d*, *e*). The medial scale, nearly as large as the buccal scale, is roughly quadrangular and often furnished with a prominent dorsolateral keel on the outer face (Fig. 7, *d*, *f*). The buccal scale extends farther adaxially than the medial scale to meet on the opposite side by a sharp process; its outer face, like the foregoing, is finely

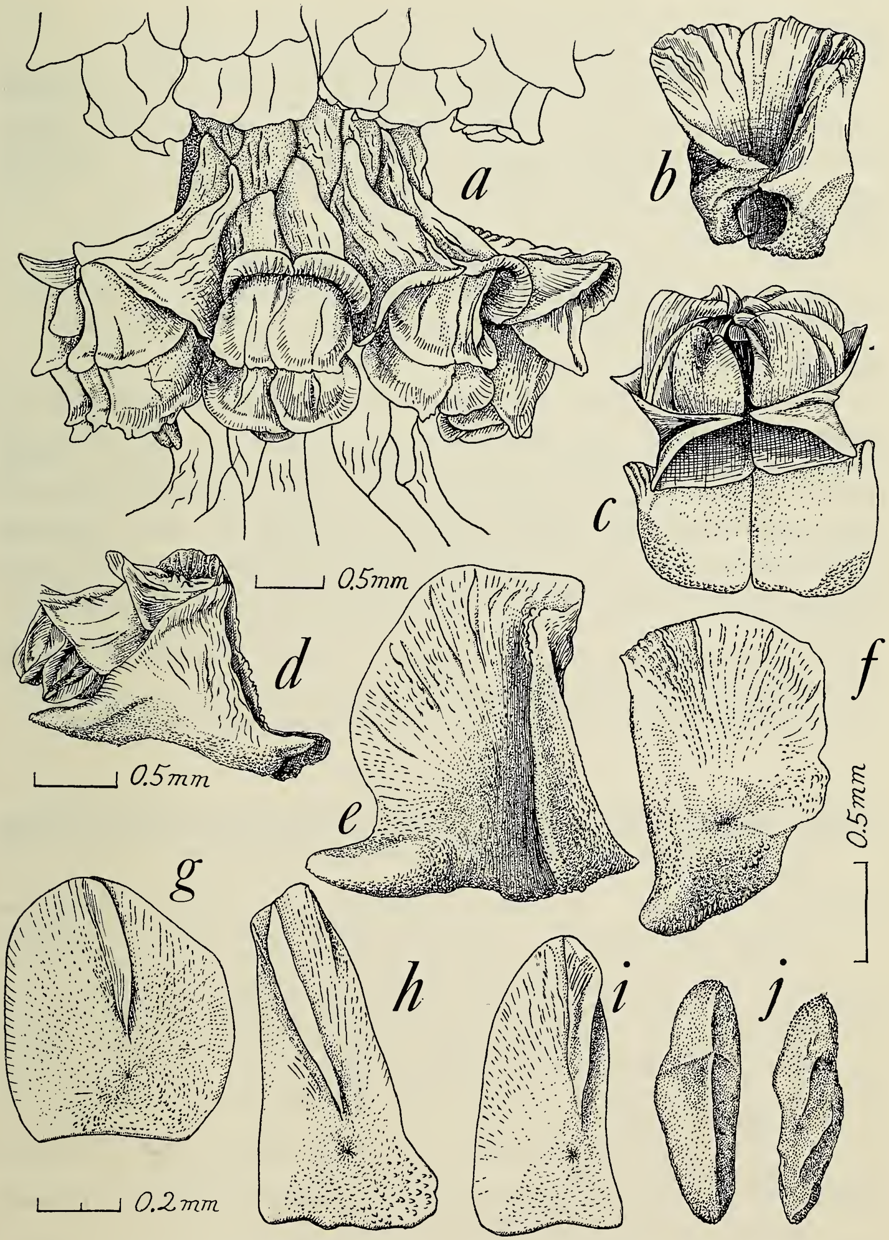

Fig. 7. *Narella biannulata* (Kinoshita): *a*, Whorl of normal zooids; *b*, Basal scale pair, from below; *c*, Adaxial view of zooid without basal scale ring (0.5 mm scale at *a* applies to *a–c*); *d*, Side view of zooid, a little smaller than the above (scale applies only to *d*); *e*, Basal scale, from inside; *f*, Medial scale, from inside (0.5 mm scale at right applies to *e*, *f* & *j*); *g*, Abaxial; *h*, Outer lateral; *i*, Inner lateral opercular scales, inner face (0.2 mm scale applies to *g–i*); *j*, Two rind scales, from outside.

striated, and often provided also with one or more dorsolateral keels, while the inner face is feebly striated only. Adaxial buccals are absent.

The operculum projects markedly beyond the buccal scales; the largest abaxial opercular is broad, rounded triangular or almost oval in outline, the others narrow, elongate triangular, and each has a very high, relatively long, inner keel and corresponding outer groove as usual (Fig. 7, *g–i*). They measure:

Abaxials: 0.6–0.7 mm long and 0.54–0.65 mm wide
Adaxials: 0.35–0.45 mm long and 0.2–0.3 mm wide
The tentacles contain very small flat rods, about 0.056 × 0.001 mm to 0.065 × 0.018 mm.

The cortical scales are very characteristic; they are arranged rather regularly in about 7 or 8 longitudinal rows around the stem of 1 mm diameter. The scales between zooid whorls (Fig. 7, *j*) are thick, oblong, about 0.7–1.8 mm long and 0.3–0.5 mm wide; their outer face is provided with several prominent wrinkles irregularly arranged, the inner face with fine granules only. In the cortex of the larger proximal part of the stem, with sparingly set zooids, the scales are apt to be more numerous, polygonal and thin.

Occurrence.—Coral ground near Uzi-sima, Satuma Province, Kyushu, 80 fathoms; June 1908. K. Kinoshita coll.

Distribution.—Known only from the type-locality mentioned above.

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Footnote

[1] "Length of spines 1.8–2.8 mm" in the measurement of basal scale pairs, as given by Kinoshita, is certainly an error for the overall length of basal scales including spines.

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91(4), 1978, pp. 1026–1036

ADELOGORGIA TELONES, A NEW SPECIES OF GORGONACEAN CORAL (COELENTERATA: OCTOCORALLIA) FROM THE GALAPAGOS ISLANDS

Frederick M. Bayer

Abstract.—A new species of the gorgonacean genus *Adelogorgia* from the Galapagos Islands is described, illustrated, and compared with the type-species. Similarity of the characteristic sclerites of *Adelogorgia* to those of related and unrelated genera is discussed and its significance considered.

A small collection of Octocorallia obtained in the Galapagos Islands by Dr. W. Duane Hope in February 1978 contains three specimens of a gorgonacean coral with gross aspect unlike any species heretofore reported either from these islands or from the Pacific coast of the Americas. Their remarkably modified coenenchymal sclerites clearly show these specimens to be congeneric with the Californian plexaurid *Adelogorgia phyllosclera* Bayer, 1958, and the second known species of the genus.

The genus *Adelogorgia* was established for an eastern Pacific gorgonacean resembling specimens of *Psammogorgia* Verrill, but having peculiarly modified coenenchymal sclerites quite unlike those of *Psammogorgia.* It was first collected near La Jolla, California, by Conrad Limbaugh in depths of 30–57 meters in 1953, 1954, and 1955, and by R. Ghilardi and J. Stewart in 1956. Although a specimen dredged in the vicinity of La Jolla in depths between 46 and 73 meters on July 3, 1906, was found among material at the Scripps Institution of Oceanography and sent to me by Mr. Limbaugh, it had been ignored until 1956, so credit for the discovery rightfully belongs to Mr. Limbaugh. Although it seems to be rather common in the vicinity of La Jolla, collections made farther to the south, in Baja California, by the same team of divers, do not include it. Neither does it occur in other collections from Baja California and the Gulf of California taken by diving and dredging, nor in collections obtained by the U.S. Fish Commission steamer *Albatross* by dredging and trawling at many localities along the coast of Central America and South America.

Family Plexauridae Gray, 1859

Genus *Adelogorgia* Bayer, 1958

Adelogorgia Bayer, 1958:46. (Type-species, *Adelogorgia phyllosclera* Bayer, 1958, by original designation and monotypy.)

Diagnosis.—Plexaurids with moderately thick coenenchyme; polyps fully retractile, communicating directly with the longitudinal canal system;

anthocodiae armed with spinose spindles converging beneath each tentacle but not forming a distinct transverse collaret. Outer layer of coenenchyme containing capstans, spindles with transverse belts of tubercles and more or less distinct median waist, leaf clubs, and asymmetrical double wheels with foliate expansions on one side; inner layer of coenenchyme containing spindles and capstans less elaborately sculptured. Axis with wide cross-chambered central core and abundantly loculated cortex.

Relationships.—Members of this genus resemble colonies of *Psammogorgia arbuscula* (Verrill, 1866) and of *Euplexaura marki* Kükenthal, 1913 (which originally was misidentified as *P. arbuscula* by Nutting in 1909) in their growth form but not in the form of their sclerites. The unilaterally foliate double wheels, often with terminal axial crests, characteristic of *Adelogorgia* are similar to the sclerites of some, but not all, species of *Swiftia* Duchassaing & Michelotti, 1864, most of which differ markedly from *Adelogorgia* in growth form. The spindles and ordinary capstans of *Adelogorgia* resemble those of *Euplexaura marki* Kükenthal, 1913, which are never unilaterally foliate and closely approach the type of sclerites characteristic of several gorgoniid genera. The relationship of *Adelogorgia* to plexaurid genera such as *Euplexaura* Verrill, 1865, and *Psammogorgia* Verrill, 1868, and to *Swiftia* (including *Platycaulos* Wright & Studer, 1889, *Callistephanus* Wright & Studer, 1889, and *Stenogorgia* Verrill, 1883), ordinarily placed in the Paramuriceidae, is by no means clear. These genera apparently belong to a closely interrelated complex and emphasize the tenuous nature and indefinite position of the boundaries between many holaxonian genera and even families.

Adelogorgia telones, sp. nov.

Figs. 1–6

Material.—Galapagos Islands: Kicker Rock, depth 23 m, on vertical rock wall; coll. W. Duane Hope, by diving, 19 February 1978. Three colonies.

Diagnosis.—*Adelogorgia* with polyps fully retractile, adjacent coenenchyme forming inconspicuous verrucae or none, anthocodiae with approximately 15–20 curved, spinose spindles converging beneath each tentacle. Average length of coenenchymal double-wheel sclerites 0.08 mm, of double spindles 0.15 mm. Color pure white or lemon yellow.

Description.—Colonies small, flabellate, branched in one plane or in intersecting planes (Fig. 1) depending upon local features of the habitat. Branching commencing a short distance above the base, mostly lateral but in some places appearing dichotomous, without anastomoses; secondary and tertiary branches arising at roughly right angles, subsequently curving upward roughly parallel with the originating branch. Branches of nearly uniform thickness, not much thinner than the main stem, 2.5–3.5 mm in diameter, commonly somewhat clavate terminally where the diameter is

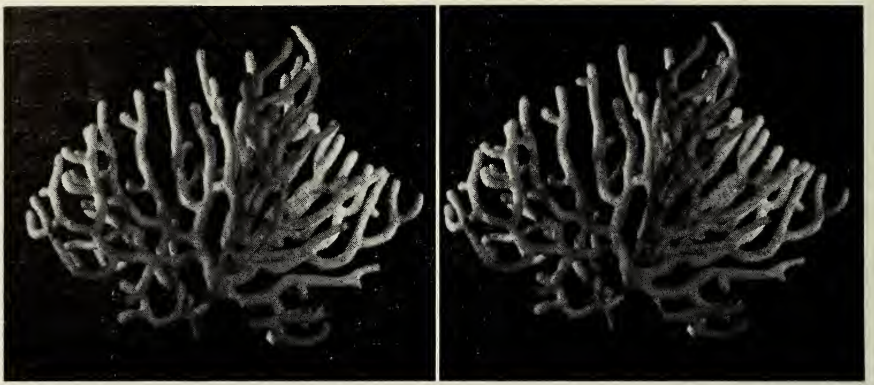


Fig. 1. *Adelogorgia telones.* Holotype colony, USNM 57453. Stereoscopic view. Width, 11 cm.

about 1 mm greater. Polyps distributed all around main stem and branches, completely retractile, usually quite flush with surrounding coenenchymal surface, in proximal parts of the colony occasionally surrounded by a low coenenchymal rim or forming low verrucae, mostly about 1.5 mm apart but as much as 2.2 mm; verrucal apertures with 8 marginal teeth composed of converging cortical sclerites. Anthocodiae with 8 subtentacular points (Fig. 2a) each consisting of about 15–20 converging, weakly curved spinose

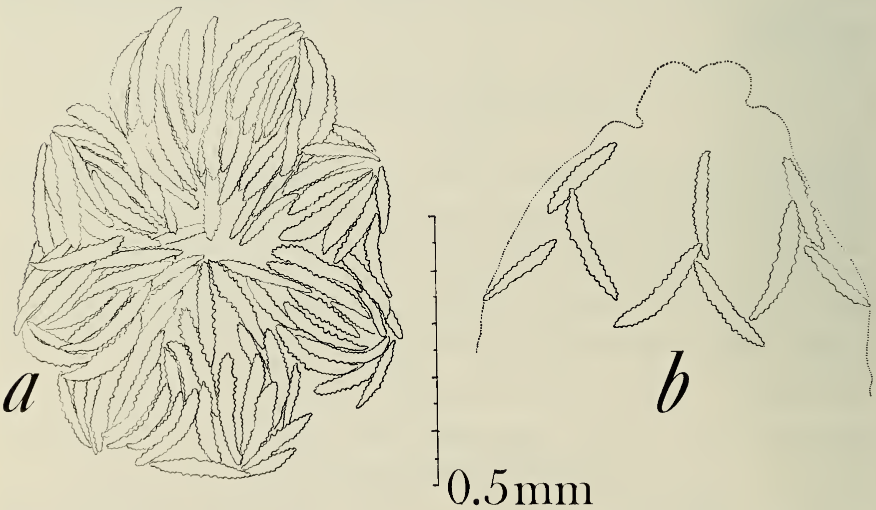


Fig. 2. Anthocodial armature. a, *Adelogorgia telones*, USNM 57453; b, *Adelogorgia phyllosclera*, USNM 50635. ×70.

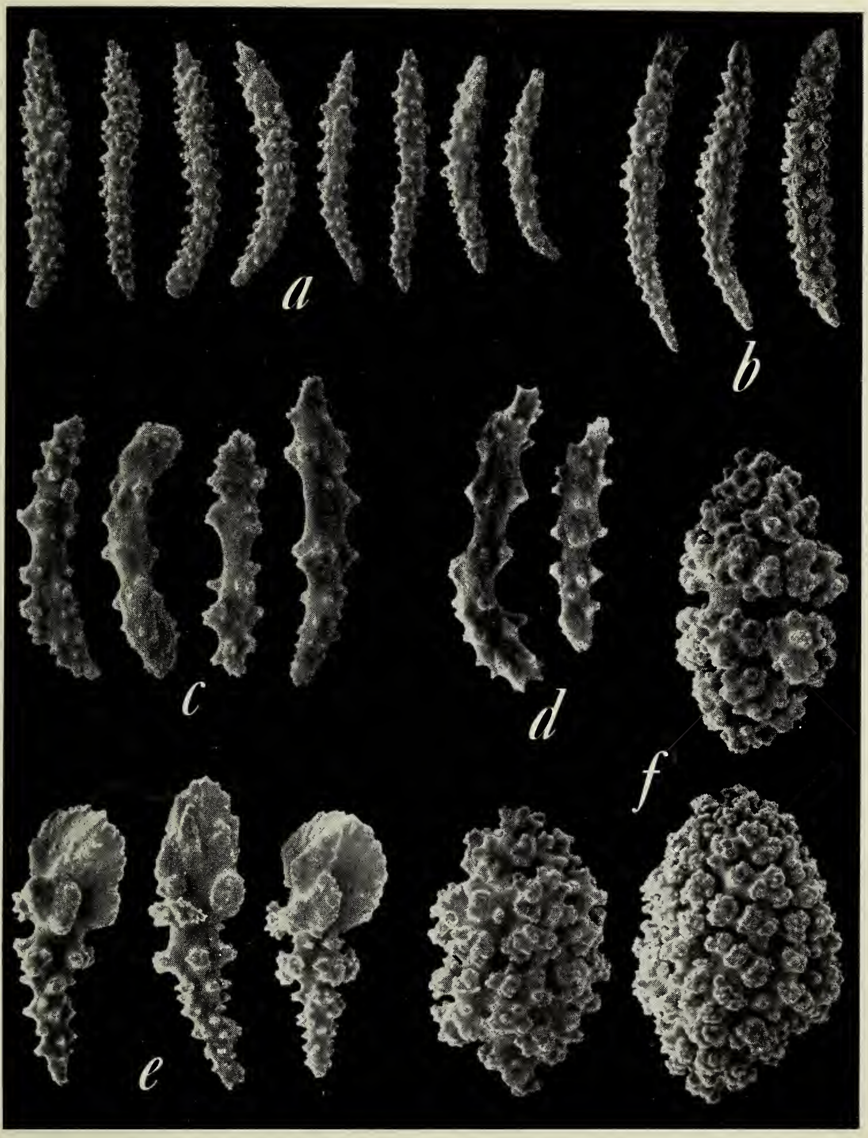
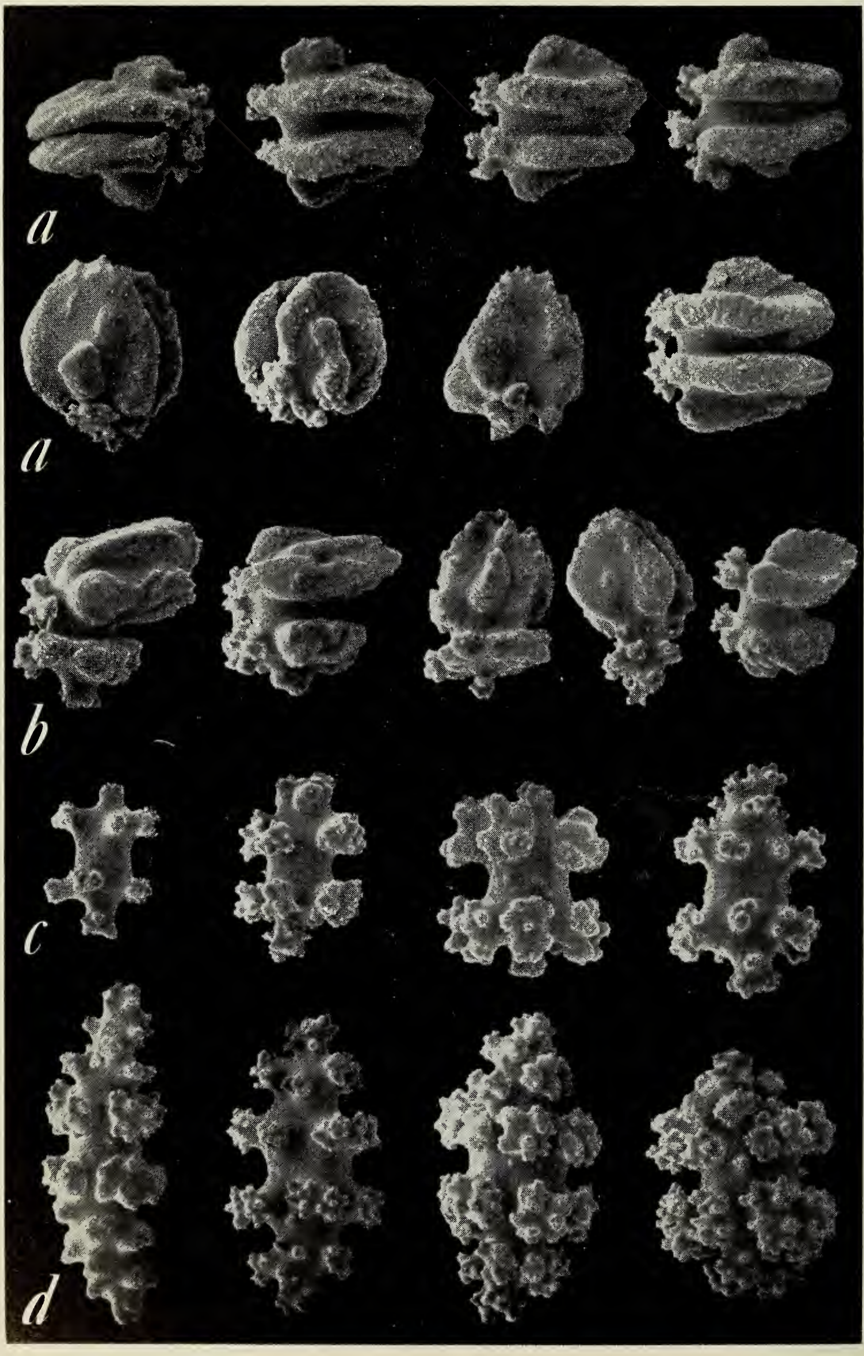


Fig. 3. Sclerites of *Adelogorgia telones*. a, Curved rods from anthocodial points, USNM 57453, ×160; b, Curved rods from anthocodial points, USNM 57455, ×160; c, Curved rods from oral disk, USNM 57453, ×400; d, Curved rods from oral disk, USNM 57455, ×400; e, Leaf-clubs from coenenchyme, USNM 57453, ×280; f, Fully developed double spindles from cortex, USNM 57453, ×300.


a
a
b
c
d

spindles about 0.16–0.28 mm long (Fig. 3a, b), the proximal ones more or less obliquely placed but not forming a well-differentiated transverse collaret. Oral disk with numerous scattered weakly spinose rods slightly curved at each end, up to about 0.13 mm in length but mostly 0.08–0.1 mm (Fig. 3c, d); in the tentacles are a few scattered, minute straight or slightly curved rods about 0.05 mm long and 0.005 mm in diameter, smooth except for a few inconspicuous short prickles near the ends. The gastric cavities of the polyps enter directly into the longitudinal stem canals surrounding the axis. Axis with a wide, chambered core and conspicuously loculated cortex; no calcification of the holdfast was observed. Coenenchyme with a superficial layer of capstans with the tubercles of the median whorls fused to form disks with serrate edges (Figs. 4a, 5a, 6a–b), and, in some cases, the terminal tubercles modified into foliate crests at right angles to the median disks. The largest of these reach a length of 0.09 mm but they average 0.08 mm. Many of these modified capstans have only one of the whorls of tubercles fused into a foliate expansion (Fig. 4b), in which case they resemble small, lopsided leaf-clubs. Beneath these foliate double wheels the coenenchyme is filled with short capstans up to 0.1 mm long but mostly 0.08–0.09 mm, symmetrical or nearly so (Fig. 4c), and tuberculate double spindles with a distinct median waist and tapered, usually acute ends (Fig. 4d), up to 0.18 mm long but averaging 0.15 mm, not unlike the double cones described by Deichmann (1936) in some species of *Thesea.* When these double spindles are fully developed, their tubercles become extremely complex and the median waist obscure or indiscernible (Fig. 3f). Some of the spindles are modified into leaf-clubs by the production of a foliate expansion at one end (Fig. 3e).

Of the three colonies obtained, two are pure white and one lemon yellow, but I can find no other difference.

Holotype.—USNM 57453. Height 9.5 cm, greatest width 11 cm. Diameter of main trunk just above holdfast, 5 mm; diameter 4 cm above holdfast, 3.7 mm; diameter of end branches 2.5 mm near origin, up to 3.5 mm just below tip. Branching apparently dichotomous but actually lateral, in three diverging planes, with some terminal twigs extending irregularly outward from the sides of the planes (Fig. 1). Unbranched terminal twigs arising from branches at intervals of 1–2.5 cm, at first growing outward at nearly 90° but in 5–10 mm curving more or less abruptly to continue parallel to the parent branch. Polyps completely retracted, 1.5–2.2 mm apart, not forming

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Fig. 4. Sclerites of *Adelogorgia telones*, USNM 57453. a, Double wheels of outer coenenchyme; b, Small torches and leaf-clubs of outer coenenchyme; c, Capstans of deeper coenenchyme; d, Double spindles of deeper coenenchyme. All figures ×300.

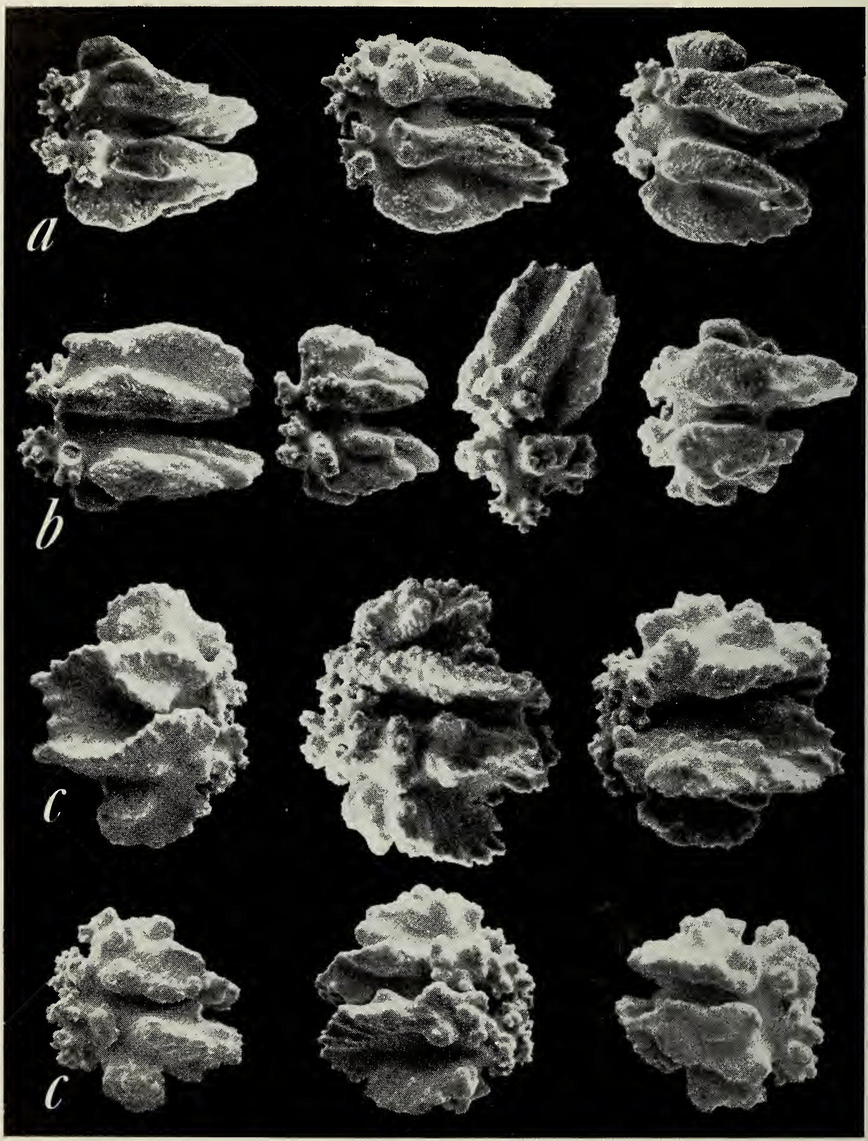

Fig. 5. Sclerites. a–b, From outer coenenchyme of *Adelogorgia telones*, USNM 57455; c, From outer coenenchyme of *Adelogorgia phyllosclera*, USNM 50186. All figures ×300.

verrucae but some of those on the trunk surrounded by a slightly raised rim of coenenchyme. Color pure white, sclerites colorless, transparent.

Paratypes.—USNM 57454. Height 10 cm, width 11 cm, branched laterally in one plane, main stem curving upward from holdfast that was attached

Fig. 6. Stereoscopic views of double-wheel sclerites. a, *Adelogorgia telones*, USNM 57453; b, *A. telones*, USNM 57455; c, *A. phyllosclera*, USNM 50186. All figures ×500.

to a vertical surface; diameter of trunk just above holdfast, 4 mm; branches and twigs nearly cylindrical, 3.2–3.5 mm in diameter, terminal twigs sometimes weakly clavate, about 1 mm thicker just below tip than elsewhere proximad. Polyps completely retracted, about 1.5 mm apart, those on trunk and proximal parts of branches forming indistinct verrucae with 8 marginal lobes. Color pure white, sclerites colorless, transparent.

USNM 57455. Height 7.5 cm, width 9 cm, branched laterally in one plane. Coenenchyme of base damaged, diameter of trunk in lowest part with coenenchyme intact, 4.2 mm; some terminal twigs 1.8 mm in diameter near point of origin and up to 4.2 mm near the clavate tips, but others of uniform diameter, approximately 3 mm, cylindrical or faintly flattened in the plane of branching. Polyps on trunk and adjacent large branches retracted into low verrucae but most of those on distal branches and terminal twigs retracted flush with the coenenchymal surface. Color lemon yellow, sclerites pale yellow, transparent.

Comparisons.—The one yellow and two white colonies of *Adelogorgia telones* differ from all known specimens of *A. phyllosclera*, which without exception are red. Although all three colonies are smaller than the largest *A. phyllosclera*, which is about 20 cm tall, the sample is too small to permit any reliable estimate of maximal size. Branching of the two species is similar, but that of *A. phyllosclera* is somewhat more open and crooked than that of *A. telones*. The polyps of *A. phyllosclera* usually form distinct hemispherical or blunt-conical verrucae, whereas those of *A. telones* form only inconspicuous verrucae or, usually, none at all. Both the marginal calicular teeth and the anthocodial armature are more strongly developed in *A. telones* than in the type-species. The sclerites of *A. telones* are somewhat smaller than those of *A. phyllosclera*, in which the double wheels reach 0.15 mm with an average of 0.1 mm, and the spindles reach 0.2 mm, with an average of 0.18 mm. Apart from being larger, the double wheels of *A. phyllosclera* (Fig. 5c) are somewhat different in shape and more elaborately sculptured than those of *A. telones*. These differences are best seen in the stereoscopic views in Fig. 6.

The colonies of *A. telones* are similar in general aspect to those of *Euplexaura marki* Kükenthal (=*Psammogorgia arbuscula* sensu Nutting, not Verrill) and the closely related (if not identical) *Psammogorgia spauldingi* Nutting, both of which have longer and less sinuous branches. Neither of those species has capstans modified into double wheels or spindles modified into leaf-clubs, but their sclerites bear a strong resemblance to the unmodified forms of both *A. telones* and *A. phyllosclera*.

The double wheels of *Adelogorgia* resemble in form sclerites of several other genera from diverse parts of the world. Remarkably similar are the double wheels of *Subergorgia* (Subergorgiidae) and *Melithaea* (Melithaeidae) (Bayer, 1956: figs. 143, 2a; 144, 2b). Those of *Eugorgia* usually have even thinner wheels and the terminal tubercles are also fused into disks (Bayer, 1956: fig. 153, 4a). Some of the double wheels of certain species of *Clathraria* (Melithaeidae) have terminal axial crests like those of *Adelogorgia.* Capstans in various species of *Swiftia* (including *Callistephanus, Platycaulos* and *Stenogorgia*) may have the tubercles more or less fused into disks (Thomson, 1927: plate 2, figs. 4, 6) and, in some cases (e.g., *Swiftia koreni* [Wright & Studer]), the terminal axial crests are developed much as in *Adelogorgia.*

As fusion of tubercles into disks occurs independently in several genera belonging to widely separated families, it evidently represents a morphological modification with a high degree of probability. The similarity of the double wheels of *Adelogorgia* and *Subergorgia* must therefore represent convergence rather than an indication of close phylogenetic relationship. When accompanied by other morphological similarities, however, as in *Adelogorgia* and *Swiftia,* such spicular modification may be viewed as evidence of relationship.

Acknowledgments

I am grateful to the collector, Dr. W. Duane Hope, for making a special effort to obtain octocorals in the Galapagos Islands, a locality from which as yet few records exist. I also acknowledge with pleasure the work of Mr. Walter R. Brown of the Scanning Electron Microscope Laboratory of the National Museum of Natural History, Smithsonian Institution, who made all of the scanning electron micrographs in this paper with a Coates & Welter model 106 field emission microscope. Darkroom work for preparation of the accompanying figures was done by Dr. Stephen D. Cairns. The manuscript was improved by the helpful suggestions of Dr. Thomas E. Bowman and Mr. C. W. Hart, Jr., to whom I extend thanks.

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A SUBSTITUTE NAME FOR THE HOMONYM *APHELOCYTHERE* HOBBS AND PETERS (OSTRACODA, ENTOCYTHERIDAE)

Horton H. Hobbs, Jr., and Daniel J. Peters

Abstract.—The name *Waltoncythere* is proposed to replace the homonym *Aphelocythere* Hobbs and Peters (1977, Smithsonian Contrib. Zool. 247:21), a name preoccupied by *Aphelocythere* Triebel and Klingler (1959, Geol. Jb. 76:338).

Hobbs and Peters (1977:21) proposed the generic name *Aphelocythere* to receive a single species *Aphelocythere acuta* described by them in the same publication. The fact that the generic name is a homonym was pointed out to us by Dr. H. J. Oertli of the Centre Micoulau, Pau, France, and Herr Hans E. E. Petersen of the Zoologisches Institut und Zoologisches Museum, Hamburg, Germany, to whom we extend our thanks. Our name was preoccupied by *Aphelocythere* Triebel and Klingler (1959:338) that was coined to receive a fossil marine species, *A. undulata* (Cytheridae-Progonocytherinae, from the Lias).

We propose the feminine name *Waltoncythere* as a substitute for *Aphelocythere* Hobbs and Peters, and assign to it only the type-species, *Waltoncythere acuta* (Hobbs and Peters, 1977:21).

This new name is chosen in memory of our late friend and fellow student of entocytherids, Margaret Walton.

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Hobbs, Horton H., Jr., and Daniel J. Peters. 1977. The Entocytherid Ostracods of North Carolina. Smithsonian Contrib. Zool. 247:iii + 73 pages, 33 figures.

Triebel, E., and W. Klingler. 1959. Neue Ostracoden-Gattungen aus dem deutschen Lias. Geol. Jb. 76:335–372, 9 pls.

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The three papers that follow are published together because they deal with the larval forms of some ommastrephid squids, *Illex illecebrosus* in particular. Larvae of this extremely abundant and commercially important species had never been recognized until two studies by C. F. E. Roper and C. C. Lu and by M. Vecchione, based on field collections conducted in 1975–6 and in 1977, respectively. These authors described the larvae considered to be of *I. illecebrosus* at the "International Workshop on the Biology of the Squid *Illex illecebrosus*" held at Dalhousie University, Halifax, Nova Scotia, 25–26 May, 1978. In the fall of 1978 R. K. O'Dor and R. D. Durward observed hatching of eggs laid in the laboratory by *I. illecebrosus*. The laboratory-hatched larvae conformed to the description based on specimens captured in the sea.

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91(4), 1978, pp. 1039–1059

RHYNCHOTEUTHION LARVAE OF OMMASTREPHID SQUIDS OF THE WESTERN NORTH ATLANTIC, WITH THE FIRST DESCRIPTION OF LARVAE AND JUVENILES OF *ILLEX ILLECEBROSUS*

Clyde F. E. Roper and C. C. Lu

Abstract.—The larvae and juveniles of *Illex illecebrosus* (Ommastrephidae) are described for the first time based on specimens from the western North Atlantic off Cape Hatteras northward to Georges Bank, New England. Two other larval forms of ommastrephid squids, Rhynchoteuthion larvae, are recognized and tentatively identified with *Ommastrephes* and *Ornithoteuthis.* Larvae and juveniles of *Illex* were captured during all seasons, indicating that spawning takes place over an extended period, possibly year-round, when the broad geographical range of the species is considered. Localities of capture of smallest larvae (1.5 mm mantle length) indicate that the spawning site of *Illex illecebrosus* lies along the outer edge of the continental shelf.

Introduction

Four species of squids of the genus *Illex* (family Ommastrephidae) occur in the Atlantic Ocean, some distributed over a broad geographical range. *Illex illecebrosus* (Lesueur, 1821) occurs in the western North Atlantic from Labrador and Newfoundland to central Florida. Single records from Greenland and Iceland, and those from northern European waters as far south as the Bristol Channel are in doubt (Lu, 1973). *Illex coindetii* (Verany, 1837) occurs in the eastern Atlantic from the North Sea to 14°S in Africa (Angola), in the Mediterranean and Adriatic Seas, as well as in the Caribbean Sea, Gulf of Mexico, and east coast of South Florida. *Illex argentinus* (Castellanos, 1960) occurs along the coast of Argentina and over the Patagonian Shelf, but the limits of its distribution are unknown because of incomplete sampling. *Illex oxygonius* Roper, Lu & Mangold, 1969 occurs in the western Atlantic from New Jersey to Florida and in the Gulf of Mexico. Details of the distributions of these four species as well as their systematics are reported in Roper, Lu, and Mangold (1969) and in Lu (1973).

All four species of *Illex* are fished extensively in nearly all sections of their ranges and the combined annual catch is estimated to be around several hundred thousand metric tons, of which 80,000 tons of *I. illecebrosus* are caught in the Canadian Atlantic provinces (Amaratunga, et al., 1978, unpublished MS report) and 55,000 tons are taken off the Middle Atlantic

States of the U.S. (Tibbetts, 1977, unpublished MS report). Catches have risen sharply as the demand for squid has increased markedly during recent years.

In spite of the broad distribution of *Illex* species around nearly the entire continental margins of the Atlantic and of the significant fisheries these species support, very little is known about their biology. Especially lacking is information about the spawning habits and spawning sites, as well as the larvae and juveniles which were unknown until recently (Lu & Roper, in press). Without knowledge of the spawning sites and life histories of each species, it is impossible to make the predictions about the populations (fecundity, recruitment, size, mortality, age, and growth, etc.) that are necessary for the management and utilization of this important resource.

We present data gathered during two U.S. National Marine Fisheries Service programs that indicate the locations of spawning sites of *Illex illecebrosus*. The larvae and juveniles of *I. illecebrosus* (1.5–18 mm mantle length) are characterized for the first time, and they are compared with two other types of sympatric western North Atlantic ommastrephid larvae.

The larvae of ommastrephid squids are characterized by the fusion of the two tentacles, initially for their entire length, into an elongate, often robust, "proboscis" that bears a few minute suckers at the terminal disc, the precursors of the suckers on the clubs when the proboscis separates. Larvae bearing the tentacles fused into a proboscis are termed the Rhynchoteuthion stage, a general designation that carries no nomenclatorial status. Chun (1903) originally recognized the form and described it as *Rhynchoteuthis*, but Pfeffer (1908) pointed out that the name was preoccupied by a fossil form and suggested the non-generic term Rhynchoteuthion, a designation followed by most subsequent workers. Okutani (1965) briefly reviewed the history of the use of the term Rhynchoteuthion.

Materials and Methods

This report is based on the material collected by the MARMAP (Marine Monitoring Assessment and Predicting) Program of the National Marine Fisheries Service (NMFS) and by the biological portion of the NMFS Deepwater Dumpsite 106 Program that was conducted by the Smithsonian Institution.

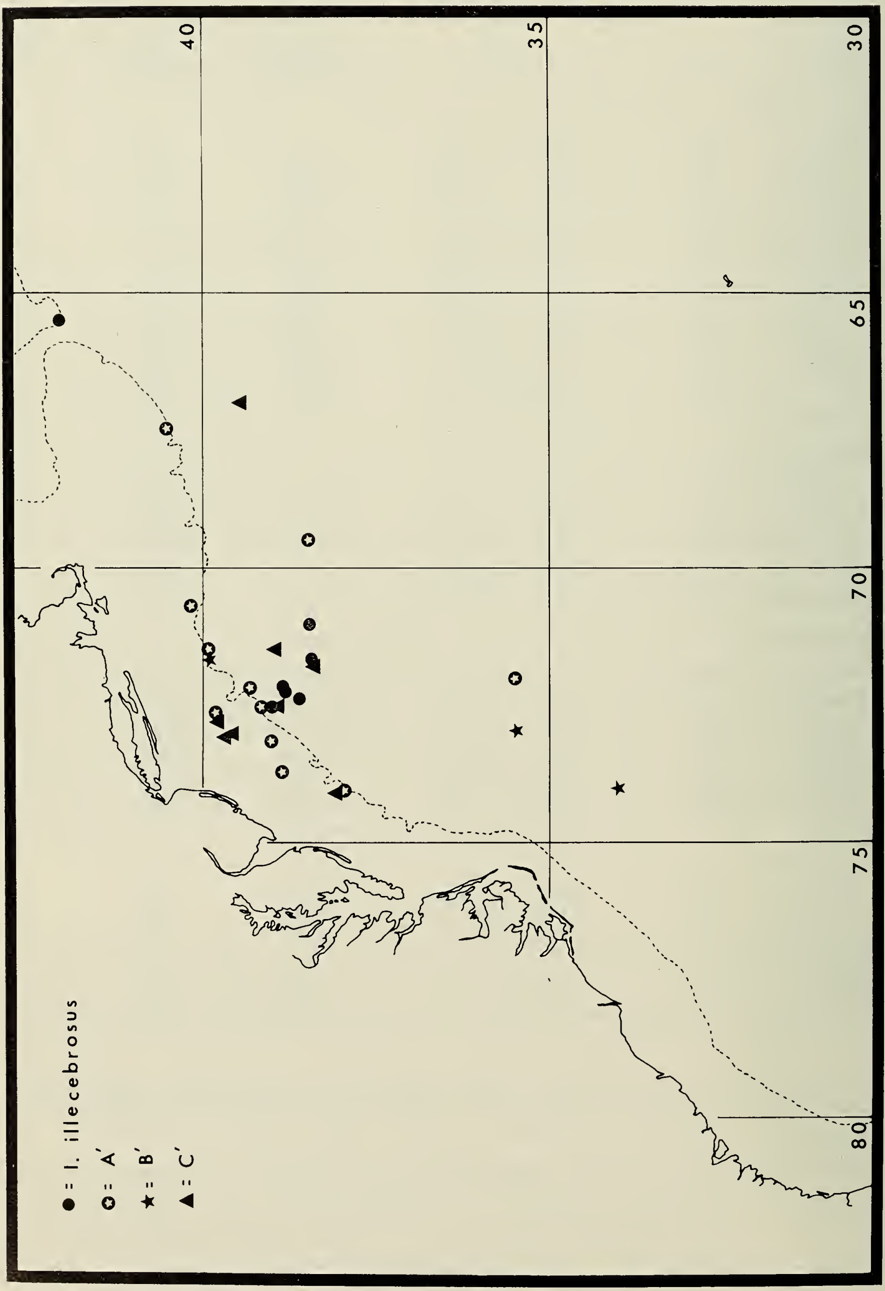
The MARMAP cruises from which these data are derived covered the area from the coast of northern Florida (29°30′N, 80°59′W), northward through the region of the New York Bight, and into New England waters (44°00′N, 66°30′W). Both Bongo nets (mesh size 0.505 mm) and neuston nets were used to sample the larval and juvenile fauna from the surface to 115 m. A total of 2,074 specimens of cephalopods was captured from 136 stations that consisted of 150 samples. Of these, 61 specimens were Rhyncho-

Table 1. Station data for Rhynchoteuthion larvae and juveniles of ommastrephid squid in the western North Atlantic.

Station number	Month	Lat. N./ Long. W.		Sampling depth m	Bottom depth m	Day/ night
Albatross IV:						
71-6-7	Sept.	40°58′	71°30′	–	55	D
71-6-25	Oct.	39°38′	73°00′	0–42	60	N
71-6-26	Oct.	39°42′	73°06′	0–25	60	N
71-6-33	Oct.	38°53′	73°42′	0–25	40	D
71-6-40	Oct.	37°59′	74°04′	0–46	130	N
71-6-43	Oct.	38°07′	74°06′	0–46	80	D
71-6-51	Oct.	39°02′	73°09′	0–46	75	N
71-6-55	Oct.	39°11′	72°32′	0–56	180	D
71-6-59	Oct.	39°22′	72°14′	0–51	1,555	D
71-6-63	Oct.	39°54′	71°32′	0–53	230	N
71-6-68	Oct.	40°13′	70°43′	0–46	130	N
Delaware II:						
72-19-9	July	38°30′	69°30′	0	3,660	N
72-19-25	July	38°30′	70°59′	0	3,475	N
72-19-88	Aug.	35°31′	72°00′	0	4,210	D
72-19-89	Aug.	35°30′	72°59′	0	3,845	D
72-19-106	Aug.	34°00′	74°01′	0	4,210	D
Albatross IV:						
74-4-11	March	39°48′	72°51′	0–76	80	N
74-5-4	May	39°00′	72°34′	0–620	915	N
74-5-5	May	38°53′	72°17′	0–720	2,015	N
74-5-6	May	38°47′	72°00′	0–615	2,745	N
74-5-8	May	38°40′	72°27′	0–630	2,470	N
74-5-9	May	38°26′	71°50′	0–550	2,855	N
Wieczno:						
74-10-77	Oct.	40°30′	67°30′	0–101	1,465	D
74-10-78	Oct.	40°30′	67°00′	0–85	730	D
74-10-97	Oct.	42°00′	65°30′	0–87	915	D
Oregon II:						
16-M	Feb.	38°49′	72°13′	0–200	2,195	N

teuthion larvae and juvenile ommastrephids from 19 stations (22 samples). The report on the cephalopods of the MARMAP Program currently is being prepared by us.

The Deepwater Dumpsite 106 is located 90 miles east of Cape Henlopen, Delaware, at 38°40′N to 39°00′N and 72°00′ W to 72°30′W. The rectangular site lies over the continental slope and rise where water depths range from 1,550 m in the northwest corner to 2,750 m in the southeast corner. Four cruises that roughly approximated the four seasons were made: Cruise 1,


40
35
30
65
70
75
80
● = I. illecebrosus
✪ = A′
★ = B′
▲ = C′

May, 1974 (Spring); Cruise 2, July–August, 1975 (Summer); Cruise 3, February, 1976 (Winter); Cruise 4, August–September, 1976 (Fall). Cruises 1 and 4 employed a non-closing net, a 10-foot Isaccs-Kidd midwater trawl (IKMT). All tows were made at night, and sampling depths ranged from 550-0 m to 790-0 m during Cruise 1 and from 675-0 m to 950-0 m during Cruise 4. Cruises 2 and 3 employed the closing-net technique with a discrete depth sampler on a 10-foot IKMT. A total of 111 stations, consisting of 390 samples, captured 342 specimens of cephalopods. Of these 12 were ommastrephid Rhynchoteuthion larvae and juveniles taken in six stations (six samples). Details of the sampling program and its results are presented in Lu & Roper (in press).

The station data for the Rhynchoteuthion larvae and the juveniles of ommastrephid squids reported here are presented in Table 1, and the distribution of specimens is plotted in Figure 1.

Results

A. *Rhynchoteuthion larvae.*—This study of cephalopods from the Deepwater Dumpsite and the MARMAP Program reveals that three types of Rhynchoteuthion larvae of the Ommastrephidae occur in the western North Atlantic. The larvae are categorized in the manner used by Sato (1973), Sato & Sawada (1974) and Yamamoto and Okutani (1975). Our designations of larval types are A′, B′, and C′ to indicate the similarity between the Rhynchoteuthion stages in the western North Atlantic and in the western North Pacific, while at the same time they show that the species or species groups from the two areas are not identical.

The Rhynchoteuthion larvae that we found to occur in the northern waters of the western North Atlantic are listed in Table 2 and are characterized below.

1. Rhynchoteuthion Type A′ (Figs. 2, 3): Rhynchoteuthion Type A′ is characterized by having the 2 lateral suckers in the ring of 8 suckers on the tip of the proboscis greatly enlarged (Fig. 2b). The enlarged suckers are 2 to 3 times the diameter of the remaining 6 suckers. The length of the proboscis in relation to the length of the mantle (dorsal), called the tentacular index (Sato, 1973; Yamamoto and Okutani, 1975), is short to moderate (TI = 3.0–7.0, mean 4.51 ± 1.60 S.D., n = 10). A single, small reflective patch, possibly the anlage of a photophore, occurs on the ventral surface of each eye. A small, round, well-defined light organ is located near the anterior end of the intestine between the intestine and the ventral

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Fig. 1. Locations of capture of Rhynchoteuthion larvae and juvenile *Illex illecebrosus.*

Table 2. Specimen data for Rhynchoteuthion larvae and juveniles of ommastrephid squid in the western North Atlantic.

Station number	Mantle length (ML) mm	Tentacle Index $\frac{TL}{ML} \times 10$
Type C′:		
74-4-11	1.50	2.5
71-6-26	1.56	3.6
74-4-11	1.67	4.0
71-6-26	2.13	4.7
71-6-43	2.19	6.3
71-6-43	2.19	7.1
71-6-25	2.63	3.6
71-6-26	2.63	4.0
71-6-43	2.69	3.3
71-6-7	3.13	3.6
74-5-9	3.13	5.2
71-6-26	3.50	3.0
74-5-4	4.69	3.1
74-10-78	4.69	3.3
Illex—Type C′ Transition:		
74-6-6	6.87	4.4
Illex illecebrosus:		
74-10-97	6.87	2.5
74-5-9	7.13	3.2
0-II-16	7.75	–
72-19-25	8.25	4.8
74-5-4	8.75	3.4
74-6-6	10.63	4.0
74-5-4	11.25	3.8
74-5-8	12.13	2.3
74-5-4	15.63	4.6
74-5-4	17.50	3.9
Type A′:		
71-6-68	1.00	6.2
71-6-59	1.04	3.6
71-6-40	1.25	3.0
71-6-33	1.46	3.4
71-6-55	1.67	3.5
71-6-63	1.67	3.8
71-6-51	1.67	4.5
74-4-11	2.04	3.1
72-19-88	3.13	7.0
72-19-9	3.13	7.0
72-19-9	4.75	–
72-19-9	7.25	–
74-10-77	–	–

Table 2. Continued.

Station number	Mantle length (ML) mm	Tentacle Index $\frac{TL}{ML} \times 10$
Type B′:		
72-19-89	2.06	10.3
71-6-63	2.09	5.4
72-19-89	2.19	7.7
72-19-106	2.19	13.7
72-19-106	2.81	9.6
72-19-106	3.75	7.0
72-19-106	–	–
72-19-106	–	–

surface of the liver (Fig. 3). The liver is short, transversely oblong, spherical in cross-section, and covered with reflective tissue.

The smaller specimens available (1.00–1.46 mm ML) (Fig. 2a) have the distinctive arrangement of suckers on the tip of the robust proboscis. The arms are very small; arms I & II are of equal length with fine, tendrilous tips and a single, mid-arm sucker each. Arms III are precursory buds only, while precursors of arms IV are not present. A few chromatophores occur on the mantle, fins, and head. The slightly stalked eyes are directed antero-laterally. Specimens of 1.67 mm ML have added 1–2 minute suckers to arms I & II; arms III have lengthened and developed 1–2 small suckers; the minute buds of arms IV are present. By the time specimens have reached 3 mm ML, arms IV are developing well, and a small, triangular slit has formed at the base of the proboscis, the beginning of the separation of the tentacles (Fig. 2c, d). The liver is spherical and is covered with reflective tissue. A single, small, round light organ occurs on the ventral surface of each eye. None of the smaller specimens show the emergence of the light organs on the liver/intestine, because both the photophores and the structures on which they lie are very easily damaged during capture. However, both types of photophores are distinctive and well-developed at 4.75 mm ML (Figs. 2e, 3).

The Rhynchoteuthion Type A′ larva becomes a juvenile when the proboscis splits along the longitudinal axis and the tentacles separate. This occurs at about 4–5 mm ML.

Eleven specimens of Rhynchoteuthion Type A′ (1.0–3.1 mm ML; one with head only) and 2 juveniles (4.8 and 7.3 mm ML) in which the tentacles have just separated were captured from the New York Bight south to the latitude of Cape Hatteras over bottom depths of 50–4,100 m. Eight specimens were captured in October in separate stations in the upper 101 m, 4 during the day and 3 at night. Four specimens, including the 2 juveniles,

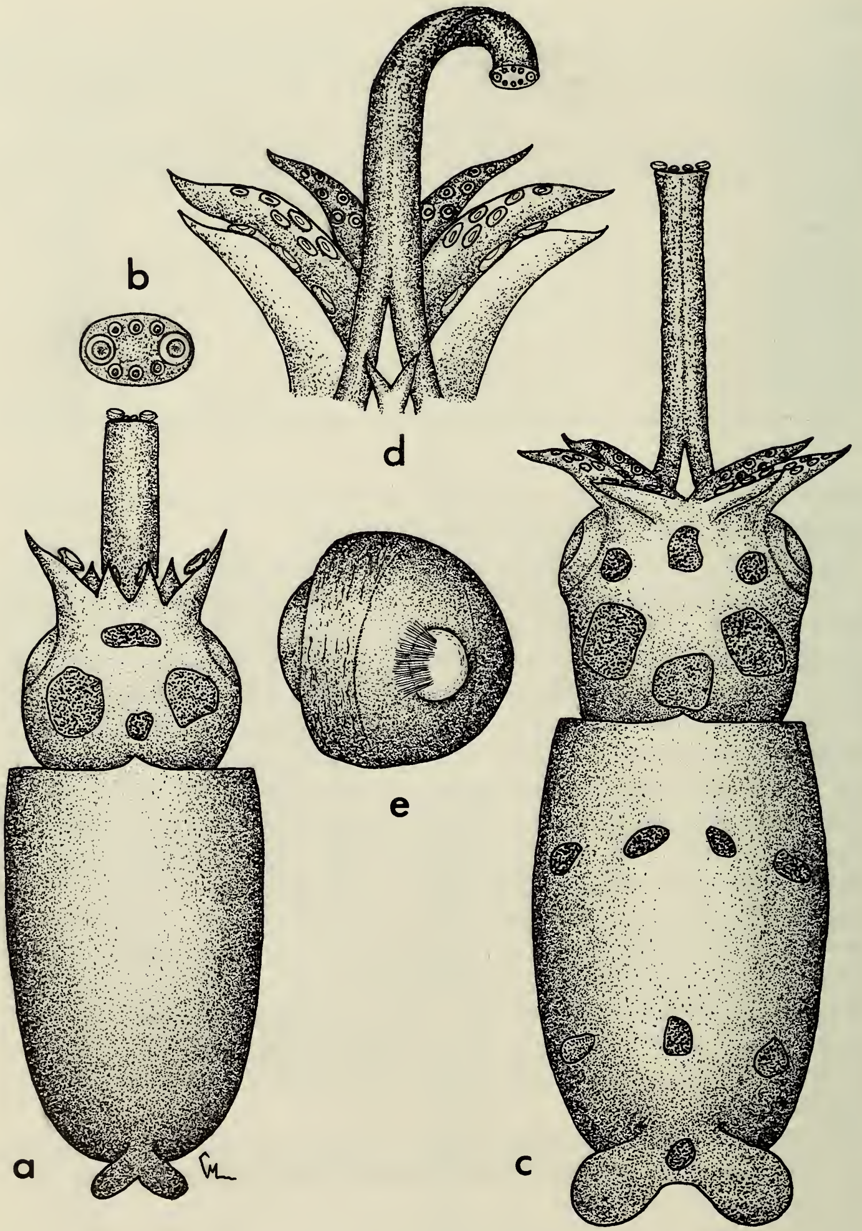


Fig. 2. Rhynchoteuthion Type A′. a, Dorsal view, 1.25 mm ML (Sta. 71-6-40); b, Suckers on tip of proboscis of a; c, Dorsal view, 3.13 mm ML (Sta. 72-19-88); d, Arm crown of c, ventral view; e, Photophore on eye, ventral view, 4.75 mm ML (Sta. 72-19-9).

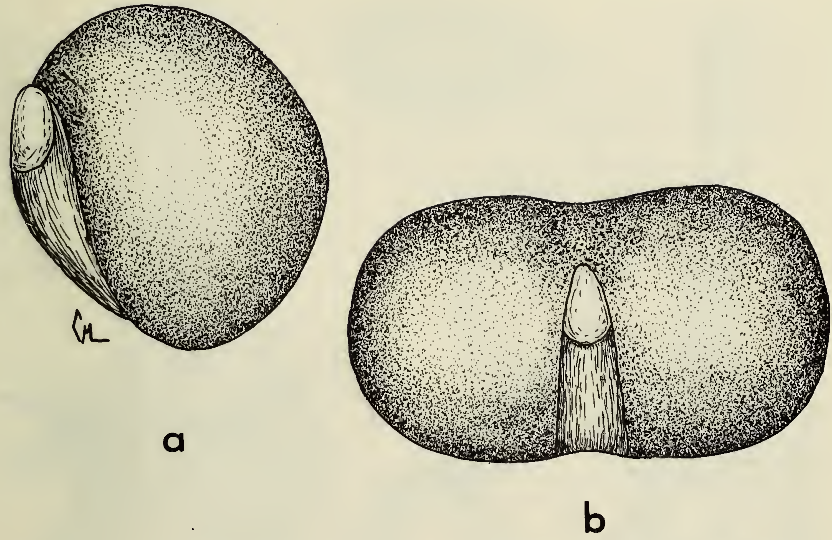


Fig. 3. Rhynchoteuthion Type A′. a, Photophore on liver, lateral view, 4.75 mm ML (Sta. 72-19-9); b, Ventral view of photophore, ink sac and liver of a.

were caught in July/August at the surface during both day and night. A single specimen was taken in March at night at 0–76 m.

2. Rhynchoteuthion Type B′ (Fig. 4): Rhynchoteuthion Type B′ is characterized by having the two lateral suckers on the tip of the proboscis slightly larger than the remaining six suckers, and in no case do they reach twice the diameter of the small suckers (Fig. 4c). The proboscis is very thin and narrow and it is moderately long to very long (Fig. 4a, b). The tentacular index ranges from 5.4–13.7 (mean 8.95 ± 2.92 S.D., $n = 6$). A single, relatively large, round, raised photophore occurs on the ventral surface of each eye (Fig. 4d). This photophore is easily dislodged and often is missing, but a circular bare patch of tissue, surrounded by reflective epithelium, may remain on the eye. A distinct, round photophore is present between the intestine and the liver on specimens from a MARMAP series well south of the Deepwater Dumpsite and northern MARMAP area (Fig. 4e). The liver appears to be quite delicate in larvae, and it and the photophore are damaged or missing in all specimens from the area of the present study. As only Rhynchoteuthion stage specimens are present in the collections (2.1–3.8 mm ML), the size at separation of tentacles is unknown.

At a size of 2.1–2.3 mm ML the proboscis is long and slender, and arms I, II, and III are well-developed; arms I are the shortest, while arms II and III are equal in length. Arms IV are precursory buds only. The round, raised

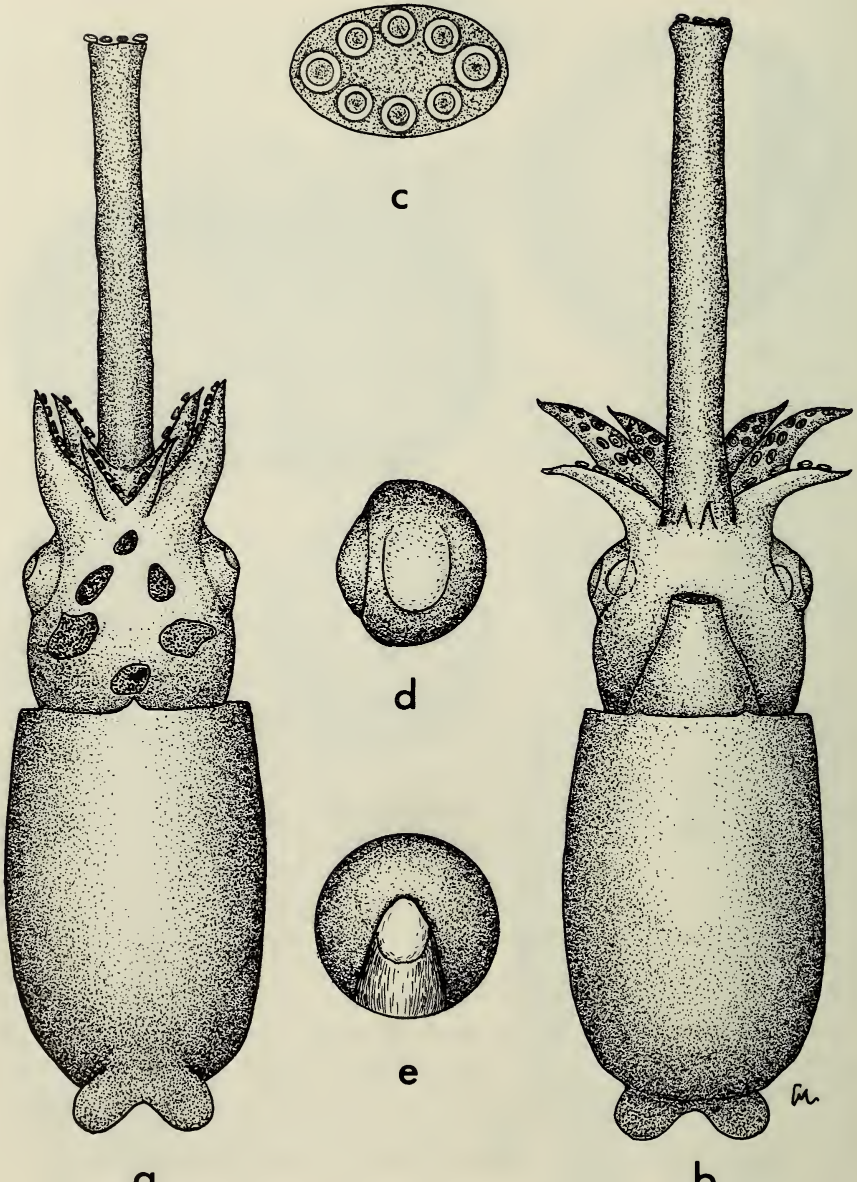


Fig. 4. Rhynchoteuthion Type B′. Composite of 2.09–2.29 mm ML (Sta. 72-6-55). a, Dorsal view; b, Ventral view; c, Suckers on tip of proboscis; d, Eye with ventral photophore; e, Photophore on ventral surface of liver.

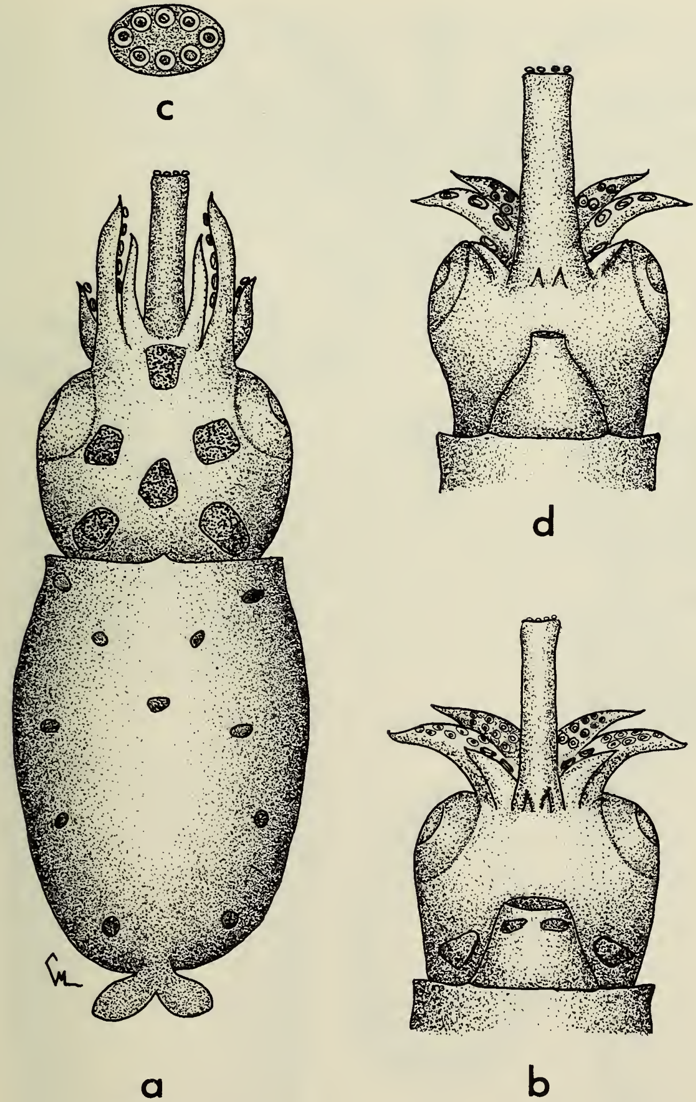
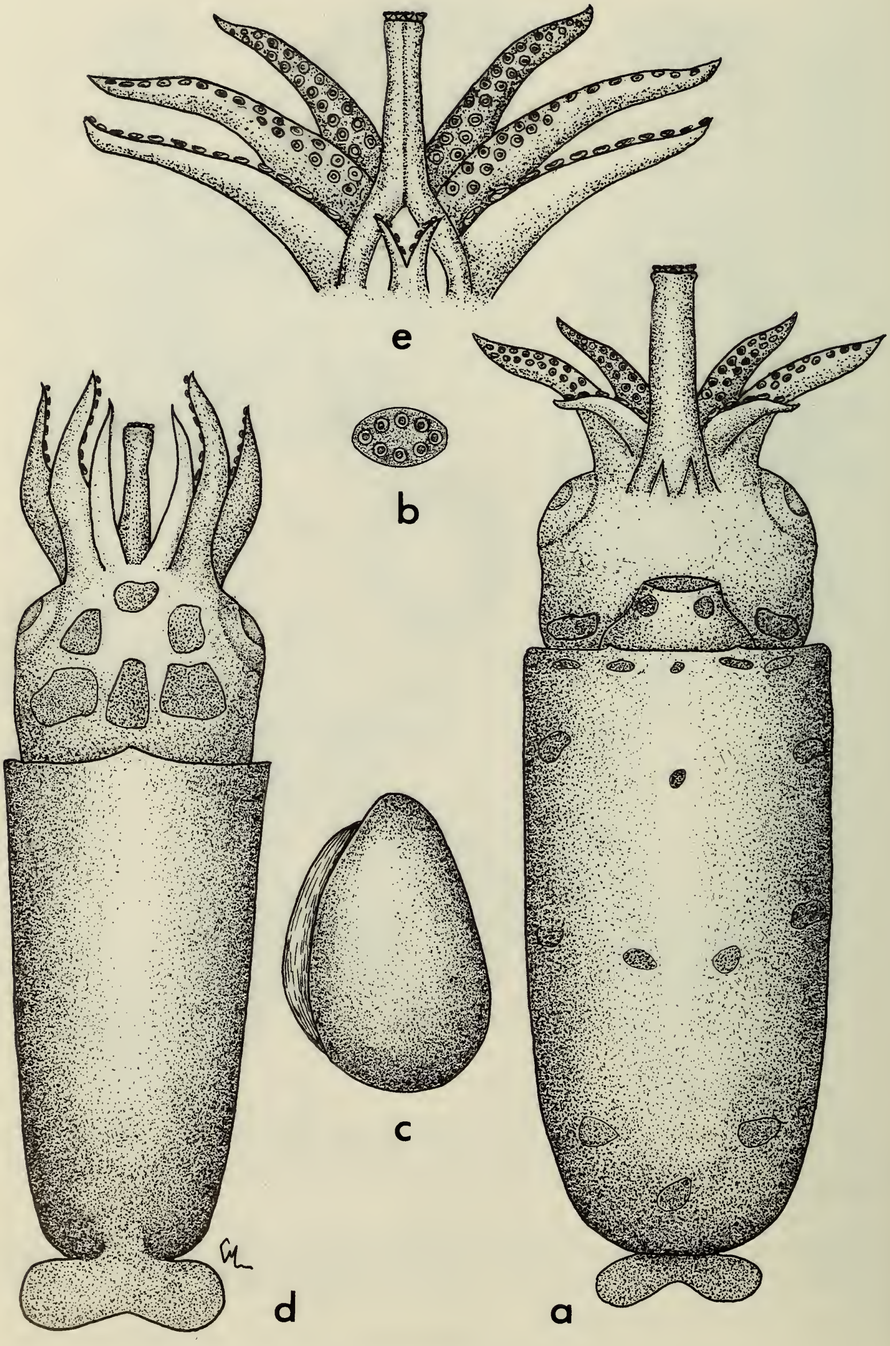


Fig. 5. Rhynchoteuthion Type C′. a, Dorsal view, 2.63 mm ML (Sta. 71-6-26); b, Ventral view of head of a; c, Suckers on tip of proboscis of a; d, Ventral view of head, 1.56 mm ML (Sta. 71-6-26).

photophores on the ventral surface of each eye and the round photophore embedded between the intestine and the ventral surface of the spherical liver are distinctly developed.

Eight specimens of Rhynchoteuthion Type B′ are available: 7 were


e
b
c
d
a

captured in August at the surface during the day in Gulf Stream water off Cape Hatteras over bottom depths of 4,000–4,700 m; 1 specimen was captured in October in the New York Bight at 0–53 m at night over the continental slope in water 500–800 m deep.

3. Rhynchoteuthion Type C′ (Figs. 5, 6, 7): The Rhynchoteuthion Type C′ larva is characterized by having all 8 suckers on the tip of the proboscis of equal, small, size; the 2 lateral suckers are never enlarged (Fig. 5c). The proboscis is relatively short and robust with a tentacular index of 2.5–7.1 (mean 4.09 ± 1.31 S.D., n = 14). Neither photophores nor anlagen of photophores occur on the eyes or on the liver. The bulbous liver is slightly elongate, pear-shaped, narrower anteriorly (Fig. 6c); it is tilted at an angle with the posterior end dorsal and the anterior end ventral.

In the smaller specimens available (1.5–1.6 mm ML) (Fig. 5d) arms I and II are about equally developed with 4–5 small suckers, but arm I is somewhat shorter. Arms III are very small and bear 2–3 small suckers, while arms IV are represented by minute precursory buds. The stout proboscis is nearly twice as long as arm *II* and bears 8 equally sized small suckers. Six large chromatophores occur on the head, and the mantle has a number of smaller chromatophores. By a ML of 3.1 mm, arms IV are slightly elongate papillae and by 4.7 they are developing rapidly. At this size arms III have caught up with arms I and II, and all are about the same length (Fig. 6d, e).

In Rhynchoteuthion C′ of about 4.7 mm ML a small, triangular opening begins to form at the base of the proboscis and a shallow, longitudinal groove, the "splitting groove," forms along the proboscis (Fig. 6e). With growth, the triangular hole enlarges between the bases of the tentacles, the proboscis is distinctly Y-shaped, and the splitting groove deepens. By 6.9 mm ML in some specimens the proboscis has split along the splitting groove nearly to the area of the club, while the tip of the proboscis has bifurcated and the incipient dactyli begin to elongate (Fig. 7b). The circlet of 8 equal-sized suckers remains intact, while minute buds of the dactylus suckers appear. The actual changeover from Rhynchoteuthion to juvenile occurs between 6 and 8 mm ML (Fig. 7a, b). All specimens less than 6 mm ML are Rhynchoteuthion and all those greater than 8 mm ML are juveniles.

Fourteen Rhynchoteuthion Type C′ larvae were taken in an area that extends from the southern New York Bight (38°N) to the southern edge of Georges Bank (41°N) in water with bottom depths of 50–2,300 m. All

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Fig. 6. Rhynchoteuthion Type C′. a, Ventral view, 3.13 mm ML (Sta. 71-6-7); b, Suckers on tip of proboscis of a; c, Liver and ink sac of a, lateral view; d, Dorsal view, 4.69 mm ML (Sta. 74-10-78); e, Arm crown of d, ventral view.

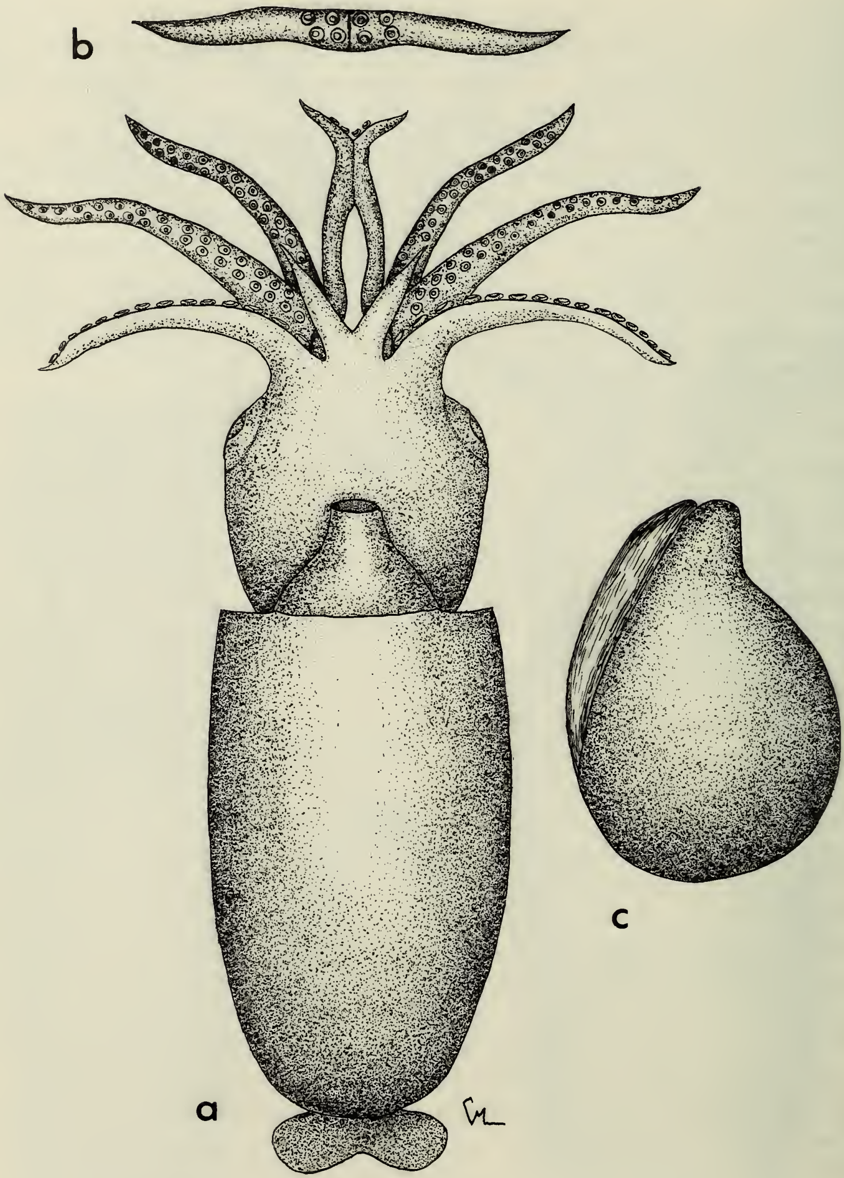

Fig. 7. Rhynchoteuthion Type C′/*Illex* Transition, 6.87 mm ML (Sta. 74-6-6). a, Ventral view; m, Bifurcated tip of proboscis, anterior view; c, Liver and ink sac, lateral view.

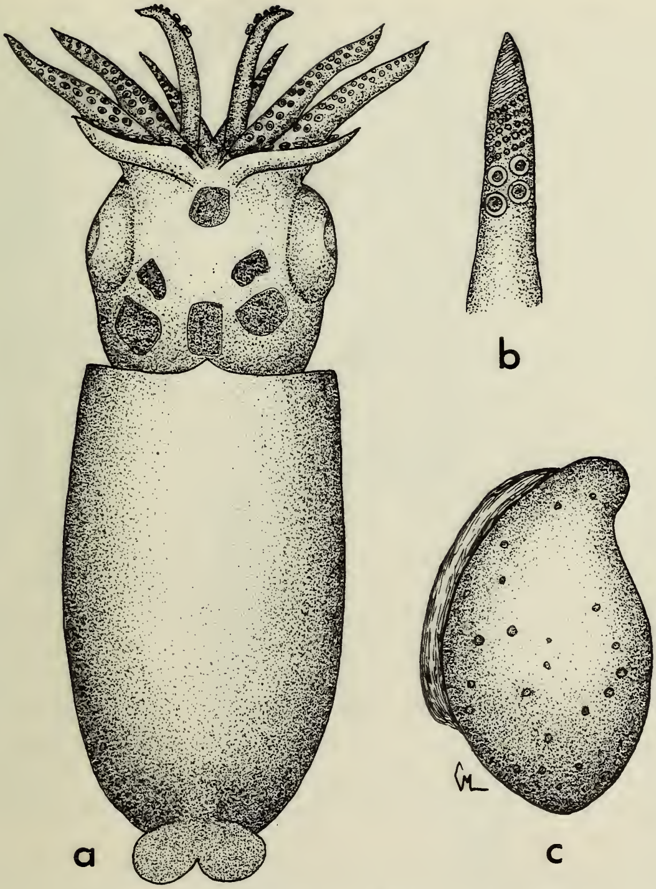

Fig. 8. *Illex* juvenile, 7.5 mm ML (Sta. 74-5-5). a, Dorsal view; b, Right tentacular club; c, Liver and ink sac, lateral view.

captures were in open nets that fished at the surface and as deep as 720-0 m, but presumably all Rhynchoteuthion Type C′ larvae actually were captured close to the surface. Captures were made both day and night and occurred during February, March, May, July, September, and October.

B. *Juveniles of* Illex illecebrosus *(Figs. 7, 8, 9).*—During studies on the Deepwater Dumpsite material we identified several juvenile specimens as *Illex illecebrosus* (Lu & Roper, in press). Additional specimens were discovered in the MARMAP collections. Specimens ranged from 6.9–17.5 mm ML, significantly smaller than the previously known smallest specimen of 68 mm ML (Verrill, 1881).

Juveniles of Ommastrephidae can be recognized as *Illex* as soon as more than 4 transverse rows of suckers occur on the dactylus, 8 rows being the maximum (Figs. 7, 8). Often it is difficult to see the dactylus suckers on the minute tips of the tentacles well enough to count the rows, or, in the case of smallest forms, to count the buds that are precursors to suckers. However, *Illex* is the only ommastrephid in which the suckers on the dactylus are very numerous, so even if an actual count can not be made, the large number of closely-packed suckers and/or buds is diagnostic. In fact, with experience, it is possible to identify the smallest juveniles by the concentration of minute sucker-buds that gives a pebbly appearance to the dactylus.

Juveniles of 7.5–8.8 mm ML have 5–8 transverse rows of small suckers on the dactylus and the manus has at least 4 larger suckers of equal size (Figs. 8a, b, 9a). At 6.9 mm ML dactylus suckers and sucker-buds are recognized as very numerous and closely packed, and the 4 equal-sized suckers on the manus form a diamond pattern. Below 6.9 mm ML most specimens are Rhynchoteuthion larvae in which the proboscis is intact, but we have identified one specimen as *Illex* with a mantle length of 6.9 mm (Fig. 7a, b). In this specimen, the proboscis has split nearly its entire length, but it is still joined in the area of the carpus and proximal manus. The splitting groove is deep. The tip of the proboscis likewise has separated and the dactyli have grown long, thin and attenuate. The dactylus bears numerous, minute, closely-packed sucker-buds. The terminal disc of the proboscis joins together the bases of the dactyli and bears a circlet of 8 equal-sized suckers. It is easy to imagine the next step in growth: the splitting groove will deepen and the tentacles will separate, dividing the terminal disc in half so that 4 equal-sized suckers form the beginning manus of the club.

The positive identification of juveniles of 6.9–8.8 mm ML as *Illex*, and especially of the specimen of 6.9 mm ML in which the tentacles are undergoing their final separation from the Rhynchoteuthion proboscis, has made it possible to connect juvenile *Illex* with the Rhynchoteuthion Type C′ larval stage.

Juveniles of 17.5 mm ML (Fig. 9b) have well developed tentacular clubs with several transverse rows of 4 suckers on the manus; transverse rows of 8 suckers occur on the proximal end of the dactylus, while the distal end is covered with papilla-like precursors to suckers (Fig. 9c).

Twelve specimens of juvenile *Illex* were caught in the same region as Rhynchoteuthion Type C′, that is, from the southern New York Bight to the southern Georges Bank. Specimens were caught day and night at or (presumably) near the surface in waters where the depth ranged from 1,500–3,000 m. No juveniles were captured in water with bottom depths shallower than 1,500 m, while Rhynchoteuthion Type C′ larvae were caught in water where bottom depths are as shallow as 55 m.

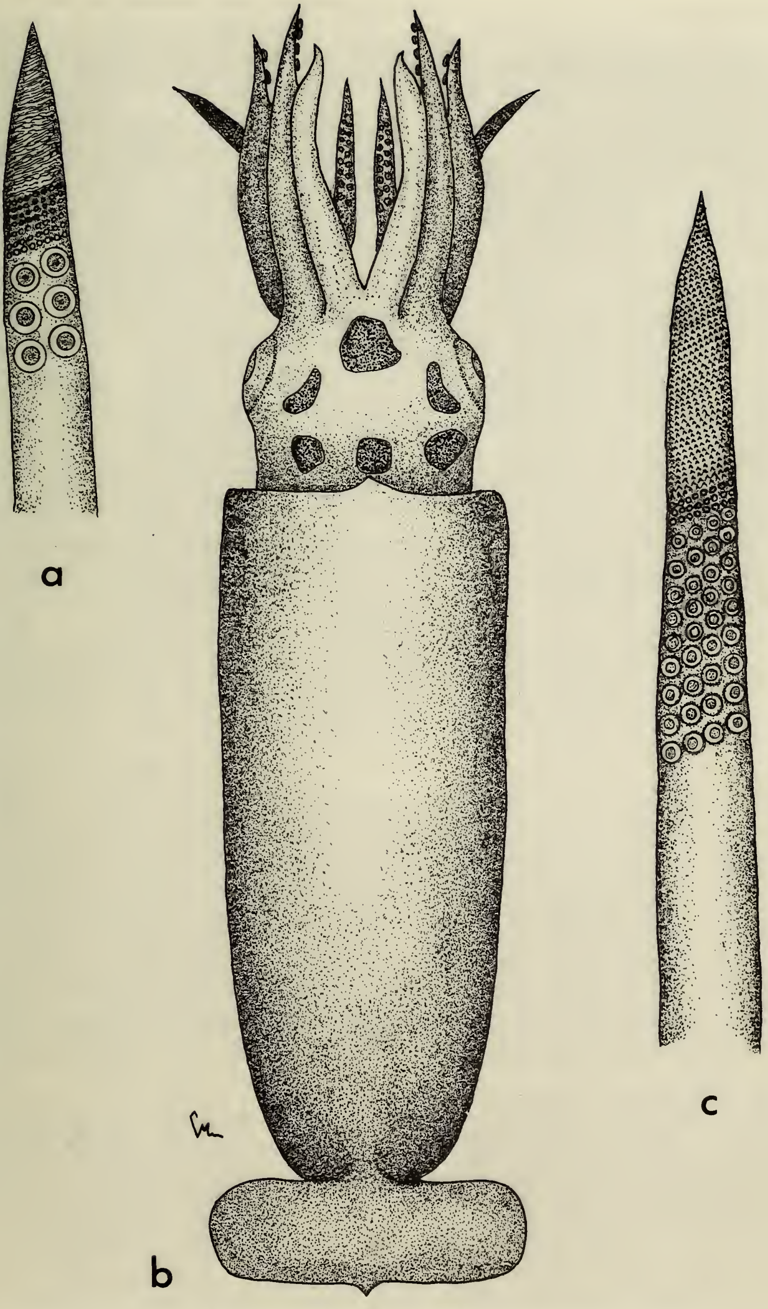

Fig. 9. *Illex* juvenile. a, Left tentacular club, 8.75 mm ML (Sta. 74-5-4); b, Dorsal view, 17.5 mm ML (Sta. 74-5-4); c, Right tentacular club of b.

Discussion

In spite of the commercial importance of *Illex illecebrosus* and the numerous collections of and references to this species, the life history remains largely unknown. No larva of any species of *Illex* had been identified from the Atlantic until now. In fact, the smallest *Illex illecebrosus* recorded in literature is that of Verrill (1881) with a mantle length of 68 mm.

The large number of samples taken over a broad geographic area, during different seasons, provides the opportunity to study the Rhynchoteuthion larvae of the Ommastrephidae. We now are able to distinguish three types of Rhynchoteuthion larvae and to positively identify one of these types as *Illex* for the first time. Once the Rhynchoteuthion of *Illex* was recognized, it became possible to attempt to link the remaining two types of larvae with the other genera of ommastrephids that occur in the western North Atlantic.

The combination of characters of Rhynchoteuthion Type A′ lead us to suggest that this is the larval form of *Ommastrephes*. Three species of *Ommastrephes* (*O. pteropus*, *O. bartrami* and *O. caroli*) occur in the western North Atlantic, but we do not have enough material yet to distinguish three forms of Rhynchoteuthion Type A′. Adult *Ommastrephes* have enlarged suckers on the median rows of the manus of the tentacular club and a dactylus with only 4 transverse rows of suckers. Rhynchoteuthion Type A′ has the lateral suckers greatly enlarged on the terminal disc of the proboscis; the terminal disc splits in half to form the manus of each club in the juvenile, and the suckers on the disc become the suckers on the manus. The Type A′ dactylus has a maximum of 4 rows of suckers. Juvenile *Ommastrephes* possess a photophore between the intestine and the ventral surface of the liver. Rhynchoteuthion Type A′ has a small distinct light organ in the same position. While the presence of a photophore on the ventral surface of the eye has not been verified in adult *Ommastrephes*, the eye does have a broad, flat patch of reflective tissue that is suspected to be luminescent because of its similarity to known photogenic tissue. A similar small, flat patch of reflective tissue occurs on the eye of Rhynchoteuthion Type A′. We feel that the resemblance of larval and juvenile characters is sufficient to allow us to suggest that Rhynchoteuthion Type A′ is the larval form of *Ommastrephes* species.

Rhynchoteuthion Type B′ has several characters that suggest it may be the larval form of *Ornithoteuthis antillarum*, the only species of the genus in the North Atlantic. The suckers on the manus of juvenile *O. antillarum* are moderately enlarged, while those on the dactylus are few in number and in only 4 rows. The lateral suckers on the terminal disc of the proboscis of Rhynchoteuthion Type B′ are slightly enlarged and the dactylus has very few suckers. Juveniles have a raised pad covered with reflective tissue on the ventral surface of each eye, very reminiscent of a photophore, while

Type B′ has a similar round, raised organ also presumed to be a photophore. Regardless of their function, they seem to be identical structures in the larva and the juvenile. In juveniles a distinct, round photophore occurs near the anterior end of the intestine on the ventral surface of the liver, and a second smaller organ occurs posteriorly on the ink sac by the curve in the intestine. A similar distinct anterior organ exists on the liver of Type B′, but no posterior organ has been found yet. While additional material is needed, it appears that Rhynchoteuthion Type B′ may be the larval form of *Ornithoteuthis antillarum.*

We have specimens that show the direct transition between the Rhynchoteuthion Type C′ larva and the juvenile of *Illex.* The suckers on the manus of juvenile *Illex* are not appreciably enlarged, while the suckers on the dactylus are in 8 transverse rows and are very small and numerous. Type C′ has all 8 suckers of equal size on the terminal disc and the precursory buds of the dactylus suckers that emerge in more than 4 rows are very numerous. The transitional stage from Type C′ to *Illex* juvenile shows the tentacles joined together only at the proximal ends of the clubs. The dactyli are greatly elongated and bear 5–8 rows of numerous suckers and sucker-buds. Where the bases of the dactyli are still fused, the terminal disc is evident by the presence of the circlet of 8 equal-sized suckers. When separation is complete 4 equal-sized suckers form the basis of the manus of each club. The species of *Illex* are the only species of ommastrephids in the western North Atlantic that do not possess some type of photophore. Rhynchoteuthion Type C′ shows no indication of having either photophores or precursors of photophores.

While we now know that Rhynchoteuthion Type C′ is the larval stage of *Illex*, we are unable to determine the species on morphological grounds. The greater New York Bight area from which Type C′ was captured is inhabited by *I. illecebrosus* throughout the area and by *I. oxygonius* in the southern part. Since *I. illecebrosus* is by far the more abundant species, and since Type C′ larvae occurred throughout the area and into New England waters, we feel that this larval form probably is that of *Illex illecebrosus.* In order for more certain specific identifications to be made, we must have more material to study.

The larvae of *Illex* were captured at widely scattered localities throughout the sampling area from 38°N to 42°N, but there is no reason to believe that they are limited to this area. Now that the larval form of *Illex* is known it should be possible to more precisely determine larval distributions and to infer spawning areas. Because some of the *Illex* larvae are so small (minimum of 1.5 mm ML) they must have been captured very close to the sites where they hatched. In fact, the samples indicate a tendency for the Rhynchoteuthion Type C′ larvae (1.5–3.5 mm ML) to occur in near-shore waters over the continental shelf (50–80 m bottom depth), while the juveniles (7–17.5 mm ML) tend to occur over the continental slope and rise (1,500–3,000 m bottom depth). A larger sample is required before this observation can be verified, but we suggest that spawning and hatching occur along the outer half and to the edge of the continental shelf (shelf-break) off the mid-Atlantic states and New England, and probably to the north and south of this area, as well. After hatching the larvae ascend to the near-surface shelf waters, are transported seaward, and occur as juveniles in slope water and Gulf Stream water. This pattern is consistent with the general pattern of water circulation, whereby an inshore drift of bottom water occurs across the shelf, while the surface water moves offshore and mixes with slope water (review in Warsh, 1975).

The spawning season apparently extends over much of the year, as the smaller larvae (1.5–3 mm ML) have been taken in March, May, September and October and the smaller juveniles (7–8 mm ML) were taken in February, May and October.

Acknowledgments

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LARVAL DEVELOPMENT OF *ILLEX* STEENSTRUP, 1880, IN THE NORTHWESTERN ATLANTIC, WITH COMMENTS ON *ILLEX* LARVAL DISTRIBUTION

Michael Vecchione

Abstract.—The larval development of *Illex* is described and figured with particular attention to development of the tentacles and the fourth pair of arms. The larvae can be identified by the presence of relatively short fused tentacles which have 8 suckers of uniform size. By the time the tentacles separate they have developed 8 rows of sucker buds in the dactylus. Growth of the tentacles appears to occur at the base as well as the distal tip and the fused area separates rapidly at about 8.50 mm dorsal mantle length. Larval *Illex* collected primarily in subsurface samples from boreal waters along the outer Continental Shelf of the Middle Atlantic Bight in February and March 1977 are considered to be *I. illecebrosus*. *Illex* sp. larvae were also taken in subsurface samples from tropical waters in the mid-shelf region of the Middle Atlantic Bight during August 1977 and in surface samples over the Hatteras Abyssal Plain in February and March 1978.

Although there is some question as to whether post-embryonic cephalopods can be termed larvae (Boletzky, 1974), one family of oegopsid squids, the Ommastrephidae, hatch in a form which is morphologically distinct from the adult form. Larval ommastrephids lack the fourth, or ventral, pair of arms, and at least in some species the third pair, and exhibit fusion of the pair of tentacles into a single appendage with suckers confined to the distal end. The fused tentacles have been referred to variously as a snout (Chun, 1910; Naef, 1923), a rostrum (Hamabe, 1961), or a proboscis-like rod (Okutani and McGowan, 1969). Although Chun (1903) named these larvae with fused tentacles *Rhynchoteuthis*, which was later changed to *Rhynchoteuthion* because of previous assignment of the former name to a fossil form (Pfeffer, 1908), he was aware that they were actually developmental stages of the family Ommastrephidae (Chun, 1910). The term "rhynchoteuthion" is now used for all such ommastrephid larvae.

One ommastrephid species, *Illex illecebrosus*, the short-finned or bait squid, has become increasingly important as a fishery resource (NMFS, 1977). In the western North Atlantic it ranges from Newfoundland and Labrador southward all along the east coast of North America but it is predominantly a cold water species. A sympatric species, *I. oxygonius*, has been captured as far north as the Chesapeake Bight (Roper, Lu, and Mangold, 1969).

This paper describes the larval development of *Illex* based on 47 specimens collected in the Middle Atlantic Bight in February–March 1977. The distribution of these larvae is presented, as well as the distribution of an ecologically distinct form collected in the Middle Atlantic Bight in August 1977 and over the Hatteras Abyssal Plain in February–March 1978.

Methods.—As part of a baseline study of the Middle Atlantic Continental Shelf, zooplankton and other data were collected quarterly along 2 transects extending from near shore to the shelfbreak, one off the eastern shore of Virginia and the other off New Jersey. Both surface and subsurface zooplankton were collected at 12 stations, 9 of which were occupied for 24 hours with surface collections every 3 hours using a neuston frame (Bartlett and Haedrich, 1968) rigged with a standard 1 m 505 μm mesh net. Subsurface oblique tows were made at night with 60 cm opening-closing bongo systems (McGowan and Brown, 1966) rigged with both 202 and 505 μm mesh nets. At the remaining 3 stations, in addition to the night bongo tows, a single night neuston sample was taken. Samples were preserved in 2–4% formaldehyde in sea water buffered with borax.

Specimens from the Hatteras Abyssal Plain were collected during the R/V *Columbus Iselin* deep sea cruise CI7802, conducted by the Virginia Institute of Marine Science during February–March 1978, in the western North Atlantic. A total of 32 stations was occupied, and at least one neuston tow was made at 18 stations. Subsurface collections were made at 4 stations using a modified Tucker trawl rigged with a 1 m 505 μm mesh net. These samples were also preserved in buffered formaldehyde in sea water.

All rhynchoteuthion larvae were examined at between 7 and 40 power under a dark field dissecting microscope equipped with an ocular micrometer. Dorsal mantle length (DML) was measured to the nearest 0.05 mm. Particular attention was directed to tentacular sucker arrangement, structure of the mantle component of the funnel locking cartilage, chromatophore patterns, and the presence of photophores or funnel pit folds. Internal examination was made by cutting the ventral mantle between the siphon and the posterior tip. Several specimens were stained with a solution of 10 mg Alcian Blue in 80 ml of ethanol and 20 ml of glacial acetic acid (Dingerkus and Uhler, 1977) to highlight cartilage structure. This also had the advantage of making developing organs such as buccal lappets and sucker buds easier to see.

Materials.—A total of 51 *Illex* sp. was examined. Of these, 39 were captured in boreal water and 12 in tropical water from calculated catches of 47 and 25, respectively, several specimens having been removed from splits of large samples. All larval and early juvenile *Illex* were taken in plankton tows using either 1 m neuston or 60 cm bongo frames with nets of either 202 or 505 μm mesh. In the gear designations listed below an abbreviation of B202 refers to a 60 cm bongo frame rigged with 202 μm mesh Nitex netting, B505 a 60 cm bongo with 505 μm netting, and N505 a 1 m neuston net of 505 μm netting.

In the following list of specimens examined, I include the VIMS collection number, number of specimens, range of dorsal mantle lengths, cruise designation, station designation, coordinates, station depth, date of collection, time of collection (EST), collecting gear, depth of collection, surface temperature, and surface salinity.

Illex sp.

Z77-002, 1 specimen, 15.15 mm, BLM06W, L6, 37°04.7′N, 74°34.6′W, 274 m, 20:II:77, 1740 hrs, N505, surface, 11.6°C, 35.8‰; Z77-003, 1 specimen, 4.30 mm, BLM06W, L6, 37°05.0′N, 74°33.3′W, 274 m, 20:II:77, 2040 hrs, N505, surface, 11.8°C, 35.8‰; Z77-009, 4 specimens, 4.00–6.30 mm, BLM06W, L6, 37°04.6′N, 74°33.4′W, 301 m, 22:II:77, 0125 hrs, B202, 0–300 m, 12.0°C, 35.8‰; Z77-011, 9 specimens, 3.65–11.00 mm, BLM06W, L6, 37°04.9′N, 74° 31.7′W, 382 m, 22:II:77, 0235 hrs, B505, 0–300 m, 12.0°C, 35.8‰; Z77-042, 4 specimens, 2.40–4.40 mm, BLM06W, J1, 38°46.4′N, 73°00.1′W, 340 m, 26:II:77, 2254 hrs, B505, 0–380 m, 11.2°C, 35.6‰; Z77-044, 1 specimen, 5.60 mm, BLM06W, J1, 38°45.3′N, 73°01.3′W, 360 m, 27:II:77, 0222 hrs, B202, 0–430 m, 11.2°C, 35.6‰; Z77-045, 1 specimen, 3.70 mm, BLM06W, J1, 38° 44.0′N, 73°00.6′W, 360 m, 27:II:77, 0235 hrs, N505, surface, 12.0°C, 35.8‰; Z77-051, 3 specimens, 4.10–13.70 mm, BLM06W, J1, 38°44.0′N, 73°00.0′W, 335 m, 27:II:77, 1755 hrs, N505, surface, 10.4°C, 35.1‰; Z77-052, 3 specimens, 3.50–4.50 mm, BLM06W, J1, 38°45.1′N, 73°01.0′W, 335 m, 27:II:77, 2032 hrs, N505, surface, 10.3°C, 35.1‰; Z77-054, 3 specimens, 5.45–6.30 mm, BLM06W, F2, 38°44.4′N, 73°09.2′W, 107 m, 28:II:77, 0125 hrs, B202, 0–65 m, 7.4°C, 35.5‰; Z77-059, 1 specimen, 3.00 mm, BLM06W, E3, 38°41.9′N, 73°33.0′W, 41 m, 28:II:77, 2310 hrs, B505, 0–20 m, 6.4°C, 35.4‰; Z77-061, 1 specimen, 3.10 mm, BLM06W, E3, 38°41.0′N, 73°32.0′W, 58 m, 28:II:77, 2350 hrs, B202, 0–26 m, 6.4°C, 35.4‰; Z77-062, 1 specimen, 4.80 mm, BLM06W, E3, 38°41.2′N, 73°32.2′W, 49 m, 1:III:77, 0125 hrs, B505, 0–35 m, 6.4°C, 35.4‰; Z77-063, 1 specimen, 3.75 mm, BLM06W, E3, 38°41.2′N, 73°32.2′W, 49 m, 1:III:77, 0125 hrs, B202, 0–35 m, 6.4°C, 35.4‰; Z77-064, 2 specimens, 4.25–5.55 mm, BLM06W, E3, 38°41.3′N, 73°32.4′W, 49 m, 1:III:77, 0200 hrs, B505, 0–38 m, 6.4°C, 35.4‰; Z77-095, 1 specimen, 3.55 mm, BLM06W, A2, 39°21.7′N, 72°32.4′W, 136 m, 3:III:77, 2000 hrs, B202, 0–105 m, 5.4°C, 35.1‰; Z77-096, 1 specimen, 4.50 mm, BLM06W, A2, 39°21.8′N, 72°31.5′W, 136 m, 3:III:77, 2100 hrs, B202, 0–95 m, 5.7°C, 35.0‰; Z77-097, 1 specimen, 4.80 mm, BLM06W, A2, 39°21.8′N, 72°31.5′W, 136 m, 3:III:77, 2100 hrs, B505, 0–95 m, 5.7°C, 35.0‰; Z77-144, 1 specimen, 21.10 mm, BLM07W, L4, 37°08.2′N, 74°37.0′W, 86 m, 20:V:77, 0440 hrs, N505, surface, 17.6°C, 35.8‰; Z77-250, 1 specimen, 2.40 mm, BLM08W, L2, 37°20.1′N, 74°58.7′W, 42 m, 20:VIII:77, 2050 hrs, B202, 0–35 m, 25.0°C, 31.7‰; Z77-297, 1 specimen, undetermined, BLM08W, A2, 39°21.5′N, 72°30.9′W, 128 m, 25:VIII:77, 2055 hrs, B202, 0–90 m, 23.3°C, 33.5‰; Z77-300, 1 specimen, 2.05 mm, BLM08W, A2, 39°21.3′N, 72°30.9′W, 128 m, 25:VIII:77, 2200 hrs, B505, 0–90 m, 23.3°C, 33.5‰; Z77-313, 1 specimen, 2.10 mm, BLM08W, B5, 39° 27.1′N, 73°02.1′W, 64 m, 26:VIII:77, 2020 hrs, B505, 0–37 m, 22.1°C, 32.1‰; Z77-333, 2 specimens, 2.55–2.65 mm, BLM08W, D1, 39°04.5′N, 73°53.4′W, 39 m, 28:VIII:77, 1855 hrs, B505, 0–13 m, 21.8°C, 32.6‰; Z77-337, 3 specimens, 2.75–3.70 mm, BLM08W, N3, 38°51.1′N, 73°44.9′W, 43 m, 28:VIII:77, 2120 hrs, B505, 0–38 m, 24.1°C, 32.6‰; Z78-008, 2 specimens, undetermined—3.20 mm, CI7802, BRI8, 38°08.1′N, 68°48.2′W, 3980 m, 20:II:78, 2300 hrs, N505, surface, 19.2°C, 36.4‰; Z78-024, 1 specimen, 8.50 mm, CI7802, 23, 36°48.4′N, 71°23.7′W, 4134 m, 3:III:78, 0906 hrs, N505, surface, 19.0°C, unknown.

Identification.—Little progress has been made in identification of rhynchoteuthion larvae to species. Naef (1923) discussed the general post-embryonic development of the family and described late larvae, which had the fourth pair of arms developed and tentacles mostly separated, of *Todarodes sagittatus* and *Ommastrephes bartrami.* He also described a juvenile *Illex coindetii* in which the tentacles had just separated. Allan (1945) assigned all of the rhynchoteuthion larvae collected off the eastern Australian coast to *Nototodarus gouldi.* Hamabe (1961, 1962) described the embryonic and post-embryonic development of *Todarodes pacificus* based on laboratory hatched and planktonic specimens. Clarke (1966) mentioned and figured two rhynchoteuthion larvae referable to either *O. caroli* or *O. pteropus* based on funnel connective structure. Development in *Symplectoteuthis oualaniensis* was figured by Silas (1968). Yamamoto and Okutani (1975) discussed three rhynchoteuthion types, one of which they assigned to *S. oualaniensis.*

Tentacles: Knowledge of the tentacular structure and development is of utmost importance in the identification of rhynchoteuthion larvae. One of the primary characters used to separate the genus *Illex* from other ommastrephid genera is the presence of 8 rows of suckers in the dactylus of the tentacle. In the larvae this pattern becomes apparent at about 8.5 mm DML.

A pattern of the 8 original suckers like that found in the larvae of some other ommastrephid species is present in *Illex.* Okutani and McGowan (1969) figured a similar pattern from a "small" Pacific specimen. Differences exist, though, between their figure and the pattern in *Illex.* They showed the tip to be elliptical in shape and size differences to exist in the suckers with the lateral suckers being largest and the smallest suckers in the middle. In *Illex* the tip is diamond shaped and the suckers are all the same size. They also stated that the smallest sizes have only 6 tentacular suckers. Chun (1910) described all of the rhynchoteuthion larvae that he examined as having 8 suckers at the "apex" of the tentacles, but his figures showed that the tentacular tip was not expanded and the suckers were in a circular arrangement. The youngest stages of rhynchoteuthion described by Naef (1923) bore only 4 tentacular suckers, but his advanced larvae of *T. sagittatus* and *O. bartrami* exhibited tentacular development which is quite similar to that described in this paper, including the 8 developed suckers and the 4 rows of sucker buds. They, of course, never developed 8 rows in the dactylus.

Relative tentacular length may be of taxonomic importance. Although the tentacles of adult squid are notoriously contractile, this is not necessarily true of larvae and early juveniles. The tentacle length of juvenile *Loligo pealei* (1.4–15.0 mm DML) examined by the author is closely correlated with dorsal mantle length. Although insufficient material is available to perform a morphometric study of *Illex* larvae, variability other than growth in the tentacle length of the specimens examined was not apparent. The tentacles were never functionally longer than the arms. But several authors (Chun, 1910; Naef, 1923; Silas, 1968; Okutani and McGowan, 1969; Morales and Guerra, 1977) have figured rhynchoteuthion specimens in which the fused tentacles were much longer than the arms.

Mantle cartilages: Other than the genus *Illex*, ommastrephid squids which are likely to be found in the study area belong to the genera *Ommastrephes* and *Ornithoteuthis*. One character that separates *Illex* from *Ommastrephes* is the structure of the mantle component of the funnel locking cartilage. In *Ommastrephes* the anterior ridge is bifurcate whereas in *Illex* it is simple (Wormuth, 1976). All larvae examined in this study had the form found in *Illex*.

Foveola: A character which distinguishes the subfamily Illicinae from the rest of family Ommastrephidae is the presence of a funnel pit which is open without either longitudinal folds or secondary pockets (Muus, 1963). Naef (1923) stated that these folds are clearly visible in older rhynchoteuthion stages, but they were not present in any of the squid examined for this study.

Chromatophores: Naef (1923) and Muus (1963) indicated that chromatophore patterns are very useful in the identification of juvenile and larval cephalopods. However, the net captured specimens examined here had been damaged during capture and preservation and the only pattern which consistently remained was that of the 3 ventral chromatophores on the head. Similar patterns have been figured for *T. sagittatus*, *O. bartrami* (Naef, 1923), *T. pacificus* (Hamabe, 1962), and *S. oualaniensis* (Silas, 1968) but not in the same arrangement.

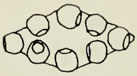
Photophores: Intestinal photophores are present in *O. pteropus* and are highly visible in the juveniles (Wormuth, 1976) but were not found in *Illex*.

Development and discussion of development.—The smallest specimens taken, DML ~ 2.40–5.00 mm, were similar in form to the individual in Fig. 1 (DML = 3.60 mm). The second and third pair of arms were about equal in length, although in the smallest larvae the third pair was somewhat shorter than the second. The fourth pair of arms was recognizable only as small protuberances with no suckers. The tentacles were fused along their entire length in the smallest specimens, although at about the size illustrated in Fig. 1 a small gap could be seen at the base. The distal tip of this tentacular organ was expanded and concave. Eight suckers were confined to this concavity and arranged from side to side in the order 1–2–2–2–1.

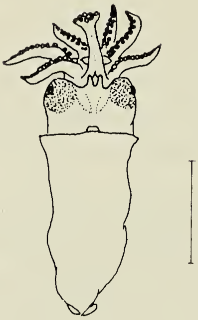
Figure 2, based on a specimen of 7.00 mm DML, was representative of larvae ranging in size from 5.00–8.00 mm. The third pair of arms had lengthened, strengthened, and developed a swimming margin. The ventral protuberances seen in smaller larvae had developed into the fourth pair of arms complete with biserial suckers which were fully developed along the proximal one-third, but still developing from buds along the distal two-thirds. Although all of the cephalic appendages had lengthened, their length was shorter relative to dorsal mantle length than those of the smaller squids. The fused tentacles were considerably shorter than any except the fourth pair of arms. While the length of the fused area, about 1.00–1.30 mm, remained the same as in smaller larvae, growth appeared to have occurred in two places. The separated area at the base of the tentacles had lengthened as had the tips of both tentacles. On both sides of the original expanded tip, which still had the same pattern of 8 fully developed suckers, were 4 rows of tiny sucker buds or *Anlagen* (Naef, 1923). Two chromatophores were visible on the ventral surface of the head, one below each eye.

The squid shown in Fig. 3 (DML = 8.50 mm) represents larvae in transition just prior to separation of the tentacles and assumption of the juvenile form. The third pair of arms was very robust. The fourth arms had further lengthened and developed more suckers. The most interesting developments, however, were in the tentacular structure. The separated sections at the bases had lengthened considerably. The tips had also lengthened and had folded together anteriorly. Many more sucker buds were present and the smallest ones at the distal extremities of the tentacles appeared to be arranged in 8 rows. Three chromatophores were visible on the ventral surface of the head, one below each eye and one on the midline just anterior to the funnel.

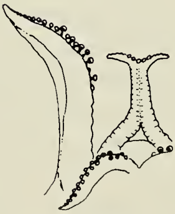
Figure 4 was drawn from a juvenile *Illex* with a dorsal mantle length of 11.00 mm. The fourth pair of arms was still the shortest of the cephalic appendages. The tentacles had separated and were about the same length as the third pair of arms. The original 8 suckers had been divided between the two tentacles while several more suckers had developed from the earliest sucker buds mentioned in the description of Fig. 2. The smallest, outermost sucker buds were arranged in 8 rows. The tentacles were not as robust as



1 A



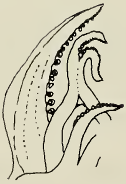
1 B



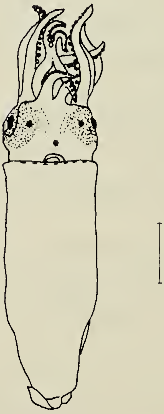
2 A

2 C

2 B



3 A



3 B

any of the arms, and in most of the other specimens of early juveniles in which the tentacles had become separated they had been damaged, probably during capture, while the arms remained intact. Three chromatophores were present on the ventral head in the same locations as those described in Fig. 3.

While the specimens drawn in Figs. 1–4 all came from the same collection, the one in Fig. 5 (DML = 21.10 mm) was taken from the same area, but three months later. Other than morphometrics and the presence of the mantle skin with its chromatophores, it is little different from the specimen illustrated in Fig. 4. The dactylus of the tentacle still has 8 tightly packed rows of undeveloped sucker buds. The 3 chromatophores on the ventral surface of the head are still recognizable. Basically, this specimen differs from adult *Illex* only in the absence of developed sexual organs.

All specimens examined lacked funnel pit folds and photophores. In all cases the anterior section of the mantle component of the funnel locking cartilage was simple rather than bifurcate. Unfortunately the skin had been abraded on almost every specimen, thus development of mantle chromatophore patterns could not be followed.

Third pair of arms: Various researchers have described rhynchoteuthion larvae smaller than any specimen found in this study and in which the third arms had not yet developed; the third arms were present and functional in the smallest specimens described here. Hamabe (1961) stated that in *Todarodes pacificus* hatched in culturing experiments the third arms, which were undeveloped at hatching, had become longer and stronger than the first and second arms within a day or two after hatching. But since the larvae were not capable of swimming it seems likely that they had hatched prematurely, as frequently happens in cultured cephalopods. A photograph, published by Boletzky (1974), of laboratory hatched *Illex coindetii* showed a post-hatching stage in which the third arms were missing but was also based on cultured material. Occurrences in the plankton of unidentified rhynchoteuthion larvae in which the third pair of arms had not yet developed include Chun (1910) and Okutani and McGowan (1969). Naef (1923) stated that this is typical of the postembryonic development in the family Ommastrephidae.

Fourth pair of arms: It is generally agreed that the fourth pair of arms are the last cephalic appendages to develop in rhynchoteuthion larvae. This can also be considered typical of ommastrephid development (Naef, 1923).

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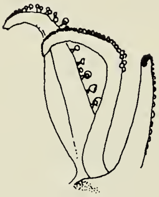
Figs. 1–3. *Illex* sp. larvae from boreal water. 1: DML = 3.60 mm; 1A, Sucker arrangement at tip of fused tentacles; 1B, Ventral view of entire animal; 2: DML = 7.00 mm; 2A, Tentacles, third arm, and fourth arm; 2B, Tentacles showing sucker arrangement at distal tip; 2C, Ventral view of entire animal; 3: DML = 8.50 mm; 3A, Tentacles, third arm, and fourth arm; 3B, Ventral view of entire animal. Scale lines = 2.00 mm.



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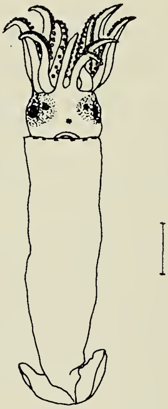

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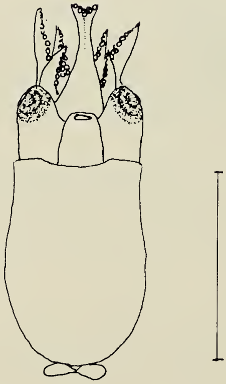

6

Tentacles: The late development of the 8 rows of sucker buds characteristic of the dactylus, together with the lengthening of the distal tips of the tentacles beyond the constant 8 fully developed suckers, supports Naef's (1923) statement that larval tentacles grow at the distal tips and that therefore the dactylus forms last. But there appears to be another area of tentacular growth, at least in *Illex*. The separated area at the bases of the tentacles lengthened consistently with increase in dorsal mantle length while the length of the fused area proximal to the 8 suckers remained constant, indicating growth occurring somewhere in the basal area. Separation of the fused area is not a gradual "unzipping" with growth of the animal. It occurs rapidly at about 8–9 mm DML and results in a weakened tentacle. Similar tentacular weakness after separation has been described for *O. bartrami* and *T. pacificus* by Okutani (1968).

Distribution and discussion of distribution.—During the period 20 February–6 March 1977, 47 rhynchoteuthion larvae and early juvenile *Illex*, DML 2.40–15.15 mm, were collected. With the exception of one mid-shelf station, which actually clusters faunistically with the outer-shelf stations (Grant, 1977), all were from outer shelf stations (Fig. 7).

Although 75 out of 117 samples taken on this cruise were surface neuston tows, 76.5% of the collections in which *Illex* occurred were subsurface bongo tows. These accounted for 83% of the *Illex* specimens collected. All neuston samples which included *Illex* were collected at night.

Because the bongo tows were oblique, the only reliable temperature and salinity data for the collections that we have are for the neuston collections. Since only 4 neuston tows caught *Illex* this is too small a sample to make inferences from. The temperature range of these neuston tows was 10.4–11.8°C while salinity ranged from 35.1–35.8‰. However, 76.9% of all winter collections that included *Illex* also included *Limacina retroversa*, a thecosome pteropod species which is a reliable indicator of boreal water (Bigelow, 1922; Chen and Be, 1964; Chen and Hillman, 1970).

A second group of 32 rhynchoteuthion larvae was collected during 20–28 August 1977. Of these, 22 were *Illex*, DML 2.10–3.70 mm, which were consistently smaller than the specimens collected the previous winter. The smaller size made direct morphological comparisons with the winter specimens impossible since differences (Fig. 6) could be the result of being at a different growth stage. The stations at which these *Illex* larvae were

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Figs. 4–5. *Illex* sp. juveniles from boreal water. 4: DML= 11.00 mm; 4A, Tentacle, third arm, and fourth arm; 4B, Ventral view of entire animal; 5: DML = 21.10 mm; 5A, Ventral view; 5B, Dorsal view. Fig. 6. *Illex* sp. larva from tropical water, DML = 2.40 mm. Scale lines = 2.00 mm.

Table 1. Summary of *Illex* collection data.

Species	Cruise	Developmental stage	N	DML range (mm)	Station depth range (m)	Surface temperature range (°C)	Surface salinity range (‰)	Gear	Water mass indicator species
Ilex illecebrosus	BLM06W	larv., juv.	47	2.40–13.70	41–360	5.4–12.0	35.0–35.8	B505 B202 N505	*Limacina retroversa*
Illex illecebrosus	BLM07W	juv.	1	21.10	86	17.6	35.8	N505	*L. trochiformis, Creseis virgula, Cavolina longirostris*
Illex sp.	BLM08W	larv.,	22	2.10–3.70	39–128	21.8–25.0	31.7–33.5	B505	*L. trochiformis, C. virgula, C. longirostris*
Illex sp.	CI7802	larv., juv.	3	3.20–8.50	3,980–4,134	19.0–19.2	36.4	N505	*L. trochiformis, C. acicula, C. longirostris*

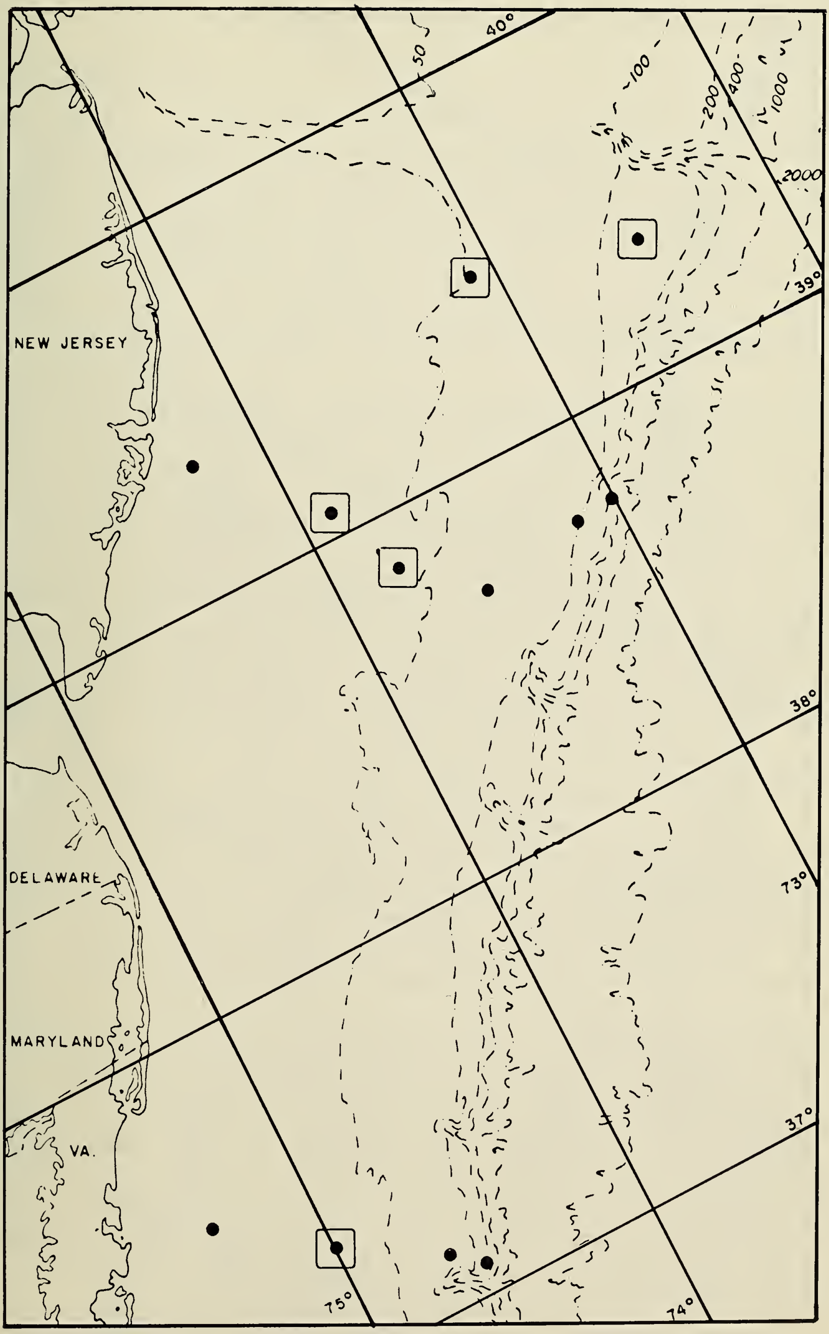

Fig. 7. Distribution of larval and juvenile *Illex* sp. February–March 1977. Stations sampled (●); stations at which *Illex* sp. were collected (☐).

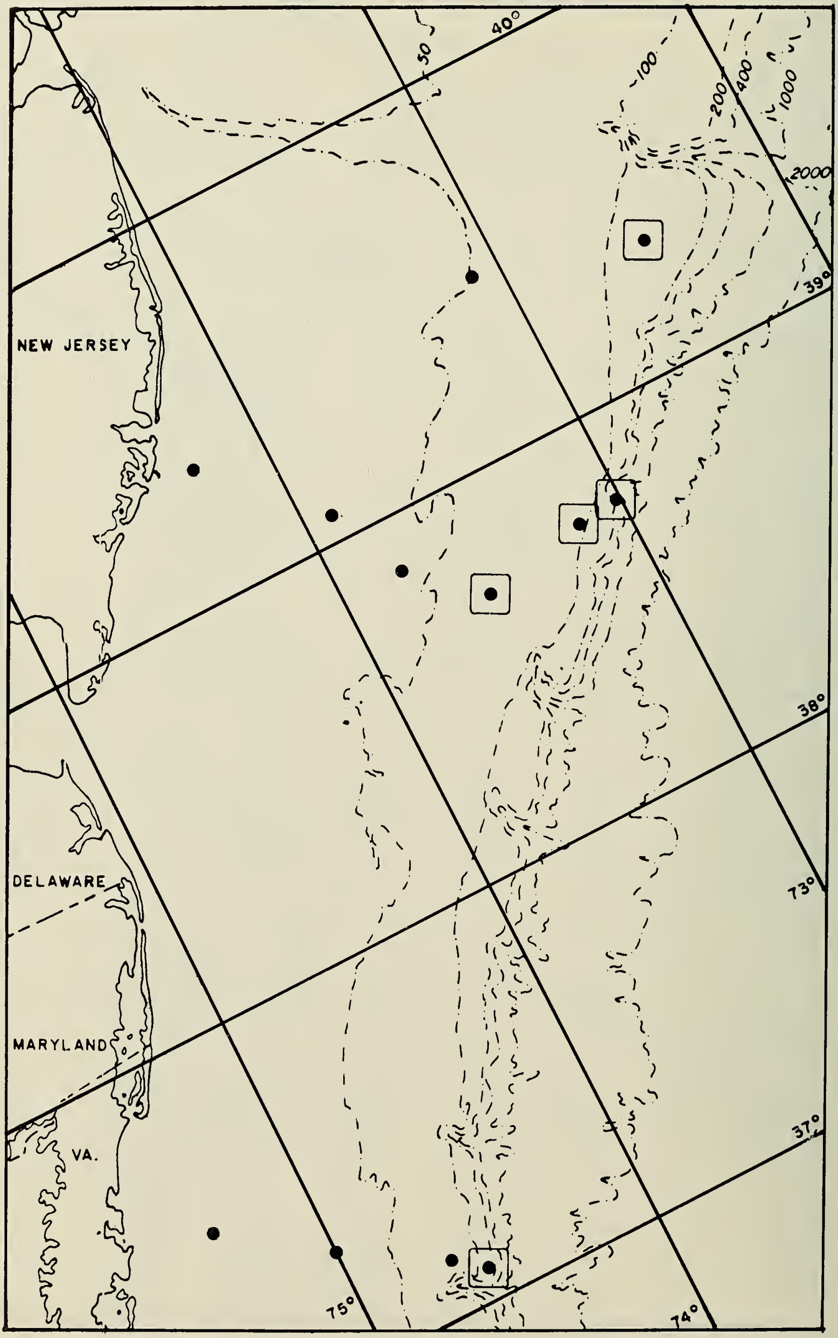

Fig. 8. Distribution of larval *Illex* sp. August 1977. Stations sampled (●); stations at which *Illex* sp. were collected (□).

collected (Fig. 8) were generally much shallower than those at which *I. illecebrosus* were found during the winter, and the surface temperatures were much higher, whereas surface salinities were lower. Thecosome water mass indicator species which were present at all of these stations include *Limacina trochiformis*, *Creseis virgula* and *Cavolinia longirostris*, which are indicators of tropical water (Chen and Hillman, 1970). Although remnants of boreal fauna, including *Sagitta elegans* and *Evadne nordmanni*, remained in the area, these *Illex* larvae were not more than a few days old and could not have been part of this remnant community.

Additionally, two *Illex* larvae and one juvenile were collected in neuston tows, one night and one day, in Gulf Stream water far offshore in February and March 1978.

Although Clarke (1966) postulated by extension of a graph from Squires (1957) that *I. illecebrosus* spawn in the summer, Squires (1967) fitted more extensive data into a von Bertalanffy growth equation and then extrapolated to a hatching time of January or February. If the growth rate of larval *Illex* is assumed to be similar to that of *T. pacificus* (Hamabe, 1962), the smallest sizes described here could not have been more than about two days old and therefore could not have drifted far from the hatching site. The larvae taken at our northernmost stations were beyond the reported northern range limits of *I. oxygonius* and boreal specimens taken there are probably *I. illecebrosus.* Although those specimens collected at the other stations were within the range of *I. oxygonius*, sufficient continuity exists between the winter samples to assume that all specimens were *I. illecebrosus.* The February–March capture of these specimens supports Squires' (1967) calculated winter hatching time for *Illex illecebrosus.*

Catching *Illex* larvae in tropical water masses certainly brings up the possibility that they are the southern species, *I. oxygonius*, but several of these were also taken north of the published range limits of *I. oxygonius.* So many ecological differences exist between these and the boreal, winter caught specimens that I am unwilling to assign them to a species at this time.

Conclusions.—Based on the funnel pit and mantle cartilage structure and the arrangement of tentacular suckers in the larger specimens, the rhynchoteuthion larvae described in this paper belong to the genus *Illex* and based on distribution the boreal specimens are *I. illecebrosus.* It is possible that younger stages exist in which the third pair of arms is not developed. Although these larvae were found in the Middle Atlantic Bight, their distribution quite likely extends farther to the north and to the south. Tentacular growth appears to occur at both the tip and the base, and separation of the fused area is comparatively rapid, resulting in weakened tentacles in the early juvenile squid.

Further sampling is necessary to resolve the identity of specimens taken in tropical water, to identify spawning and hatching areas, and to obtain better specimens for a more complete larval description including chromatophore patterns, morphometrics, and possible smaller sizes.

Acknowledgments

My conversations with Clyde F. E. Roper and C. C. Lu in Nova Scotia caused me to reexamine my unidentified rhynchoteuthion larvae and find the tropical *Illex* sp. George C. Grant has been very helpful throughout this project. Comments by Eugene M. Burreson and Peter O. Smyth assisted me in finalizing the manuscript which Shirley Sterling has patiently retyped so many times. Contribution No. 860 from the Virginia Institute of Marine Science, Gloucester Point, VA 23062, U.S.A. This research was performed under contract nos. 08550-CT5-42 and AA550-CT6-62 with the Bureau of Land Management, U.S. Dept. of Interior.

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A PRELIMINARY NOTE ON *ILLEX ILLECEBROSUS* LARVAE HATCHED FROM EGGS SPAWNED IN CAPTIVITY

R. K. O'Dor and R. D. Durward

Precocious maturation of female *Illex illecebrosus* held under conditions previously described in the 15 meter diameter pool of the Aquatron Laboratory at Dalhousie (O'Dor *et al.*, 1977) resulted in production of six egg masses during September and October, 1978. These were produced by four females with spermatophores implanted in their mantle cavities as described by Hamabe *et al.* (1974) and consisted of tenuous spheres of nearly neutrally bouyant jelly ranging from about 40 to 120 cm in diameter. The masses were neither attached to the substrate nor deposited in buckets provided, but were free to drift in the slightest current. They contained on the order of 10^5 eggs (oblate spheroids, 0.6 by 0.9 mm) spaced at distances of about 1 cm in an apparently uniform jelly. Although they fragmented when handled, some fragments were transferred to smaller containers where embryonic development was observed.

The larvae which hatched after 6 to 8 days at 13°C had mantle lengths of about 1.1 mm and a small internal yolk sac. Their appearance after eight days of development is shown in Figs. 1 and 2. At this stage they had a mantle length of 1.25 mm, two pairs of dorsal arms (I, II) and a developing proboscis. Their size, chromatophore pattern, arm and proboscis de-

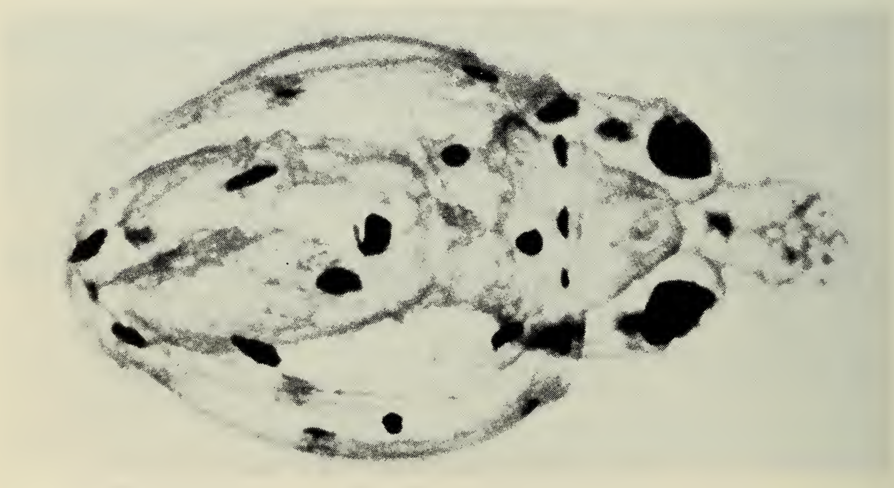

Fig. 1. Photograph of a living *Illex illecebrosus* larva 7 days after hatching. Mantle length is 1.25 mm.

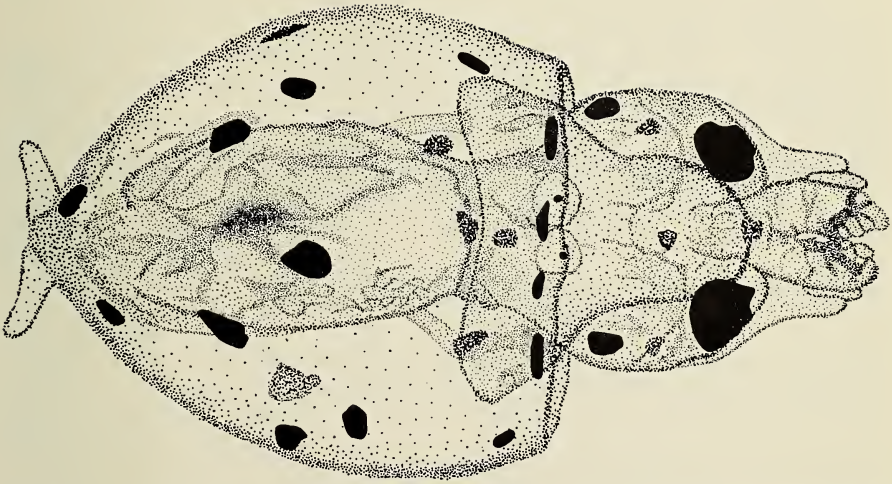

Fig. 2. Ventral view of an *Illex illecebrosus* larva from a specimen preserved 8 days after hatching. Mantle length is 1.25 mm.

velopment appear from our preliminary examination to be consistent with the developmental sequence of Rhynchoteuthion type "C" proposed by Roper and Lu (1979) and with the larvae and juveniles characterized as *Illex illecebrosus* by Vecchione (1979). The earliest larvae described by these authors are more advanced than our specimens and probably are at least several days older. All of the specimens they have illustrated have three more chromatophores on the head, one ventral and two dorsal; however these are near the base of the head in a region of rapid growth and are likely the result of further development.

These observations confirm the link between Rhynchoteuthion type C and *Illex illecebrosus*, but further data are still required to distinguish *I. illecebrosus* from *I. oxygonius*.

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