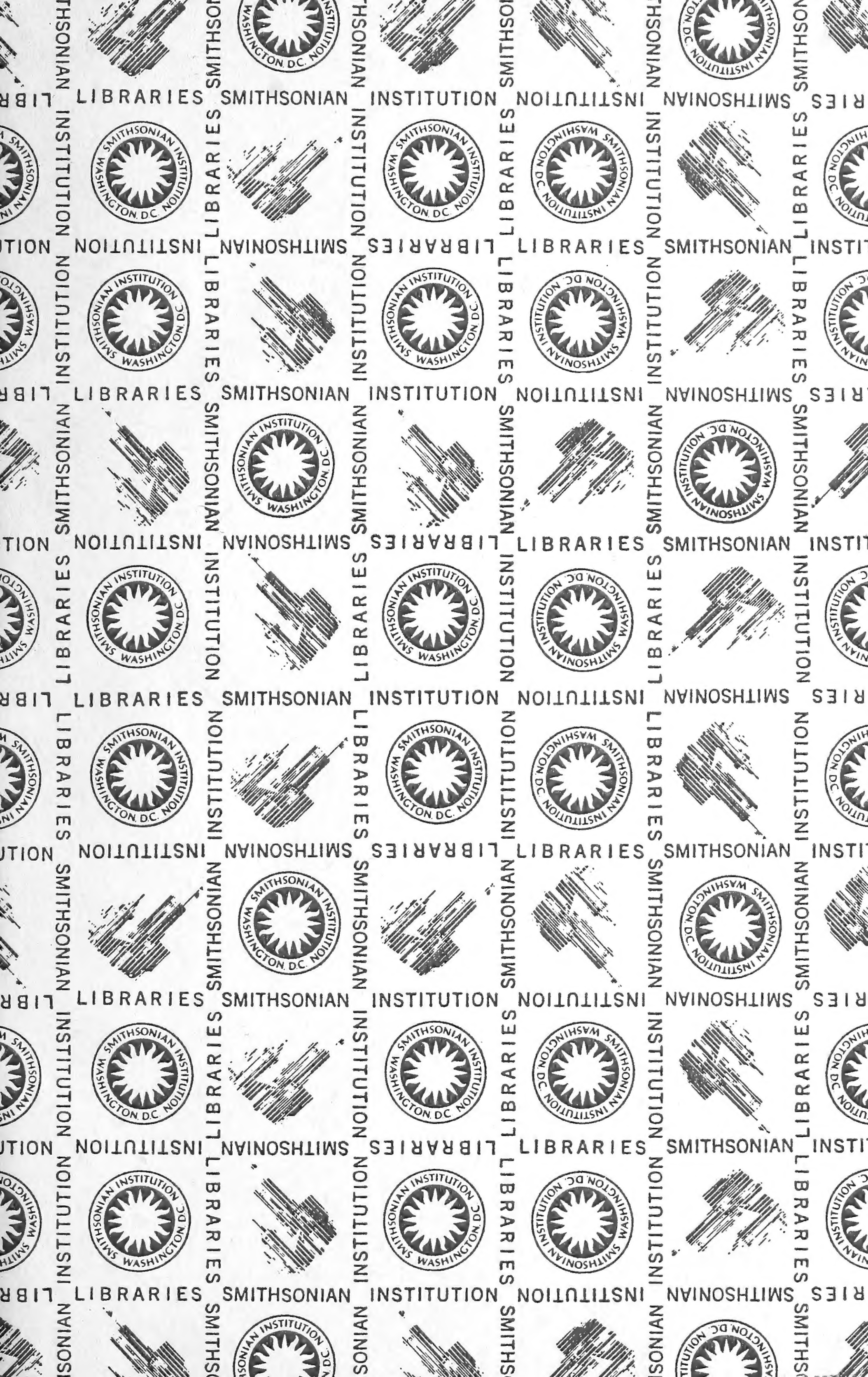
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of the Biological Society of Washington

PROCEEDINGS

of the

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VOLUME 89
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Volume 89

BIOLOGICAL SOCIETY OF WASHINGTON

PROCEEDINGS

1052nd Meeting—10 March, 1976

NINETY-SEVENTH ANNUAL MEETING

The meeting was called to order at 2:10 p.m. by the Secretary, Duane Hope, in the absences of the President, Clyde Jones, and Vice President, Clyde Roper.

Hope called for a reading of the minutes of last year's annual meeting, although it was moved, seconded and passed that it be waived.

The second item of business was the Treasurer's report, which was handed out to all in attendance, and contained a budgetary breakdown for 1974 for comparative purposes. During Flint's discussion of the budget he noted that the large increase in the endowment this year was attributable to a recent flier placed in mailings to individuals and libraries announcing the availability of back numbers. Several series were sold, especially to libraries. The total income for the Society was up slightly over last year. The overall costs were down considerably from last year, mainly because we paid for three mailings of the Bulletin this year, whereas we paid for four last year, plus the reprinting of Bulletin Number Two. Other notable expense was the final repayment of a previous loan. Financially, it was a good year with operating expenses increased from $6,756.66 to $10,542.94, and the worth of the Society up from $35,469.33 last year to a present balance of $43,732.55.

Flint called attention to the sharp increase in the deficit between our total publication payments to Allen Press versus the total income from authors. He advised that we may have to increase some of our charges to bring income more in balance with expenses.

Ted Spilman questioned the large difference between the direct publications costs of 1974 and 1975, and Flint responded by pointing out that costs were higher in 1974 because he paid for four mailings of the Proceedings plus the reprinting of Bulletin Two.

Ashley Gurney asked if more universities were refusing to pay page charges. Flint indicated there hasn't been much change in the number paying. Gurney further pointed out that federal organizations may begin to object to carrying the burden of page charges. Spilman pointed out that most universities pay page charges for the Proceedings of the Entomological Society of Washington.

The next item of business was a brief review of the year's council meetings by Hope.

There were two council meetings during 1975. At the first meeting we discussed the possibility of making Emperor Hirohito an honorary member of the Biological Society of Washington during his visit to the Museum. After much discussion it was concluded that no mechanism existed in the Constitution for bestowing such an honor, and if any honors were to be bestowed, it would be best done by the Director of the Museum.

We then discussed whether or not Allen Press was becoming too expensive for the Society. Since they are charging the Society $25.25 per published page and we charge authors $21.00 per page, the Society had realized a $4,064.00 deficit for volume 87, which was covered by subscription fees and interest on investments. It was eventually decided that, since Allen Press produced high quality printing and their page charges are not excessive, we would stay with them.

At the second Council Meeting the cost of the journal to the Society and our overall financial status were discussed. It was then moved and passed that page charges be increased from $21.00 to $25.00.

The third item of business was an Editorial Report by Austin Williams. Volume 88 of the Proceedings of the Biological Society of Washington (1975–1976) contained 49 papers and 548 pages, six papers and about 50 pages more than volume 87. The subjects dealt with were botanical (1), flatworms (1), mollusks (1), annelids (4), arthropods (26, of which 18 were on crustaceans), echinoderms (1), and vertebrates (15, of which six were on fishes). Thirty-two of the papers were paid, 17 unpaid, or partially paid, and three manuscripts were rejected. For the first time in recent years a volume of the Proceedings was published over more than one calendar year. For Volume 89, there are 17 papers in press (12 paid, one unpaid, four uncertain) and 17 papers under review. Three have been rejected. Leslie Knapp will succeed W. R. Taylor as Associate Editor for vertebrates.

The fifth item of business was a membership report given by Duane Hope as Secretary. The membership status is as follows:

New members—29
Reinstated—4
Resigned—35
Total full members—337
Total associate members—9
Total life members—4
Total emeritus—2
New subscriptions—5
Subscriptions stopped—7
Free subscriptions—5
Paid subscriptions—222

The sixth item of business was a special award to John Miles who has for many years been Custodian of the Society. Mr. Miles has performed without remuneration such time consuming tasks as collating the separates of each issue of the Proceedings, and of addressing and mailing each issue. After acknowledging his help, he was presented with the eleventh and twelfth volumes of Grzimek's Animal Life Encyclopedia.

The seventh item of business was a report on the results of the election given by the Secretary. The results are as follows:

President—Bruce Collette
Vice President—Richard Cowan
Secretary—Duane Hope
Treasurer—Oliver Flint
Councilors
  Frederick Bayer
  Horton Hobbs III
  Henry Setzer
  Don Wilson
  George Zug

The meeting was then turned over to the new president, Bruce Collette who called for further items of old business and then for new business. There being none of either, a motion was moved and passed for adjournment.

W. Duane Hope
Secretary

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PROCEEDINGS
OF THE
IOLOGICAL SOCIETY OF WASHINGTON

A REVIEW OF THE BATS OF THE ENDEMIC WEST INDIAN GENUS *EROPHYLLA*

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Baton Rouge, Louisiana 70893

The subfamily Phyllonycterinae of the family Phyllostomatidae is comprised of the genera *Brachyphylla, Phyllonycteris,* and *Erophylla*; all are endemic to the West Indies. Two species are presently included in the genus *Erophylla*: *E. bombifrons,* which occurs east of the Windward Passage on Hispaniola and Puerto Rico and *E. sezekorni,* which is found on most of the major islands west and north of the Windward Passage including Cuba, Jamaica, and the Bahamas. The present taxonomic status of populations of *Erophylla* rests in large measure upon studies involving relatively few specimens from limited geographic areas. No attempt has yet been made to determine and evaluate variation within the genus as a whole.

In the process of reevaluating the taxonomic status of all named populations within this genus, I have examined 624 specimens. Names used throughout the greater part of the text are those in current use. Nomenclatural changes that I propose are given at the end of the discussion.

Taxonomic History

Gundlach (1861) erected the genus *Phyllonycteris* for two new species of bats from Cuba (*poeyi* and *sezekorni*). Miller (1899) described *Phyllonycteris bombifrons* of Puerto Rico and *P. planifrons* of the Bahamas. Elliot (1905) described *Phyllonycteris santa-cristobalensis* of Hispaniola. Subsequently, Miller (1906) erected the genus *Erophylla* to include (as separate species) *sezekorni, bombifrons, planifrons,* and *santacristobalensis.*

Allen (1917) proposed a taxonomic arrangement for this group that is basically the one most in use at present. Allen treated *santacristobalensis* as a subspecies of *Erophylla bombifrons* and applied the name *Erophylla sezekorni* to populations in Cuba, Jamaica, and the Bahamas. He proposed the name *E. sezekorni syops* for the Jamaican population and treated *E. planifrons* Miller of the Bahamas as a subspecies of *E. sezekorni.*

Shamel (1931) treated *planifrons* as a distinct species when he described *E. planifrons mariguanensis* of the southern Bahamas. Koopman, et al. (1957) reported several new Bahamian records of *Erophylla* and adopted G. M. Allen's interpretations in treating *planifrons* as a subspecies of *E. sezekorni.* The interpretations of Allen also form the basis for the taxonomic treatment of the genus presented in Hall and Kelson (1959, pp. 147–148).

Recent studies of *Erophylla* have not dealt with intrageneric relationships. Silva Taboada and Pine (1969) discussed morphological and ecological features in the genus, but their comparisons were largely intergeneric. Baker and Lopez (1970) reported on the karyotype of *E. bombifrons* from Puerto Rico, but karyotypes from other populations of *Erophylla* are not available for comparison. Varona (1974) treated *Erophylla* as a subgenus of *Phyllonycteris* but retained the same species and subspecies names for populations as given in Hall and Kelson (1959).

According to Hall and Kelson (1959) there are two subspecies of *E. bombifrons*—the nominate race on Puerto Rico and *santacristobalensis* on Hispaniola. These authors recognize four subspecies of *E. sezekorni*—the nominate race on Cuba, *syops* on Jamaica, *planifrons* throughout most of the Bahamas (except for the extreme southern region) and *mariguanensis* in the southern Bahamas. Varona (1974) includes the Isle of Pines in the range of nominate *sezekorni* and records an unassigned subspecies of *E. sezekorni* from Grand Cayman in The Cayman Islands.

Several islands not indicated in previous accounts may now be added to the list of islands whence *E. sezekorni* has been taken. Among these are Andros, Acklins, San Salvador, and Great Inagua, all of which are part of the Bahamas proper. Also inculded are Providenciales, North Caicos and Middle Caicos of the Caicos Islands (geographically a part of the southern Bahamas) and Cayman Brac in the Cayman Islands.

HABITS AND HABITAT

E. sezekorni is a relatively common bat in caves throughout the southern Bahamas. Walker, et al. (1975) states that members of this genus generally roost in the deeper and darker parts of caves. I found *E. sezekorni* on exposed surfaces and deep within solution cavities on the ceilings of caves, often in areas where much daylight penetrated. I usually saw members of this species in groups of four to 30 individuals. Two cylindrical solution cavities, each about 5 m deep, and 1 to 2 m in diameter, in the ceiling of a cave at Conch Bar, Middle Caicos, each contained about 50 individuals of *Erophylla* on 12 January 1972. Pale bats seen frequenting the blossoms of sisal (*Agave sisilana*) on North Caicos at dawn and dusk during February 1972 were identified by sight as this species.

Some of the individuals that I encountered in caves were extremely wary and flew away immediately upon being approached; others showed little concern even when a strong beam of light was focused upon them. Most often, however, individuals responded to a flashlight beam by moving their heads about rather nervously, then flying off to another part of the cave.

Most of my observations were made during the day when the bats were hanging from the walls and ceilings of caves and were relatively inactive. However, on 30 January 1972, when I visited the cave at Conch Bar, Middle Caicos, about one hour before sunrise, I found many *E. sezekorni* flying inside the main chamber. Several individuals were seen landing on a particular stalactite and on a lateral projection on the cave wall that had water slowly flowing over the surfaces. The bats did not hang by their feet in the conventional manner after landing at these sites but lit in an upright position, grasping the rock surface with all four appendages; the wings were folded against the body. The bats maintained this position for only 2 to 5 seconds at a time and four or five individuals appeared to make a number of return trips at less than 1-minute intervals. That the bats were drinking water seems a likely possibility, although I did not directly observe them doing so. None of the dry surfaces was visited by bats in this fashion.

FETAL DEVELOPMENT

Data from 91 gravid or lactating females and immature individuals indicate that most prenatal development takes place during the first part of the year and that parturition probably occurs most often in early summer. Females bearing small embryos have been taken during early and late February and individuals with well developed fetuses have been obtained in April and May. Lactating females have been collected in June and many immature (probably newborn) individuals have been taken in July. Immature individuals approaching adult size may be found during August. Further details on nursing females and developing young are presented in Table 1.

MORPHOLOGICAL COMPARISONS

Coloration: Specimens of *Erophylla* show much variation in coat color and for the most part I detected no consistent differences among presently recognized subspecies. Individuals of *E. b. santacristobalensis* (Hispaniola) are more reddish tan than the drab, darker brown specimens of *E. b. bombifrons* (Puerto Rico) but specimens of the four subspecies of *E. sezekorni* range from pale buff to medium or dark brown and many individuals have white on the head.

Part of the range of variation and overlap in color among samples from different islands is shown in Fig. 1. Specimens included in these comparisons are those that I recently collected on Crooked Island, Mayaguana and the Caicos Bank, and specimens from the Schwartz collection that were prepared between 1961 and 1968 and kept under similar storage conditions. Comparisons were made with a Gardner Color and Color-Difference Meter (Model XL–10). This instru-

TABLE 1. Seasonal data on nursing females and developing young in the genus *Erophylla*.

Date Collected		No. and Condition of Specimens Examined	Locality
11 February	(1928)	1 small embryo	Hispaniola
26–28 February	(1917)	11 small embryos	Cuba
10 April	(1972)	2 fetuses (crown-rump length = 10.6 and 11.1 mm, $\bar{x} = 10.9$)	Crooked I. (Bahamas)
27–28 April	(1968)	9 fetuses (crown-rump length = 14.0–17.5 mm, $\bar{x} = 15.8$)	Andros I. (Bahamas)
5 May	(1972)	6 fetuses (crown-rump length = 13.7–20.3 mm, $\bar{x} = 17.9$)	Crooked I. (Bahamas)
13 June	(1966)	3 lactating females	New Providence (Bahamas)
26 June	(1966)	1 lactating female	San Salvador (Bahamas)
5–6 July	(1916)	2 immature individuals and 1 nursing female	Puerto Rico
9 July	(1935)	41 immature individuals	Cat I. (Bahamas)
22 July	(1904)	5 immature individuals	Great Abaco (Bahamas)
27 July	(1938)	8 immature individuals (total length = 55–64 mm, $\bar{x} = 59.9$)	Great Inagua (Bahamas)
20 August	(1910)	1 immature individual near adult size	Jamaica

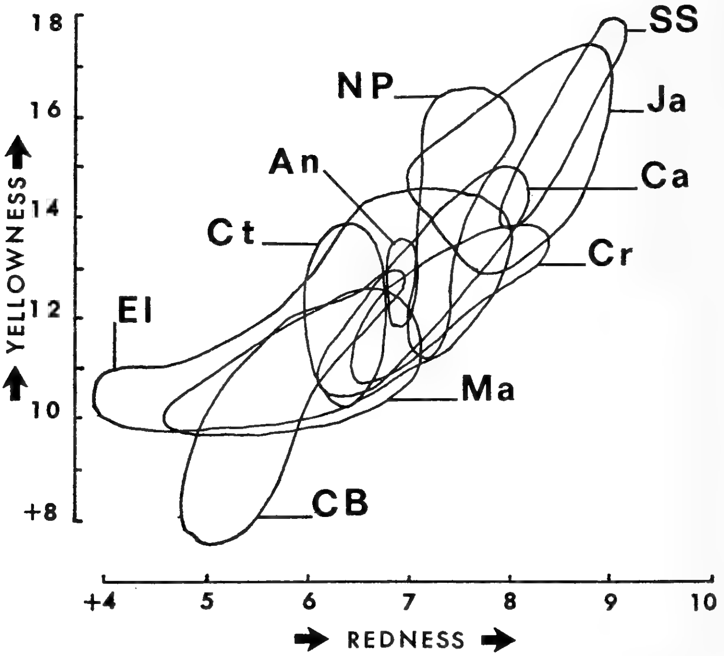

FIG. 1. Color variation in 10 samples of *Erophylla sezekorni* as follows: El, Eleuthera; Ct, Cat Island; An, Andros Island; NP, New Providence; SS, San Salvador; Ja, Jamaica; Ca, Caicos Islands; Cr, Crooked Island; MA, Mayaguana; CB, Cayman Brac. Lines circumscribe values obtained with a Gardner Color and Color-Difference Meter.

ment measures color reflected from a flat surface on three scales. The L scale indicates paleness and ranges from 0 (black) to 100 (white). The a scale indicates redness when the reading is positive and greenness when negative, whereas the b scale measures yellowness when the reading is positive and blueness when negative. A reading of L 50, a 0, and b 0 indicates gray. Readings were taken on the posterodorsal surface of the skins covering an area 20.0 mm in diameter. The instrument scales were calibrated on a white standard according to values assigned to the standard by the manufacturer (L 91.6, a –1.3, b –0.1).

A considerable amount of variation in color occurs within samples from the same locality. Some may be attributed to ontogenetic changes, molt condition, atmospheric bleaching (although the caves that I visited in the southern Bahamas were well aerated and had no strong smell of ammonia) or to fading of specimens in storage. However, segregating available material according to age, season, and storage history would result in many exceedingly small samples for comparison. I do not believe that color differences can be used effectively to distinguish subspecies of *Erophylla* as they are currently defined, but more detailed color evaluations will require additional material of comparable status.

Mensuration: Measurements, and the manner in which they were taken for this study, are as follows: skull length (distance between posteriormost portion of skull and tips of incisors), condylobasilar length (distance from posterior margin of condyles to a line connecting posterior margins of alveoli of anteriormost incisors), maxillary toothrow (distance from posterior margin of third molar to anterior surface of corresponding canine at its base), breadth at canines (distance across snout at level of canines, including outer tooth surface), postorbital breadth (least distance across skull, at a point posterior to orbits), zygomatic breadth (greatest distance across zygomata), breadth of braincase (greatest width of braincase), cranial height (greatest vertical distance between top of skull and ventralmost point of occipital bone), breadth at canines/breadth of braincase (a percentage), breadth of braincase/skull length (a percentage), cranial height/skull length (a percentage), total length (measurements taken on fluid-preserved specimens are combined with measurements taken from labels on study skins), forearm length including carpal elements (measurements taken on fluid-preserved specimens and study skins are combined), ear length (from notch; taken only on fluid-preserved specimens), tail length (from fluid-preserved specimens only), tibia length (from fluid-preserved specimens only).

Mensural comparisons include specimens from 17 localities shown in Fig. 2. Statistical data for selected measurements are presented in Table 2. A test for statistically significant differences using a one way classification analysis of vari-

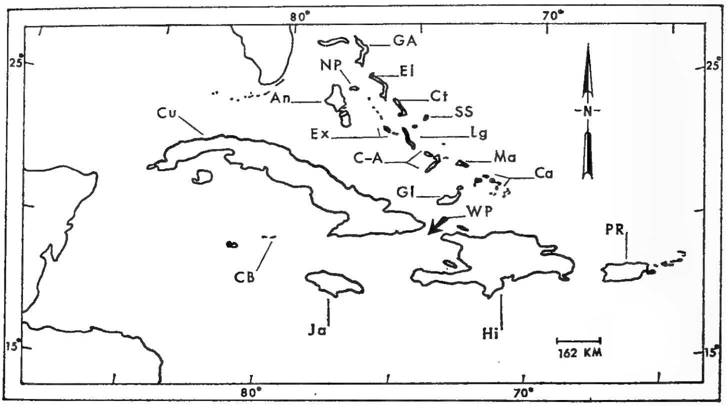

Fig. 2. Map of the Bahamas and Greater Antilles showing localities for 17 samples of *Erophylla* as follows: GA, Great Abaco; NP, New Providence; An, Andros; El, Eleuthera; Ct, Cat Island; Ex, the Exumas; Lg, Long Island; SS, San Salvador; C-A, Crooked Island and Acklins Islands; MA, Mayaguana; CA, Caicos Islands; GI, Great Inagua; Cu, Cuba; CB Cayman Brac; Ja, Jamaica; Hi, Hispaniola; PR, Puerto Rico. WP=Windward Passage.

ance was conducted. Specific comparisons for selected samples representing different subspecies pairs were made. The results of this test are summarized in Table 3. All measurements are in millimeters and sexes have been combined in these comparisons.

There are no obvious well-marked differences in comparisons between and among any of the subspecies, although statistically significant differences are apparent in each subspecies for at least two (*E. bombifrons santacristobalensis* with *E. b. bombifrons*) to as many as six *E. sezekorni planifrons* with *E. s. mariguanensis*) of the 15 characters examined. One character (forearm length) shows statistically significant differences in all comparisons, yet the range for this character for 508 individuals (from six named populations) is 41.6–50.0. Comparisons between selected samples of fluid preserved specimens and dried skins showed no significant differences in forearm length and I have combined wet and dry measurements in all comparisons.

Furthermore, there may be more variation within the limits

TABLE 2. Selected measurements from six samples of *Erophylla*; each island includes the type-locality for one of the six nominal subspecies. Each set of numbers includes mean and sample size (row 1), range (row 2), and standard deviation and coefficient of varation (row 3).

	New Providence *planifrons*	Mayaguana (*mariguanensis*)	Cuba (*sezekorni*)	Jamaica (*syops*)	Hispaniola (*santacristobalensis*)	Puerto Rico (*bombifrons*)
Length	24.5 –(18)	25.2 (6)	24.3 (31)	24.7 (29)	24.1 (18)	24.3 (18)
Skull	23.7 – 25.4	24.6 – 26.1	23.6 – 25.1	23.7 – 25.7	23.4 – 25.0	23.3 – 24.9
	0.52 2.12	0.54 2.16	0.38 1.58	0.49 2.00	0.44 1.84	0.44 1.79
Cranial	8.4 (19)	8.5 (6)	8.3 (44)	8.4 (29)	9.0 (21)	9.1 (18)
Height	8.1 – 8.8	8.3 – 8.8	7.9 – 8.8	8.0 – 8.9	8.4 – 9.6	8.6 – 9.6
	—— ——	0.23 2.72	0.19 2.30	0.25 2.93	0.31 3.45	0.26 2.85
Forearm	46.0 (50)	46.6 (35)	45.4 (88)	46.5 (66)	46.7 (49)	47.7 (47)
Length	43.2 – 47.6	44.5 – 49.2	41.6 – 48.2	44.7 – 49.3	45.1 – 48.9	45.7 – 50.0
	0.99 2.16	0.96 2.06	1.29 2.83	1.07 2.31	0.97 2.08	0.94 1.98
Ear	19.7 (33)	19.8 (29)	19.3 (41)	19.3 (43)	16.9 (39)	17.3 (30)
Length	19.0 – 21.0	19.0 – 21.0	18.0 – 20.0	17.0 – 21.0	15.0 – 18.0	15.0 – 19.0
	0.59 2.97	0.58 2.92	0.79 4.08	0.85 4.40	0.83 4.94	0.84 4.84

TABLE 3. Results of F-test comparisons of four pairs of samples of nominal *Erophylla* for 15 character states; * indicates ($P < .05$), ** indicates ($P < .01$) ns indicates no statistical differences at the .05 or .01 levels of significance.

	Hispaniola vs. Puerto Rico (*santacristobalensis* vs. *bombifrons*)	New Providence vs. Mayaguana + Caicos Ids. (*planifrons* vs. *mariguanensis*)	New Providence vs. Cuba (*planifrons* vs. *sezekorni*)	Cuba vs. Jamaica (*sezekorni* vs. *syops*)
Skull Length	ns	**	ns	*
Condylobasilar Length	ns	**	ns	*
Maxillary Toothrow	ns	ns	**	ns
Breadth at Canines	ns	ns	ns	ns
Postorbital Breadth	ns	ns	**	ns
Zygomatic Breadth	ns	ns	ns	ns
Breadth of Braincase	ns	*	**	ns
Cranial Height	ns	ns	ns	ns
$\frac{\text{Breadth at Canines}}{\text{Breadth of Braincase}} \times 100$	ns	**	ns	ns
$\frac{\text{Breadth of Braincase}}{\text{Skull Length}} \times 100$	ns	**	**	ns
Total Length	ns	ns	ns	ns
Forearm Length	**	*	*	**
Ear Length	ns	ns	ns	ns
Tail Length	ns	ns	ns	ns
Tibia Length	**	ns	ns	**

of any presently recognized subspecies in the genus than between subspecies. The greatest number of characters showing statistically significant differences (six) was found in the comparisons between *E. sezekorni planifrons* and *E. s. mariguanesis.* All specimens of *E. s. planifrons* in this particular series of comparisons are from New Providence (the type-locality). In at least three of these six characters there is actually a greater difference between the mean of the New Providence sample and that of some other sample within the range of *E. s. planifrons* than between the mean of New Providence material and that of the sample *E. s. mariguanensis.*

Also, examination of this material indicates that many of the mensural differences mentioned in the original descriptions of the various named taxa of *Erophylla* do not hold true, or at least are of a lesser magnitude than previously indicated.

Miller (1899) stated that *planifrons* differs from *sezekorni* in possession of very slender but complete zygomatic arches, a slightly broader and flatter rostrum, and a relatively smaller braincase. Actually the presence of complete zygomatic arches is characteristic of all members of the genus *Erophylla* and is one feature used to distinguish this genus from *Phyllonycteris,* all members of which have incomplete zygomatic arches. Also, I found no statistically significant differences (at the .01 or .05 levels) for the measurement breadth at canines, or for the ratio breadth at canines/breadth of braincase, but I did find a significant difference ($P < .01$) in the breadth of braincase/skull length ratio in the *planifrons* vs. *sezekorni* comparison. Eighteen specimens of *planifrons* ranged from 39.6 to 42.9 ($\bar{x} = 40.8$) whereas 31 specimens of *E. s. sezekorni* ranged from 37.7 to 41.6 ($\bar{x} = 40.0$) for this character.

Allen (1917) stated than *E. s. syops* of Jamaica differed conspicuously from *planifrons* and *sezekorni* in its "wider rostrum with molar rows nearly parallel instead of converging anteriorly." My comparisons between *syops* and *sezekorni* indicate no significant difference (at the .01 or .05 levels) for the measurements breadth at canines and breadth of braincase or for the ratio breadth at canines/breadth of braincase.

Shamel (1931) indicated that *E. p. mariguanensis* differed mensurally from *E. p. planifrons* in its larger size and smaller teeth but longer maxillary toothrow. My comparisons between these two forms showed no statistically significant differences (at .01 or .05 levels) in total length or maxillary toothrow but did ($P < .01$) for skull length. Eighteen specimens of topotypic *planifrons* ranged from 23.7 to 25.4 ($\bar{x} = 24.5$) for skull length whereas 27 specimens of *mariguanensis* from Mayaguana and the Caicos Bank ranged from 24.2 to 26.1 ($\bar{x} = 25.2$) for this character.

Discussion

I believe that the designation of subspecies on the basis of the color and mensural differences discussed above is an overrefinement. Such an approach, in this case, if strictly and consistently applied, would result in further fragmentation of the *Erophylla* complex into additional weakly defined nomenclatural units. Differences between many of the currently recognized taxa are slight and much overlap occurs in most characteristics. I see no advantage in recognizing (or constructing) a host of subspecies within the genus *Erophylla.*

There are, however, two groups in this complex that are morphologically distinct (although some overlap occurs in all comparisons) and geographically separated. One group occurs west and north of the Windward Passage (Fig. 2), has a relatively long skull with low cranial profile, relatively long ears, and ranges in color from yellowish brown to dark brown (*sezekorni*). The other group occurs east of the Windward Passage, has a relatively short skull with high cranial profile, relatively short ears, and is usually dark brown (*bombifrons*).

Members of one group are most easily separated from members of the other group by differences in skull shape. The cranial height/skull length ratio is diagnostic. Thirty-six specimens of the *bombifrons* group average 37.4 (35.9–39.5) for this character whereas 159 specimens of the *sezekorni* group average 34.3 (31.9–36.9). The means of 12 samples of *sezekorni* range from 33.7 to 35.1 for this character, whereas the two samples of *bombifrons* average 37.3 and 37.5. Figure 3 shows an overlay of outlines of the two skull types modified from

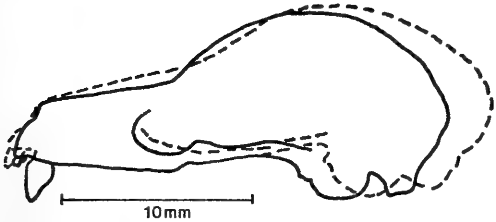

FIG. 3. Superimposed profiles of skulls of the "sezekorni type" (dashed line) and the "bombifrons type" (solid line) modified from illustrations in Hall and Kelson (1959).

illustrations in Hall and Kelson (1959). A noteworthy similarity in cranial proportions occurs between the skull profiles in this overlay and that of two subspecies of *Hylonycteris underwoodi* from Mexico and Central America illustrated in Phillips and Jones (1971). One subspecies of *H. underwoodi* is found on the Atlantic versant whereas the other occupies the Pacific versant; no zone of geographical contact has been determined.

The *bombifrons* and *sezekorni* groups too are geographically separated from each other. Thus the determination of specific or subspecific status in this case (as in the situation involving *Hylonycteris* becomes a matter of evaluation of the available morphological data. I interpret *bombifrons* and *sezekorni* to be well differentiated subspecies of *Erophylla sezekorni* as follows:

Erophylla sezekorni sezekorni (Gundlach)

Phyllonycteris sezekorni Gundlach, 1861, p. 818 (type-locality: Cuba).
Phyllonycteris planifrons Miller, 1899, p. 34.
E[rophylla]. sezekorni, Miller, 1906, p. 84.
Erophylla sezekorni syops Allen, 1917, p. 167.
Erophylla planifrons mariguanensis Shamel, 1931, p. 252.

Distribution: Known from the Bahama Islands (including Great Abaco, New Providence, Andros, Eleuthera, Cat Island, Great Exuma, Little Exuma, Long Island, San Salvador, Crooked Island, Acklins Island, Mayaguana, and Great Inagua), from the Caicos Bank (on Providenciales, Middle Caicos, North Caicos, and East Caicos), Cuba, Isle of Pines, Grand Cayman and Cayman Brac in the Cayman Islands, and Jamaica.

Specimens examined: Great Abaco: 30(MCZ). New Providence: 58(2 AMNH, 3 AS, 6 MCZ, 47 USNM). Andros: 23(AS). Eleuthera: 13(11 AS, 2 USNM). Cat Island: 63(12 AS, 51 MCZ). Exumas: 18(Great Exuma, 5 AMNH; Little Exuma, 13 AMNH). Long Island: 12(MCZ). San Salvador: 2(AS). Crooked Island: 21 (LSUMZ). Acklins Island: 1(LSUMZ). Mayaguana: 38(4 LSUMZ, 11 MCZ, 23 USNM). Caicos Islands: 39(Providenciales, 12 LSUMZ; North Caicos, 4 LSUMZ; Middle Caicos, 19 LSUMZ; East Caicos, 4 USNM). Great Inagua: 11(MCZ). Cuba: 91(Las Villas Prov., 1 MCZ; Oriente Prov., 64 AMNH, 18 MCZ, 8 USNM). Cayman Brac: 9(AS). Jamaica: 77(St. James Parish, 55 AMNH, 6 MCZ, 10 USNM; St. Elizabeth Parish, 6 AS).

Erophylla sezekorni bombifrons (Miller), new combination

Phyllonycteris bombifrons Miller, 1899, p. 36 (type-locality, near Bayamón, Puerto Rico).
Phyllonycteris santa-cristobalensis Elliot, 1905, p. 236.
Erophylla bombifrons, Miller, 1906, p. 84.

Distribution: Known from Puerto Rico and Hispaniola.

Specimens examined: Hispaniola: 48 (Haiti: Dépt. du Nord Ouest, 2 USNM; Dépt. de l'Artibonite, 46 USNM). Dominican Republic: 18(Sánchez Ramírez Prov., 2 AMNH; San Cristobal Prov., 1 USNM; La Romana Prov., 10 AS; La Altagracia Prov., 5 AS). Puerto Rico: 52(Guanica, 1 AMNH; 5.5 mi. or 8.9 km NE Utuado, 5 AS; Bayamón and vicinity, 2 MCZ, 14 USNM; 2 mi. or 3.2 km SSE El Verde, 1 AMNH; Pueblo Viejo and vicinity, 8 AMNH, 11 USNM; Vega Alta y Vega Baja, 10 MCZ).

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I thank Roy Constantine and Donald W. Newsom of the Louisiana State University Department of Horticulture for use of the Gardner Color and Color-Difference Meter, Kenneth L. Koonce of the Department of Experimental Statistics for assistance with statistical analyses and William H. LeGrande for assistance in preparing the skull profile overlay in Fig. 3.

J. Knox Jones, Karl F. Koopman, George H. Lowery, Jr. and Albert Schwartz reviewed drafts of the manuscript and for their comments and criticisms I am grateful.

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PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

MILLIPEDS OF THE SIGMORIA LATIOR COMPLEX (POLYDESMIDA:XYSTODESMIDAE)[1]

By Rowland M. Shelley
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The milliped genus *Sigmoria* is one of the most heterogeneous in the family Xystodesmidae. Proposed by Chamberlin (1939) and summarized by Hoffman (1950) and Chamberlin and Hoffman (1958), the genus is characterized by a male gonopod with the telopodite bent distally into a sigmoid curve. Hoffman (1958) stated that it had become a 'catch all' genus for xystodesmids not readily conforming to other genera and suggested a possible criterion for *Sigmoria*, but a generic revision is still many years away. The fourteen species which comprise the genus present a bewildering variety of forms with little but the sigmoid curvature in common. Five species, however—*S. latior* (Brölemann, 1900); *S. aberrans* Chamberlin, 1939; *S. conclusa* Chamberlin, 1939; *S. mariona* Chamberlin, 1939; and *S. furcifera* Hoffman, 1949—share the common feature of a medial expansion (flange) at midlength of the telopodite. The last species was described from near Pineville, West Virginia; the others were originally reported from North Carolina localities and listed by Wray (1967).[2]

My interest in these xystodesmids began with the collection of an individual from William B. Umstead State Park, Wake Co., North Carolina. Subsequent discoveries in Johnston, Moore, and Wilkes Cos. indicated that the form was widely

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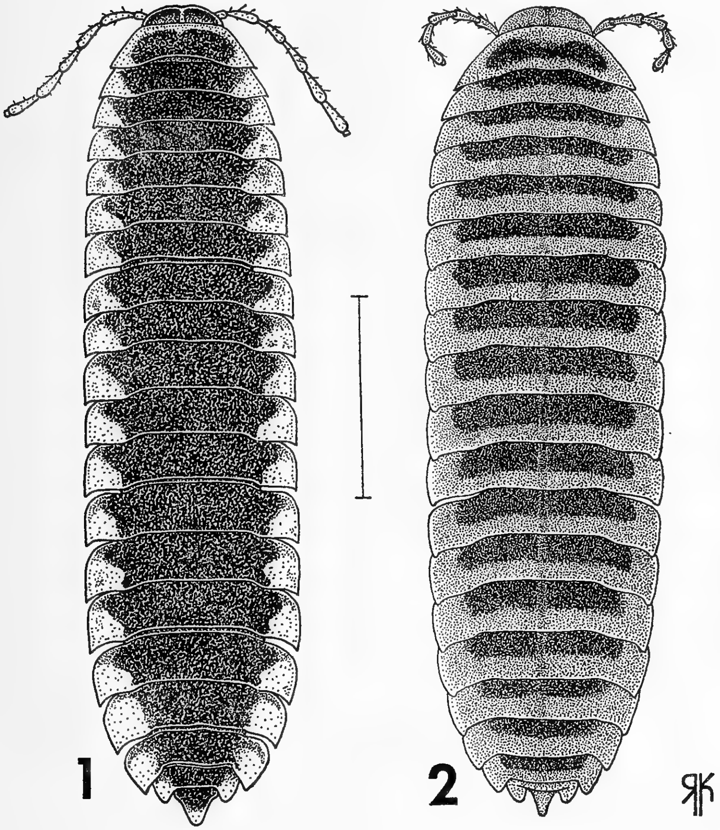
[1] Contribution No. 2, North Carolina State Museum of Natural History.

[2] Chamberlin (1939) reported the type locality of *S. conclusa* as being "Tennessee:Altapass." However, Hoffman (1950) corrected the error by stating that this locality was actually in Mitchell County, North Carolina.

distributed across the northern half of the state, and upon examination of available museum material, I discovered that it actually extends into southern South Carolina. Two distinct color patterns are evident (Figs. 1, 2), but all individuals are otherwise similar externally. The average W/L ratio is 26.3% and is relatively constant throughout the range. The male gonopods, however, are highly variable in terms of the size and shape of the flange, the shape of the prefemoral process, and the presence or absence of a subterminal tooth on the telopodite. In assessing the pattern of this variation throughout the range (Fig. 17), it is apparent that the existence of five separate species can no longer be justified. In three regions (not four as stated by Shelley (1975a)), the frequency of certain gonopodal characters indicates that the populations are sufficiently distinct to be designated as subspecies, but nowhere is there sufficient reason to name more than one full species. Since S. *latior* is the oldest available name, it is retained as the single species represented by this flanged form. The population previously represented by S. *mariona* warrants distinction as a subspecies, and an undescribed subspecies occurs in southern South Carolina. The other three species—S. *aberrans*, S. *conclusa*, and S. *furcifera*—are identical with the nominate subspecies. Intergrades of variable characteristics occur in the intervening area between the three subspecies.

The taxonomically important characters in the S. *latior* complex involve chiefly the male gonopod, although color pattern is of limited value (see distribution section). Specific aspects of the gonopod that are diagnostically important include the size and shape of the flange, degree of development of the subterminal tooth, conformation of the telopodite distad to the tooth, overall length and degree of angulation in the prefemoral process, and presence or absence of bifurcation.

Due to the subtle gonopodal differences between subspecies and intergrades, only the identity of mature males can be accurately established. The male gonopod is also the most reliable determinant for distinguishing this complex from other xystodesmids. Female xystodesmids are easily misidentified, even to genus, and a female with a seemingly



Figs. 1–2. Color patterns in *Sigmoria latior.* 1, metaterga solid black in color, without stripes, displayed in northern half of range by S. *l. latior.* Specimen is a male from Rendezvous Mtn., Wilkes Co., North Carolina (NCSM 1854). 2, striped color pattern (metaterga with stripe along caudal edge connecting with paranota) displayed in southern half of range by S. *l. mariona,* S. *l. hoffmani,* and all intergrades. Specimen is a male S. *l. latior* × S. *l. hoffmani* intergrade from 3.7 mi. SW Wagram, Scotland Co., North Carolina (NCSM 2538). Scale line = 1.0 cm for Fig. 1 and 0.75 cm for Fig 2.

appropriate color patern does not necessarily belong in the S. *latior* complex. Consequently, literature records based on females alone cannot be considered reliable. In the course of this study, I have examined over 120 specimens, but only samples with at least one mature male were considered. The range and distribution patterns, therefore, are those of adult males. Expansion of the ranges by the acquisition of further male specimens is likely in the future.

The nomenclatorial rearrangement of these flanged diplopods is carried out herein. A full description is presented for the nominate subspecies, and diagnostic characters are detailed for the others. A key is presented to facilitate identification. The range of each subspecies and intergrade combination is discussed along with specific locality records, and the overall distribution of the complex is summarized. Ecological observations are also reported.

Abbreviations used in the text to designate the sources of preserved study material are as follows:

CM—Carnegie Museum, Pittsburgh, Pennsylvania.
MNHP—Museum National d'Histoire Naturelle, Paris, France.
NCSM—North Carolina State Museum, Raleigh, North Carolina.
RLH—Private collection of Richard L. Hoffman, Radford, Virginia.
RVC—Private collection of the late Ralph V. Chamberlin, now being accessioned by the United States National Museum.
USNM—United States National Museum, Washington, D. C.

ACKNOWLEDGMENTS

As with most papers on millipeds of the southeastern U. S., Leslie Hubricht deserves primary recognition for his field collections. More specimens of the S. *latior* complex have been secured by him than by any other collector, and the present picture would certainly not have emerged without his outstanding field work.

Additional collectors, too numerous to list, also contributed one or a few specimens. Each is cited after the respective collection in the text. In this regard, I add my thanks to the North Carolina Department of Natural and Economic Resources, Division of State Parks, for permission to collect in the North Carolina State Parks.

For the privilege of examining the types of *Fontaria latior* and *Sigmoria furcifera* respectively, I gratefully acknowledge the assistance of J. P. Mauries, Museum National d'Histoire Naturelle, Paris, France, and Ralph E. Crabill, Jr., U. S. National Museum. Specimens from the Carnegie Museum were kindly loaned by George E. Wallace.

I am deeply indebted to Richard L. Hoffman, who collected many specimens himself and generously loaned me his entire collection, containing most of the available material. Dr. Hoffman also contributed valuable comments and suggestions on the manuscript. Figures 1 and 2 were prepared by Renaldo G. Kuhler, N. C. State Museum staff artist; the other illustrations are the work of the author.

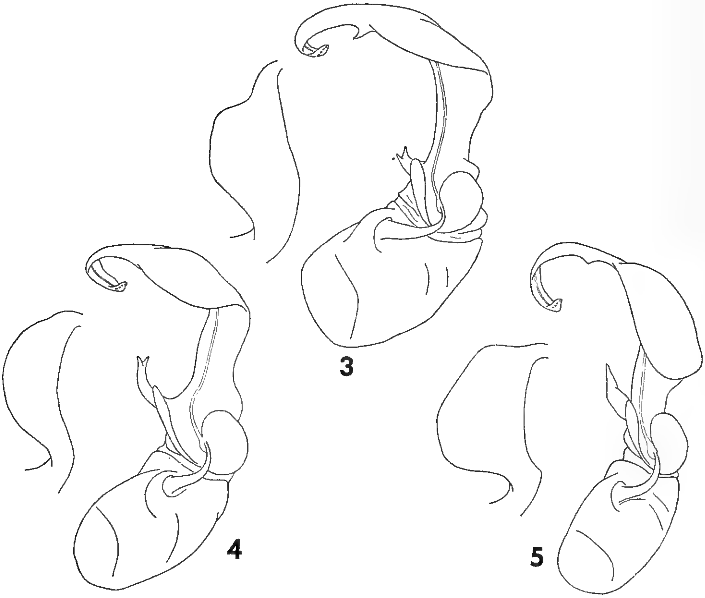
KEY TO THE SUBSPECIES OF SIGMORIA LATIOR (BASED ON ADULT MALES)

1. Telopodite of male gonopod with subterminal tooth on medial edge distad to flange; metaterga with or without yellowish stripe along caudal edge 2
   Telopodite of male gonopod without subterminal tooth on medial edge distad to flange; metaterga with yellowish stripe along caudal edge; eastern slope of mountains of southwestern North Carolina ....*latior mariona Chamberlin*
2. Prefemoral process simple or with varying bifurcation; flange moderate, at maximum depth well above level of prefemoral process (medial view), subequal in depth to that of distal curvature of telopodite; distal curve of telopodite narrow, beginning closer to tip than to subterminal tooth; metaterga solid black in color, without stripe along caudal edge; northern North Carolina to southern West Virginia ....*latior latior* (Brölemann)
   Prefemoral process simple, never bifurcate; flange greatly enlarged, extending at maximum depth to level of prefemoral process (medial view), greater in depth than that of distal curvature of telopodite; distal curve of telopodite broad, usually beginning closer to subterminal tooth than to tip; metaterga with yellowish stripe along caudal edge; coastal plain of southern South Carolina ....*latior hoffmani* new subspecies

Sigmoria latior latior (Brölemann), new status

Figures 3, 6–14

Fontaria latior Brölemann, 1900, p. 123, pl. 6, figs. 37–42.
Apheloria latior Attems, 1938, p. 168.



Figs. 3–5. Left male gonopods of *Sigmoria latior* subspecies (medial view) with direct view of flange. 3, *S. l. latior,* specimen from 4 mi. SE Jonas Ridge, Burke Co., N. C. (RLH). 4, *S. l. mariona,* holotype, specimen from Marion, McDowell Co., N. C. (RVC). 5, *S. l. hoffmani,* holotype, specimen from 4.4 mi. NW North, Orangeburg Co., S. C. (RLH).

Sigmoria latior Hoffman, 1950, p. 5—Chamberlin & Hoffman, 1958, p. 50. —Wray, 1967, p. 152.

Sigmoria aberrans Chamberlin, 1939, p. 8, pl. 3, figs. 24, 25.—Hoffman, 1950, p. 2.—Chamberlin & Hoffman, 1958, p. 49.—Wray, 1967, p. 152. [New synonymy.]

Sigmoria conclusa Chamberlin, 1939, p. 8, pl. 3, figs. 22, 23.—Hoffman, 1950, p. 4.—Chamberlin & Hoffman, 1958, p. 49.—Wray, 1967, p. 152. [New synonymy.]

Sigmoria furcifera Hoffman, 1949, p. 387, pl. 27, figs. 17, 18.—Hoffman, 1950, p. 4.—Chamberlin & Hoffman, 1958, p. 50. [New synonymy.]

Type-specimen: Male holotype (MNHP) collected from "North Carolina" without additional data. The collector is unknown, and the specimen was originally housed in the collection of E. Simon, who later gave it to Brölemann. Having examined this specimen, I can now report that it came from the region of intergradation in south-central North Carolina, and the type-locality is thus restricted to the region south of the Deep-Cape Fear Rivers. Of the material available to me, it conforms most closely to a male from Raeford, Hoke Co. (RLH), but is sufficiently different to prohibit further specification of the probable locality. The subspecies in northern North Carolina, to which the specimen is closest morphologically and geographically, is hereby considered the nominate subspecies.

Although Brölemann's specimen must remain the holotype, the range of the nominate subspecies is here restricted to the region north of the Deep-Cape Fear Rivers, and therefore a more "typical" male has been selected for redescription. This individual was collected by R. L. Hoffman, 11 July 1962, 4 mi. SE Jonas Ridge, Barkhouse Recreation Area, Burke Co., North Carolina (RLH).

Diagnosis: Metaterga without stripes along caudal edge, solid black in color; paranota varying from red to yellow in color; male gonopods with following characters: prefemoral process short, bent at midlength into approximately a right angle, simple or bifurcate; flange moderate, extending (medial view) only as low as tip of telopodite; subterminal tooth present, subtriangular; distal curvature of telopodite beginning much closer to tip than to tooth, forming arc with relatively narrow diameter.

Description: Given in full only for the nominate subspecies, the others differing only in color pattern and gonopod structure.

Length 42.6 mm, maximum width 11.1 mm, W/L ratio 26.1%. Color in life: paranota bright lemon yellow, metaterga black; yellow stripe along anterior edge of collum, connecting with paranotal spots; epicranium dark brown, suture white; frons and genae light brown, clypeus yellow; antennae yellow, ultimate and penultimate segments brown; venter white; legs white basally, other podomeres yellow, claws and distal end of tarsi brown.

Head capsule smooth, polished; epicranial suture thin but distinct; antennae moderately long and slender, reaching back to middle of paranota of third segment and becoming progressively more hirsute distally; first antennomere subglobose, 2–6 clavate, 7 short and truncate; genae not margined laterally, genal apices projecting slightly beyond adjacent margins of cranium.

Terga smooth, polished; paranota depressed, continuing slope of dorsum, damaged on right side of segments 2–4; anterior corners of paranota rounded; posterior edge of paranota continuous with that of metaterga on segments 1–11, becoming angled at 12 and progressively more so caudally; peritremata thick and conspicuous, sharply set off from paranotal surface, produced slightly caudad beginning on segment 7; ozopores opening dorsally, located in middle of peritremata.

Pregonopodal sterna unmodified except for pair of small, paramedial knobs between 4th pair of legs; postgonopodal sterna produced into small, blunt lobes subtending both pairs of coxae on segments 8–16; sternal surface smooth, glabrous, slightly depressed between lobes on caudal edge. Pregonopodal legs densely hirsute; postgonodal legs becoming progressively less hirsute caudally; small coxal spine present on legs of segments 9–17. Hypoproct rounded; paraprocts with margins strongly thickened.

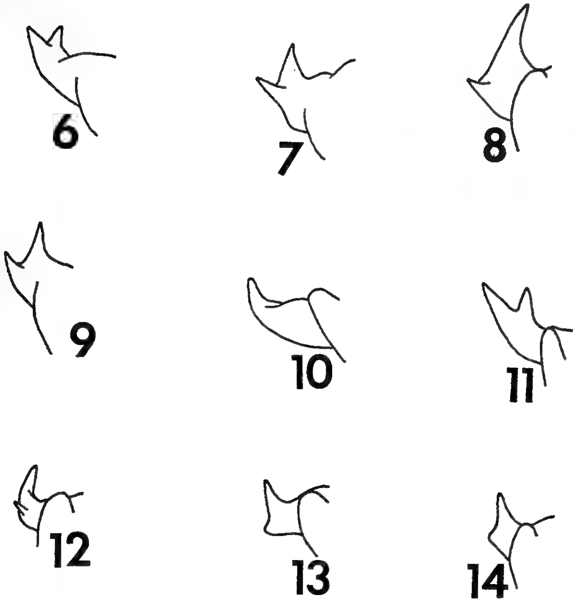
Gonopodal aperture elliptical, indented on antero-lateral margin; edges slightly raised. Gonopods (medial view) with prefemoral process short, bifurcate, vertical component slightly longer and thicker than horizontal component, bent at nearly a right angle at midlength (juncture of two components); flange extending nearly as low as tip of telopodite, well above level of prefemoral process; subterminal tooth sharply pointed, distinct; telopodite angled slightly downward distad to tooth; distal curve of telopodite forming arc with relatively narrow diameter, beginning of curve proximal to tip, much closer to tip than to subterminal tooth.

Variation: All specimens seen in life (or with color notations) have solid black metaterga (without stripes), but the color of the paranota and stripe along the anterior edge of the collum may vary. Individuals from Wilkes Co., North Carolina, were red (NCSM 1854) and orange (NCSM 1826), while those from Johnston and Wake Co., in the eastern piedmont, were yellow (NCSM 1557, 1704). A specimen with red paranota from Roaring Gap, Alleghany Co., North Carolina, was illustrated by Levi, Levi, and Zim (1968, p. 149). Aside from color, there is little difference in the non-gonopodal characters.

On the gonopods, however, the prefemoral processes vary considerably. They may be simple or bifurcate, with either component longer and more prominent than the other (Figs. 6–14). Regardless of the relative lengths of the components, the angle between the vertical component and the base of the process is approximately a right angle. The overall length of the process is about the same in all individuals, but seems to be slightly longer in those which lack bifurcation.

The other gonopodal characters vary little from the condition described above for the Burke Co. specimen. The subterminal tooth is slightly reduced and rounded on individuals from Buchanan, Washington (3 miles NE Mendota), and Grayson Cos., Virginia, but otherwise it is distinct and subtriangular. The distal curve of the telopodite is much closer to the tip than to the tooth, but the distance between the curve and tooth is greater in some individuals. In all specimens, the flange (medial view) is subequal in depth to that of the distal curvature of the telopodite.

Distribution: This subspecies spans elevations of approximately 300–3000 ft. in North Carolina, southwestern Virginia, and southern West Virginia, and includes localities previously reported for *S. aberrans* and *S. conclusa* (Hoffman, 1950; Chamberlin & Hoffman, 1958; and Wray, 1967) and *S. furcifera* (Hoffman, 1949, 1950; and Chamberlin



Figs. 6–14: Variation in prefemoral processes of *S. l. latior* (medial view), localities as follows: 6–10, five individuals from Rendezvous Mtn., Wilkes Co., N. C. (NCSM 1854). 11, near Pineville, Wyoming Co., W. Va. (USNM 1809). 12, 8 mi. SE Blowing Rock, Caldwell Co., N. C. (RLH). 13, William B. Umstead State Park, Wake Co., N. C. (NCSM 1704). 14, near summit of Clinch Mtn., Washington Co., Va. (RLH).

& Hoffman, 1958). Known range extremes include the Ohio River drainages of southern West Virginia in the north and west and the upper Neuse River basin of North Carolina in the east. No specimens have been encountered in the Tar or Roanoke basins in either North Carolina or Virginia. In North Carolina, the range extends as far south as the Catawba River in the western piedmont and mountains and the Deep-Cape Fear Rivers in the eastern piedmont; no specimens have been collected in the coastal plain.

The subspecies appears to be a valley form in montane regions, as suggested by Hoffman (1950). The highest known elevation is 3018 ft., near the summit of Clinch Mountain, Washington Co., Virginia. The Clinch Mtn. specimens are also the only representatives of the subspecies known authentically from regions which drain into the Tennessee River. In the North Carolina mountains, the subspecies has not been collected in Tennessee River drainages and is known only from the regions surrounding the headwaters of the New River, which flows into the Ohio, and the Atlantic draining Yadkin and Catawba Rivers.[3] Specimens have been examined as follows:

West Virginia: Wyoming Co., 1♂, 12 July 1947, H. H. Hobbs, Jr., and C. M. Wilson (USNM 1809). McDowell Co., 5 mi. E Iaeger, 1♂, 29 June 1950, L. Hubricht (RLH).

Virginia: Buchanan Co., 3 mi. SW Vansant, 1♂, 1♀, 1 July 1951, R. L. Hoffman and W. B. Newman (RLH). Russell Co., north slope of Clinch Mtn., 0.25 mi. E fire tower, 1♂, May 1974, D. W. Ogle (RLH). Washington Co., E side Clinch Mtn. near summit, 2 mi. N Mendota, 1♂, 31 July 1965, R. L. Hoffman and K. P. Brownell (RLH); woods along Va. hwy. 802, 3 mi. NE Mendota, 1♂, 31 July 1965, R. L. Hoffman and K. P. Brownell (RLH); and Straight Branch at Dripping Rock, near Damascus, 1♂, 1♀, 3 August 1941, S. T. Brooks (CM 52). Grayson Co., 1 mi. W Independence, 1♂, 18 June 1950, R. L. Hoffman and J. A. Fowler (RLH). Patrick Co., 2 mi. N North Carolina line, north of Mt. Airy, 1♂, 13 June 1937, L. P. Schultz and E. D. Reid (RLH).

Tennessee: Johnson Co. Backbone Rock Recreation Area, 4 mi. S Damascus, 3♂, 2♀, 11 July 1962, R. L. Hoffman (RLH).

North Carolina: Ashe Co., Mill Hill, 1♂, 31 July 1932, C. M. Breder (RLH). Alleghany Co., SE side of Roaring Gap on U. S. hwy. 21, 2♂, 1 May 1965, Radford College Expedition (RLH). Watauga Co., Boone, Campus of Appalachian State University, 1♂, 18 June 1948, M. Wright (RLH); and along Payne Branch Rd. between Boone and Blowing Rock, 1♂, 11 August 1962, H. F. Loomis (RLH). Wilkes Co., 1.5 mi. NW Wilbar, 2♂, 24 May 1958, L. Hubricht (RLH); 9 mi. NW Wilkesboro, Rendezvous Mtn., 8♂, 4♀, 25 July 1973, R. M. Shelley (NCSM 1854); 1 mi. S Oakwood, Brushy Mtns., 5♂, 5♀, 5 April 1952, L. Hubricht (RLH); 7.5 mi. E Wilkesboro, 2♂, 23 July 1950, L. Hubricht (RLH); and 9 mi. SE Wilkesboro, jct. N. C. hwy. 115 co. rd. 2428, 1♂, 2♀, 26 July 1973, R. M. Shelley (NCSM 1826). Caldwell Co., along U. S. hwy. 321, 8 mi. SE Blowing Rock, 1♂, 13 July 1962, R. L. Hoffman (RLH); and Hudson, 2♂, 1♀, 5 April 1952, L. Hubricht (RLH). Mitchell Co., Altapass, 3♂, several ♀, R. V. Chamberlin (RVC) (see footnote 3). Burke Co., 4 mi. SE Jonas Ridge, Barkhouse Recreation Area, 1♂, 11 July 1962, R. L. Hoffman (RLH); and 4 mi. N Morganton, 1♂, 3 October 1953, L. Hubricht (RLH). Davie Co., 4 mi. NE Mocksville, 1♂, 26 October 1952, L.

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[3] Altapass, the supposed type locality for S. *conclusa*, is near the headwaters of the North Toe River of the Tennessee River System, but it is also less than a mile from the divide with the Catawba River System in McDowell County. Both Dr. Hoffman (personal communication) and I have visited Altapass without finding S. *l. latior*, and it seems likely that the material in question actually came from across the divide in McDowell County and was labeled "Altapass" since this was the closet town. Chamberlin, who collected the specimens himself, was obviously confused about his location since he thought Altapass was in Tennessee! Thus, since Altapass is the only North Carolina locality within the Tennessee River System and since no additional specimens have ever been collected there despite several attempts, it is disregarded pending confirmation with fresh material.

Hubricht (RLH). Randolph Co., Ramseur, 1♂, 15 June 1954, H. E. Evans (RLH). Wake Co., William B. Umstead State Park, 1♂, 20 April 1973, R. M. Shelley (NCSM 1704). Franklin Co., 1.5 mi. S Pilot, near Mocassin Creek, 3♂, 2♀, 2 May 1959, L. Hubricht (RLH). Johnston Co., 2.8 mi. SW Clayton, 5♂, 18 April 1959, L. Hubricht (RLH); and 11.1 mi. SW Smithfield, along co. rd. 1330, 0.2 mi. N jct. N. C. hwy. 210, 3♂, 3 October 1972, R. M. Shelley (NCSM 1557).

Remarks: Hoffman (1950) noted that the West Virginia specimens are the northernmost in the genus *Sigmoria* and suggested an additional locality in north-central West Virginia (Lewis Co., near Jackson Mills), approximately 120 miles NE Pineville. This record was based on a female specimen, but as noted earlier, authentic records can only be based on mature males. Thus, the Lewis Co. locality should be deleted until confirmed by an adult male.

The identity of S. *aberrans*, described from Linville Falls, North Carolina, by Chamberlin (1939), is still somewhat in doubt. No county was given in the original description or by Hoffman (1950), but Chamberlin & Hoffman (1958) and Shelley (1975a) reported that the type-locality was in Avery Co. Although the Linville River, a tributary of the Catawba, arises in Avery Co., both the town of Linville Falls and the falls themselves are in adjacent Burke Co. The type locality for S. *aberrans* is therefore in Burke Co. rather than Avery.

The type-series of S. *aberrans* was comprised of "several males and females" (Chamberlin, 1939), but they are all now missing from their depository, the Chamberlin collection. No male topotypes are available either, although Hoffman (1950) refers to a topotype as being the key to the identification of a number of undetermined specimens of *Sigmoria*. This topotype, however, identified in his personal collection, is a female and unsatisfactory for species identification. Thus, no authentic male specimens of S. *aberrans* are available, and to further complicate matters, Chamberlin's description and illustrations (1939) are inadequate representations of the characters of the species. The color notations in the description, however, are typical of S. *l. latior*, and if a gonopod of this subspecies is examined by looking straight at the tip of the telopodite, the view vaguely resembles Chamberlin's sketch of S. *aberrans*. The best clue to the identity of S. *aberrans* is the specimen of S. *l. latior* from Burke Co., 4 mi. SE Jonas Ridge (RLH). This locality is approximately 5.5 mi. ESE Linville Falls and the closest available to the type-locality of S. *aberrans*. Thus, on the basis of this male and the few clues in Chamberlin's description (1939), it is concluded that S. *aberrans* is a flanged *Sigmoria* and conspecific with S. *l. latior*.

In selecting a specimen to redescribe the nominate subspecies, I chose without regard to locality and happened to pick the aforementioned male from Burke Co., 4 mi. SE Jonas Ridge. I did so because the specimen is one of the best available, is not broken, has both gonopods present, and typically represents the characters of the subspecies. I wish to emphasize that the selection of this particular specimen for redescription of *S. l. latior* had nothing whatsoever to do with its proximity to the type-locality of *S. aberrans*.

In Chamberlin's 1939 paper, five species are originally described in *Sigmoria*, one of which, *S. divergens*, has since been transferred to *Cleptoria* (Hoffman, 1967), which Chamberlin also proposed in the same paper. Of the remaining four species, *S. aberrans* and *S. conclusa*, described consecutively, are identical, and two descriptions later is the conspecific *S. mariona*, here reduced to a subspecies. Thus, of the five species originally proposed in *Sigmoria*, only the type species, *S. munda*, remains intact. As with *S. aberrans*, the type-series of *S. conclusa* also consists of "several males and females," which, except for the male holotype, are in a jar of paratypes in the Chamberlin collection. These paratypes are badly fragmented, but there are three pieces with gonopods, two being *S. l. latior* and the other, a sigmoid form that is apparently undescribed! Thus, Chamberlin (1939) proposed consecutive synonyms, obscured the identities of both species through inadequate descriptions and illustrations, confused the type-locality of *S. conclusa* by placing it in Tennessee, and missed an undescribed species collected at the same time, not to mention the *Cleptoria* situation! This is perhaps somewhat extreme but nevertheless a not too atypical example of the type of confusion that exists in the pre-1950 literature on North American diplopods.

Sigmoria latior mariona Chamberlin, new status

Figure 4

Sigmoria mariona Chamberlin, 1939, p. 9, pl. 2, figs. 17, 18.—Hoffman, 1950, p. 6—Chamberlin & Hoffman, 1958, p. 50.—Wray, 1967, p. 152.

Type specimens: Male holotype and one male and two female paratypes collected by R. V. Chamberlin, 12 August 1910, from Marion, McDowell Co., North Carolina (RVC).

Diagnosis: Metaterga with yellowish stripes along caudal edge connecting with paranotal spots; male gonopods with following characters: prefemoral process bifurcate with vertical component usually much more prominent than horizontal component, although subequal in holotype; flange moderate, in depth (medial view) subequal to or slightly less than that of distal curvature of telopodite; subterminal tooth always absent; distal curvature of telopodite beginning approximately midway between apex and flange (or tooth location), forming arc with moderate diameter.

Variation: All specimens have a broad stripe along the caudal margin of the metaterga; accompanying notations indicate that the stripes and paranota are yellowish in life. On the gonopods, the two components of the prefemoral process are subequal in length in the holotype, but the vertical component is much larger in the Transylvania and Polk

Co. specimens. The depth of the flange relative to that of the distal curvature of the telopodite varies from subequal to a slightly more shallow flange. The latter condition is found on the Transylvania specimen and is due to the larger arc diameter formed by the distal curvature of the telopodite and not to a reduced flange. Absence of the subterminal tooth is the diagnostic feature of S. *l. mariona.*

Distribution: The subspecies has been collected only along the eastern edge of the mountains of southwestern North Carolina, in regions that drain into South Carolina and, eventually, the Atlantic Ocean. It has not been found west of the eastern continental divide in the French Broad River basin or other regions that drain into the Tennessee River. No specimens have been found in South Carolina, but S. *l. mariona* should be expected in the montane portions of Greenville and Pickens Counties. The low elevations of the three available specimens indicate that this subspecies is a valley form also. Specimens have been examined as follows:

North Carolina: McDowell Co., Marion, 2♂, 2♀, 12 August 1910, R. V. Chamberlin (RVC) HOLOTYPE and PARATYPES. Polk Co., Tryon, 1♂, March 1922, J. T. Nichols (RLH). Transylvania Co., Toxaway Gorge, 1100′, pine flat, 1♂, 3 August 1961, J. P. Paul (RLH).

Remarks: Hoffman (1950), Chamberlin & Hoffman (1958), and Wray (1967) all reported the Polk Co. locality as being the first definite record of S. *latior.* However, the specimen has the diagnostic characters of S. *l. mariona,* and the locality record is included here and not under the nominate subspecies.

Since both have a bifurcate prefemoral process, a comparison of S. *l. latior* and S. *l. mariona* is in order. The most obvious difference involves the subterminal tooth, which is present in the former and absent in the latter. They also differ in color pattern, with S. *l. mariona* being striped while the metaterga of S. *l. latior* are solid black in color. The distal portion of the telopodite of S. *l. mariona* is more broadly curved, with the curve beginning closer to the flange. The flange of the nominate subspecies tends to be squared, whereas that of S. *l. mariona* is more rounded. In overall length, the prefemoral process of S. *l. mariona* is longer, with a more obtuse angle between the base of the process and the tip of the vertical component. Some specimens of S. *l. latior* lack bifurcation, whereas all individuals of S. *l. mariona* display the trait, although the vertical component is much more prominent in the Polk and Transylvania specimens. Thus, S. *l. mariona* is quite different from S. *l. latior* and exhibits similarities to the South Carolina subspecies, which will be discussed in the following section.

Sigmoria latior hoffmani, new subspecies

Figure 5

Type specimen: Male holotype collected by L. Hubricht, 14 May 1960, from upland mixed woods, 4.4 mi. NW North, Orangeburg Co., South Carolina (RLH). The subspecies is named after Richard L. Hoffman, in recognition of his contributions to the taxonomy of North American diplopods and his generous assistance to me, including the loan of all available material of this subspecies.

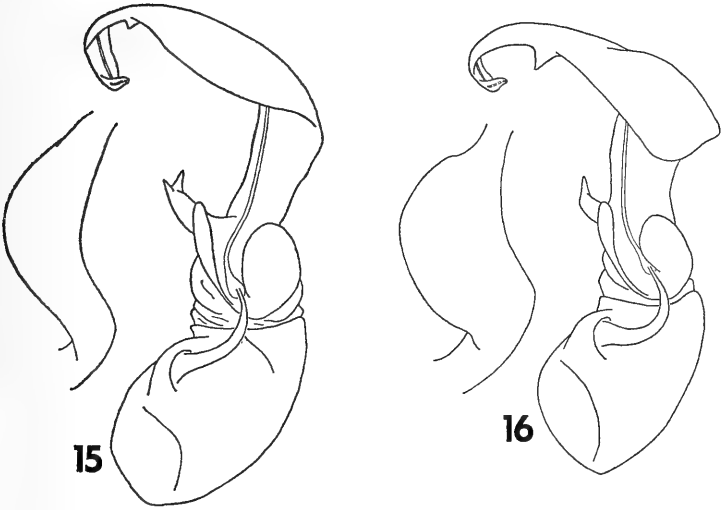
Diagnosis: Metaterga with yellowish stripes along caudal edge connecting with paranotal spots; male gonopods with following characters: prefemoral process simple, not bifurcate, angle between base and tip greater than 90°; flange greatly enlarged, extending (medial view) to level of prefemoral process, greater in depth than that of distal curvature of telopodite; subterminal tooth present but variable; distal curvature of telopodite beginning closer to tooth than to tip of telopodite, forming arc with relatively broad diameter.

Variation: All specimens have a broad stripe along the caudal edge of the metaterga; accompanying notations indicate that the stripes and paranota are yellowish in life. On the gonopods, the size of the flange varies and is largest in the southernmost individuals with the largest being on the males from Colleton Co. The most variable character is the subterminal tooth, which is sharply pointed on the Charleston Co. specimens and is a low, flat callus on a male from Berkeley Co. The tooth on the holotype is intermediate between these extremes, and no pattern is evident to the tooth variation. The distal curvature of the telopodite is narrowest in the Charleston specimens but is still greater than that of the other subspecies.

Distribution: The subspecies appears to be restricted to the coastal plain of southern South Carolina, between the Savannah and Congaree-Santee Rivers; intergrades have been collected from across the Santee in Williamsburg Co. and the Congaree in Richland Co. Specimens have been examined as follows:

South Carolina: Lexington Co., Swansea, 1♂, 23 December 1951, L. Hubricht (RLH); and Pelion, 1♂, 17 April 1954, L. Hubricht (RLH). Berkeley Co., near diversion canal on S. C. hwy. 45, SW Pineville, 2♂, 13 June 1959, L. Hubricht (RLH). Charleston Co., swamp, 1.5 mi. S Adams' Run, 5♂, 1♀, 5 July 1959, L. Hubricht (RLH). Orangeburg Co., upland mixed woods, 4.4 mi. NW North, 1♂, 14 May 1960, L. Hubricht (RLH) HOLOTYPE. Bamberg Co., Lemon Swamp, 2.2 mi. S Bamberg, 1♂, 21 November 1959, L. Hubricht (RLH). Colleton Co., 5 mi. N Yemassee, 2 ♂, 2♀, 10 June 1963, D. R. Whitehead (RLH).

Remarks: This subspecies differs from the nominate subspecies in color pattern and most gonopodal characters, and it exhibits the extreme in development of the flange and distal curvature of the telopodite. It resembles *S. l. mariona* in color pattern, and the prefemoral processes of the gonopods of the two subspecies are similar in length, with a more obtuse angle between the base and tip than in *S. l. latior.* The subterminal tooth, absent in *S. l. mariona,* is variable in *S. l. hoffmani* and much reduced in some individuals. The distal curvature of the



Figs. 15–16. Left male gonopods of *Sigmoria latior* intergrades (medial view) with direct view of flange. 15, S. *l. latior* × S. *l. mariona,* specimen from 2.2 mi. SE Dysartsville, McDowell Co., N. C. (RLH). 16, S. *l. latior* × S. *l. hoffmani,* specimen from Raeford, Hoke Co., N. C. (RLH).

telopodite, beginning midway between the flange (tooth location) and tip in S. *l. mariona,* begins closer to the tooth in S. *l. hoffmani.* The flange of S. *l. hoffmani,* while larger than those of the other two subspecies, resembles that of S. *l. latior* in its squarish configuration. Relationships between the three subspecies will be discussed in the concluding section.

Intergrades

As shown in the distribution map (Fig. 17), a large zone of intergradation occurs in the region of the central Carolinas, around their common border. The gonopods of the intergrades vary, depending upon the relative expression of the characters of each subspecies, but all known specimens display the striped color pattern of S. *l. mariona* and S. *l. hoffmani.* Only a small number of intergrades are available, and none have been collected which could be interpreted as displaying characters of all three subspecies.

S. *l. latior* × S. *l. mariona*

The one available specimen resembles S. *l. mariona* in color pattern, size and shape of the flange, and distal curvature of the telopodite. It resembles *S. l. latior* in the prefemoral process and subterminal tooth; the latter, however, is reduced from the condition in the nominate subspecies. Locality data are as follows: North Carolina, McDowell Co., 2.2 mi. SE Dysartsville, 2♂, 1♀, 19 September 1953, L. Hubricht (RLH).

S. l. latior × *S. l. hoffmani* (hereafter abbreviated *l* × *h*)

The specimens from this zone of intergradation possess gonopods that are generally intermediate between the two subspecies. There is usually some bifurcation of the prefemoral process, but the structure is intermediate in overall length and angulation. Both the distal curvature of the telopodite and depth of the flange are also intermediate. The subterminal tooth, however, conforms more to the condition in *S. l. latior.* As mentioned previously, all specimens are striped (an *S. l. hoffmani* trait), but the color varies as in *S. l. latior*, being yellow in the Morrow Mountain specimens and pink in those from Scotland Co.

The range of intergradation extends roughly from the Deep-Cape Fear Rivers of North Carolina to the Congaree-Santee Rivers of South Carolina. Individuals are known from as far west as the Uwharrie Mtns., North Carolina, from Morrow Mountain State Park. Specimens have been examined as follows:

North Carolina: Stanly Co., Morrow Mtn. State Park, 1♂, 31 July 1951, T. Cohen (RLH); and 5♂, 2♀, 9 August 1973, R. M. Shelley (NCSM 1891). Moore Co., 4.4 mi. SW Robbins, along N. C. hwy. 24, 0.5 mi. W jct. co. rd. 1276, 1♂, 24 April 1973, R. M. Shelley (NCSM 1729). Hoke Co., Raeford, 1♂, 1♀, 22 March 1952, L. Hubricht (RLH). Scotland Co., 3.7 mi. NW Wagram, 4♂, 8 October 1974, J. E. & M. R. Cooper (NCSM 2538). Unknown Co. (restricted to S of Deep-Cape Fear Rivers) and date, 1♂, collector unknown (MNHP) HOLOTYPE of *Fontaria latior.*

South Carolina: Richland Co., 1♂, 26 April 1963, B. Power (RLH); and 2♂, 4♀, May 1963, M. Byrd (RLH). Williamsburg Co., near Santee River on S. C. hwy. 41, 12.5 mi. SSW Andrews, 2♂, 13 June 1959, L. Hubricht (RLH).

S. l. mariona × *S. l. hoffmani* (hereafter abbreviated *m* × *h*)

No specimens have yet been taken that are intermediate between these two subspecies. They should be expected, however, in the western piedmont of South Carolina, perhaps around Greenville and Spartanburg. The absence of material is particularly unfortunate in view of the morphological similarities between the two subspecies, and future collecting should be concentrated in the probable area of intergradation.

Ecology

Little can be said about the ecology or specific habitat requirements of these subspecies. Most of the loaned material lacked this information, but I can report on the material which I collected. One point of interest is the relative abundance of the nominate subspecies in the western and eastern piedmont of North Carolina. In four years of surveying the eastern piedmont diplopods, in all habitats at all seasons, only four males have been discovered: three in Johnston Co. (NCSM 1557) and one in William B. Umstead State Park, Wake Co. (NCSM 1704). Conversely, in a three-day summer field trip to Wilkes Co., in the northwestern piedmont and foothills, 11 males and 10 females were collected, and at one locality a number of individuals were examined but not retained. This apparent disparity in relative abundance might be due to habitat differences, with the foothills of Wilkes Co. being more desirable in terms of thickness of the humus layers, temperature, humidity, and other factors. The humus layers are noticeably thinner in the eastern piedmont, and the frequent periods of hot, dry weather render all diplopods scarce, not just males of *Sigmoria.*

As for specific habitat characteristics, most of the millipeds are found in the same habitats as xystodesmids in general—under rocks, logs, and in litter and humus layers of predominantly hardwood localities. Notations accompanying the specimens of *S. l. hoffmani,* however, indicate that 9–11 individuals were collected from swamps or swampy habitats. The southeastern swamps and coastal plain are not generally regarded as preferred habitats for xystodesmids, but one other genus known from the region is *Stelgipus,* reported by Chamberlin & Hoffman (1958) from Wadmalaw Island, Charleston Co.

Some of the North Carolina specimens came from habitats which are different enough to warrant specific attention. The male from William B. Umstead Park (NCSM 1704), for example, was found dead, apparently drowned, in a pool of water in a pine-hardwood locality. The specimens from Johnston Co. (NCSM 1557) were found in a rather unlikely habitat, on sandy soil under a thin layer of leaves. This same locality has yielded *Apheloria* and immatures of *Nannaria,* probably *N. conservata,* as well as *Ptyoiulus* (Shelley, 1975b). In Scotland Co., four males, *l* × *h* intergrades (NCSM 2538) were discovered under a log near a burned house overgrown with weeds. All other specimens were collected in habitats that are typical for xystodesmid millipeds.

DISTRIBUTION

Sigmoria latior ranges from the mountains of southern West Virginia to the Savannah River region of coastal South Carolina (Fig. 17), a distance of roughly 400 miles. In Virginia and West Virginia, the range is narrow, but it widens considerably in the Carolinas, the area of major concentration. There it becomes triangular in shape with *S. l. latior* in the north, *S. l. mariona* in the southwest, *S. l. hoffmani* in the south, and intergrades centrally. The distributional pattern could aptly be described as the Carolinas, with a northwestward projection into southern West Virginia. Specific ranges for the three subspecies are as follows:

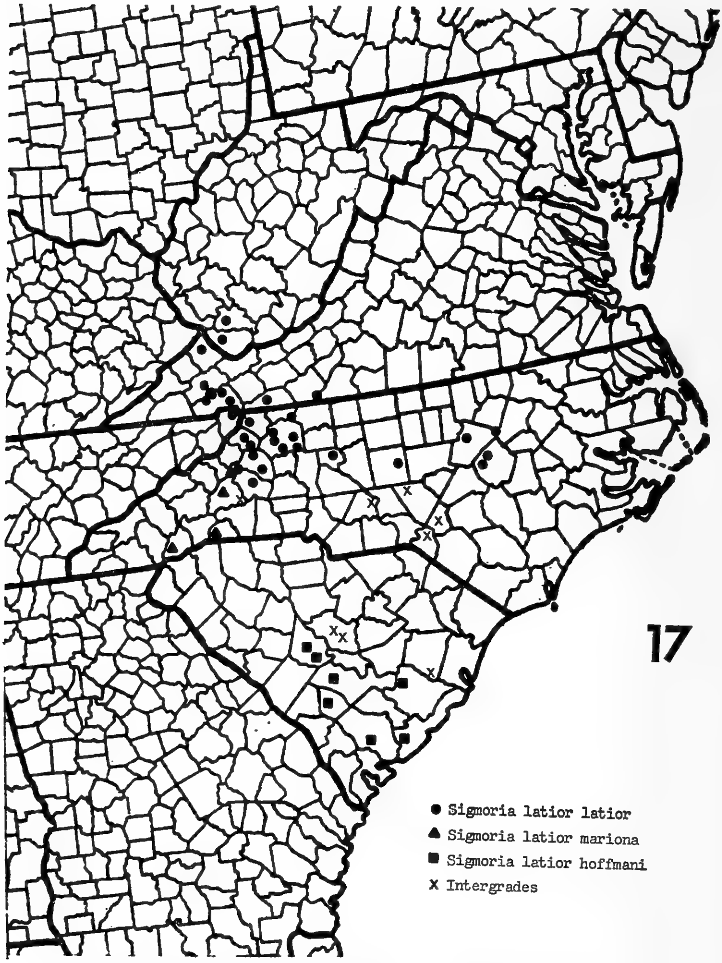


FIG. 17. Distribution of *Sigmoria latior* in eastern United States.

latior—northern piedmont and mountains of North Carolina, north of the Deep-Cape Fear and Catawba Rivers, through southwestern Virginia to southern West Virginia.

mariona—eastern mountain slope (Atlantic drainages) of southwestern North Carolina.

hoffmani—coastal plain of southern South Carolina, between the Savannah and Congaree-Santee Rivers.

Several points about the distribution are noteworthy. First, rivers and drainage basins are important factors influencing the ranges of the subspecies; they effectively form boundaries for both S. *l. latior* and S. *l. hoffmani*. Disparities in distribution in individual river systems are also intriguing. For example, the nominate subspecies is common in the upper New River basin in northwestern North Carolina, but it has not been encountered along the New River in the Ridge and Valley Province of Virginia, one of the most thoroughly collected areas in the southeast (Hoffman, 1969). Also, except for specimens of S. *l. latior* from localities near the Clinch and Holston Rivers in Virginia, no adult males have been authentically taken from localities that drain into the Tennessee River. In Watauga Co., North Carolina, two individuals have been collected from localities near the headwaters of the New River, but none have been found in the Watauga basin, only a few miles away. Likewise, S. *l. mariona*, in southwestern North Carolina, is known only from the Atlantic drainages along the eastern mountain slope and has not been encountered in the French Broad basin, just across the eastern continental divide. Although lack of adult males may partially explain this absence, it is also true that considerable field work has been carried out in the Tennessee drainages. If males are present in numbers at all similar to those in neighboring basins, it seems that at least one would have been discovered by now. The absence of S. *latior* from the Great Smoky Mountains, to cite one specific region, is considered more real than artificial, since it too is one of the best collected areas in the southeast (Hoffman, 1969). The mountains and valleys of the Tennessee River System abound in climax forests with thick humus layers, so the absence cannot be due to unsuitable habitat. Instead, it seems that the pattern can best be attributed to two factors: altitude restrictions and competition.

Hoffman (1950) suggested that the species might be a valley form despite its occurrence in a mountainous region. Although he was speaking primarily for northwestern North Carolina and adjacent Virginia, it now appears that the observation is valid for all montane forms of the species. In elevation, the species ranges from near sea level in coastal South Carolina (S. *l. hoffmani*), to approximately 3018 ft. near the summit of Clinch Mtn., Washington Co., Virginia (S. *l. latior*). Nowhere does it approach the high mountain peaks, and most of the material was collected in river valleys. This preference for valleys may partially explain the absence from the Tennessee drainage; in order to cross the eastern continental divide, it would have to ascend intervening higher elevations.

Throughout much of its range, S. *latior* is the only known *Sigmoria* present. Several additional species, however, occur in the mountains of the Tennessee River System, including the abundant S. *nantahalae* in areas surrounding the headwaters of the Nantahala (Little Tennessee) and Hiwassee Rivers (Hoffman, 1958). It thus seems that competition with these species or even other diplopods could partially explain the distributional pattern.

In a different region, no individuals have been found in the Tar and Roanoke River basins of piedmont North Carolina. I have collected extensively in these regions, but *Apheloria* is the only xystodesmid found. In this case, the reason might be lack of suitable habitat. Much of the area around Kerr and Gaston Lakes (impoundments of the Roanoke River) and the upper Tar River basin was once cotton farmland that is now reverting back to forests and is currently in pine stages of succession. Tracts of hardwoods or even mixed hardwoods and pine are rare, whereas they are more plentiful in the upper Neuse River basin, where all eastern piedmont specimens of S. *l. latior* have been found.

The nominate subspecies has also not been encountered in piedmont Virginia. In this case, however, so little field work has been carried out that I cannot state with any degree of confidence that the absence is real.

A final distributional note involves the two distinct color patterns (Figs. 1, 2). The striped subspecies, S. *l. mariona* and S. *l. hoffmani,* are the southernmost, while S. *l. latior,* with solid black metaterga, occupies the northern half of the range. The dividing line between the two patterns coincides closely with the southern border of distribution for S. *l. latior,* and all the intergrade material is striped, regardless of location. Color pattern alone, therefore, restricts a specimen to either half of the range.

RELATIONSHIPS

Relationships of S. *latior* with other species of Sigmoria cannot be inferred at this time. Within the species itself, the nominate subspecies is morphologically the simplest and the form closest to a more primitive ancestor. In the flange and distal curvature of the telopodite, S. *l. latior* represents the simplest condition, while S. *l. hoffmani* displays the extreme development of each structure. The third subspecies, S. *l. mariona,* is intermediate in both of these characters, and the loss of the subterminal tooth appears to be a secondary modification. The geographical evidence suggests an origin in northwestern North Carolina, with migration northwestward to West Virginia and southward-eastward in North Carolina and into South Carolina. Although S. *l. mariona* is intermediate between S. *l. latior* and S. *l. hoffmani,* it is uncertain whether the latter evolved from S. *l. mariona* or directly from the nominate subspecies, since expansions toward South Carolina and southwestern North Carolina are believed to have occurred concurrently. Of highest priority now are collections in the Greenville-Spartanburg region, for *m* × *h* intergrades, and in piedmont Virginia, to determine if yet another subspecies occurs in that region.

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PROCEEDINGS
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REVIEW OF THE INDO-PACIFIC PIPEFISH GENUS *CHOEROICHTHYS* (PISCES: SYNGNATHIDAE), WITH DESCRIPTIONS OF TWO NEW SPECIES

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Recent major works on Indo-Pacific pipefishes (Weber and De Beaufort, 1922; Herald, 1953; Smith, 1963) were based largely on compilations from the literature and examination of relatively few specimens. A number of early errors and inaccuracies have thereby been perpetuated and, for the most part, there is little useful information available on intraspecific variation or geographic distribution. Unlike my predecessors, I have been able to examine collections, of the International Indian Ocean Expedition and several more recent expeditions, from over much of the tropical Indo-Pacific region. These materials and other museum holdings provide the basis for this report on *Choeroichthys*, an abdominal pouch genus of pipefishes (Syngnathidae: Gastrophori).

Methods and Materials

Measurements of standard length (SL) were made on a measuring board, graduated in 0.5 millimeter (mm) intervals, and estimated to the nearest 0.5 mm under low-power magnification; snout depth was taken with an ocular micrometer; other measurements were made with needlepoint dial calipers and recorded to the nearest 0.1 mm. All fin-rays were counted separately. Except in damaged or anomalous specimens, anal and caudal fin-rays are, respectively, 4 and 10 in all species of *Choeroichthys* and routine counts are omitted; fish with atypical caudal fin-ray counts were considered to have regenerated tails and were omitted from data on ring counts and proportional measurements.

Measurements requiring special definition follow: SL—straight-line distance from tip of lower jaw (mouth closed) to articular base of median caudal fin-rays; head length (HL)—tip of lower jaw to rear margin of opercle; snout length—tip of lower jaw to anterior inner margin of bony orbit; minimum snout depth—least vertical dimension of snout posterior of gape; pectoral fin length—length of longest fin-ray from articular base to tip; length of pectoral fin-base—straight-line distance between articular bases of upper and lowermost rays; length of dorsal fin-base—distance between anterior and posterior angles of insertion; anal ring depth—minimum distance between outer margins of superior and inferior trunk ridges on ring bearing anus. Counts of trunk rings begin with that bearing pectoral fin-base and end with that bearing anus; counts of tail rings begin with that bearing anal fin and end with penultimate ring, excluding terminal element bearing caudal fin-base. In the few cases where anus and anal fin occur on the same ring, the minimum trunk ring count is recorded (e.g. 16 rather than 16.5). Positional relationship of dorsal-fin base to trunk and tail rings is estimated to the nearest fourth of ring length and indicated by the formula: trunk rings covered + tail rings covered = total rings covered by dorsal fin-base (subdorsal rings). Color descriptions are from specimens preserved in alcohol.

Materials examined are listed by general localities from west to east and roughly north to south; depths are reported in meters (m). Maps delineate general distribution and do not show all collection sites.

Abbreviations for repositories of examined material: AMS—Australian Museum, Sydney; AMNH—American Museum of Natural History; ANSP—Academy of Natural Sciences, Philadelphia; BMNH—British Museum (Natural History); BPBM—Bernice P. Bishop Museum; CAS—California Academy of Sciences; CAS-SU—former Stanford University specimens housed at CAS; FMNH—Field Museum of Natural History; GCRL—Gulf Coast Research Laboratory Museum; HUJ—

Hebrew University of Jerusalem; LACM—Natural History Museum, Los Angeles Co.; MCZ—Museum of Comparative Zoology; MNHN—Museum National d'Histoire Naturelle, Paris; QM—Queensland Museum; RMNH—Rijksmuseum van Natuurlijke Histoire; RUSI—J. L. B. Smith Institute of Ichthyology, Rhodes University; UG—University of Guam; UMMZ—Museum of Zoology, University of Michigan; USNM—National Museum of Natural History, Smithsonian Institution; WAM—Western Australian Museum.

Choeroichthys Kaup

Choeroichthys Kaup, 1853:233 (name only, nomen nudum). Kaup, 1856:55 (type-species by original designation, *Choeroichthys valencienni* Kaup, 1856 equals *Syngnathus brachysoma* Bleeker, 1855).

Diagnosis: Superior trunk and tail ridges continuous, lateral trunk ridge continuous with inferior tail ridge, inferior trunk and tail ridges discontinuous near anal ring; scutella with or without keels, with or without knoblike projections on posterior margins of rings below lateral trunk ridge; lateral and median dorsal snout ridges present; opercle with complete median longitudinal ridge and additional ridges above and below; margins of head and body ridges smooth, finely denticulate or somewhat serrate; snout length 1.5–2.5 in head length; trunk rings 14–21; tail rings 17–25; subdorsal rings 3.75–8.25, mostly on trunk; dorsal fin-rays 17–34; pectoral fin-rays 18–23; anal fin-rays 4; caudal fin-rays 10. Brood pouch abdominal; pouch protective plates and brood pouch folds present; brood pouch eggs in two longitudinal rows (1–2 layers deep), covered by protective dermal folds which meet with somewhat inverted margins along ventral midline. Odontoid processes present on premaxillae and dentaries. Maximum size about 80 mm SL. Indo-Pacific.

Remarks: Confusion exists in the literature concerning brood pouch morphology in this genus. Weber and De Beaufort (1922) and Smith (1963) imply that brood pouch folds are united, or temporarily united, along the ventral midline; Herald's (1953) generic key states that pouch folds are absent in *Choeroichthys*. I find that pouch folds completely cover the eggs and that fold margins are always free and curved slightly dorsad along midline of egg-filled pouch (Fig. 9). In most egg-bearing males, the eggs are in a single layer of two parallel longitudinal rows, but 3–4 rows (1.5–2 layers) are present in some specimens.

Dawson and Fritzsche (1975) reported the occurrence of odontoid processes (Fig. 1) on one or both jaws in three genera of abdominal-pouch pipefishes: *Syngnathoides* Bleeker, *Heraldia* Paxton and *Choeroichthys*. Although lacking pulp cavity and enamel layer of true teeth, it is assumed that these bony projections function as teeth and

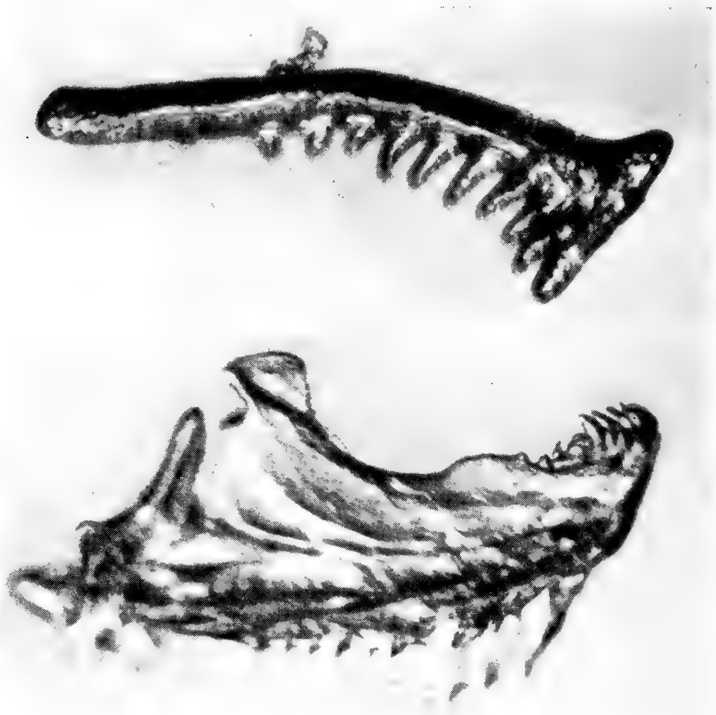


FIG. 1. Odontoid processes in *Choeroichthys sculptus.* Top: Right premaxilla, length ca. 0.8 mm. Bottom: Left mandible, length ca. 0.9 mm.

that specialized feeding modes (grazing?) have developed in "toothed" pipefishes. Apparently vestigial in *C. smithi,* these processes are well developed and usually visible under ×30 magnification in subadult and adult congeners.

Smith (1963) considered the smooth or serrate character of bony ridges to be of systematic importance in this genus, but ridges vary from almost smooth to serrate in both *C. brachysoma* and *C. sculptus.* Trunk ring counts show little variation in a number of groups of pipefishes (Herald and Randall, 1972; Dawson, 1974) but this is not so in *Choeroichthys.* The most frequently collected species (*brachysoma* and *sculptus*) exhibit geographic variation in modal trunk ring frequencies but these variations are presently unexplained. I find no other significant intraspecific differences.

KEY TO THE SPECIES OF CHOEROICHTHYS

1. Scutella of trunk and tail keeled (Fig. 9); dorsal fin-rays 27–34; subdorsal rings 6.25–8.25 ....*C. sculptus* (Günther)
   Scutella not keeled (Fig. 3); dorsal fin-rays 17–26; subdorsal rings 3.75–6.0 .... 2.
2. Snout short, its depth less than 3 in length; trunk rings 18–19; dorsal fin bicolored, dark in front and pale posteriad...*C. smithi* n. sp.
   Snout longer, its depth more than 3.5 in length; trunk rings 14–18 (99.6% with 17 or fewer); dorsal fin not bicolored, mainly pale throughout .... 3.
3. Without knoblike projections below lateral ridge on posterior margins of trunk rings; head length averages about 5 in SL; tail rings 17–20 (fewer than 20 in 93% of specimens); sides of trunk plain or with one or two rows of small dark spots; body without bars ....*C. brachysoma* (Bleeker)
   Males (females?) with distinct knoblike projections below lateral ridge on posterior margin of most trunk rings (Fig. 6); head length about 4 in SL; tail rings 20–21; body with dark bars (at least in males) ....*C. cinctus* n. sp.

Choeroichthys brachysoma (Bleeker)

Figures 2 and 3

Syngnathus brachysoma Bleeker, 1855:327 (original description, Batu Archipelago).

Choeroichthys valencienni Kaup, 1856:55, pl. 3 (original description, Isle of Bourbon).

Doryichthys serialis Günther, 1884:30, pl. 3 (original description, Port Molle, Queensland).

Choeroichthys suillus Whitley, 1951:393 (original description, Port Denison, Queensland).

Diagnosis: Scutella not keeled; without knoblike projections below lateral trunk ridge on posterior margins of rings; snout depth more than 3.5 ($\bar{x} = 4.5$) in snout length; head length averages about 5 in SL; rings total 31–37; dark lateral stripe on snout and opercle; with or without rows of dark spots on trunk; body without bars; dorsal fin not bicolored.

Description: Dorsal fin-rays 18–26 ($\bar{x} = 21.4$); rings 14–18 + 17–20 = 31–37; subdorsal rings 2.5–5.5 ($\bar{x} = 3.8$) + 0–1.75 ($\bar{x} = 0.8$) = 3.75–6.0 ($\bar{x} = 4.6$). See Tables 1–4 for additional counts and measurements.

Ridges variously smooth to finely serrate; median dorsal snout ridge low (Fig. 3); lateral snout ridge sublinear, not strongly arched; usually with 2–4 prominent suborbital ridges; other head ornamentation variable; pectoral cover plate with two longitudinal ridges, often additionally ornamented with short low ridges. Trunk and tail ridges deeply notched

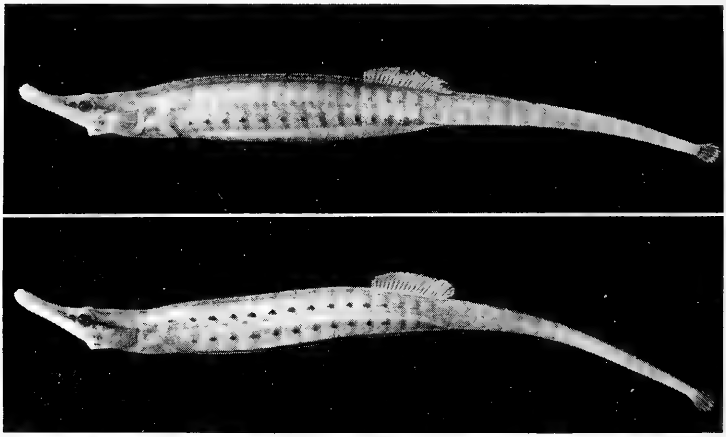


FIG 2. *Choeroichthys brachysoma* (Bleeker). GCRL 13849, Australia. Top: Male, 54 mm SL. Bottom: Female, 52 mm SL.

or but slightly indented between rings; posterior angles of tail rings produced as short pointed spines, merely pointed, or occasionally rounded or truncate. Scutella inconspicuous, without keels; without projecting knobs on rear margins of trunk rings; ring surfaces not strongly depressed between ridges, usually with finely reticulate ornamentation. Odontoid processes distinct in most specimens.

Ground color tan to dark brown; plain, marbled or with faint irregular stripes. Typically with prominent dark stripe on side of snout and across all or most of opercle. Females usually with a row of small dark spots above and below lateral trunk ridge. Most males with upper spots restricted to 1st through 3rd and last 4 or 5 trunk rings, and with complete row of spots below; spots may be obsolete in some males or two complete rows of spots may be present. Trunk of males often margined with dark brown; pigmentation of brood pouch folds usually replicates ground color, but folds covered with rather large dark spots in some Australian specimens (ANSP 113482; GCRL 13861). Dorsal fin immaculate or with faint scattering of brown flecks along rays and fin base; pectoral rays often flecked with brown; caudal fin brownish with pale distal margin.

Smallest examined male with eggs in pouch (29.5 mm SL) contained 24 eggs in two rows of 12. A 51 mm specimen had pouch folds extending along 15 rings with eggs beneath 12; there were two rows, each with 21 eggs in the outer of two layers.

Discussion: Among examined material (Fig. 4, Table 4), modal trunk ring counts of 14 occur only in collections from Singapore, the northern Gulf of Thailand, and in three small lots from Palau. The count is

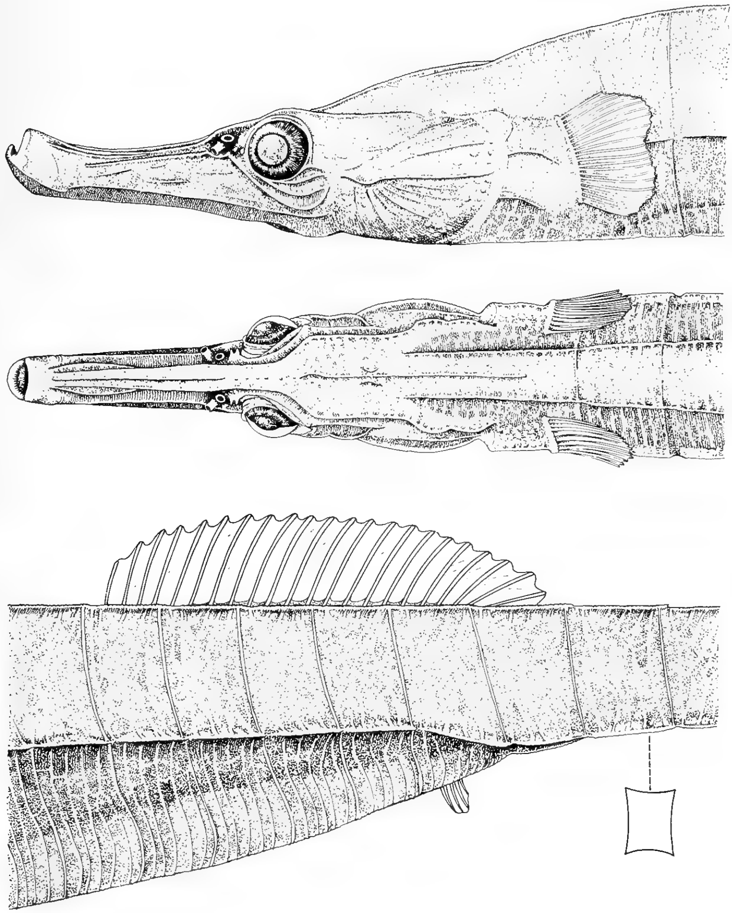


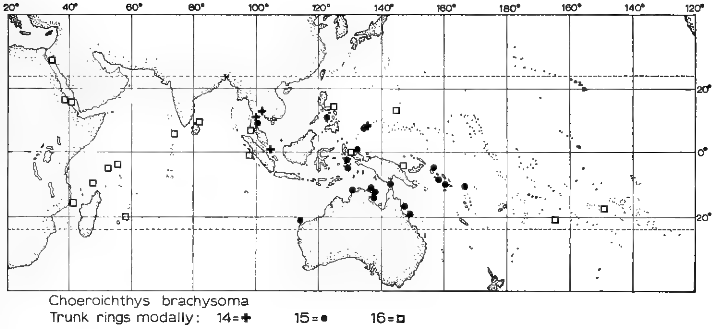
Fig. 3. *Choeroichthys brachysoma.* Top and middle: Lateral and dorsal aspects of head and anterior trunk rings. Bottom: Posterior trunk and anterior tail rings, illustrating ridge pattern, dorsal and anal fins and section through tail ring. From 56 mm SL male, USNM 173706.

modally 15 in Australian, Solomon Island and most other western Pacific samples. Trunk rings are usually 16 throughout the Red Sea-Indian Ocean region and in a number of small collections from the Mariana, Cook and Society islands. Total ring frequency averages 35 in Red Sea-Indian Ocean material and 33 in Pacific collections, but I find no substantial differences in these populations. *Choeroichthys* *brachysoma* exhibits considerable variation in development of head and body ridges and in ground color. I find no consistent trends in character of ridges (e.g. smooth or rough); Australian material is darker than most, but dark specimens are not uncommon elsewhere (Mozambique, Philippines, etc.).

Bleeker's holotype (RMNH 7250) is now completely faded and the snout is damaged. Ridges are rather strongly denticulate and distinctly notched between rings; most tail rings with posterior angles produced as shore spines. This male specimen (ca. 49.5 mm SL) has two suborbital ridges on the left and three on the right side; the empty brood pouch extends beneath 13 trunk rings. See Tables 1, 2 and 4 for additional data.

Kaup (1856:55) reported the holotype of *C. valencienni* from the Isle of Bourbon (Reunion Is.) and also (p. 75) from Ile de France (Mauritius). Data from this specimen are here included under Mauritius (Table 4). The holotype of *Choeroichthys suillus* Whitley was differentiated from *C. brachysoma* by differences in ring counts and coloration, and by the smooth character of the ridges. Whitley (1951) reported 18 + 20 rings, 5 + 1 subdorsal rings, 21 dorsal, 18 pectoral and 5 anal fin-rays. I count 18 + 19 rings, 5 + 0.5 subdorsal rings, 24 dorsal, 21 (2) pectoral and 4 anal fin-rays in this specimen (AMS IA.1806). Although somewhat faded, traces remain of a snout-opercular stripe and diffuse brown blotches persist above the lateral ridge on 6 or 7 anterior trunk rings; no indication remains of ". . . light blotches across back." reported by Whitley. Head and body ridges are largely smooth, head ornamentation is minimal, and ring surfaces are somewhat striate. This specimen falls within known variation of *C. brachysoma* in all measurements and counts except frequencies of trunk and total rings; there is one more trunk ring (two more than in other Australian samples), and the total ring count is higher by one (Table 4). The described pale bars on the dorsum and the dusky trunk blotches are unusual, but the persistent snout-opercular stripe is characteristic of *C. brachysoma.* A similar stripe and barred dorsum also occur in *C. sculptus,* but the keeled scutella of this species are absent in the holotype of *C. suillus.* This nominal species therefore differs from *C. brachysoma* in ring count and surface ornamentation (both variable in *brachysoma*), and in some color markings. Pending collection of additional material I treat the type of *C. suillus* as a variant of *C. brachysoma. Choeroichthys suillus mallus* Whitley (1954) was synonymized with *Doryrhamphus melanopleura* (Bleeker) by Paxton (1975).

Distribution: *Choeroichthys brachysoma* ranges from the Gulf of Aqaba in the Red Sea to the Society Islands (Fig. 4). The species is infrequently collected to the east of the Solomons, and it is largely replaced by *C. sculptus* throughout the tropical central Pacific. Although available data show most specimens as being taken in depths of less than 5 m, there is one SCUBA collection from 21.3–27.4 m in the Seychelles.



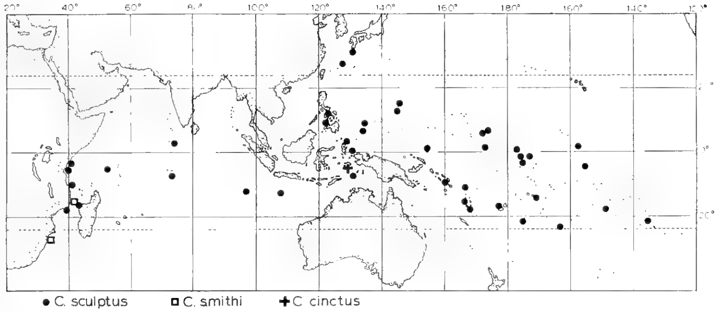


FIG. 4. Distributions of species of *Choeroichthys* as determined from material examined.

Material examined: 286 specimens, 13.5–62.5 mm SL, including holotype: RED SEA: Israel: HUJ E.62-487. Gulf of Aqaba: USNM 214537, 214575, 214578. Ethiopia: HUJ E.62.4025; GCRL 13858; USNM 214532, 214538, 214576, 214579. INDIAN OCEAN: Mozambique: RUSI 3787, 3788, 3790–3792. Aldabra Is.: USNM 214536, 214539. Seychelles: ANSP 108966, 108974–108977, 108986, 108989, 108999, 110039; USNM 214526. Mauritius: BPBM 16301; MNHN 6037 (holotype of *C. valencienni*). Maldive Is.: FMNH 75867. Ceylon: GCRL 13859; USNM 214530, 214531, 214534, 214577, 214580. Thailand: GCRL 13862; USNM 214527. Batu Archipelago: RMNH 7250 (holotype of *Syngnathus brachysoma*). PACIFIC OCEAN: Singapore: *BMNH* 1952.12.16.9–10; CAS-SU 34957, 39417, 39418; FMNH 47186; GCRL 13860. Gulf of Thailand: CAS 32271, 32278, 32279. Philippine Is.: CAS 32273, 32276; USNM 137270, 137272, 214624. Molucca Is.: RMNH 21105; USNM 210655, 210656, 214535. Palau Is.: CAS 32261–32268, 32270, 32272, 32277. New Guinea: CAS-SU 26687; USNM 214533.

Australia, Western Australia, Monte Bello Is.: BMNH 1913.12.6.10. Australia, Northern Territory: AMS IA.4401; GCRL 13849; USNM 173703–173707, 173709. Australia, Queensland: AMS IA.1293, IA.1806 (holotype of *C. suillus*), IA.5731, IA.6187; AMNH 32451–32453; ANSP 113482, 119350; BMNH 1881.10.12.29;82 (two syntypes of *Doryichthys serialis*); GCRL 13861; QM 10858. Mariana Is.: CAS 32274. Solomon Is.: BPBM 16248; CAS 19947, 19950; GCRL 13714; USNM 214528. New Hebrides: CAS 32275. Cook Is.: BPBM 5685, 18611. Society Is.: CAS 32269; FMNH 75876.

Choeroichthys cinctus, new species

Figures 5 and 6

Diagnosis: Scutella not keeled; males (females?) with knoblike projections below lateral ridge on posterior margins of most trunk rings; snout depth more than 3.5 (4.3–5.8) in its length; head length about 4 in SL; tail rings 20–21; males (females?) with dark bars on body; dorsal fin not bicolored.

Description: Dorsal fin-rays 22–25; rings 15 + 20–21 = 35–36; subdorsal rings 3.5 + 1.25–1.5 = 4.75–5.0. Measurements (mm) of holotype follow: standard length 38.0; head length 10.0; snout length 5.8; minimum snout depth 1.0; length of dorsal fin-base 4.0; length of pectoral fin-base 1.1; caudal fin length 1.8; anal ring depth 1.7. See Tables 1–3 for additional data.

Ridges rough, finely denticulate to serrate; median dorsal snout ridge low (Fig. 6); lateral snout ridge sublinear, not strongly arched; usually with one suborbital ridge; opercle more or less waffled by intersecting ridges above and below median longitudinal ridge; pectoral cover plate with some irregular low ridgelike sculpturing and two longitudinal ridges. Trunk and tail ridges distinctly notched between rings; posterior angles of tail rings pointed, produced as short spines in holotype. Posterior margins of all but 1st through 3rd trunk rings with knoblike lateral projections located about midway between lateral ridge and base of pouch protective plates; these are best developed over posterior trunk rings. Scutella inconspicuous, without keels; ring surfaces distinctly depressed between ridges and between anterior and posterior margins, finely ornamented with irregular lines but not striate. Odontoid processes prominent and rather sharply pointed in study material, 8–9 projections on right premaxilla and 6–7 on left dentary of holotype.

Ground color tan to near white. Without distinct stripe on snout or opercle, but with brown preorbital blotch and a larger diffuse blotch dorsolaterally behind eye; underside of lower jaw, dorsum and sides of snout elsewhere shaded with microchromatophores; dorsum of head behind eyes, suborbital, opercle and pectoral cover plate with rather large diffuse spots or blotches. Sides of trunk with prominent series of partial or complete brown bars, each bisected by pale vertical line at juncture of adjacent rings; bars less regular or blotchlike on dorsum

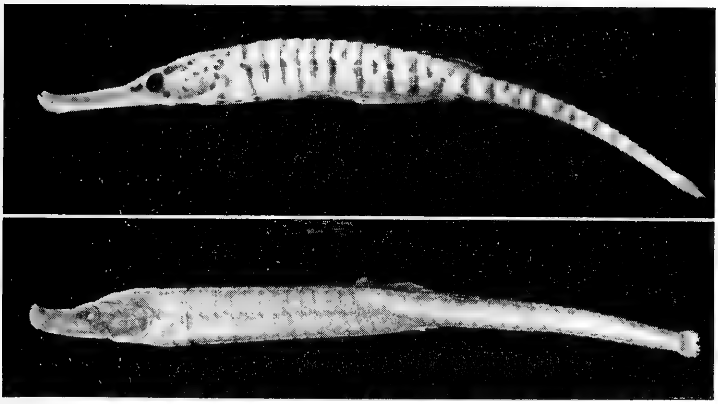


FIG. 5. Top: *Choeroichthys cinctus* n. sp. USNM 214567, holotype, 38 mm SL, male. Bottom: *Choeroichthys smithi* n. sp. RUSI 3744, holotype, 44 mm SL, female.

and on sides and venter of tail; interspaces pale or shaded with chromatophores; lateral trunk ridge and tips of knoblike projections pale; venter of 1st and 2nd trunk rings blotched; one or two diffuse blotches anteriad on brood pouch folds of holotype and one paratype (BPBM 18610), folds otherwise pale; ventral margins of pouch protective plates narrowly lined with brown. Dorsal and pectoral fins with light basal scattering of chromotophores, immaculate elsewhere; caudal fin of one fish (BPBM 18610) with pale base and distal margin and broad brown bar between, fin mainly pale in other material. Dr. J. E. Randall noted life coloration as "pale yellowish with dark brown broken bars."

Brood pouch folds orginate near middle of 3rd trunk ring in one fish (BPBM 18610), at anterior margin in remainder; pouch folds encompass 13 rings in holotype and the pouch contains two rows of three eggs each beneath 10th–13th rings; other specimens without eggs.

Etymology: From the Latin *cinctus,* surround or gird, in allusion to the barred color pattern of preserved males.

Comparisons: Males of *Choeroichthys cinctus* are readily separable from all congeners by their banded coloration and by the projecting knobs on lower sides of trunk. It is problematical whether this color pattern is replicated in females, but I expect the lateral projections to be present in both sexes. This species lacks the keeled scutella of *C. sculptus,* lacks the bicolored dorsal fin of *C. smithi,* and has fewer trunk rings than either (15 against 18 or more in *sculptus* and *smithi*). The slender snout and sublinear lateral snout ridge suggest closer relationship to *C. brachysoma.* Head length is apparently somewhat longer in *C. cinctus* (averaging 3.5 in SL against 5.0 in *brachysoma*), and tail ring counts (20–21) exceed those of most examined [illegible].

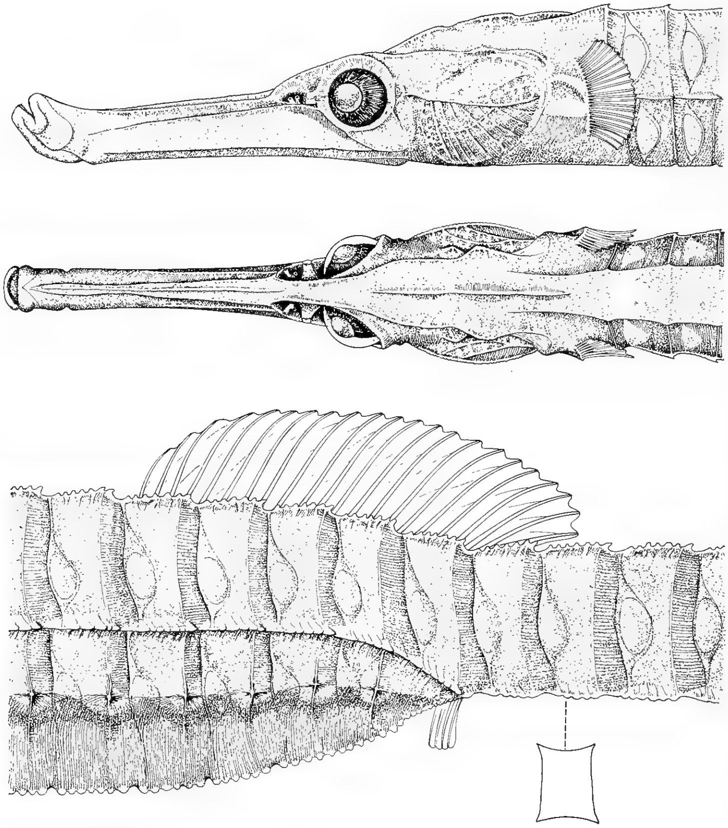


Fig. 6. *Choeroichthys cinctus.* Top and middle: Lateral and dorsal aspects of head and anterior trunk rings. Bottom: Posterior trunk and anterior tail rings, illustrating ridge pattern, dorsal and anal fins and section through tail. From 36 mm SL male paratype, USNM 210061. Note blunt projections ("knobs") between lateral trunk ridge and ventral margin of trunk.

brachysoma (among 180 brachysoma from Pacific collections only 4 had more than 19 tail rings).

Distribution: *Choeroichthys cinctus* is known only from the Moluccas (Fig. 4) where it is sympatric with both *C. brachysoma* and *C. sculptus.* This species is known only from SCUBA collections within a 11–36.5 m depth range.

Material examined: Holotype: USNM 214567 (38.0 mm SL, male), Indonesia, Molluca Is., Namalatu, Latuhalat Is., ca. 03°47′S, 128°06′E, ca. 150 m offshore, 11–18.3 m, 14 Mar. 1974, VGS 74–13. Paratypes: USNM 210061 (36.5 mm SL, male), Saparua, 13.7–16.8 m. BPBM 18610 (36.5 mm SL, male), Latuhalat Is., 36.5 m.

Choeroichthys smithi, new species

Figures 5 and 7

? *Choeroichthys* n. sp. Smith, 1951:53 (Delagoa Bay).

Choeroichthys valencienni (not of Kaup) Gabie, 1960:73, pl. 17 (misidentification, Mozambique).

Choeroichthys suillus (not of Whitley) Smith, 1963:529, pl. 78 (misidentification; Mozambique, Zanzibar ?). Smith, M. M., 1975:29 (common name: shortfin pipefish).

Diagnosis: Scutella not keeled; without distinct knoblike projections below lateral ridge; snout depth less than 3.0 ($\bar{x} = 2.3$) in length; trunk rings 18–19; rings total 36–40; without distinctive markings on head or body; dorsal fin bicolored.

Description: Dorsal fin-rays 17–21 ($\bar{x} = 19.4$); rings 18–19 + 18–21 = 36–40; subdorsal rings 3.25–4.5 ($\bar{x} = 4.0$) + 0–1.25 ($\bar{x} = 0.6$) = 3.75–5.25 ($\bar{x} = 4.5$). Measurements (mm) of holotype follow: standard length 44.0; head length 8.0; snout length 3.4; minimum snout depth 1.5; length of dorsal fin-base 4.2; pectoral fin length 1.6; length of pectoral fin-base 1.4; caudal fin length 1.5; anal ring depth 2.5. See Tables 1–3 for additional data.

Ridges smooth; median dorsal snout ridge elevated posteriorly, usually obsolete anteriad (Fig 7); lateral snout ridge distinctly arched; suborbital ridge present or obsolete; head not highly ornamented with lines or low ridges; pectoral cover plate with two principal ridges, otherwise mainly smooth. Trunk ridges notched or merely indented between rings, tail ridges distinctly notched; posterior angles of tail rings pointed but not produced as short spines. Scutella inconspicuous, without keels; vestiges of low projections occasionally present below lateral ridge on rear margin of some trunk rings, not produced as "knobs"; ring surfaces not distinctly depressed between ridges, ornamented with fine irregular lines but not striate. Odontoid processes reduced to minute projections, not readily visible under ×30 magnification; four projections on premaxilla and one or two on dentary of one dissected specimen.

Ground color tan to dark brown. Holotype with faint irregular streaks of darker brown on dorsum of head and all ring surfaces; without trace of stripe on snout or opercle and without distinctive markings on trunk or tail. Dorsal fin distinctly bicolored in all undamaged specimens, anterior portion brown with pale distal margin, pigmentation reduced posteriad to a continuous brown band along proximal third or fourth of fin, postero-distal portion of fin immaculate. Caudal fin brownish with pale distal margin.

A 40 mm SL male (USNM 214566) has brood pouch folds originat-

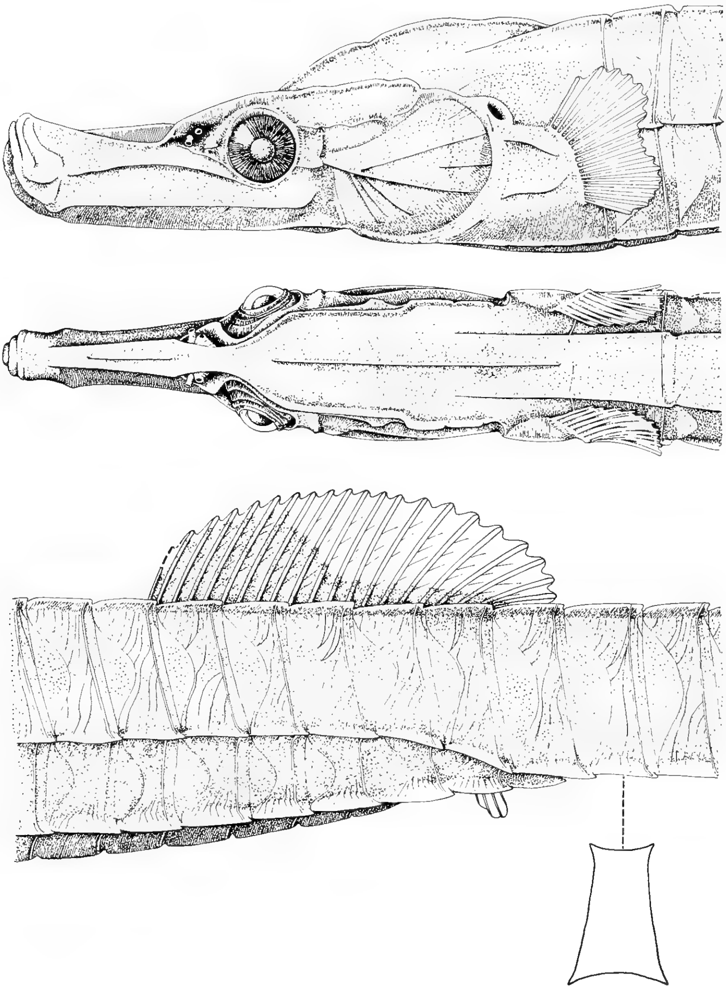


FIG. 7. *Choeroichthys smithi.* Top and middle: Lateral and dorsal aspects of head and anterior trunk rings. Bottom: Posterior trunk and anterior tail rings, illustrating ridge pattern, dorsal and anal fins and section through tail ring. From 44 mm SL holotype, RUSI 3744.

ing at anterior margin of 3rd trunk ring and once contained two rows of about 19 eggs each in a single layer (eggs now mostly lost). The smallest examined male with eggs in pouch was 36.5 MM SL (RUSI 3775).

Etymology: Named in memory of the late Dr. J. L. B. Smith, collector of the present material.

Comparisons: The rather deep snout and distinctly arched lateral snout ridge of *Choeroichthys smithi* are very similar to those of *C. sculptus.* These species are, however, clearly separated by the keeled scutella of the latter (not keeled in *smithi*), coloration and by a number of meristic differences (Tables 1–3). Remaining congeners have slender snouts, linear lateral snout ridges and essentially unmarked dorsal fins (snout deep, ridge arched, fin bicolored in *smithi*). Meristic characters in these forms overlap to some extent, but total ring counts of *C. smithi* are greater than those of 92% of examined *C. brachysoma* and complete separation from *C. cinctus* is indicated by trunk ring counts (18–19 against 15 in *cinctus*).

Discussion: Smith (1963) apparently identified this material as *Choeroichthys suillus* Whitley on the basis of trunk ring counts and smooth character of head and body ridges. Compared with the holotype of *C. suillus*, this species has a deeper snout, arched rather than linear lateral snout ridge, fewer dorsal fin-rays (17–21 against 24), lacks the snout-opercular stripe and the dorsal fin is bicolored (stripe present, dorsal fin immaculate in holotype of *suillus.*

Attempts to locate the collection reported by Gabie (1960) have been unsuccessful, but the deep snout with arched lateral ridge, trunk ridge configuration and number of trunk rings (18 or 19) clearly refer the figured specimens to *C. smithi.*

Distribution: *Choeroichthys smithi* is known only from the coast of Mozambique (Fig. 4) where it is sympatric with both *C. brachysoma* and *C. sculptus.* There are no data on habitat or depth of capture. Specimens reported from Delagoa Bay and Zanzibar (Smith, 1951, 1963) were not available for study and their identity is uncertain.

Material examined: Holotype and 12 paratypes, 26.5–47.5 mm SL. Holotype: RUSI 3744 (44.0 mm SL, female), Mozambique, Inhaca, ca. 1951, J. L. B. Smith. Paratypes: RUSI 3775 (8 specimens); GCRL 13848 (1); USNM 214566 (2), Pinda. RUSI 4238 (1), probably Pinda.

Choeroichthys sculptus (Günther)

Figures 8 and 9

Doryichthys sculptus Günther, 1870:185 (original description, Fiji Is.).

Doryrhamphus macgregori Jordan and Richardson, 1908:246, fig. (original description, Philippine Is.).

Microphis ocellatus Snyder, 1909:598 (original description, Tanegashima Is.).

Diagnosis: Scutella keeled; without knoblike projections below lateral ridge on posterior margins of trunk rings; snout rather short, its depth 3.5 or less in length ($\bar{x} = 2.7$); rings total 40–45; sides of trunk usually

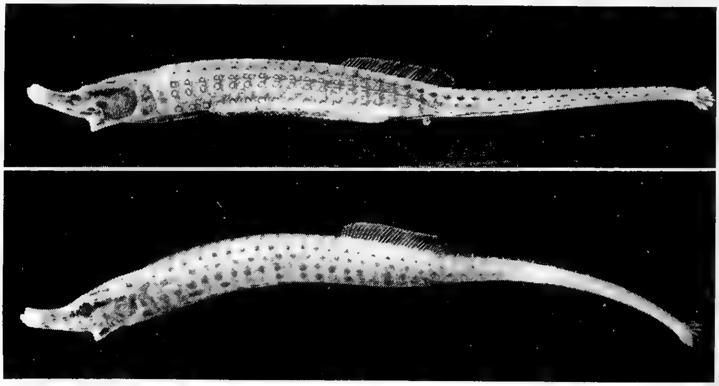


FIG. 8. *Choeroichthys sculptus* (Günther) GCRL 13817, Phoenix Is. Top: Male, 62 mm SL. Bottom: Female, 60 mm SL.

with 4 rows of dark spots or ocelli; trunk without bars; dorsal fin not bicolored.

Description: Dorsal fin-rays 27–34 ($\bar{x} = 30.6$); rings 18–21 + 21–25 = 40–44; dorsal fin on 4.0–7.25 ($\bar{x} = 5.7$) trunk and 0.5–2.5 ($\bar{x} = 1.6$) tail rings; subdorsal rings total 6.25–8.25 ($\bar{x} = 7.3$). See Tables 1–3 and 5 for additional data.

Ridges smooth to finely denticulate, infrequently serrate; median dorsal snout ridge (Fig. 9) low, somewhat elevated behind, sometimes obsolete anteriad; lateral snout ridge arched; usually with one or two short suborbital ridges; other head ornamentation variable; pectoral cover plate with irregular low ridges or surface sculpture in addition to two principal longitudinal ridges. Trunk and tail ridges typically notched between rings; posterior angles of tail rings pointed but usually not produced as short spines. Scutella conspicuous, each with projecting ridge or keel so that trunk appears to have three lateral ridges between dorsal and ventral margins, and tail appears to have a median lateral ridge; similar keels present on dorsum and on venter of tail; keels on successive lateral tail scutella separate in young, often subcontinuous in large specimens; keels often with slight notch near middle of ring. Without knoblike projections on rear margins of trunk rings; ring surfaces not depressed between ridges, ornamented with irregular lines or ridges but not striate. Odontoid processes (Fig. 1) usually conspicuous under magnification, premaxillary projections rather bluntly pointed.

Ground color light tan to dark brown. Usually with diffuse dark blotch over nares and preorbital and with dark stripe on upper portion of opercle; often with narrow postorbital stripes on dorsum of head; venter of snout pale, head irregularly blotched elsewhere. Dorsum of trunk and tail plain or with irregular small dark spots and streaks;

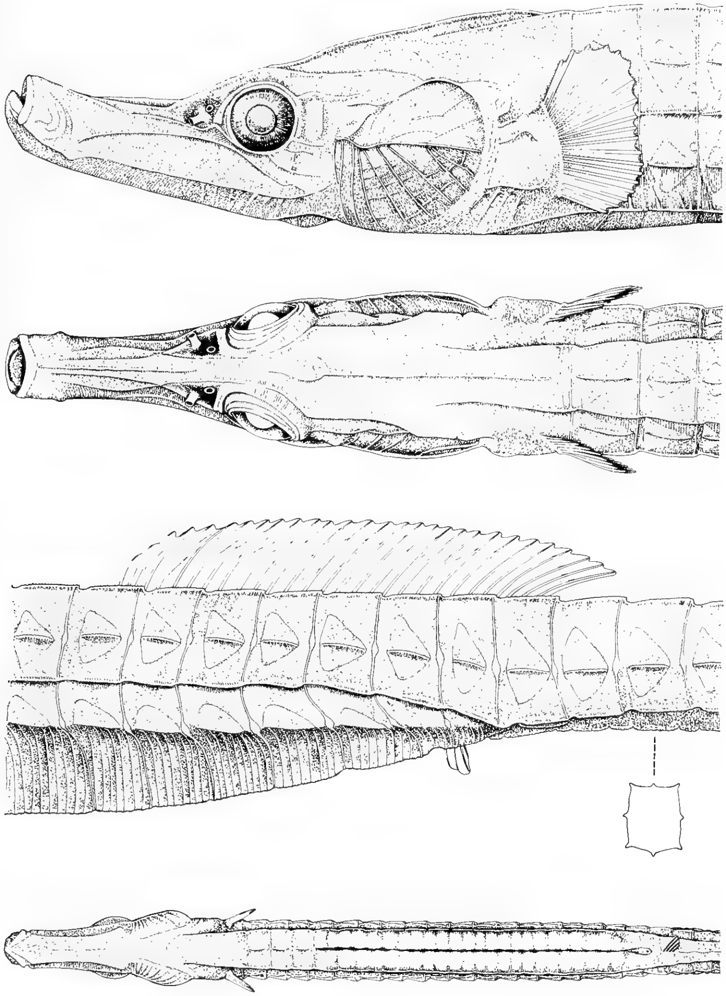


Fig. 9. *Choeroichthys sculptus.* Top to bottom: Lateral and dorsal aspects of head and anterior trunk rings. Posterior trunk and anterior tail rings, illustrating ridge pattern, dorsal and anal fins and section through tail ring (from 53 mm SL male, GCRL 13195). Ventral aspect of trunk of mature male, illustrating brood pouch configuration and arrangement of eggs (54 mm SL, GCRL 13817).

dorsum of dark specimens often with pale bars (subequal to ring length), about 4 on trunk and 4–5 on tail. Males with or without row of dark spots (one per ring) between superior trunk ridge and keels of dorsolateral scutella; typically with three similar rows of larger dark-margined ocelli on remainder of trunk, one above lateral trunk ridge and two below; sides of tail usually with one or two rows of dark spots; pigmentation of brood pouch folds replicates ground color. Females and juveniles lack ocelli; trunk usually with four rows of dark spots or blotches on sides and two rows on venter; spots in one or two rows on sides of tail, often in single row on venter of some tail rings. Dorsal and pectoral fins mainly pale; caudal fin pale or brownish with pale distal margin.

Smallest male examined with brood pouch eggs was 46 mm SL and developing pouch folds were noted in 40–45 mm fish. A 50 mm specimen had pouch folds originating on 4th trunk ring and contained a single two-rowed layer of 29 eggs beneath 14 rings; a 70.5 mm fish contained a total of 68 eggs in two rows.

Discussion: This is a very distinctive form, readily separable from all congeners by the keeled scutella. Among examined material (Fig. 4, Table 5), trunk ring counts are modally 20 in collections along and near the east African coast; trunk rings are modally 19 in the Chagos Archipelago and eastward throughout the Indo-Pacific region. Tail ring counts are somewhat more variable in Pacific material, but total ring frequencies are similar in Indian Ocean and Pacific samples. East African fish are usually brown, whereas pale ground coloration is rather common in other areas.

Syntypes consist of single male and female specimens. The male (50 mm SL), in rather poor condition, retains no trace of brood pouch folds and I select the 53 mm SL female (BMNH 1858.12.27.106) as the lectotype of *Doryichthys sculptus*. Measurements (mm) follow: head length 9.4; snout length 4.4; minimum snout depth 1.4; length of dorsal fin-base 6.7; anal ring depth 2.4; there are at least 14 odontoid processes on the upper jaw and 18 on the lower (See Tables 1, 2 and 5 for meristic data).

Distribution: *Choeroichthys sculptus* ranges from Kenya and Mozambique to Makatea Is. in the Tuamotu Archipelago (Fig. 4). Smith's (1963) citation of a Red Sea record by Günther (1870) is incorrect, since only Fiji Island material was mentioned. With the exception of Duncker's (1915) questionable record ["Ostafrika, Abessinien (Mus. Calcutta)"], the species is unknown from the Red Sea. *Choeroichthys sculptus* has not occurred in collections from Ceylon, Malay Peninsula, western Indonesia or Australia and it is apparently replaced in these areas by *C. brachysoma*. Bathymetric data are limited but I have seen no collection records from depths greater than 2.4 m.

Material examined: 301 specimens, 35.0–79.5 mm SL, including lectotype and paralectotype. INDIAN OCEAN: Kenya: RUSI 3780, 3782, 3785. Latham Is.: USNM 214529. Mozambique: RUSI 3776–3779, 3781,

TABLE 1. Frequency distributions of trunk, tail and total rings in species of *Choeroichthys.*

	Species			
	brachysoma	*cinctus*	*smithi*	*sculptus*
Trunk Rings				
14	34			
15	142	3*		
16	75*			
17	4			
18	1		8*	9
19			3	230*
20				46
21				4
Tail Rings				
17	19			
18	123*		2	
19	96		1	
20	18	2*	4	
21		1	4*	56
22				134
23				70
24				23*
25				6
Total Rings				
31	4			
32	33			
33	99			
34	52*			
35	49	2*		
36	18	1	2	
37	1		1	
38			3	
39			3*	
40			2	45
41				121
42				87
43				32*
44				4
x̄	33.6	35.3	38.2	41.4

* Primary type.

TABLE 2. Frequency distributions of dorsal fin-rays, pectoral fin-rays and total subdorsal rings in species of *Choeroichthys.*

	Species			
	brachysoma	*cinctus*	*smithi*	*sculptus*
Dorsal fin-rays				
17			1	
18	1		2	
19	8		1	
20	43		2	
21	106*		3*	
22	83	1		
23	24	1		
24	6			
25	2	1*		
26	1			
27				4
28				10*
29				41
30				72
31				70
32				53
33				22
34				2
$\bar{x}$	21.4	23.3	19.4	30.6
Pectoral fin-rays				
18	17		1	2
19	65		7*	18
20	100		2	97*
21	33*	3	1	129
22	10	3*		16
23	1			1
$\bar{x}$	19.8	21.5	19.3	20.5
Total subdorsal rings				
3.75	4		2	
4.00	21			
4.25	56		2	
4.50	81		3	
4.75	65	1*	4*	

* Primary type.

TABLE 2. (cont.)

	Species			
	brachysoma	*cinctus*	*smithi*	*sculptus*
5.00	38*	2	1	
5.25	10		1	
5.50	4			
5.75	1			
6.00	2			
6.25				6
6.50				16*
6.75				29
7.00				55
7.25				66
7.50				65
7.75				43
8.00				17
8.25				2
x̄	4.6	4.9	4.5	7.3

3783, 3784, 3786. Madagascar: UMMZ 186037. Amirante Is.: ANSP 108998. Chagos Archipelago: USNM 214439, 214441, 214450. Maldive Is.: FMNH 75866. Cocos-Keeling Is.: ANSP 128424, 128427, 128432; GCRL 13181. Christmas Is.: WAM 21084, 21085. PACIFIC OCEAN: Philippine Is.: CAS 32286, 32288, 32289, 33307, 33308; CAS-SU 20202 (holotype of *Doryrhamphus macgregori*); USNM 137271. Ryukyu Is.: USNM 62946, 74536 and CAS-SU 21133 (holotype and two paratypes of *Microphis ocellatus*); USNM 214442. Molucca Is.: AMS IB.2022; BPBM 18533. New Guinea: CAS-SU 26688. Palau Is.: CAS 32283; USNM 154637. Mariana Is.: ANSP 114272; CAS 32282. Solomon Is.: CAS 24177. New Hebrides: AMS IA.783, I.6421-4, I.6573; BPBM 10741; CAS 19445, 32285; CAS-SU 25081; FMNH 21081, 21082. Marshall Is.: FMNH 42867; LACM 7329; USNM 166816. Gilbert Is.: MCZ 35302. Fiji Is.: ANSP 101339; BMNH 1858.12.27.106 (lectotype of *Doryichthys sculptus*), 1858.12.27.107 (paralectotype); CAS–SU 24837, 24896; FMNH 21076–21080; GCRL 13195. Phoenix Is.: GCRL 13816, 13817; USNM 116096, 116097, 214440, 214443–214446, 214449. Tonga Is.: BPBM 10762. Samoa Is.: USNM 116094, 116095, 116098. Cook Is.: AMS IA.5374; BPBM 17677. Line Is.: ANSP 75797; USNM 214448. Society Is.: CAS 32280; MCZ 11734; USNM 214447.

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TABLE 3. Measurements (mm), mean ($\bar{x}$), standard error of mean (s), standard deviation (ó), regression equation and coefficient of correlation (r) for selected characters in species of *Choeroichthys.* Head length (y) against standard length (x); in remaining regressions, head length is the x-variate. Correlation coefficients significant at $p = .01$.

Species	Character	N	Range	$\bar{x}$	s	σ	Regression equation	r
brachysoma	Standard length	198	13.5–62.5	44.9	0.58	8.15		
	Head length	198	4.0–11.9	9.0	0.08	1.19	$y = 3.169 + 0.130x$	0.889
	Snout length	198	1.8– 7.7	4.5	0.05	0.74	$y = 0.919 + 0.596x$	0.954
	Length of dorsal fin-base	194	1.9– 6.8	4.6	0.07	0.95	$y = -1.272 + 0.657x$	0.819
sculptus	Standard length	182	35.0–79.5	53.6	0.62	8.35		
	Head length	182	7.0–12.2	9.2	0.07	0.93	$y = 3.894 + 0.098x$	0.878
	Snout length	182	3.0– 5.7	4.1	0.04	0.49	$y = -0.344 + 0.482x$	0.914
	Length of dorsal fin-base	182	5.0–13.1	7.9	0.11	1.49	$y = -1.892 + 1.069x$	0.670
smithi	Standard length	11	26.5–47.5	37.4	1.68	5.56		
	Head length	11	5.9– 9.0	7.2	0.24	0.81	$y = 1.898 + 0.142x$	0.977
	Snout length	11	2.5– 3.8	3.1	0.11	0.36	$y = 0.005 + 0.430x$	0.942
	Length of dorsal fin-base	11	2.6– 5.3	3.6	0.22	0.73	$y = -2.488 + 0.850x$	0.941
cinctus	Standard length	3	36.5–38.0					
	Head length	3	9.3–10.0					
	Snout length	3	5.1– 5.8					
	Length of dorsal fin-base	3	3.4– 4.0					

TABLE 4. Frequency distributions of trunk, tail and total rings in populations of *Choeroichthys brachysoma.*

	Trunk rings					Tail rings				Total rings						
Locality	14	15	16	17	18	17	18	19	20	31	32	33	34	35	36	37
Red Sea																
Israel		2	2				1	3					3	1		
Ethiopia			14	3			4	10	3				3	9	5	
Indian Ocean																
Mozambique		2	12				1	12	1				3	10	1	
Aldabra Is.			3				1	1	1				1	1	1	
Seychelles Is. ‡			16				5	11					5	11		
Mauritius			3				1	2					1	2		
Maldive Is.			4					1	3					1	3	
Ceylon		1	9					5	5					6	4	
Thailand			3					2	1					2	1	
Batu Arch.			1*				1*						1*			
Australia		1					1					1				
Pacific Ocean																
Singapore	20	1				2	12	7		2	12	6	1			
Gulf of Thailand	2	1					2		1		1	1	1			
Philippine Is.		4	1				3	1	1			3	1	1		

* Holotype of *C. brachysoma.*
‡ Including Amirante Is.

TABLE 4. (cont.)

Locality	Trunk rings					Total rings				Tail rings						
	14	15	16	17	18	17	18	19	20	31	32	33	34	35	36	37
Moluccas Is.		4	1				3	2				2		3		
Palau Is.	6	11				5	10	2		2	6	8	1			
New Guinea		1	1				1	1					2			
Australia	5	103	1		1†	11	68	31†			13	68	28			1†
Mariana Is.			1						1						1	
Solomon Is.	1	10				1	8	2			1	9	1			
New Hebrides		1					1					1				
Cook Is.			1	1				2						1	1	
Society Is.			2					1	1					1	1	

† Holotype of *C. suillus.*

TABLE 5. Frequency distributions of trunk, tail and total rings in populations of *Choeroichthys sculptus.*

	Trunk rings				Tail rings					Total rings				
Locality	18	19	20	21	21	22	23	24	25	40	41	42	43	44
Indian Ocean														
Kenya			3			2	1					2	1	
Latham Is.			1			1						1		
Mozambique		1	28	4	8	20	5			1	5	20	7	
Madagascar			1			1						1		
Amirante Is.			2		1	1					1	1		
Chagos Arch.	1	10	1		4	8				4	8			
Maldive Is.		1			1					1				
Cocos-Keeling Is.		12				11	1				11	1		
Christmas Is.		2			2					2				
Pacific Ocean														
Philippine Is.	1	8	1		1	8	1			1	8	1		
Ryukyu Is.		2	1		2		1			1	1	1		
Moluccas Is.	1	1				1	1				2			
New Guinea		2			2					2				
Palau Is.		3			1	2				1	2			
Mariana Is.		22			2	13	5	1	1	2	13	5	1	1
Caroline Is.		2				2					2			
Solomon Is.		1				1					1			
New Hebrides	1	40	3		10	12	19	3		8	15	17	4	
Marshall Is.	1	2				3				1	2			
Gilbert Is.			1		1						1			
Fiji Is.	1	17*				1	12	5*			2	11	5*	
Phoenix Is.	3	61	2		17	28	6	12	3	17	28	7	11	3
Tonga Is.		2			1		1			1		1		
Samoa Is.		33	1		1	16	15	2		1	15	16	2	
Cook Is.		2			1	1				1	1			
Line Is.		3	1		1		1		2	1	1	1	1	
Society Is.		2				1	1				1	1		
Tuamotu Arch.		1				1					1			

* Lectotype.

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PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

NEW SPECIES OF *APOCHTHONIUS*, MAINLY FROM CAVES IN CENTRAL AND EASTERN UNITED STATES (PSEUDOSCORPIONIDA, CHTHONIIDAE)

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Since my earlier publication on cave species of *Apochthonius* (Muchmore, 1967), many interesting specimens belonging to this genus have been collected, another species has been described (Benedict and Malcolm, 1973), and the genus has been given a firmer base by the redescription of the type species, *Apochthonius moestus* (Banks) (Muchmore and Benedict, 1976). Though there is still very little knowledge about the common epigean forms of *Apochthonius* in the eastern United States, lack of time prohibits a comprehensive treatment of the genus now. However, it does seem worthwhile to describe several new cave-associated species, which will improve our understanding of the cavernicolous fauna. Types of the new species are desposited in the Florida State Collection of Arthropods in Gainesville, Florida.

Family Chthoniidae Hansen
Genus *Apochthonius* Chamberlin

The diagnostic characters of this genus are presented at length by Muchmore and Benedict (1976).

Apochthonius titanicus, new species
Figures 1–3

Material: Holotype male (WM 1383.01001) and two paratype tritonymphs found under a bit of paper near "The Titans" in Blanchard Springs Caverns, three miles east of Fifty Six, Stone County, Arkansas, 27 September 1967 (Thomas C. Barr, Jr. and Terry Marsh).

Diagnosis: A large species of *Apochthonius*, with only two eyes and attenuated appendages; generally similar to *A. malheuri* Benedict and Malcolm (1973), but with only eight setae, rather than ten, at anterior margin of carapace. Of similar size and proportions to *A. typhlus* Muchmore (1967), but with two eyes rather than none.

Description of holotype male: With the general features of the genus (see Muchmore and Benedict, 1975). All sclerotized parts light tan. Carapace about as long as broad, distinctly narrowed posteriorly; with small denticulate epistome; two indistinct eyes, about two ocular diameters from anterior margin; chaetotaxy 8-4-4-2-4 = 22. Abdomen typical; tergal chaetotaxy 4:4:6:6:6:8:8:9:8:6:1T2T1:0; sternal chaetotaxy 13:[4-4]:(4)$\frac{8\text{-}7}{4\text{-}4}$(4):(4)6(4):13:13:13:12:11:T2T2T2T:0:2. Coxal chaetotaxy 2-2-1:3-0-CS:3(2)-2(3):2-3:2-3; each coxa I with three spinelike setae of the usual kind, the anterior and posterior bases on each side with long prominent spurs, the middle base poorly developed and without a spur (Fig. 1); no intercoxal tubercle.

Chelicera 0.88 as long as carapace; hand with seven setae; fixed finger with 12 marginal teeth, and movable finger with five, including one isolated subterminally; spinneret a barely discernible elevation of the finger margin; serrula exterior with 18 blades; flagellum of eight pinnate setate.

Palp relatively large and slender (Fig. 2); femur 1.25 and chela 1.90 times as long as carapace; trochanter 1.9, femur 5.7, tibia 2.2, and chela 5.9 times as long as broad; movable finger 2.04 times as long as hand. Trichobothria typical, as in Fig. 3. Fixed finger with 98 and movable finger with 77 contiguous, marginal teeth evenly graded in size with none conspicuously larger than adjacent ones. Movable finger with rounded sensillum on external surface, closer to *st* than to *sb*.

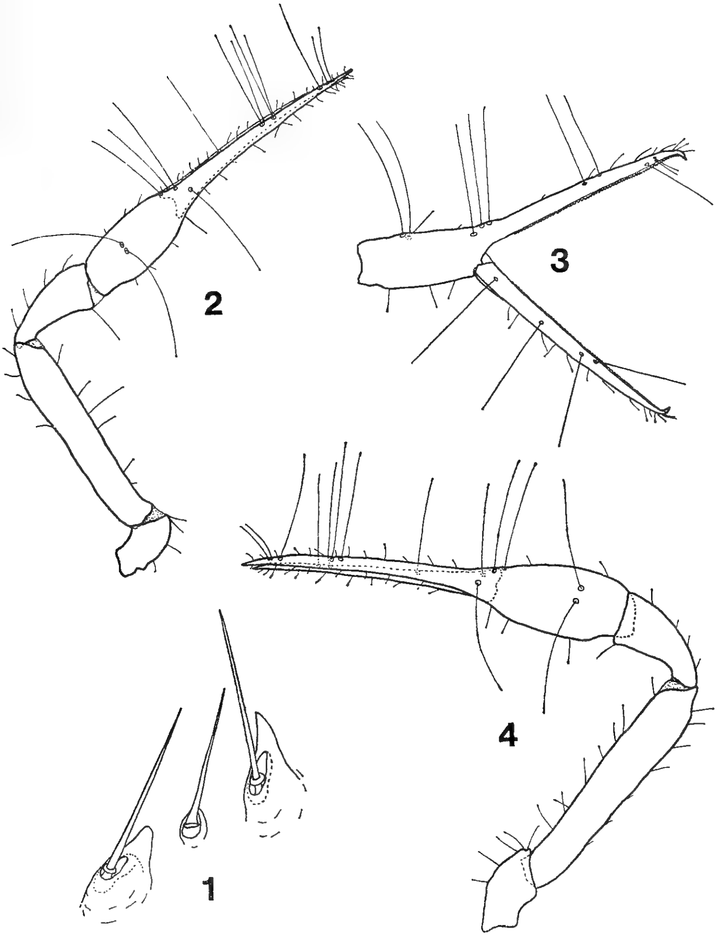
Legs slender; leg IV with entire femur 3.3 and tibia 5.0 times as long as deep. Tactile setae on tibia and both tarsi of leg IV.

Female: Unknown.

Tritonymph: Much like adult but smaller and paler. Carapacial chaetotaxy 8-4-4-2-4 = 22. Coxal chaetotaxy 2-2-1:3-0-CS:2-2:1-3:1-3; each coxa I with two spinelike setae, each base with a long prominent spur. Sternal chaetotaxy 4:(1)6(1):(1)6(1):9:10:10:11:11:T1T1T1T:0:2. Hand of chelicera with six setae; flagellum of seven pinnate setae; spinneret a distinct, low elevation. Fixed finger of palpal chela with about 83 and movable finger with about 67 contiguous marginal teeth, none of unusual size or proportions.

Measurements (mm): Holotype male: Body length 2.01. Carapace length 0.59. Chelicera 0.525 by 0.23. Palpal trochanter 0.245 by 0.13; femur 0.74 by 0.13; tibia 0.355 by 0.16; chela 1.12 by 0.19; hand 0.385 by 0.185; movable finger 0.785 long. Leg IV: entire femur 0.615 by 0.185; tibia 0.45 by 0.09; metatarsus 0.23 by 0.065; telotarsus 0.41 by 0.05.

Tritonymph: Body length 1.56–1.62. Carapace length 0.445–0.46.



Figs. 1–3. *Apochthonius titanicus*, new species. 1, Coxal spines on left coxa I; 2, Dorsal view of left palp; 3, Lateral view of right chela.

Fig. 4. *Apochthonius mysterius*, new species. Dorsal view of right palp.

Chelicera 0.40–0.445 long. Palpal femur 0.53 by 0.105–0.11; tibia 0.265–0.27 by 0.13–0.14; chela 0.835–0.86 by 0.14–0.15; hand 0.29 by 0.15–0.155; movable finger 0.555–0.57 long.

Etymology: The species is named *titanicus* for the large stalagmites, "The Titans," near which the specimens were found in Blanchard Springs Cave.

Apochthonius mysterius, new species

Figure 4

Material: Holotype female (WM 2932.01001) found in the Red Fork Passage of Mystery Cave, about 5 miles SE of Perryville, Perry County, Missouri, 5 November 1972 (Jerry J. Lewis).

Diagnosis: A large, eyeless form with attenuated appendages; similar to *A. typhlus* Muchmore (1967), but with fewer setae on abdominal tergites, nine rather than eight setae in cheliceral flagellum, and more slender palpal femur.

Description of holotype female: With the general features of the genus. All sclerotized parts light brown. Carapace about as long as broad; with small, denticulate, quadrangular epistome; no trace of eyes; chaetotaxy 8-4-5-2-4 = 23. Abdomen typical; tergal chaetotaxy 2:4:4:6:7:7:8:8:7:7:T2T:0; sternal chaetotaxy 7:(4)6(3):(4)6(4):11: 9:12:11:10:T1T1T1T:0:2. Coxal chaetotaxy 2-3-0:2-1-CS:2-2:2-3:2-3; each coxa I with three spinelike setae of the usual kind, all their bases with long, prominent spurs; no intercoxal tubercle.

Chelicera 1.03 times as long as carapace; hand with seven setae; fixed finger with about 16 teeth; movable finger with about 11 very small, worn teeth, without an isolated subterminal tooth; spinneret a small elevation; serrula exterior with 19 blades; flagellum of nine pinnate setae, the posterior one much shorter than the others.

Palps large and slender (Fig. 4); femur 1.35 and chela 2.10 times as long as carapace; trochanter 2.1, femur 5.65, tibia 2.1, and chela 5.65 times as long as broad; movable finger 2.08 times as long as hand. Trichobothria in typical positions. Fixed chelal finger with 110 and movable finger with about 90 (tip broken) contiguous, marginal teeth, evenly graded in size; movable finger with a sensillum composed of two contiguous sense pits between trichobothria *st* and *sb*, but nearer the former.

Legs rather slender; leg IV with entire femur 2.95 and tibia 5.1 times as long as deep. Tactile setae of usual kind on tibia and tarsi of leg IV.

Male: Unknown.

Measurements (*mm*): Body length 2.0. Carapace length 0.63. Chelicera 0.65 by 0.30. Palpal trochanter 0.325 by 0.155; femur 0.85 by 0.15; tibia 0.39 by 0.185; chela 1.325 by 0.235; hand 0.445 by 0.235; movable finger about 0.925 long. Leg IV: entire femur 0.68 by 0.23; tibia 0.51 by 0.10; metatarsus 0.245 by 0.075; telotarsus 0.465 by 0.055.

Etymology: The species is named for Mystery Cave, where it is found.

Apochthonius russelli, new species

Figure 5

Material: Holotype female (WM 1289.01001) found in the Pig Entrance of Russell Cave, Russell Cave National Monument, Jackson

County, Alabama, 17 August 1967 (S. B. Peck and A. Fiske); one paratype tritonymph from Reece Cave, four miles ESE Stevenson, Jackson County, Alabama, 3 August 1967 (S. B. Peck and A. Fiske).

Diagnosis: A moderate sized species of *Apochthonius* having only two eyes, eight setae at anterior margin of carapace, and slightly attenuated appendages compared to A. *moestus* (See Muchmore and Benedict, 1976).

Description of holotype female: With the general characters of the genus. All sclerotized parts light brown. Carapace about as long as broad, narrowed posteriorly; with a small, spinous epistome; two eyes present, small and with flat corneas; chaetotaxy 8-4-4-2-4 = 22. Abdomen typical: tergal chaetotaxy 4:4:6:6:6:8:9:8:9:6:1T2T1:0; sternal chaetotaxy 7:(3)7(3):(4)7(3):12:11:11:10:12:T1T2T2T:0:2. Coxal chaetotaxy 2-1(2)-1:2-0-CS:2-2:2-3:2(1)-3; each coxa I with three spinelike setae of the usual kind, all their bases having long, prominent spurs; no intercoxal tubercle.

Chelicera 0.98 as long as carapace; hand with seven setae; fixed finger with 14 teeth and movable finger with nine teeth, including one isolated subterminally; spinneret a very low elevation of finger margin; flagellum of eight pinnate setae.

Palps moderately elongate (Fig. 5); femur 1.15 and chela 1.77 times as long as carapace; trochanter 1.7, femur 4.6, tibia 1.85, and chela 4.7 times as long as broad; movable finger 1.98 times as long as hand. Trichobothria typical in arrangement. Fixed finger with 80 and movable finger with 72 contiguous, marginal teeth, evenly graded in size and shape; movable finger with a small sensillum on external surface between levels of trichobothria *st* and *sb*, nearer the latter.

Legs typical; leg IV with entire femur 2.8 and tibia 4.05 times as long as deep. Tactile setae of usual kind on tibia and tarsi of leg IV.

Male: Unknown.

Tritonymph: Similar to adult but smaller, less slender and with reduced numbers of setae in many places. Carapace with a small, rounded epistome; only two faint eyespots; chaetotaxy 8-4-4-2-4 = 22. Coxae I each with only two spinelike setae. Anterior genital operculum with four small setae. Cheliceral hand with six setae, and flagellum of seven pinnate setae. Palpal femur 4.1, tibia 1.8, and chela 4.6 times as long as broad. Fixed chelal finger with 59 and movable finger with 53 marginal teeth; movable finger with a small sensillum just proximad of *st*.

Measurements (*mm*): Holotype female: Body length 1.65. Carapace length 0.48. Chelicera 0.47 by 0.245. Palpal trochanter 0.215 by 0.125; femur 0.555 by 0.12; tibia 0.28 by 0.15; chela 0.85 by 0.18; hand 0.295 by 0.18; movable finger 0.585 long. Leg IV; entire femur 0.45 by 0.16; tibia 0.325 by 0.08; metatarsus 0.15 by 0.065; telotarsus 0.29 by 0.045.

Tritonymph: Body length 1.00. Carapace length 0.33. Palpal femur

0.33 by 0.08; tibia 0.18 by 0.10; chela 0.51 by 0.11; hand 0.185 by 0.115; movable finger 0.35 long. Leg IV: entire femur 0.28 by 0.11.

Etymology: The species is named for Russell Cave, where the holotype was found.

Remarks: This is the first record of a definitely troglobitic species of *Apochthonius* from a southern state, previous such species being known from the mideastern states of Virginia and West Virginia and from the midwestern states of Indiana, Missouri and Arkansas. It is from an area in northestern Alabama where troglobitic species of *Tyrannochthonius* are not uncommon (see Chamberlin and Malcolm, 1960).

Apochthonius minor, new species

Figures 6 and 7

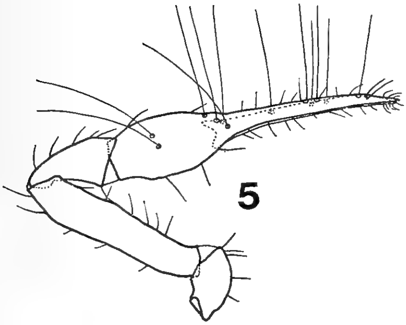
Material: Holotype male (WM 1275.02002) and two paratype males from litter at entrance to Parker Cave, 2 miles NE of Subligna, Chatooga County, Georgia, on 20 June 1967 (S. Peck and A. Fiske). One female paratype from Morrison Cave, 2 miles E of Trenton, Dade County, Georgia, on 13 July 1967 (S. Peck and A. Fiske).

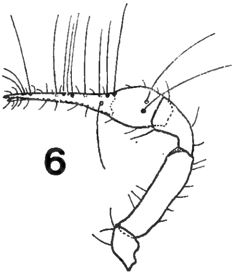
Diagnosis: A small species of *Apochthonius,* with only two distinct eyes and rather robust appendages. In size it is close to *A. minimus* Schuster (1966), but it differs from that species and from the larger *A. moestus* (Banks) in having only eight setae along the anterior margin of the carapace, rather than ten (see Muchmore and Benedict, 1976).

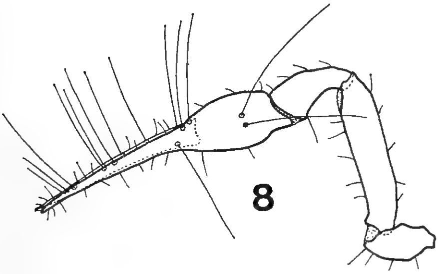
Description of male: With the general features of the genus. All sclerotized parts light brown. Carapace about as long as broad, somewhat narrowed posteriorly; small spinous epistome present; two small corneate eyes in anterior position, at most, very faint, none-corneate eyespots in posterior position; chaetotaxy 8-4-4-2-4 = 22. Abdomen typical; tergal chaetotaxy of holotype 4:4:6:7:7:8:9:9:8:6:1T2T1:0; sternal chaetotaxy of holotype $12{:}[4\text{-}4]{:}(3)\frac{7\text{-}6}{4\text{-}4}(3){:}(3)6(2){:}12{:}11{:}11{:}11{:}12{:}\mathrm{T2T2T2T}{:}0{:}2$. Coxal chaetotaxy 2-3-0:3-0-CS:2-2:2-3:2-3; each coxa I with three spinelike setae of the usual kind, all bases with small spurs; no intercoxal tubercle.

Chelicera about 0.85 as long as carapace; hand with seven setae; fixed finger with about 10 teeth, movable finger with seven, including one isolated subterminally; spinneret absent, though openings of silk ducts can be seen at the finger margin; serrula exterior with about 15 blades; flagellum apparently of eight pinnate setae.

Palps relatively short and stout (Fig. 6); femur about 0.95 and chela about 1.53 as long as carapace; trochanter 1.6–1.65, femur 4.0–4.3, tibia 1.75–1.9 and chela 4.5–4.7 times as long as broad; movable finger 1.94–2.06 times as long as hand. Trichobothria arranged as in Figure 7. Fixed chelal finger with 45–51 and movable finger with 52–53 contiguous, marginal teeth; distal 35–40 teeth on fixed finger and distal







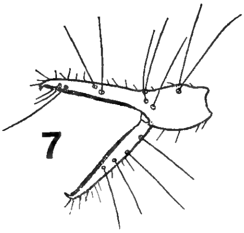


FIG. 5. *Apochthonius russelli,* new species. Dorsal view of left palp.

FIGS. 6 and 7. *Apochthonius minor,* new species. 6, Dorsal view of right palp; 7, Lateral view of left chela.

FIG. 8. *Apochthonius hypogeus,* new species. Dorsal view of right palp.

25–30 on movable finger distinctly cusped, more basal ones rounded and lower; most teeth evenly graded in size, but movable finger with four or five larger ones in distal half of row (15th, 17th, 20th, 24th, and 28th in holotype). Movable finger with a prominent, elevated, rounded sensillum on external surface between trichobothrium *st* and the dental row (at level of teeth 38–40).

Legs rather robust; leg IV with entire femur 2.3–2.35 and tibia 3.0–3.1 times as long as deep. Tactile setae of usual kind on tibia and tarsal segments of leg IV.

Female: Much like the male, but slightly larger and more robust. No posterior eyespots visible on carapace. Tergal chaetotaxy 4:4:8:8:9:10:9:9:9:6:1T2T1:0; sternal chaetotaxy 8:(3)5(3):(3)8(3):11:11:11:11:13:T2T2T2T:0:2. Coxal chaetotaxy as in the males, but only two spinelike setae present on right coxa I, while left coxa I has the usual three. Movable finger of chelicera with a distinct knoblike spinneret.

Palps stouter than in male; femur 3.65, tibia 1.9, and chela 3.8 times as long as broad. Teeth of chelal fingers as in males, with three slightly larger teeth in distal half of row on movable finger (13th, 15th and 20th).

Measurements (mm): Males (ranges for the three type specimens): Body length 0.88–1.02. Carapace length 0.29–0.30. Chelicera 0.25–0.26 by 0.125–0.14. Palpal trochanter 0.12–0.13 by 0.075–0.08; femur 0.28 by 0.065–0.07; tibia 0.14–0.155 by 0.08; chela 0.445–0.46 by 0.095–0.10; hand 0.15–0.155 by 0.095–0.10; movable finger 0.295–0.31 long. Leg IV: entire femur 0.25–0.26 by 0.11; tibia 0.17–0.18 by 0.055–0.06; metatarsus 0.08–0.09 by 0.04–0.045; telotarsus 0.15–0.17 by 0.03–0.04.

Female: Body length 1.21. Carapace length 0.36. Chelicera 0.30 by 0.155. Palpal trochanter 0.14 by 0.08; femur 0.31 by 0.085; tibia 0.18 by 0.095; chela 0.49 by 0.13; hand 0.18 by 0.13; movable finger 0.325 long. Leg IV: entire femur 0.28 by 0.125; tibia 0.21 by 0.065; metatarsus 0.105 by 0.045; telotarsus 0.18 by 0.04.

Etymology: This species is named *minor* because it is one of the smallest in the genus.

Remarks: Similar in proportions to *A. moestus* (Banks), the only epigean species of *Apochthonius* presently recognized from the eastern United States (Muchmore and Benedict, 1976), *A. minor* differs in its smaller size, in having only eight setae on the anterior margin of the carapace, and in having the posterior pair of eyes reduced or absent. This last feature is most interesting in view of the fact that the species has been found both inside and outside of caves. Reduction of the eyes to this extent (virtual loss of the posterior pair) has heretofore been seen in *Apochthonius* only in forms that are almost certainly troglobitic (see Benedict and Malcolm, 1973). It appears probable then that *A. minor* lives in the soil well away from light and perhaps preferably in rock crevices and the mouths of caves, whence it would be easy to move right into the caves, at least occasionally.

Because the possession of three coxal spines on each coxa I is almost invariable in *Apochthonius*, it is noteworthy that the single known female of *A. minor* has only two such spines on right coxa I. This condition may be teratological or may be indicative of a tendency toward reduction in the number of spines in this species.

The occurrence of *A. minor*, one of the smallest species of the genus, in Chatooga County, Georgia, is reminiscent of the presence of *Microcreagris pumila*, one of the smallest *Microcreagris*, in the same place (see Muchmore, 1969). In addition to small size, both have stouter appendages than most species of their respective genera, both are paler than usual, and both have the posterior pair of eyes reduced or lacking. It seems likely that the two species have been modified in similar ways to meet the same conditions (whatever they may be) in hypogean situations and at the entrances of caves in northwestern Georgia and northeastern Alabama.

It is also interesting to note that a male and a female of a larger, typically epigean species of *Apochthonius* were collected along with the specimens of *A. minor* outside of Parker Cave. Because the surface dwelling forms of *Apochthonius* from the southeastern United States have not yet been studied and described, these larger specimens cannot be identified at this time.

Apochthonius hypogeus, new species

Figure 8

Material: Holotype female (WM 1552.01001) taken from under a rock in a ravine, elevation 3,000 feet, on the east slope of Great North Mountain, Augusta County, Virginia, 20 March 1968 (Thomas C. Barr, Jr.).

Diagnosis: A medium sized species of *Apochthonius,* having four small eyes with flattened corneas and eight setae at anterior margin of carapace.

Description of holotype female: With the general features of the genus. All sclerotized parts pale tan. Carapace about as long as broad; with only a tiny, spinous epistome; four eyes present, each very small and with a flat cornea; chaetotaxy 8-4-4-2-4 = 22. Abdomen typical; tergal chaetotaxy 4:4:7:7:7:8:9:9:9:7:1T1T1:0; sternal chaetotaxy 8:(3)8(3):(4)6(4):12:12:12:12:14:T2T2T2T:0:2. Coxal chaetotaxy 2-2-1:3-0-CS:2-2:2-3:2-3; each coxa I with three spinelike setae of the usual kind, their bases having very short anterior spurs; no intercoxal tubercle.

Chelicera 0.91 as long as carapace; hand with seven setae; fixed finger with nine teeth, and movable finger with five small teeth, including one isolated subterminally; spinneret a small, but distinct, elevation; flagellum apparently of eight pinnate setae.

Palps only moderately slender (Fig. 8); femur 1.02 and chela 1.67 times as long as carapace; trochanter 1.9, femur 4.35, tibia 2.0, and chela 4.75 times as long as broad; movable finger 1.96 times as long as hand. Trichobothria arranged in typical order. Fixed finger with 74 and movable finger with 71 continguous, marginal teeth, evenly graded in size and proportions; movable finger with a small sensillum on external surface about midway between levels of trichobothria *st* and *sb*.

Legs much as in *A. moestus*; leg IV with entire femur 2.55 and tibia 3.7 times as long as deep. Tactile setae of usual kind on tibia and tarsi of leg IV.

Male: Unknown.

Measurements (*mm*): Body length 1.54. Carapace length 0.47. Chelicera 0.43 by 0.21. Palpal trochanter 0.21 by 0.11; femur 0.48 by 0.11; tibia 0.26 by 0.13; chela 0.785 by 0.165; hand 0.27 by 0.16; movable finger 0.53 long. Leg IV: entire femur 0.42 by 0.165; tibia 0.295 by 0.08; metatarsus 0.14 by 0.06; telotarsus 0.265 by 0.045.

Etymology: The species is named *hypogeus* because of its apparent adaptation for life beneath the surface of the ground.

Remarks: While this species is similar in size and proportions to *A. moestus*, it is less well sclerotized, therefore lighter in color, and has the eyes much reduced in size; thus, it would appear to be specifically adapted to life in a subterranean environment. It may be troglophilic, though there are no known caves in the immediate vicinity of its capture. An interesting fact is that four colorless isopods of the genus *Miktoniscus* (possibly *racovitzai*?) were collected along with the pseudoscorpion. This may indicate either that there are cave passages underlying this area and connecting with caves to the east, or that these forms may undergo depigmentation and reduction of eyes outside of a true cave environment.

Apochthonius colecampi Muchmore

A. colecampi Muchmore, 1967, p. 89.

Recently two females, possibly referable to this species, have been collected by John L. Craig in Bat Cave, east central Crawford County, and in Mushroom Cave, south central Franklin County, Missouri. Most of the measurements and proportions are nearly identical to those of the holotype female from Cole Camp Cave. They differ from the holotype mainly in the numbers of some setae and the teeth on the chelal fingers. However, acceptance of these specimens as *A. colecampi* presents some distributional difficulties, because Bat Cave and Mushroom Cave are over 100 miles from the type-locality. In order for the same species to occupy both caves, easy access between the caves would have had to exist in fairly recent times. Because the species appears to be somewhat cave adapted (larger size and elongated appendages), it would seem doubtful that movement between the caves has occurred overland. Since we know nothing of the pseudoscorpion faunae of neighboring caves or of the surface around and between the caves, it is impossible to understand the relations of these forms at the present time.

Apochthonius indianensis Muchmore

A. indianensis Muchmore, 1967, p. 92.

A single female apparently assignable to this species was found by J. R. Reddell in Donahue Cave, 1½ miles SW of Bedford, Lawrence County, Indiana. This specimen is very similar to the holotype male in all respects, excpt for a few differences directly attributable to the difference in sex. As Donahue Cave is about 10 miles NW of Donaldson Cave, the type-locality, it seems likely that the species is distributed through several caves in the area.

Apochthonius holsingeri Muchmore

A. holsingeri Muchmore, 1967, p. 93.

At hand is a tritonymph collected by L. M. and B. L. Ferguson in Blue Spring Cave, Alleghany County, Virginia, which may represent this species. Like the holotype male, it is completely eyeless and has six setae on the cheliceral hand, and the chaetotaxies of carapace and tergites are similar; further, it is of the right size for a tritonymph of the species. Blue Spring Cave is about 35 miles SW of Cave Run Pit Cave, the type-locality.

Other pseudoscorpions belonging to the genus *Apochthonius* have been collected in the following caves: ALABAMA: McKinney Cave #45, Colbert County (S. and J. Peck); Paint Rock Cave, Jackson County (S. Peck); Reece Cave, Jackson County (S. Peck and A. Fiske); Burwell Cave, Madison County (S. Peck); Ellis Cave, Madison County (S. Peck and A. Fiske); Hutton Cave, Madison County (W. B. Jones); Spook Cave, Madison County (S. Peck); Cave #824, Morgan County (S. Peck); McGlendon Cave, St. Claire County (S. Peck and A. Fiske). ILLINOIS: Brown's Hole Pit Cave, Hardin County (J. Lewis). KENTUCKY: Running Branch Cave, Edmonson County (S. Peck); Copelin Cave, Hart County (T. C. Barr, Jr.); Lester Collins #2 Cave, Jackson County (T. G. Marsh). MARYLAND: Rocky Gap Cave, Allegany County, (R. Franz). TENNESSEE: Round Mountain Cave, Franklin County, (S. Peck and A. Fiske).

Because none of the above specimens is noticeably modified for cave existence, it may be assumed that they are surface forms accidentally or facultatively living in the caves. The actual status of these forms will not be known until much more is learned about the epigean pseudoscorpions of the eastern half of the country.

DISCUSSION

Benedict and Malcolm (1973) have discussed the troglobitic modifications among several of the known species of *Apochthonius*. The species described above fit fairly well into the pattern which those authors described. However, a few comments are in order here.

As with many cavernicolous animals, the cave-dwelling *Apochthonius* species usually show distinct lightening of the body and appendages. I question whether this is a real reduction of pigment, however; rather it seems to result simply from a thinning of the cuticle. Most pseudoscorpions appear not to have any true pigment in the cuticle but only show the color of the proteins, chitin, etc. in the cuticular layers. When these layers are thick the animal, or part of the animal, appears darker than when the layers are thin. Progressive thinning of the cuticle in cavernicolous animals, which live in areas of constant high humidity and do not require much protection against desiccation, results in the general lightening of the animals.

The reduction and loss of the unneeded visual apparatus of cavernicolous animals is probably fortuitous and proceeds at widely different rates in different species. If so, it is not surprising to find every condition, from four good eyes to none at all, in a large sampling of independently developing cavernicolous species.

Benedict and Malcolm (1973) use total body length as a measure of the size of the animals they studied. However, I am of the opinion that a better measure, at least when comparing individuals within a species or species in a genus, is the length of the carapace. Total body length, which is the sum of the lengths of the carapace and the abdomen, is greatly variable in an individual and therefore, in a species. While the length of the carapace is constant in a given stage of an individual, the length of the abdomen varies greatly according to the nutritional state, the reproductive condition, and, to some extent, the method of preservation of the creature. More reliable measurements and comparisons can, of course, be made using the constant character.

In addition to the length/width ratios of the palpal femur and chela, I have found that a good measure of the attenuation of the palp is given by the relative lengths of the femur and chela in comparison with the length of the carapace. In most epigean forms I have studied, the femur/carapace ratio is less than 1.1 and the chela/carapace ratio is less than 1.7, while in most of the troglobitic forms the corresponding ratios are greater than 1.15 and 1.75 respectively; as in the study of Benedict and Malcolm, *A. coecus* falls in between, together with *A. hypogeus.* I have at hand a number of specimens of *Apochthonius* sp. from southeastern United States which are larger than *A. moestus* and most other epigean forms; these tend to have appendages which approach some of the troglobites in slenderness. A detailed study may show that attenuation of the appendages is primarily a result of allometric growth.

The distribution of cavernicolous forms of *Apochthonius* is rather interesting. While the genus is apparently very common in the surface fauna all through the eastern United States (unpublished records), its representation in caves is sparse. Epigean forms seem to wander into caves occasionally in various parts of this range, but cave adapted forms have been found only in certain, rather narrowly prescribed locations. These places, in West Virginia, Virginia, Alabama, Indiana, Missouri and Arkansas, are all more or less at the periphery of the ranges of cavernicolous species of *Kleptochthonius*, (subgenus *Chamberlinochthonius*), which are fairly common in caves in Kentucky, Tennessee, southern West Virginia and western Virginia (see Malcolm and Chamberlin, 1961; Muchmore, 1965, 1966, 1970, 1974). It would appear that competitive exclusion is operating against the generally smaller *Apochthonius* species.

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PROCEEDINGS
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MICROBROTULA RANDALLI, A NEW VIVIPAROUS OPHIDIOID FISH FROM SAMOA AND NEW HEBRIDES, WHOSE EMBRYOS BEAR TROPHOTAENIAE

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The objectives of this paper are: to diagnose the viviparous ophidioid fish genus *Microbrotula* Gosline; to describe an heretofore unknown species of the genus from Samoa and New Hebrides; to record in this species the second known occurrence of trophotaeniae in ophidioid fishes; and to discuss the possible significance of trophotaeniae.

Microbrotula (Gosline, 1953) was described for two species from Oahu, Hawaii: *rubra* (type-species) and *nigra* (subsequently referred to *Oligopus* Risso, where it is a homonym and renamed *Oligopus waikiki* by Cohen, 1964). Gosline's description of *M. rubra* was based on six specimens, of which three have been available for study.

One of the four Samoan *Microbrotula* is a gravid female, and upon examining embryos we discovered that they carried trophotaeniae, structures found in the embryos of several other species of viviparous fishes. We describe them in some detail.

Microbrotula Gosline

Diagnosis: Chin barbels absent. Gill membranes free from each other and from isthmus. Live-bearing; no ossified parts in male intromittent organ. Ventral fins immediately adjacent to each other, each with a single ray originating well behind symphysis of cleithra, a distance equal to approximately two-thirds snout length or more; pelvic girdle not extending anteriorly to symphysis of cleithra. Vertical fins confluent, covered with thin skin through which fin rays easily visible.

Pectoral fin entire, without separate elongated rays; pectoral peduncle not greatly elongated, broader than long. Caudal fin rays 4 to 6. Body relatively short, depth 5.3–6.4 in standard length, completely covered with small imbricate scales. Lateral line in the form of free papillae. Head partly naked. Eyes developed but small, more than 6 times in head length. Snout depressed. Anterior nostril tubular, located directly above upper lip. Spine on opercle sharp and needle-like. Maxillary expanded posteriorly, not sheathed, with a small ventrally-directed process near postero-ventral angle. Tongue with an anterior, prow-like extension. Developed gill rakers on first arch 3 or 4. Branchiostegal rays 7. Teeth not all tiny and granular, some enlarged, present on premaxillary, vomer, palatine and dentary; no median basibranchial tooth patch; paired tooth patches at the base of gill arches 3 and 5.

First neural spine short, neural spines 4 to 7 depressed. Ribs absent on first centrum. Abdominal vertebrae 11 or 12; total vertebrae 51 to 56. Parietals separated by supraoccipital.

Discussion: *Microbrotula* appears to more closely resemble *Calamopteryx* than any other known ophidioid genus, as noted by Böhlke and Cohen (1966). Most importantly, both genera contain small viviparious species with imbricate scales on the body, confluent vertical fins, a single ray in each ventral fin, no ossified parts in the male intromittent organ, and 7 branchiostegal rays.

Several important distinguishing characters are (*Microbrotula* first followed by *Calamopteryx* in parenthesis): pectoral peduncle and radials normal—the three specimens of *M. rubra* that we have examined do not resemble the figure given by Gosline (1953, fig. 1c) for this character (greatly elongate); first ribs on centrum 2 (on centrum 1); lower angle of preopercle lacking a curved, anteriorly-directed spine (spine present); spine on opercle sharp and needle-like (flattened and flap-like); dorsal fin rays 81 to 88 (58 to 70); anal fin rays 71 to 76 (40 to 57); caudal fin rays 4 to 6 (8 to 10); vertebrae 51 to 56 (37 to 46).

Calamopteryx was not yet known when Gosline (1953) described *Microbrotula*. He stated that, "*Microbrotula* seems to be a dwarfed, shallow-water offshoot of a *Cataetyx*-like fish" a suggestion with which we concur and which would apply to *Calamopteryx* as well.

The two known species of *Microbrotula* may be distinguished by means of the characters presented in Table 1.

Microbrotula randalli, new species

Figure 1

Description: See Table 2 for counts and measurements. Body compressed, relatively short for an ophidioid, tail end of body pointed but not attenuate.

Postorbital part of head about as deep as broad. Snout depressed, broadly rounded in dorsal view. Jaws subequal but fleshy snout pro-

TABLE 1. Diagnostic characters for two species of *Microbrotula*.

Character	*randalli*	*rubra*
Pores on top of head	5; 1 median in rear of interorbital area, 1 each near antero-and postero-dorsal segments of each eye	none
Pectoral fin rays	11	13–14*
Vertebrae	53–56	51–52
Orbit diameter into head length (hl)	6.4–8.4	11.0–15.4
Interorbital width into hl	10.7–13.7	3.6–4.2
Snout length into hl	5.4–6.2	4.0–5.2
Predorsal distance into SL	2.4–2.5	2.1–2.3

* Gosline (1953) gives 12–14.

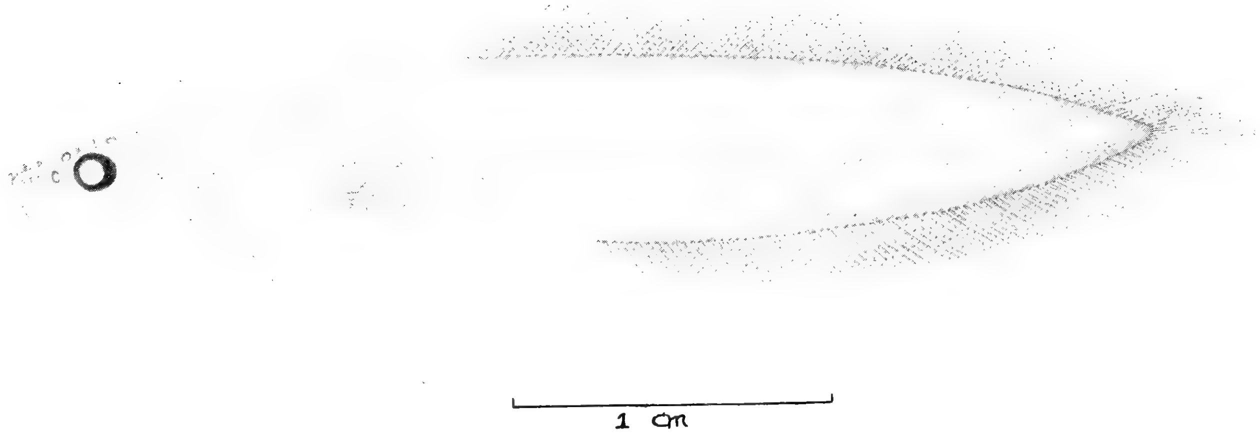


FIG. 1. *Microbrotula randalli*, paratype, USNM 214112, ♀, 35.8 mm SL.

jecting beyond jawbones. Orbit elliptical; eyes directed antero-laterally. A spectacle, which covers the orbit, transparent over the protruding lens, translucent elsewhere. Anterior nostril a tissue thin tube projecting directly over upper lip; posterior nostril a prominent pore in front of mid-level of orbit. Dorsal rim of maxillary sheathed for most of its length but expanded postorbital section free.

Minute, unpigmented papillae sparsely distributed on head, most abundant on snout. Indistinct ridges and flaps on snout, most obvious at tip of upper jaw. Sensory pores present along mandibular, lateral, infra-orbital and supra-orbital canals; precise enumeration is not possible. The most obvious pores are 5 on the surface of head: 1 each at the antero and postero-dorsal segments of each orbit, and a median one at the rear of interorbital region.

Gill rakers on first arch in the form of 2 or 3 flat spiny pads on the upper arm, a compressed spiny raker at the angle, preceded on the lower arm by a pad, a compressed triangular raker, a pad, a triangular raker, and 5 or 6 pads. The two developed rakers on lower arm anteriorly depressed so that their rear spiny faces are dorsally directed.

Premaxillary dentition consists of a row several teeth wide of minute granular teeth; at anterior end of the premaxillary, anterior to the vomer, the row is broader and in addition to small teeth also 5 to 10 longer sharp pointed needle-like teeth. Vomerine teeth in a tuft on each side of head of bone, grading from tiny and granular to larger and needle-like. Palatine with a long narrow band of teeth similar to those on the vomer, the largest farther anterior. The dentary bears a broad band of small, closely packed granular teeth and along the medial edge of the band a widely spaced row of 12 to 15 longer needle-like teeth.

Fin rays slender and filamentous, membrane connecting rays of median fins clear to slightly translucent, rays free distally. Pectoral fin on a broad fleshy pad, fin extending about two-thirds of distance from the pectoral base to the vent. Ventral fins immediately adjacent to each other and located well behind symphysis of cleithra. Caudal fin rays exserted.

Body scales imbricate, small, transparent and cycloid. Scales imbricate to non-overlapping on the head, several present over dorsal area of spectacle and on expanded rear part of maxillary; snout and tip of lower jaw naked.

Color in alcohol pale straw. Small, widely spaced, brown chromatophores present behind eye and to a greater or lesser extent on cheek and along side of body. Peritoneum pale. Live color salmon pink (based on notes by Randall and a color transparency).

The single male specimen has a trianglar, fleshy hood immediately posterior to vent, which rests in a depression anterior to anal fin. A minute, fleshy tubercle projects at each side of base of hood. Inner surface of the hood cleft in midline, enclosing a small compact papilla (?penis) which is followed by another median papilla.

TABLE 2. Selected Measurements and counts for *M. randalli.*

Character	Holotype BPBM 17507		Paratypes							
			BPBM 18032		USNM 214112		USNM 214112		USNM 214703	
Sex	♀		♀		♀		♀		♂	
Measurements	mm	%	mm	%	mm	%	mm	%	mm	%
Standard length (SL)	42.6		26.3		35.8		38.1		38.3	
As % SL										
Body depth at vent	6.8	16.0	4.1	15.6	5.7	15.9	6.3	16.5	7.2	18.8
Snout to dorsal fin	17.2	40.4	10.8	41.1	15.0	41.9	—	—	15.8	41.2
Snout to anal fin	21.3	50.0	13.1	49.8	17.8	49.7	—	—	19.9	52.0
Snout to ventral fin	8.5	19.9	5.5	20.9	7.3	20.4	7.9	20.7	8.5	22.2
Ventral fin length	—	—	4.2	16.0	5.8	16.2	4.8	12.6	5.2	13.6
Pectoral fin length	6.9	16.2	4.6	17.5	6.9	19.3	7.3	19.2	6.6	17.2
Pectoral fin base height	1.5	3.5	1.0	3.8	1.3	3.6	1.1	2.9	1.2	3.1
Head length (HL)	11.8	27.7	7.5	28.5	9.6	26.8	9.8	25.7	10.8	28.2
As % SL										
Orbit diameter, horizontal	1.4	11.9	1.0	13.3	1.5	15.6	1.6	15.5	1.3	12.0
Snout length	1.9	16.1	1.2	16.0	1.7	17.7	1.9	18.4	2.0	18.5
Jaw length	4.9	41.5	3.3	44.0	4.6	47.9	4.6	44.7	4.9	45.4
Interorbital width, least	1.1	9.3	0.7	9.3	0.7	7.3	0.8	7.8	0.8	7.4
Symphysis of cleithra to ventral fin	1.5	12.7	0.8	10.7	1.1	11.5	1.5	14.6	1.6	14.8
Counts										
Dorsal fin rays	86		—		84		83		81	
Anal fin rays	74		—		71		76		71	
Caudal fin rays	6		6		5		6		6	
Vertebrae	12 + 44 = 56		12 + 43 = 55		12 + 43 = 55		12 + 43 = 55		12 + 41 = 53	
Dorsal starts over centrum no.	10		11		10		10		10	
Anal starts under centrum no.	16		16		15		17		15	
Lateral scale rows	—		—		—		63		66	

Study material: *Microbrotula randalli*. HOLOTYPE: Bernice P. Bishop Museum (BPBM) 17507, ♀ 35.8 mm SL, American Samoa, Tutuila, Fagafele Bay, 30–38 m, small caves in reef front at reef-sand interface, rotenone, collectors J. E. Randall, R. C. Wass and G. Yamasaki, 8 May 1974. PARATYPES: BPBM 18032 (1) and National Museum of Natural History (USNM) 214112 (2), data as for holotype; USNM 214703 (1), Efate (Vaté) Island, New Hebrides, Feb. 1974.

Microbrotula rubra. HOLOTYPE: USNM 162710, ♂ 36.2 mm SL. PARATYPES: BPBM 13760 (=UH 98), ♀ 45.2 mm SL; USNM 162711, ♀ 32.3 mm SL, stained and cleared specimen in glycerine.

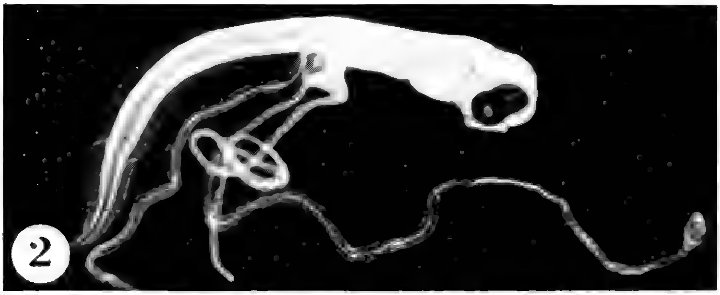
TROPHOTAENIAE AND EMBRYOS

Trophotaeniae are ribbon-like structures extending from the anal region of the embryos of several kinds of viviparous fishes. They were first described in goodeid fishes and subsequently have been found in the zoarcid genus *Parabrotula* and the ophidioid genus *Oligopus*. Descriptions of these structures in *Oligopus* and references to their occurrence are given by Wourms and Cohen (1975).

Four of the five known specimens of *Microbrotula randalli* are females. One of them is gravid and has several eyed embryos protruding, tail foremost, from the genital aperture, along with numerous tangled streamers of ribbon-like tissue. Other embryos can be seen through the body wall packed into both ovaries. Each embryo bears three elongate trophotaeniae which appear identical with structures described by Wourms and Cohen (1975) in *Oligopus longhursti*.

We have studied the gross anatomy and histology of embryos and trophotaeniae. Whole embryos, stained with methylene blue or alizarin or unstained, were examined with reflected and transmitted light microscopy. Conventional methods were used for histology. Tissue sections, five micra in thickness, were stained with Mallory's triple stain or hematoxylin and eosin. Detailed methodology appears in Wourms and Cohen (1975).

Embryos: All embryos taken from the one gravid female were in the same stage of development. Embryos range from 3.5 to 4.0 mm. in total length (Fig. 2). They are mid-finfold embryos which correspond to stage 4 (finfold embryo) of *Dinematichthys ilucoeteoides* as described by Wourms and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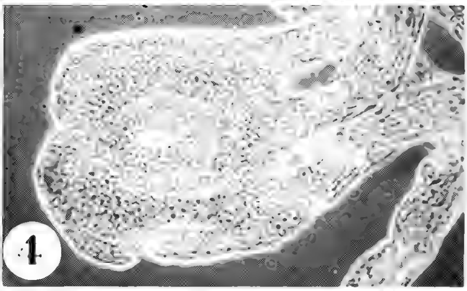
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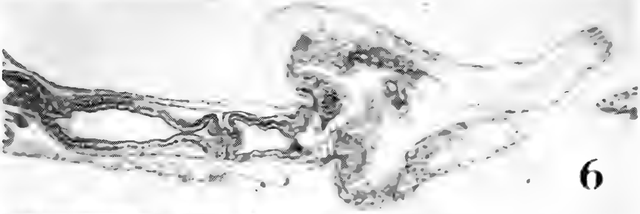
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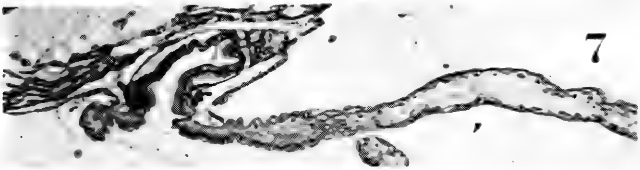
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Bayne (1973). Also, they are equivalent to stage 30–31 of *Fundulus* (Armstrong and Child, 1965). They are similar to other unspecialized teleost embryos at a comparable stage of development except for the presence of three long trophotaeniae which extend from the anal region (Fig. 2 and 3).

The dorsal and ventral fin folds have formed and extend around the caudal end of the embryo without interruption. The body of the embryo is straight except for a slight curvature in the caudal region. There is no protruding yolk mass. Sections through the slightly distended abdominal region re-

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FIG. 2. *M. randalli,* whole mount, glycerinated preparation of a 3.5 mm embryo; three trophotaeniae project from anal region; middle trophotaenia fully extended; each is considerably longer than the embryo. Darkfield optics; 20×.

FIG. 3. *M. randalli,* enlargement of anal region of embryo shown in fig. 2; on far right outline of gut appears on ventral surface of embryo ventral to a band of chromatophores; fleshy peduncle surrounds anus and gives rise to three trophotaeniae from anterior margin (somewhat distorted in this fig.); a refractile central core of connective tissue is present within each trophotaenia. Darkfield optics; 50×.

FIG. 4. *M. randalli,* isolated trophotaenial peduncle viewed from the ventral surface, posterior to the left, anus in the center; three trophotaeniae originate on anterior margin to the right, two are lateral, one is median; polygonal cells of the peduncle may be distinguished. Phase contrast; 80×.

FIG. 5. *M. randalli,* approximately saggital section through embryo, anterior to left; from left to right, brain, notochord and somatic muscles may be distinguished; ventral to these the gut (arrows) extends as a continuous tube from the mouth through the pharynx, foregut, hindgut and anus; trophotaenial peduncle extends fore and aft from the anus; transverse sections of trophotaeniae are present nearby. Brightfield; 100×.

FIG. 6. *M. randalli,* longitudinal section through lower ventral region, foregut to left, a prominent constriction separates fore and hindguts; hindgut opens through anus; trophotaeniae extend from both sides of peduncle-anal region. Brightfield; 100×.

FIG. 7. *M. randalli,* approximately saggital section of anal region, anterior to right; hindgut opens through anus; epithelial lining of hindgut is continuous with trophotaenial epithelium. Brightfield; 100×.

veal only a small amount of granular yolk material (Fig. 5). Far less yolk is present than in the embryos of *Oligopus* (Wourms and Cohen, 1975) and *Dinematichthys* (Wourms and Bayne, 1973) at similar stages of development.

The large, well-formed eyes are the most distinctive feature of the head. A lens is present. The choroid fissure is nearly obliterated. The retina is heavily pigmented and contains a reflecting layer. The neural retina consists of several well defined layers of cells. A nasal placode and the otic capsules have formed. There is a dorsal expansion of the mid-brain. Sections through the brain reveal both its considerable size and cellular complexity (Fig. 5). Pectoral fins are partially formed, and the pectoral girdle (cleithrum?) is a well ossified sliver of bone extending the entire depth of the embryo. Although ossified regions are present around the brain case and ethmoid, bone margins cannot be distinguished. The opercular flap has begun to form and is free. The lower jaw and gill arches have formed. Based on study of serial sections, the lower jaw is free and the mouth is open. Somatic muscles of the trunk and tail are organized into myomeres; striations can be distinguished in sections. The notochord is conspicuous both in whole mounts and sections. In addition, from sectioned material, one can identify the heart, liver, gall bladder (?), regions of the digestive tube, kidney, and ureter. The heart and larger blood vessels contain red blood cells.

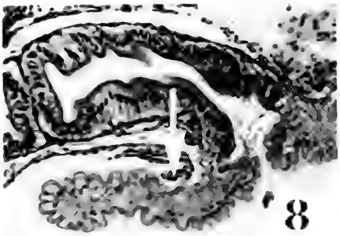
Preserved embryos are a pale, translucent white color. A band of chromatophores originates behind the pectoral fin, extends to the anus, and then continues along the body above the ventral finfold. Pigment is scattered in the ventral finfold and in the rear part of the dorsal finfold and adjacent areas of the body. Also, a narrow line of chromatophores begins at the level of the trophotaenial peduncle and extends posteriorly in the lateral midline of the embryo.

Gross morphology of the trophotaeniae: Three long processes, termed trophotaeniae, extend from the anal region of the embryo (Fig. 2). They occur in the form of a pair of anterior lateral processes and a single anterior median process (Fig. 4). Trophotaeniae originate from a conspicuous fleshy peduncle. The peduncle is a discoidal structure which resembles an inverted mushroom cap; it consists of a central and a peripheral region. The central region surrounds the anus and is about 0.14 mm wide by 0.21 mm long; under favorable conditions, centripetal striations which give this area a sphincter-like appearance can be observed. Beyond the central region lies the peripheral region of the peduncle. Although in close proximity to the ventral surface of the embryo, it remains free along its dorsal, lateral, and ventral surfaces; the cells in this region are polygonal. The length of the entire peduncle, 0.42 mm, is equal to its width. The posterior margin of the peduncle forms a double crescent. The three trophotaeniae arise from its anterior margin (Fig. 4).

Trophotaeniae are free along their entire length except at their origin. All three processes are of approximately equal length and are longer than the embryo. In embryos of 3.4–4.0 mm. total length, the trophotaeniae are 5.0 to 6.0 mm. long. They are about 85–100 micra in diameter at their base and 40–55 micra in diameter at the tip. In shape, trophotaeniae are slender cylinders which may flatten into ellipsoidal ribbons (Fig. 5 and 14). With the aid of dark field optics, a refractile central core of connective tissue can be observed within each trophotaenia. In preserved specimens trophotaeniae are deciduous.

Histology of the gut and trophotaeniae: At this stage, the gut is a simple tube which is open at both ends. Beginning at the anterior end, one can distinguish seven regions: 1) mouth–oral cavity; 2) pharynx; 3) anterior portion of the foregut, above the liver and yolk mass (future stomach ?); 4) a constriction at which several ducts (pancreatic, bile ?) empty; 5) posterior portion of the foregut; 6) a well defined circular valve; and 7) the hindgut and anus (Figs. 5, 6, 8 and 9). To this may be added the trophotaenial peduncle and trophotaeniae which are gut tissues "outside" of the body.

The tubular gut is composed of a single layer of epithelial cells which rest on a thin basal lamina and a poorly developed investing layer of connective tissue. The mouth, pharynx, and anterior portion of the foregut are lined with a simple epithelium. The cells range in shape from flat squamous to



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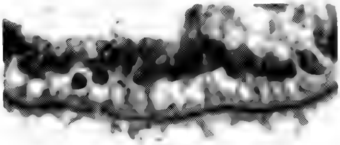

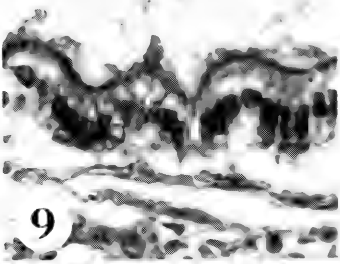

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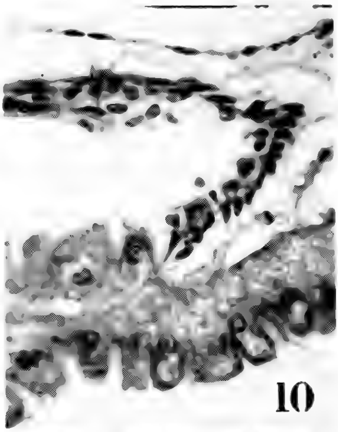

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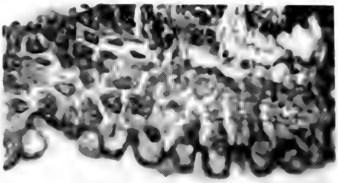

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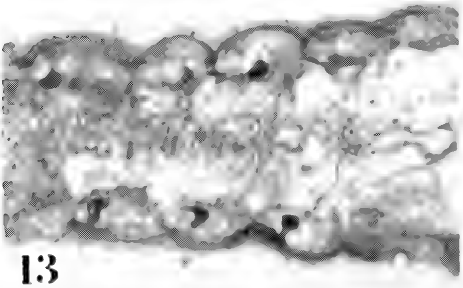

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low cuboidal. They lack a striated border. No secretory cells have been observed.

The posterior portion of the foregut is separated from the hindgut by a well defined sphincter-like constriction (Figs. 6, 7, 8). The hindgut terminates at the anus where its cells form a gradual transition with those of the trophotaenial peduncle. Cells of the posterior foregut and the hindgut are identical. They are tall columnar epithelial cells which possess a well defined striated border (Figs. 8, 9). The cells are about 15 micra in height and 5 to 7 micra wide. Nuclei are about 3–4 micra in diameter. Occasional bits of debris are found in the lumen of the hindgut. In the region of the anus, there is a gradual and almost imperceptible transition from

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FIG. 8. *M. randalli*, approximately saggital section of hindgut, anus and trophotaenial peduncle, anterior to left. Brightfield; 200×.

FIG. 9. *M. randalli*, longitudinal sectional of gut, lumen in center, bounded by gut epithelium; free (apical) surface of gut cells have a well defined striated border. Brightfield; 820×.

FIG. 10. *M. randalli*, enlargement of area marked by arrow in fig. 8; note abrupt transition at junction between flattened, squamous cells of embryonic skin and large, dome-shaped cells of trophotaenial peduncle. Phase contrast; 820×.

FIG. 11. *M. randalli*, section through central region of trophotaenial peduncle, free (ventral) surface at bottom; dome-shaped cells bear microvilli on apical surface. Phase contrast; 615×.

FIG. 12. *M. randalli*, longitudinal section through a trophotaenia; a single layer of epithelial cells forms the outer surface; there is a prominent central core of connective tissue; tissue spaces extend between the core and surface epithelium. Brightfield; 500×.

FIG. 13. *M. randalli*, longitudinal section of a trophotaenia; surface epithelium composed of slightly flattened cuboidal cells; apical cell surface convex, with a well defined striated border formed of numerous microvilli; nuclei are basal; central core of connective tissue with many fibrils. Phase contrast; 820×.

FIG. 14. *M. randalli*, transverse section of trophotaenia; epithelial cells have a triangular profile; filaments or fibrils extend from basal surface toward central core; tissue spaces present between cells; microvilli of striated border are conspicuous. Phase contrast; 615×.

the cells of the hindgut to those of the peduncle. This is accomplished in part by a shift from a columnar epithelium to a cuboidal epithelium.

The trophotaenial peduncle is a fleshy disc of tissue which surrounds the anus. The anus opens in the central region of its ventral surface (Figs. 4, 8). In sections, the most conspicuous aspect of the peduncle is its papillose surface. This consists of cuboidal epithelium. The apical surface of each cell is highly convex, and there is a marginal cleft between apical portions of adjacent cells. This accounts for the knobby or papillose surface. The apical cell surface possesses a well defined striated border (Figs. 10, 11). Beneath the cells there is a thin basal lamina and a core of dense connective tissue. With the exception of the central region of the peduncle where connective tissue cells are abundant (Fig. 11), the underlying connective tissue contains few cells. Peduncle cells are larger than intestinal cells. They are about 20 micra high by 14 micra wide. Nuclei also seem larger, being 5–7 micra in diameter.

In addition to the anus-peduncle zone of transition, there are two other transition regions, peduncle to skin and peduncle to trophotaenia. There is a distinct zone of transition where the dorsal and lateral surfaces of the peduncle meet the embryonic skin on the ventral surface of the embryo (Fig. 10). The transition zone consists of about 10–15 cells. The embryonic skin is much flattened, squamous epithelium. Cells and cell nuclei are smaller than the peduncle cells. They lack a striated border. The transition from squamous skin cells to papillose peduncle cells involves a linear sequence of squamous cells whose apical surface becomes more dome shaped and whose height increases.

Peduncle cells seem to be giant cells. Their nuclear size raises the question of polyploidy, a state not uncommon in the cells of temporary structures. A second question concerns the papillose appearance of the peduncle epithelium. Is this the normal state of the living cell or does it represent a contraction induced by fixation? In passing, we note that, at the base of the peduncle, there are vacuolated cells as well as profiles of structures which look like transverse sections of lacteals.

The final zone of transition is from the peduncle to the trophotaenia. The transition is gradual. Peduncle cells become reduced in height and flattened, losing their papillose appearance. Trophotaeniae consist of: an outer layer of epithelium; an interior core of connective tissue; and many secondary tissue spaces. The outer surface of the trophotaenia is formed by a continuous sheath of cells. It is simple epithelium in which all cells are morphologically identical. Cell shape is midway between that of a low cuboidal and a high squamous epithelium. Cells are 21–28 micra wide by 10–11 micra in height. The nucleus is about 3.5 micra in diameter. The apical cell surface is convex and bears a well defined striated border in which microvilli are readily distinguished. Nuclei occupy a basal position. A nucleolus is present. In tangential sections, boundaries between adjacent cells are well developed and stain intensely. The epithelial cell cytoplasm is intensely acidophilic. In transverse sections, epithelial cells appear conical (Fig. 14). The apex of the cell is wider than the base. A cytoplasmic process or fibril extends from the basal surface into the central region of the trophotaenia. The interior of the trophotaenia comprises: a dense mass of connective tissue with a central core of refractile connective tissue fibers (Figs. 2, 3, 12, 13); epithelial cell processes; and mesenchymal cells. Secondary tissue spaces are found between the basal regions of epithelial cells. They establish a series of compartments which lie between the external epithelial sheath and the central core (Figs. 12, 13). In transverse sections, the tissue spaces often tend to be radially arranged (Fig. 14). In some sections, there are structures which appear to be central blood vessels. They are associated with the central core of connective tissue fibrils.

FUNCTION AND SIGNIFICANCE OF TROPHOTAENIAE

Among viviparous ophidioid fishes trophotaeniae are known to occur only in embryos of *Oligopus longhursti* and *Microbrotula randalli.* In both species, trophotaeniae are of essentially identical structure.

Epithelial cells forming the outer surface of trophotaeniae are continuous with and identical to the epithelium which lines the "intestinal" portion of the embryonic gut. Minor organizational differences exist, viz., gut cells are columnar while trophotaenial cells form a low cuboidal epithelium. Both cell types, however, are identical. Moreover they have no structural similarity to the cells which comprise the embryonic integument. We suggest that the trophotaeniae of *Microbrotula* embryos function in the absorption of intra-ovarian nutrients of maternal origin. They are placental analogues. We attribute this function to the trophotaeniae as their epithelial cells are structurally identical to intestinal epithelial cells whose known function is the absorption of nutrients. The argument and its limitations are presented at length elsewhere (Wourms and Cohen, 1975). Moreover, in a study of goodeid embryos, Mendoza (1972) presented ultrastructural evidence of considerable pinocytotic activity in the trophotaenial epithelium, an observation which lends additional support to their role as an absorptive epithelium. The occurrence of trophotaeniae in embryos of most goodeid fishes, a zoarcid, and two ophidioids is a remarkable example of convergence in the evolution of embryonic adaptations (Wourms and Cohen, 1975).

In the only gravid female *M. randalli* which we were able to examine, we were surprised to find that it contained few embryos, and that each embryo possessed only a small amount of yolk. It is unlikely that these embryos were close to term, even though they were protruding from the genital aperture and had only a small amount of yolk left. They are not as well developed as full term *Dinematichthys* embryos (Wourms and Bayne, 1973) and probably would be incapable of feeding. Protrusion of embryos from the genital aperture is considered a preservation artifact. *Microbrotula* embryos probably continue to develop within the femal to a stage at least equivalent to full term *Dinematichthys* embryos. Considering the small amount of yolk which remains, it is obvious that trophotaeniae must play an important role in nourishing embryos of *Microbrotula*, at least those at a relatively advanced stage of development.

In addition to differing from *O. longhursti* by having less yolk in embryos which have not reached full term, *M. randalli* is surprisingly less fecund. One specimen of *Oligopus* (99 mm SL) carried an estimated 6500 eggs. In *Microbrotula*, Gosline noted 50 to 80 eggs in each ovary of a specimen of *M. rubra* (37.5 mm SL) for a total of 100 to 160, and we count a total of about 80 through the body wall of a cleared 32.3 mm specimen. We have not dissected the single gravid specimen of *M. randalli* noted above, but on the basis of observations through the thin body wall would estimate a fecundity of the same order of magnitude in both *Microbrotula* species. Even when size difference is compensated for by extrapolating to equivalent ovarian volumes, *Microbrotula* is still less fecund (an estimated 800–1300 embryos vs 6500).

It has been proposed that trophotaeniae in *Oligopus* serve to maximize the advantage of high fecundity (Wourms and Cohen, 1975). If the preceding is a valid assumption, then what function is served by trophotaeniae in low fecundity *Microbrotula*?

Although *Microbrotula* and *Oligopus* are taxonomically more closely related to each other than is either to the Goodeidae, the function of trophotaeniae in *Microbrotula* apparently more nearly resembles the function of trophotaeniae in goodeids. Both kinds of fishes have low fecundity and a relatively small supply of yolk, and it seems reasonable to propose that the "placental" function of trophotaeniae supplements an inadequate supply of nourishment in the yolk. Support is given this interpretation by the situation in the related *Dinematichthys*, a low fecundity viviparous species that lacks trophotaeniae and is well supplied with yolk (Wourms and Bayne, 1973).

Given the present meager knowledge on size of full term embryos, duration of gestation, and number and frequency of broods, the above hypothesis seems the most economical possible.

The occurrence of trophotaeniae appears to be capricious in nature, and to invoke convergent evolution is to describe, not explain. An interesting analogous situation, which regrettably deepens the mystery rather than suggesting an explanation, concerns the occurrence of true spermatophores in vertebates (Nielsen, Jespersen and Munk, 1968). These structures are found in certain salamanders, diverse elasmobranches, one known cyprinodontoid fish (the group that includes Goodeidae) and a diverse group of viviparous ophidioid fishes. Furthermore, within the ophidioid genus *Calamopteryx,* two species have spermatophores while one does not (Nielsen *in* Cohen, 1973).

ACKNOWLEDGMENTS

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PROCEEDINGS
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REDESCRIPTION, RELATIONSHIPS AND STATUS OF THE MARYLAND DARTER, *ETHEOSTOMA SELLARE* (RADCLIFFE AND WELSH), AN ENDANGERED SPECIES

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Introduction

The original description of the Maryland darter, *Etheostoma sellare* (Radcliffe and Welsh, 1913), was based on two subadult male specimens taken in 1912. Little else has ever been published about this darter. Since 1961, seven collections have yielded 78 additional specimens. The purpose of this paper is to utilize the 80 existing specimens in a redescription of *E. sellare* and to summarize information concerning its biology and status as an endangered species.

Radcliffe and Welsh recorded the type-locality of the Maryland darter as "Swan Creek near Havre de Grace, Md." Presumably this is the Swan Creek actually located at Aberdeen and for 50 years many collections were taken in this and other streams in an effort to obtain Maryland darters. All attempts failed until 1962 when a group of Cornell University students discovered a juvenile specimen concealed among numerous juvenile tessellated darters that they had taken from Gasheys Run near Aberdeen, Maryland (Fig. 1). The rediscovery of the Maryland darter, reported by Knapp et al. (1963), stimulated field work along the lower Susquehanna River and an adult female was also taken in Gasheys Run by Knapp and party in April, 1965. As both Gasheys Run and

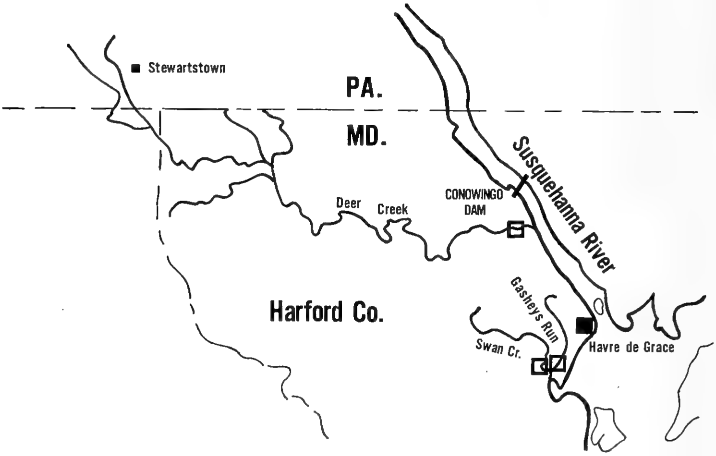

FIG. 1. Map of a portion of the Chesapeake Bay drainage in northern Maryland and southern Pennsylvania showing collection sites of *Etheostoma sellare.*

the adjacent Swan Creek are quite small, the question remained as to why rather substantial collecting efforts failed to take more specimens. This may have been answered when Edward C. Raney and Frank J. Schwartz located a population of the Maryland darter in Deer Creek near Havre de Grace in May, 1965. Although, collections had been taken from Deer Creek prior to 1965, the apparently restricted habitat of the darter near the creek mouth had been overlooked.

In recognition of its scarcity, the Maryland darter was designated as an endangered species in both the IUCN Red Data Book (Miller, 1969) and the U.S. Department of Interior Red Book of Threatened Wildlife of the United States (Bureau of Sport Fisheries and Wildlife, 1973). It also has been accorded similar status by Miller (1972) and by the Smithsonian Institution Center for Natural Areas (1974). Recently, the Maryland darter acquired a controversial aspect when a sewage treatment plant, built at Stewartstown, Pennsylvania, applied to the Environmental Protection Agency (EPA) for permission to release chlorinated wastes into Ebaugh's Creek, a headwater branch of Deer Creek. A public hearing was held by EPA on 25 September 1974, and despite considerable opposition, the permit was granted effective 30 October 1974. If, as it appears likely, Deer Creek is the principal habitat of the Maryland darter, the darter may be placed in considerable jeopardy. A warning concerning possible detrimental effects of the chlorinated wastes on the darter was given by Knapp (1974).

METHODS

The diagonal scale count is the number of scales downward and posteriorly from the origin of the second dorsal fin to, but not including the pored scales in the lateral sensory series. Cephalic sensory canal data was primarily taken from the right side of the head. The remaining counts and measurements used in this study follow the methods of Hubbs and Lagler (1958:19–24). Standard length (SL) and other measurements are given in millimeters (mm).

Etheostoma sellare (Radcliffe and Welsh)
Maryland darter

Hadropterus sellaris Radcliffe and Welsh, 1913:29–32 (original description, type-locality, Swan Creek).

Poecilichthys sellaris: Hubbs and Black, 1940:3 (comparison with *P. variatus* group).

Etheostoma (*Etheostoma*) *sellare*: Bailey and Gosline, 1955:16, 39 (vertebrae).—Knapp et al., 1963:455 (rediscovery).—Collette, 1965: 588 (nontuberculate).—Richards, 1966:823–827 (relationships).—Collette and Knapp, 1966:48 (types).

DIAGNOSIS

Distinguished from other darters by the following combination of characters: lateral line straight and complete with 43 to 53 ($\bar{x} = 46.8$) scales; caducous scales lacking; infraorbital and supratemporal canals complete; preoperculomandibular pores ten; branchiostegal membranes slightly conjoined, each with six branchiostegals; snout moderately produced; premaxillary frenum present; vertebrae 39 to 41 ($\bar{x} = 40.1$); first intraneural spine usually between the fourth and fifth neural spines; pyloric cecae two; pelvic fins long, separated by a space equal to ¾ or more of each fin base; anus surrounded by blunt striated lobes, not finger-like villi; preopercular margin entire; anal fin with two spines, the 2nd relatively weak; palatine and vomerine teeth well-developed; back usually crossed by four dark saddles.

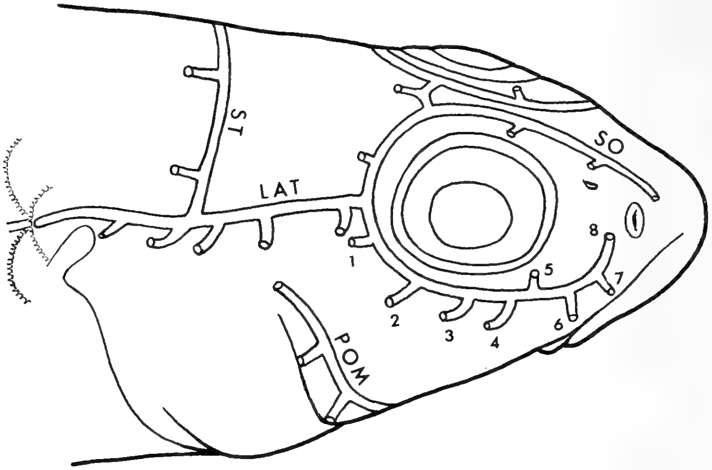

FIG. 2. Cephalic sensory canal system in *Etheosoma sellare.* ST = supratemporal, LAT = lateral, SO = supraorbital. Pores of the infraorbital canal are numbered 1–8. Preoperculomandibular canal (POM) partially shown.

DESCRIPTION

Meristic characters: Scale and fin ray counts are given in Table 1. No differences in counts that could be attributed to sex were found except in the diagonal scale count where there is a slight indication that males may have more scales than females. Precaudal and caudal vertebrae varied from 14 to 16 ($\bar{x} = 14.9$) and 24 to 27 ($\bar{x} = 25.2$) respectively. Total vertebrae varied from 39 to 41 ($\bar{x} = 40.1$); counts of 15 + 25 were found in 51 of 72 specimens.

Squamation: Top of head, nape, breast and prepectoral areas scaleless. Belly naked except, a few weakly ctenoid scales immediately in front of anus in a few specimens. Back, sides, cheeks and opercles with well-developed ctenoid scales. The small ctenoid scales extending onto caudal fin base more extensively developed on upper half of fin. Perhaps there is a correlation between this and another asymmetrical feature of the caudal fin in which the margin of the lower lobe is typically eroded into a broad curve and the upper lobe appears to be slightly longer (no difference between sexes).

Cephalic sensory çanals: Cephalic sensory canals (Fig. 2) complete and showed little variation except the infraorbital canal which varied both in position and number of pores between individuals and between left and right sides of the same individual. Observations taken from the right side follow: preoperculomandibular canal (partially illustrated)

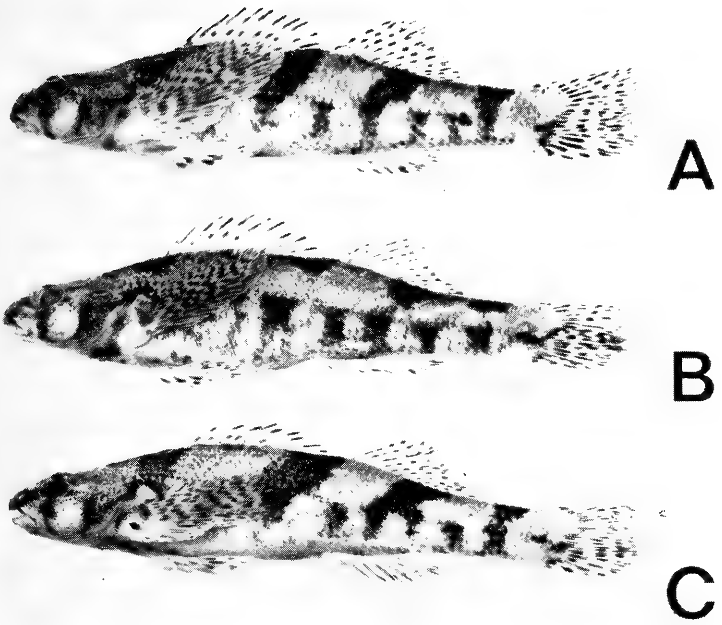

FIG. 3. *Etheostoma sellare,* USNM 212147, Deer Cr. A. Male, 55 mm SL, B. Atypical pattern, female, 63 mm SL. C. Female, 58 mm SL.

with 10 pores (in 72 specimens) and 9 (2): lateral canal with 5 pores (67) or 4 (7); supratemporal canal with a median pore and one lateral pore in all but one specimen which had a second lateral pore; supraorbital canal with coronal, anterior and posterior nasal, interorbital and postorbital pores; infraorbital canal with 8 pores (47), 9 (20) and 10 (7). In individuals with 8 infraorbital pores, 38 had the pattern shown in Fig. 2, 8 had both the 4th and 5th pores directed dorsally and 1 had pores 3, 4 and 5 directed dorsally. Specimens with 9 or 10 infratorbital pores frequently had 3 pores opening toward the upper lip and/or an extra pore directed up toward the eye. Infraorbital canal patterns on right and left sides were similar in 27 specimens and different in 41.

Color in alcohol: *Etheostoma sellare* has a relatively elaborate dark pattern that includes small spots, larger blotches, bars and saddles (Fig. 3). As in many other darters, the largest specimens are usually darkest.

Head more or less extensively stippled with dark brown spots on opercle, cheek, interorbital area, snout, lips and gular area. Triangular opercular flap behind opercular spine dark brown, melanism extending ventrally along the membrane and along edge of opercle and subopercle varies between individuals. Edge of preopercle outlined in dark brown contrasting with lighter cheek area immediately anterior. A characteristic darkspot at four o'clock position behind eye, a brown, usually vertical subocular bar, an interorbital dark bar that extends onto upper eye and a preocular dark bar angling downward onto upper lip.

Background color of back and sides brownish varying between individuals from brown to light tan. This fades out on lower side so venter appears yellowish. Individual scales or groups of scales having darker pigmentation frequently stand out from surrounding lighter areas. Such darker spots often appear reddish in freshly preserved specimens but are not apparent in life.

Pattern of saddles and blotches on trunk somewhat variable. Most commonly, back crossed by four dark brown saddles which often, but not always, extend ventrally to below lateral line. Widest saddle located between the two dorsal fins, next widest crosses nape in front of first dorsal fin and extends down toward pectoral fin base, a third, slightly narrower saddle lies beneath posterior five or six rays of soft dorsal fin and the narrowest crosses over caudal peduncle. Anterior saddle vertical while remaining three usually slant forward ventrally. Usually three to five dark brown blotches in spaces between saddles just below lateral line. In a second, uncommon pattern, saddles more or less abbreviated to mere dorsal blotches and about seven dark blotches situated below lateral line (Fig. 3B). Intermediacies between the two described patterns occur so that only one, two or three saddles may be developed and frequently a saddle that extends down one side of specimen does not extend down the other. Occasionally a fifth dorsal blotch or saddle is present near middle of first dorsal fin base. The saddles were poorly developed in the juvenile (22 mm SL) taken from Gasheys Run in 1962 and a lateral series of blotches in the form of x's and w's was prominent along trunk. With this color pattern, the Maryland darter juvenile was quite difficult to separate from tessellated dater juveniles taken in the same collection.

Small, black or brown basicaudal spot usually present on termination of lateral line or just below lateral line. Two small yellowish areas near base of caudal fin give caudal fin an asymmetrical pattern; lower area ventral to basicaudal spot and lies primarily anterior to caudal fin base; upper yellowish area somewhat larger and extends onto base of caudal fin rays. The two yellowish areas coincide with development of scale patches on caudal base, described above.

A dark prepectoral bar contrasts with yellowish area located between it and pectoral base; bar usually extends length of pectoral base and sometimes farther ventrad. Below prepectoral bar, one or two discrete brown blotches often extend onto chest just behind opercular membrane.

All fins have dark brown spots developed to a greater or lesser extent on rays with a few dark chromatophores extending onto adjacent interradial membranes but membranes primarily clear. Dark blotches on rays more or less aligned to give appearance of bands.

First dorsal fin with basal row of brown blotches followed by clear area, then a narrow row of brown blotches followed by clear band and finally a broader band of brown blotches. Tips of the spines clear.

Second dorsal fin has about four or five alternating clear and dark brown bands. Tips of rays clear. About four to six alternating dark brown and yellowish vertical bands on caudal fin; tips of rays clear.

Base of pectoral fin rays with roughly rectangular brown blotch extending across upper eight or ten rays. Below blotch, a light area that can be bright yellow in life; distally about ten alternating yellowish and dark brown bands with yellowish areas somewhat wider.

Pelvic fin typically clear at base, with a few indistinct dark streaks along rays about ¼ distance from base and then two or three alternating dark brown and yellow bands on distal half of fin. Melanism best developed on upper side of pelvic fin rays.

Color in life: The following description is based on field observations made by Raney and Schwartz (18 May 1965), Thomas and Masnik (10 July 1971), and on photographs of live specimens taken by me (1 November 1974).

Scales covered by dark saddles usually brownish (sometimes blackish) with black posterior edges, while scales covered by the lateral dark blotches primarily blackish. Edges of dark saddles, especially posterior edges, appear as greenish flecks. Interspaces between saddles and lateral blotches and light areas of head and nape vary from golden to olivaceous. Lower side and belly usually whitish but some have golden cast. Melanistic stippling and flecking on light colored areas of body varies from slight to moderate but may be heavier on lower sides.

Ray tips of first dorsal, anal, lower pectoral and anterior pelvic fin rays white. Remaining fin ray tips clear. Below clear or milky tips, alternating spots of brown and yellow on rays create appearance of alternating brown and yellow bands. Instead of yellow, two bands near base of anal fin clear as is basal pelvic fin band.

Brightest feature of color pattern is yellow-orange blotch on base of pelvic fin. A second distinctive feature is the golden-orange prepectoral blotch that sometimes surrounds a prepectoral brown bar or may be best developed below the bar. A second golden blotch on lower rear edge of opercle was noted by Michael T. Masnik. Anterior rim of eye golden in life, pupil blackish and iris orange.

Systematic position: Radcliffe and Welsh (1913) placed their new species in the genus *Hadropterus* without comment. Noting the lack of caducous scales, Hubbs and Black (1940) reassigned *Etheostoma sellare* to *Poecilichthys* and discussed its relationships with *P. variatus* group. Bailey and Gosline (1955) envisioned the subgenus *Etheostoma* as including *E. sellare* and 14 other species. The only modification to their interpretation of the subgenus has been the change in status of *E. gutselli*

TABLE 1. Counts of meristic characters in *Etheostoma sellare* (* indicates holotype).

Lateral Line Scales

43	44	45	46	47	48	49	50	51	52	53	N	x̄
2	7	8	12*	21	15	4	4	1	–	1	75	46.8

Least Caudal Peduncle Scales

16	17	18	19	N	x̄
34	30*	10	1	75	16.7

Diagonal Scales

	6	7	8	9	N	x̄
♀	23	8	–	–	31	6.26
♂	21	20	1	1	43	6.58
	44	28	1	1	74	6.54

Dorsal Spines

7	8	9	10	11	12	N	x̄
1	5	32	30	6*	1	75	9.5

Dorsal Soft Rays

11	12	13	N	x̄
17*	51	7	75	11.9

Total Dorsal Rays

19	20	21	22	23	N	x̄
1	10	31	26*	7	75	21.4

Anal Rays

8	9	10	N	x̄
25*	48	2	75	8.7

Total Pectoral Rays

26	27	28	29	30	N	x̄
2	3	48*	10	12	75	28.4

Left Pectoral Rays

13	14	15	N	x̄
4	52*	19	75	14.2

from a species to a subspecies of *E. blennioides* (Miller, 1968), so that the subgenus currently includes 14 species. Based on the presence or absence of breeding tubercles, Collette (1965) recognized three species groups (*E. zonale, E. inscriptum, E. variatum*). Richards (1966) used differences in dentition, tuberculation, body shape, color pattern and habits to distinguish three somewhat different species groups (*E. blennioides, E. thalassinum, E. variatum*) and two specialized relatives (*E. bennius* and *E. sellare*). Because of its specialized head shape and naked belly, Tsai (1966) concluded that "*E. sellare* diverged very early from other members in the evolution of the subgenus *Etheostoma*."

The Maryland darter has been placed in the subgenus *Etheostoma* primarily on the basis of vertebral counts, straight and complete lateral line, complete cephalic canals, number of anal spines, branchiostegal membrane connection and presence of dorsal saddles on the body. A comparison of selected characters found in *E. sellare* appears in Table 2. *E. sellare* differs from all other members of the subgenus in shape of snout, type of female urogenital papilla, lack of sexually dimorphic

TABLE 2. Comparison of *E. sellare* with other species in the subgenus *Etheostoma*.

Character	Others in subgenus	*E. sellare*
Shape of snout	blunt and declivitous	moderately produced
Female urogenital papilla	a long tube	a short pad
Coloration	males with bright colors	no bright colors
Branchiostegal juncture	moderately to broadly joined	slightly joined
Saddles	present in *E. variatum* group	present
Fifth infraorbital pore	extended upward on tube in some	upward on tube
Nape squamation	scaled in most	naked
Belly squamation	scaled in most	naked
Cheek squamation	naked in most	scaled
Shape of head viewed from above	not triangular	triangular

coloration and triangular shape of head when viewed from above. Despite breeding colors in male *E. blennius* being restricted to a narrow submarginal orange band and some basal orange markings in the first dorsal fin (a pattern quite similar to that found in the dorsal fin of *E. swannanoa*), I regard the complete lack of such color in *E. sellare* as significant. The Maryland darter also has fewer belly scales than most other members of the subgenus. The belly is completely naked in about 85% of the Maryland darter specimens. A few have scales encroaching toward the midline of the belly immediately in front of the vent and fewer still have one or two scales on the midline in this area but the belly is not really bridged by complete scale rows. Such encroaching scales tend to be smaller than scales on the sides of the body, are often partially embedded and have a reduced number of ctenii. None of the ctenii appear to be enlarged. Some populations of *E. histrio*, *E. rupestre* and *E. blennioides* tend to have a reduction in belly squamation but even in these, the average condition is more scales on the belly than in the Maryland darter. The belly is usually naked only in certain populations of *E. zonale*. The heavily scaled cheek in *E. sellare* can also be found in some populations of *E. zonale* and *E. blennioides* but, aside from a few specimens of *E. rupestre*, the Maryland darter is unique in the subgenus in having a naked nape.

Two additional characters that *E. sellare* shares with at least some members of the subgenus are the upward development of a tube bearing the fifth infraorbital pore and the presence of dorsal saddles. Similar pore conditions can also be found in four subgenera of *Percina*: *Hadropterus, Ericosma, Alvordius* and *Imostoma*. The presence of saddles is not restricted to the subgenus *Etheostoma* as they are found in *Ammocrypta asprella*, *Etheostoma trisella* and in *Percina uranidea* and other species of the subgenus *Imostoma*.

Finally, *E. sellare* averages fewer dorsal spines than other species in the subgenus (Table 3).

The above discussion has covered several characters that, within the subgenus *Etheostoma*, are found only in *E. sellare* or are shared by *E. sellare* with one or two other species. Present knowledge indicates that *E. sellare* is a primative darter that, except for lacking caducous scales, might be placed in the genus *Percina*. Within the genus *Etheostoma*, it appears most closely related to the subgenus *Etheostoma* but does not fit there well. It is hoped that additional studies utilizing anatomical, osteological and electrophoretic characters will indicate whether the concept of the genus *Percina* should be expanded to include the Maryland darter, whether a new monotypic subgenus should be erected for it in the genus *Etheostoma* or whether it should be retained in the subgenus *Etheostoma*.

Life History and Ecology

Little is known about the life history, behavior and ecology of the Maryland darter. This is primarily due to the small number of successful collections that have been made and the fact that no collections have been taken just prior to or during spawning. The high and turbid water conditions that typically prevail on lower Deer Creek during the spring have made collecting and observation of the darter very difficult.

Adults in CU 48607 (Deer Creek, 18 May 1965) are clearly post-spawning specimens with gonads and urogenital papillae in regressed states. Several specimens were checked for ripeness in the field by Raney with negative results. Ovaries in the adult female in USNM 212146 (Gasheys Run, 25 April 1965) were also regressed so spawning may have occurred in the early or middle part of April. April water temperatures in Gasheys Run average several degrees higher than those in Deer Creek. Gonads and urogenital papillae appear well-developed in adult specimens taken in Deer Creek, November 10, 1965 (USNM 212147). The right ovary from a specimen (64.2 mm SL) collected in November contained 407 eggs with an average diameter of one mm. Egg counts from gravid females are needed to estimate the number of eggs that actually mature.

Urogenital papillae and the lobes surrounding the anus are illustrated in Fig. 4. In both sexes, the anus is surrounded by irregularly shaped, flattish lobes that are quite different from the fingerlike villi found in *Etheostoma vitreum*.

As the breeding season approaches, the female urogenital papilla

TABLE 3. Dorsal spine counts in the subgenus *Etheostoma* (modified from Tsai, 1966, Richards, 1966 and Miller, 1968).

Species	Number of dorsal spines 7	8	9	10	11	12	13	14	15	N	x̄
E. sellare	1	5	32	30	6	1	–	–	–	75	9.5
E. histrio	–	–	71	222	48	–	–	–	–	328	9.9
E. inscriptum	–	7	129	494	67	3	–	–	–	700	9.9
E. thalassinum	–	1	44	174	37	–	–	–	–	256	10.0
E. zonale lynceum	–	1	7	78	33	1	–	–	–	120	10.2
E. zonale zonale	–	–	11	200	666	100	3	–	–	980	10.9
E. rupestre rupestre	–	–	–	10	36	7	1	–	–	54	10.9
E. blennius	–	–	–	–	16	20	3	–	–	39	11.7
E. rupestre cahabanum	–	–	–	3	33	80	9	–	–	125	11.8
E. tetrazonum	–	–	–	1	5	20	3	–	–	29	11.9
E. swannanoa	–	–	–	1	29	80	23	–	–	133	11.9
E. osburni	–	–	–	1	1	21	19	–	–	42	12.4
E. variatum	–	–	–	–	–	24	18	–	–	42	12.4
E. euzonum	–	–	–	–	–	5	6	–	–	11	12.5
E. kanawhae	–	–	–	–	1	14	28	2	–	45	12.7
E. blennioides gutselli	–	–	–	–	1	35	37	15	–	88	12.8
E. blennioides pholidotum	–	–	–	–	11	192	557	120	3	883	12.9
E. blennioides blennioides	–	–	–	–	4	143	640	163	2	952	13.0
E. blennioides newmani	–	–	–	–	1	94	852	614	56	1,618*	13.4

* Includes one specimen with 16 dorsal spines not shown in table.

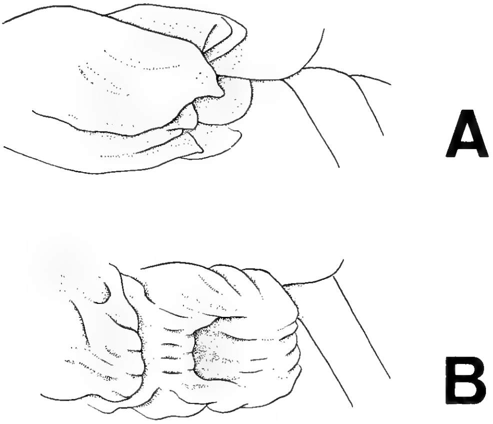

FIG. 4. Ventrolateral view of urogenital papillae in *Etheostoma sellare.* A. Male, B. Female.

develops as a swollen white pad that nearly reaches the first anal spine. The short urogenital papilla of the male, appearing like the tip of a bullet, shows little seasonal variation in size and shape and is often obscured by the overhanging anal flaps. The anal flaps connecting to either side of the base of the male urogenital papilla were described by Hubbs and Black (1940). No breeding tubercles have been found in the Maryland darter.

Examination of length frequencies of 72 specimens (Fig. 5) of the Maryland darter taken in Deer Creek (31 in May 1965, 35 in Nov. 1965, 4 in Aug. 1970 and 2 in July 1971) indicates the presence of three year classes. Lumping length data from different collection dates is usually not an acceptable practice, and the data in Fig. 5 probably presents an erroneous picture of the number of individuals in an age group or year class at a given time. Unfortunately, no single collection was large enough to demonstrate a clear picture of the number of age groups or year classes in the population at a given time and I believe that the lumped data has clarified this aspect. This assumption is valid only if there is little variation in the growth rate in different years. A cursory examination of scales seemed to verify that the three apparent peaks represent age groups 0, I and II. Scales from the 70 mm SL specimen showed three annuli and possibly a fourth. The average SL of age group 0 males and females was 53.9 mm and 47.3 mm respectively but in combining the remaining age groups, males averaged 60.4 mm SL and females 58.8 mm SL. It appears that some actual size differences between sexes in older specimens may exist because the seven largest specimens were males. The 21 mm juvenile in CU 43491

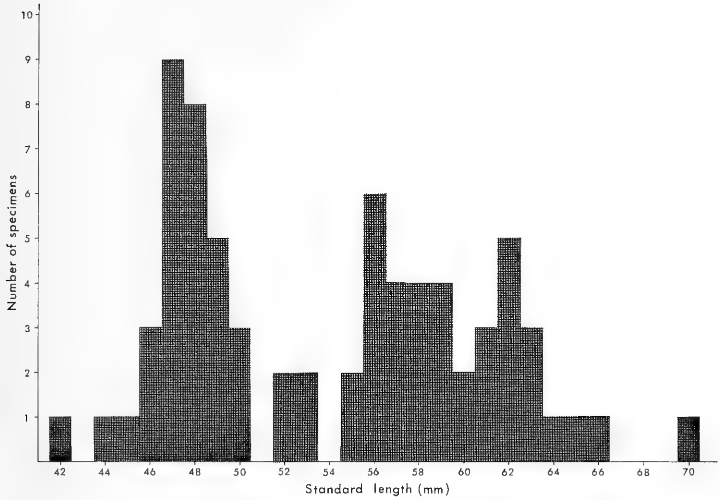

FIG. 5. Length frequency distribution of 72 specimens of *Etheostoma sellare* from Deer Creek.

(Gasheys Run, 10 June 1962) was undoubtedly a young-of-the-year fish.

Radiographs taken to provide vertebral counts of the Maryland darter also revealed some information about food habits. Of the 35 specimens taken on Nov. 10, 1965, 28 had from one to approximately eleven ($\bar{x} = 6.2$) snails in their digestive tracts. No snails could be seen in the other seven specimens and digestive tracts were removed from five of these. The contents were as follows: specimen no. 2, parts of three different caddis fly larvae (Hydropsychidae, *Hydropsyche* sp.); spec. no. 5, one larval *Hydropsyche* sp., one mayfly head (Heptageniidae), four snails (Hydrobiidae, probably *Clappia virginica*); spec. no. 6, one larval *Hydropsyche* sp., two stone fly nymphs (Perlidae); spec. no. 10, two larval *Hydropsyche* sp.; spec. no. 20, two complete and parts of two other larval *Hydropsyche* sp. The digestive tract was removed from one specimen whose radiograph showed snails and was found to contain seven snails that are close to *Clappia virginica* (Hydrobiidae) and remnants of two larvae of *Hydropsyche* sp. No snails were visible in the radiographs from 32 specimens collected during April and May but a single snail was present in one of five specimens taken 29 August 1970.

According to Joseph Rosewater (pers. comm.), *Clappia virginica* is found on vegetation and rocks and on silty substrates in rivers and in the mouths of smaller tributaries. It appears that snails and caddis fly larvae are a major constituent of the fall diet of the Maryland darter in

Deer Creek. Although snails have been found in the diets of other species of darters (Page, 1974; Stiles, 1972), they have usually been in trace amounts. Recently snails have been found to be an important food item in darters of the subgenus *Imostoma* and perhaps the major food item of *Percina tanasi*, the snail darter (Etnier, 1976).

All Maryland darter specimens except the two from Gasheys Run and the two type-specimens have come from the immediate vicinity of the large riffle on Deer Creek just below Stafford Road bridge. On 23 October 1974, this riffle was found to be about 25 meters wide across the crest. Gurly flowmeter readings taken in swift water near the foot of the riffle at heights of 5.1, 20.3 and 45.7 cm above the bottom were 29, 84.8 and 79 cm/sec. respectively. The maximum depth of the riffle, 61 cm, was at the point where the flowmeter readings were taken. The bottom is primarily rubble and rocks near the crest of the riffle with silt and gravel becoming more abundant toward the sides and foot. Rooted aquatic plants are moderately abundant on rocks in the riffle area. Plant samples taken on 10 November 1965 were riverweed, *Podostemum ceratophyllum* along with smaller amounts of curly pondweed, *Potamogeton crispus.*

A U.S. Geological Survey water stage recorder gauge is located on Deer Creek 15 m upstream from the U.S. Highway 1 bridge, 1.6 km north of Kalmia, Maryland. The gauge site is 44 m above sea level and about 18.1 km above the site of the Maryland darter. Average daily discharges, in cubic meters per seconds (cms) during the unusually wet period from October 1972 to September 1973 were: October, 3.6; November, 8.4; December, 10.9; January, 8.7; February, 9.9; March, 7.4; April, 12.2; May, 9.2; June, 7.9; July, 5.4; August, 3.8; and September, 3.4. The average daily discharge during the above period, 7.5 cms, contrasts with the average over the six previous years of 5.6 cms. That the Maryland darter has to contend with rather severe fluctuations in water level is evidenced by the following readings at Kalmia: from 3.6 cms on 13 November to 47.5 cms on 14 November 1972; from 15.4 cms on 7 December to 32 cms on 9 December 1972; from 7.1 cms on 31 March to 28.6 cms on 2 April 1973; and from 9.5 cms on 27 May to 35.1 cms on 28 May 1973. Obviously the flows at the Stafford Road crossing are in excess of those upstream at Kalmia.

Edward C. Raney (field notes, 18 May 1965) indicated that most of the Maryland darters were taken on the south side of the riffle within 5 m of shore, that a few were taken along the north side of the riffle where the current was not too swift and that none were taken in the center of the riffle. Apparently the water level at the Deer Creek site was higher on this date than on subsequent dates when the darter was collected. On 23 October 1974, a specimen was taken at the foot of the riffle where the depth was 61 cm and on 1 November 1974, one specimen was taken near the south shore in shallow water and one specimen was taken near the head of the riffle a little north of midstream, also in shallow water. Collette and Knapp encountered water conditions so low on 10 November 1965, that the crest of the riffle was only 9 to 15 m wide. The deepest part of the riffle was carrying enough water for seining and the Maryland darters were primarily taken in the swiftest area of the current, a chute no more than 6.1 m in width. At this time, several juveniles were taken up to 30 m below the riffle area and up to 60 to 90 m upstream from the bridge.

Other fishes most commonly found associated with *E. sellare* in the Deer Creek riffle are *Anguilla rostrata* (Lesueur), *Nocomis micropogon* (Cope), *Rhinichthys atratalus* (Hermann), *R. cataractae* (Valenciennes) and *E. olmstedi* (Storer). Of these, the longnose dace is probably the most abundant. *E. olmstedi* is not commonly taken with *E. sellare* and prefers the quieter currents at the edges of the riffle.

DISTRIBUTION

To date, the Maryland darter has been reported from only three Harford County, Maryland sites: Swan Creek, Gasheys Run and Deer Creek (Fig. 1).

No additional specimens have been collected from Swan Creek since the type-collection in 1912. To quote Radcliffe and Welsh (1913), "The examples of the new species herein described were seined in Swan Creek, near Havre de Grace, Maryland, in water 6 inches deep, on a long, stony riffle, where the bottom was comparatively free from bowlders and the current so swift that one would not have expected to find fishes of any kind." The above description of the type-locality is vague and as the lower reaches of Swan Creek are heavily silted today, there is little possibility of identifying the riffle in question.

The precise location where the juvenile specimen was taken on Gasheys Run in 1962 is unknown as it was collected unnoticed among many tessellated darter juveniles. It was taken within a distance of 0.8 km upstream or downstream from the Oakington Road crossing. The 1965 female specimen was taken from a small riffle located approximately 0.8 km upstream from the Oakington Road crossing. Records of the Maryland darter from Deer Creek are only from the area immediately adjacent to the Stafford Road crossing of the stream.

The two confirmed Maryland darter sites in Gasheys Run and Deer Creek are located on the lower reaches of those streams. In Deer Creek, it appears to be the first major riffle area above tidewater while in Gasheys Run, it is somewhat further upstream. A considerable amount of collecting in Gasheys Run and a moderate amount of collecting in Deer Creek indicates that, despite the presence of seemingly good habitat further upstream and the lack of any appreciable physical barrier, the Maryland darter does not move up these streams much above base level. Perhaps, like *Etheostoma histrio* (see Tsai, 1968), *E. sellare* is restricted to swift riffles of the Coastal Plain. If so, its range in the lower Susquehanna River could have been markedly reduced when the submergence of coastal areas resulted in the formation of Chesapeake

Bay. A further constriction of range may have occurred with completion of Conowingo Dam in 1928 and other impoundments further upstream toward Harrisburg. The mouths of streams immediately above Conowingo Dam are inundated and comparable sites on many streams such as Swan Creek below the dam are rather heavily silted and more or less polluted. If this reasoning is correct the Deer Creek riffle site may be the only habitat for the Maryland darter remaining in the lower Susquehanna drainage.

Unlike Swan Creek, the lower reaches of Gasheys Run flow through woodlands and except for immediately above its mouth, are relatively unsilted. Gasheys Run is about 8 km in length and, at normal flow, most riffles are only 1 to 3 m in width. The riffles are primarily composed of gravel and currents are slower than in Deer Creek as evidenced by the replacement of *Rhinichthys cataractae* with *R. atratalus* and by the abundant presence of *Etheostoma olmstedi.* During droughts, Gasheys Run barely maintains a flow. It is probable that the lack of suitable habitat prevents *E. sellare* from becoming permanently established in Gasheys Run and that only stragglers from Deer Creek are periodically found there. Such stragglers may occasionally spawn in Gasheys Run and so account for the juvenile taken in 1962 but it is possible that the juvenile was also a straggler. It is only about 21 kms from the mouth of Deer Creek to the mouth of Gasheys Run and during periods of peak discharge, the influence of freshwater from Deer Creek may be detected along the west bank of the Susquehanna River down to its mouth (pers. comm., Kenneth Unruh). With the periodic high water levels in Deer Creek mentioned previously and with Conowingo Dam blocking upstream movement, conditions are certainly favorable for the movement of Maryland darters downstream. Darters do survive in the upper Bay as appreciable numbers of *Etheostoma olmstedi* are found along the shore above the mouth of Swan Creek. Gasheys Run is the first significant tributary entering the upper Bay on the western shore below the mouth of the Susquehanna River.

One alternative to a Deer Creek origin of stragglers reaching Gasheys Run would be for the Maryland darter to live in the Susquehanna River below Conowingo Dam. This would not appear likely as severe fluctuations in the amount of water released from Conowingo Dam occur almost daily. When the dam is generating electrical power, the river below resembles a giant raceway. Much of the substrate is bedrock and unconsolidated materials such as rubble and gravel have almost been flushed out. Protected areas tend to fill with silt. Little darter collecting has been attempted in this difficult and seemingly unfavorable habitat so it cannot be entirely ruled out as a possibility.

STATUS

If the Deer Creek riffle site supports the only permanent population, the outlook for the continued survival of this species is grim. Its apparently chosen habitat near the mouth of the creek is vulnerable to disturbances, man-made or natural. Limnological studies (pers. comm., Dr. John Foerster, WAPORA, Inc., Washington, D.C.) have indicated appreciable amounts of pollution there in recent years from agricultural and other sources. Samples of algal growths that were common along the margins of Deer Creek at Stafford Road crossing on 21 August 1974 primarily consisted of the blue green genera *Microcoleus* and *Oscillatoria.* These are probable indicators of pollution. The sewage treatment plant at Stewartstown remains a threat because of its possible malfunction, not to mention the poorly understood, long-term effects of chloramines introduced there.

The Maryland darter is protected by both federal and state regulations and recently the Fish and Wildlife Service, USDI, appointed a "recovery team" (Charles Frisbie, Maryland Department of Natural Resources, John Sheridan, U.S. Fish and Wildlife Service and Leslie Knapp) to draft a "recovery plan" in an attempt to promote the survival of this unique fish. Further clarification of the range and ecological requirements of *E. sellare* is prerequisite to such a plan and a survey is in progress. When such information is available, it is hoped that some measure of permanent protection can be accorded to the Maryland darter.

MATERIAL

All collections of the Maryland darter known to me are listed below. Collections not examined in this study are indicated by an asterisk following the catalog number. The following abbreviations have been used: National Museum of Natural History (USNM); Cornell University (CU); Tulane University (TU); Museum of Zoology, University of Michigan (UMMZ); Virginia Polytechnic Institute (VPI); University of Florida, Gainesville (UF). USNM 74346 (♂, 39 mm SL), holotype, Swan Cr. near Havre de Grace, Harford Co., Md., 2 May 1912, Lewis Radcliffe and William W. Welsh. USNM 74347 (♂, 39), paratype, same data as holotype. CU 43491 (1, 21), Gasheys Run at Oakington Rd. crossing, 0.9 mi E jct Oakington Rd. and Hw 22 in Aberdeen, Harford Co., Md., 10 June 1962, L. W. Knapp, W. J. Richards, Robert Victor Miller and N. R. Foster. USNM 212146 (♀, 48), same locality as CU 43491, 25 April 1965, L. W. Knapp, B. B. Collette and D. M. Cohen. CU 48607 (9♂, 7♀, 44-62), Deer Cr. at Stafford Rd., 1.2 mi above mouth at Susquehanna R and 2.3 mi SE Darlington, Harford Co., Md., 18 May 1965, E. C. Raney and F. J. Schwartz. CU 48607* (2), same data, cleared and stained. CU 49496 (9♂, 6♀, 46–63), same locality and collectors as CU 48607, 30 May 1965. USNM 212147 (18♂, 16♀, 42–70), same locality as CU 48607, 10 Nov. 1965, L. W. Knapp, Collette and H. A. Fehlmann. UF 20808 (♂, 58), same data as USNM 212147. TU 64249* (2, 45, 61), removed from CU 49496. CU 99006 (2♂, 52, 61), same locality as CU 48607, 29 Aug. 1970, D. C.

Thomas and M. Masnik. VPI 2468 (♀, 58; ♂, 60), removed from CU 99006. VPI 2651 (♂, 53), same locality as CU 48607, 10 July 1971, D. L. Thomas, Masnik and J. Wong. UMMZ 191647* (1, 62), same data as VPI 2651.

ACKNOWLEDGMENTS

I especially thank the following individuals for generously relinquishing their interests in this study and for providing information from field notes, unpublished manuscripts, and other sources: Bruce B. Collette, Michael T. Masnik, Edward C. Raney, Frank J. Schwartz, David L. Thomas, and Chu-fa Tsai. William M. Howell and Edward C. Raney arranged for the loan of specimens from the Cornell University Fish Collection as did Robert D. Ross from the fish collection of Virginia Polytechnic Institute. Reeve M. Bailey, University of Michigan, Royal D. Suttkus, Tulane University and Kenneth Unruh, Harford County Department of Planning and Zoning provided data. Among the many people who provided valuable assistance in the field, I would like to thank W. R. Carter, Daniel M. Cohen, Bruce B. Collette, H. Adair Fehlmann, Betty H. Knapp and James D. Williams. Neil Hotchkiss identified the aquatic plants, Paul J. Spangler and Oliver S. Flint, Jr. the aquatic insect larvae and Joseph Rosewater the snails. Radiographs were taken by John Butler, Edgar N. Gramblin and Martin F. Gomon. James F. Mckinney prepared the photographs. Special appreciation is due the National Marine Fisheries Service Systematics Laboratory, USNM for allowing Keiko Hiratsuka Moore to make the fine drawings. The manuscript was read by Bruce B. Collette, Ernest A. Lachner and James D. Williams.

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No. 7, pp. 119–126 25 June 1976

PROCEEDINGS
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NICOTHOE TUMULOSA A NEW SIPHONOSTOME COPEPOD PARASITIC ON THE UNIQUE DECAPOD *NEOGLYPHEA INOPINATA* FOREST AND SAINT LAURENT

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A new decapod crustacean representing the only known extant member of the Glypheidae was recently described by Forest and Saint Laurent (1975). This unique specimen was collected during an *Albatross* cruise in 1908 and until recently remained unidentified in the collections of the Smithsonian Institution. During an examination of that specimen, parasitic copepods were collected from the gills. That material forms the basis of this paper.

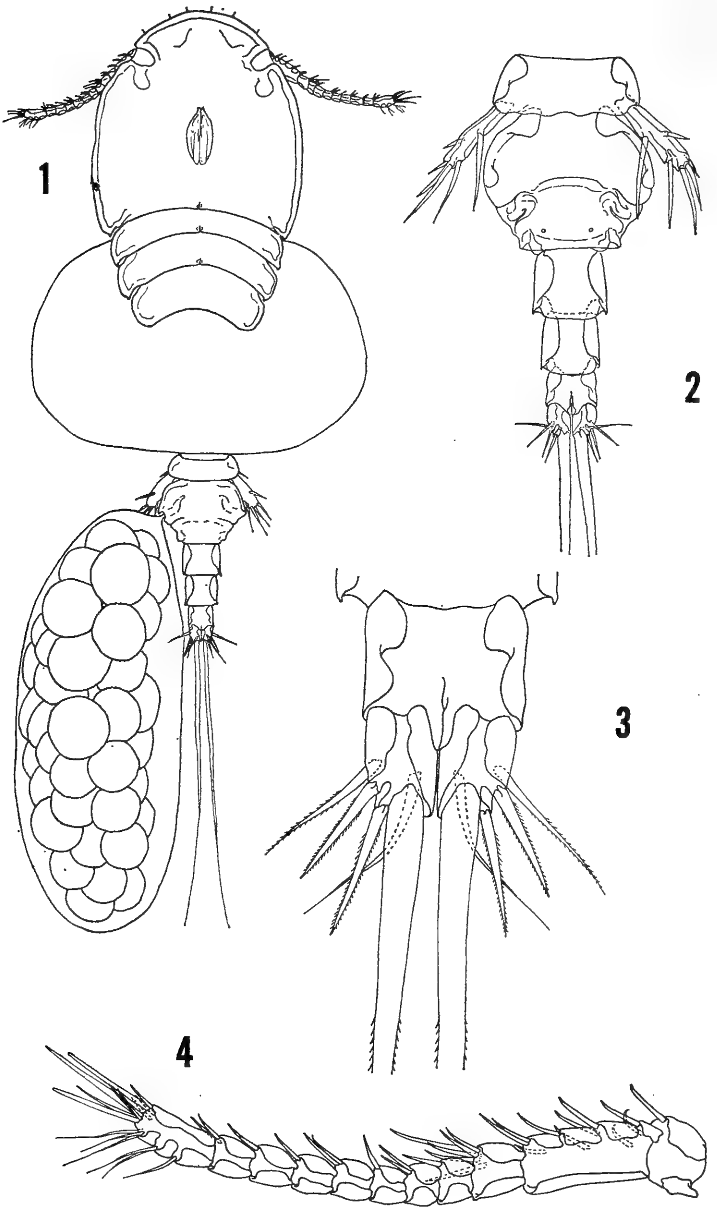
All drawings were made with the aid of a Wild drawing tube.

I wish to thank J. Forest and M. de Saint Laurent for bringing the parasitic copepods to my attention.

Nicothoe tumulosa new species
Figures 1–14

Material studied: Holotype ♀ (USNM 154661), and 5 paratype ♀♀ (4 adult, 1 immature) (USNM 154662), parasitic on the gills of decapod crustacean *Neoglyphea inopinata* Forest and Saint Laurent collected from off Malavatuan Is., Philippines, 17 July 1908, *Albatross* Sta. 5278.

Female: Body form as in Figure 1. Total length 1.24 mm. Greatest width 0.59 mm (measured at widest part of thorax). Cephalon slightly wider than long (413 μm × 389 μm). Thoracic segments fused laterally and ventrally to form a laterally expanded globular trunk with 3 dorsal plates covering most of anterior half. Surface of trunk (excluding plates) covered with many small sclerotized bumps. Thoracic segment bearing leg 5 free. Genital segment (Fig. 2) rounded, slightly wider

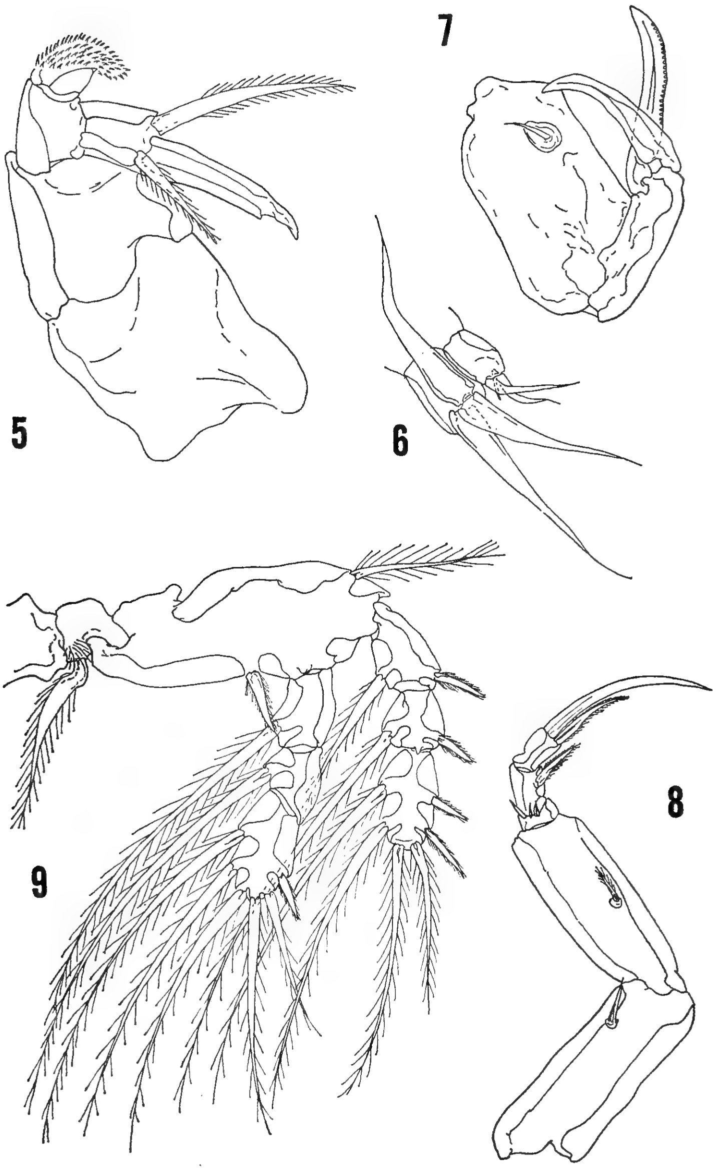


Figs. 1–4. *Nicothoe tumulosa,* new species, female: 1, Dorsal; 2, Genital segment and abdomen; 3, Caudal rami; 4, First antenna.

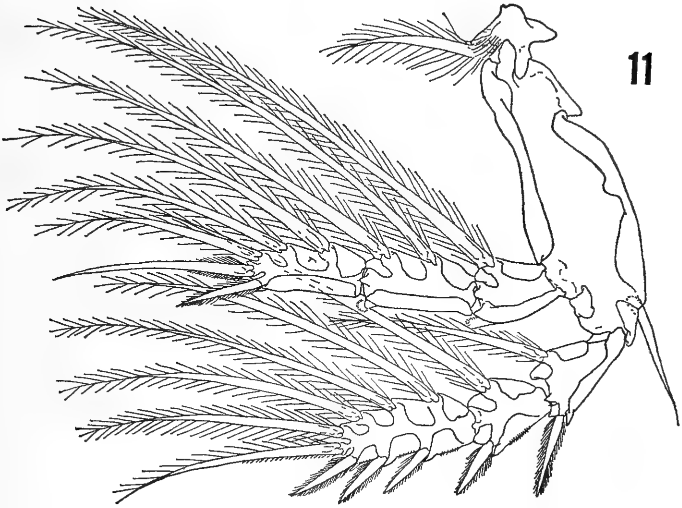
than long (171 μm × 124 μm). Abdomen (see Fig. 2) 3-segmented, each segment wider than long (77 μm × 65 μm, 65 μm × 59 μm, and 50 μm × 44 μm respectively) and with well sclerotized lateral margins. Caudal rami (Fig. 3) longer than wide (35 μm × 21 μm), well sclerotized, bearing one long seta (561 μm) and 4 short setae, all setae with short, fine, plumosities except inner subterminal seta naked.

First antenna (Fig. 4) 11-segmented, each armed with setae respectively as follows: 1, 10, 6, 1, 2, 1, 2, 1, 1, 2, 13 setae and 2 aesthaetes. Kabata (1967) described the armature of the terminal segment of the first antenna of *Nicothoe analata* Kabata in considerable detail and the new species described here agrees with that description. All setae on first 10 segments are short and thicker toward tip than those of last segment. Second antenna (Fig. 5) 5-segmented; first 2 stout and unarmed; third short, bearing a prominent spinulose palp; fourth short and bearing 2 plumose setae on outer distal corners; fifth much longer than wide with short distal claw; last 2 segments directed at right angle to basal 3. Mouth cone as in other members of genus with simple bladelike mandible within. First maxilla (Fig. 6) biramose; exopod bearing 2 long and 1 short setae (Kabata 1966, shows 2 short setae in *N. analata* but a second seta could not be found in the present species), endopod with 2 long anterior and 1 posterior setae. Second maxilla (Fig. 7) 2-segmented; basal segment stout, armed with a short seta near base; terminal segment bearing 2 prominent spines, outermost clawlike, innermost bladelike with row of denticles. Maxilliped (Fig. 8) 5-segmented; basal 2 segments of about equal length, each with short seta; third segment short and bearing 3 short setae (2 "denticles" in *N. analata* Kabata), fourth segment with stout, plumose seta, fifth segment with 2 prominent setae, longest recurved and clawlike, shorter finely plumose.

Legs 1–4 biramose, each ramus 3-segmented, each with 1-segmented sympod as in other species of genus. Leg 1 (Fig. 9) sympod with long plumose seta on outer edge; stout, finely plumose seta near inner base of endopod; long plumose seta near interpodal plate; exopod first segment with stout finely fringed spine at outer distal corner and plumose seta on inner margin, second segment armed as in first, third segment with 2 outer finely fringed spines and 4 terminal to inner setae; endopod first segment with inner plumose seta, second segment armed as in first, third segment with single outer fringed spine and 5 terminal to inner setae. Leg 2 (Fig. 10) sympod as in leg 1 except without finely plumose seta near inner base of endopod; exopod first 2 segments as in leg 1, last segment with 3 outer fringed spines and 5 terminal to inner setae; endopod first segment with inner seta and fringed process on outer distal corner, second segment with 2 inner setae and fringed process on outer distal corner, last segment with single fringed spine and 5 terminal to inner setae. Leg 3 (Fig. 11) sympod as in leg 2 except outer seta appears naked; exopod armed as in leg 2; endopod first 2 segments as in leg 2, last segment with 2 fringed



Figs. 5–9. *Nicothoe tumulosa*, new species, female, cont.: 5, Second antenna; 6, First maxilla; 7, Second maxilla; 8, Maxilliped; 9, First leg.



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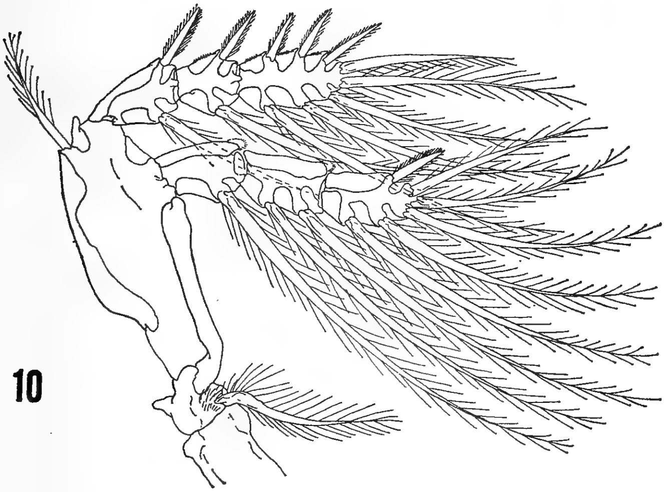

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Figs. 10–11. *Nicothoe tumulosa,* new species, female, cont.: 10, Second leg; 11, Third leg.

terminal spines (longest fringed on basal third only) and 3 inner setae. Leg 4 (Fig. 12) sympod as in leg 3; exopod armed as in leg 3; endopod as in leg 3 except only 2 inner setae on last segment. Leg 5 (Fig. 13) with short seta near base of free segment; free segment with 6 setae bearing short plumosities (outer 3 shorter than inner 3). All segments of legs 1–5 heavily sclerotized. Leg 6 absent.

Spine and setal formula of legs 1–4 as follows (Roman numerals refer to spines, Arabic to setae):

	P_1		P_2		P_3		P_4	
	exo	end	exo	end	exo	end	exo	end
seg 1	I:1	0:1	I:1	0:1	I:1	0:1	I:1	0:1
seg 2	I:1	0:1	I:1	0:2	I:1	0:2	I:1	0:2
seg 3	II:4	I:5	III:5	I:5	III:5	II:3	III:5	II:2

Spine and setal formula of legs 1–4 of all other species of *Nicothoe* (according to Kabata 1966. For convenience Kabata's symbols have been changed to conform to those above).

	P_1		P_2		P_3		P_4	
	exo	end	exo	end	exo	end	exo	end
seg 1	I:1	0:1	I:1	0:1	I:1	0:1	I:1	0:1
seg 2	I:1	0:1	I:1	0:2	I:1	0:2	I:1	0:2
seg 3	III:4	I:5	III:5	II:2	III:5	II:3	III:5	II:3

Eggs sacs typically cyclopoid, containing 50–60 eggs.

Immature female: The collection contained an immature female (Fig. 14) which agrees in all respects with the adult except for the lack of trunk modification typical of adult females. Kabata 1967 illustrated and discussed the immature female of *N. analata*, and as in *N. tumulosa* it also is distinguished from the adult only by the trunk modification. Measurements for the immature female as follows: length 938 μm, greatest width (cephalon) 437 μm, cephalon length 395 μm, genital segment 136 μm long and 177 μm wide, length and width of abdominal segments respectively 59 μm × 83 μm, 59 μm × 59 μm, 35 μm × 53 μm, caudal ramus 38 μm long and 24 μm wide, its longest seta 561 μm long.

Color in preserved specimens—purple.

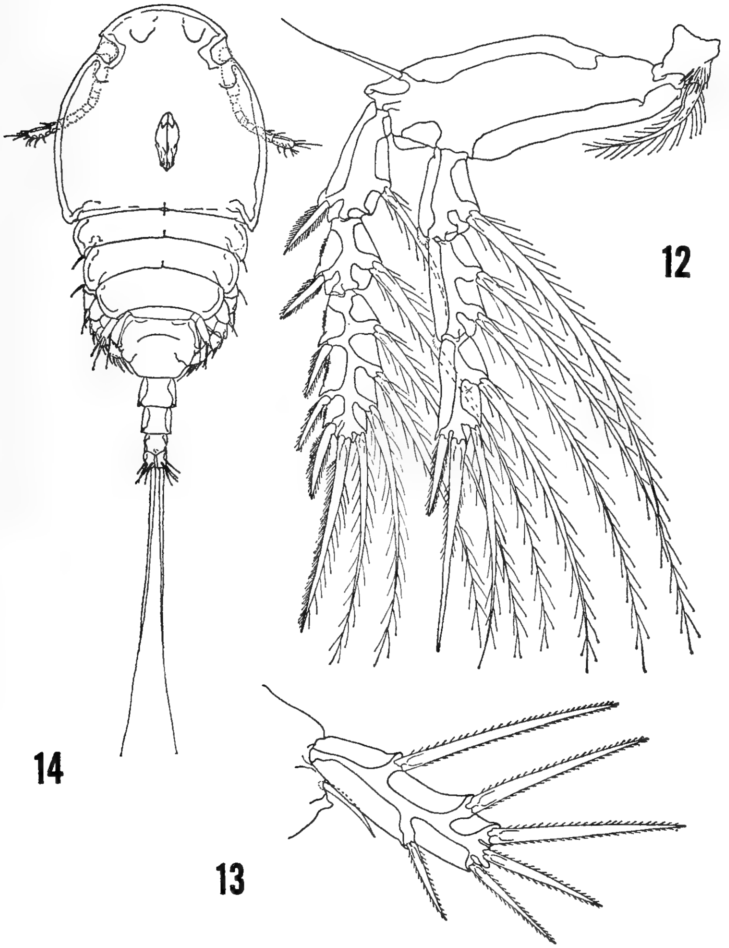
Male: unknown.

Etymology: *tumulosa*, Latin, to be full of mounds, alluding to the nature of the surface of the trunk of the adult female.

Remarks: *Nicothoe tumulosa* can be separated from all other species of the genus by the spine and setal formulae of legs 1–4 (see text description). It can be further separated by the nature of the trunk modification of the adult female.

It might be expected that the copepod would exhibit primative characters relative to the other members of the genus based on the primative nature of the host. The only condition evident in the new species suggesting this is that it has the least trunk modification of the known species. Aside from this nothing else suggests that it is ancestral or could be construed as primative relative to other *Nicothoe*.

Prior to the description of the new species the genus *Nicothoe* has been



Figs. 12–14. *Nicothoe tumulosa,* new species, female, cont.: 12, Fourth leg; 13, Fifth leg; 14, Immature female.

known only from hosts of the genus *Homarus* (*H. gammarus*) and various species of the Indo-Pacific genus *Metanephrops.*

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PROCEEDINGS
OF THE
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EURYTEMORA RICHINGSI, A NEW SPECIES OF DEEP-WATER CALANOID COPEPOD FROM THE ARCTIC OCEAN[1]

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There are 32 described species of *Eurytemora* of which 12 are considered to be synonyms (Table 1) (Giesbrecht and Schmeil, 1898; Sars, 1902; Gurney, 1931, 1933; Smirnov, 1931). Of the 20 valid *Eurytemora* species (Table 2), 7 are restricted to fresh water, 7 are found in both fresh and brackish water, and 4 occur only in brackish water. *Eurytemora affinis*, *E. herdmani*, and *E. pacifica* are the only species known to live also in marine waters, but usually they have been found close to shorelines and always above a continental shelf. This paper describes a new species, *E. richingsi*, from deep samples collected in the Canada Basin of the Arctic Ocean. *Eurytemora richingsi* is the first *Eurytemora* species to be reported only from a marine environment.

Gurney (1931) suggested the possibility that *Eurytemora* may have evolved from the marine genus *Temora* in the "arctic sea of glacial times." The genus has a definite northern distribution and it is therefore not surprising to find an Arctic marine representative.

Eurytemora richingsi was collected from Fletcher's Ice Island (T-3) using 1-m closing nets with mesh aperture of 0.110 mm (Damkaer, 1975). Figures were drawn with the aid of a Wild M20 drawing tube. The letter after each figure legend refers to the 0.10-mm scale to which the figure was

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[1] Contribution No. 876 from the Department of Oceanography, University of Washington WB-10, Seattle, Washington 98195.

Table 1. *Eurytemora* synonymy.

- *E. affinis* (Poppe, 1880)
  - *E. inermis* (Boeck, 1865)
  - *E. hirundo* Giesbrecht, 1881
  - *E. hirundoides* (Nordquist, 1888)
- *E. americana* Williams, 1906
  - *E. thompsoni* Willey, 1923
  - *E. transversalis* Campbell, 1930
  - *E. kieferi* Smirnov, 1931
- *E. canadensis* Marsh, 1920
  - *E. tolli* Rylov, 1922
- *E. lacustris* (Poppe, 1887)
  - *E. intermedia* Nordquist, 1887
- *E. pacifica* Sato, 1913
  - *E. johanseni* Willey, 1920
- *E. velox* (Lilljeborg, 1853)
  - *E. lacinulata* (Fischer, 1853)
  - *E. clausii* (Hoek, 1878)
  - *E. adleri* Schiklejew, 1931

drawn. Body length measurements were taken from specimens in glycerine, from the anterior border of prosome to posterior edge of uropods.

The authors are indebted to Dr. T. Saunders English for the opportunity to study the samples collected from Fletcher's Ice Island and for other kindnesses. The specimens were found coincidental to an investigation directed by Dr. English and supported through Office of Naval Research (Contract N00014-67-A-0103-0005 Project NR083 012).

Eurytemora richingsi, new species

Figures 1–17

Material studied: Holotype female, 1.68 mm (USNM 154756) 1000–500 m, 83°14'N, 153°48'W, 12 June 1968; allotype male, 1.52 mm (USNM 154757) 400–350 m, paratypes, 1 female and 1 male (USNM 154758) 500–400 m, 83°14'N, 154°2'W, 10 June 1968.

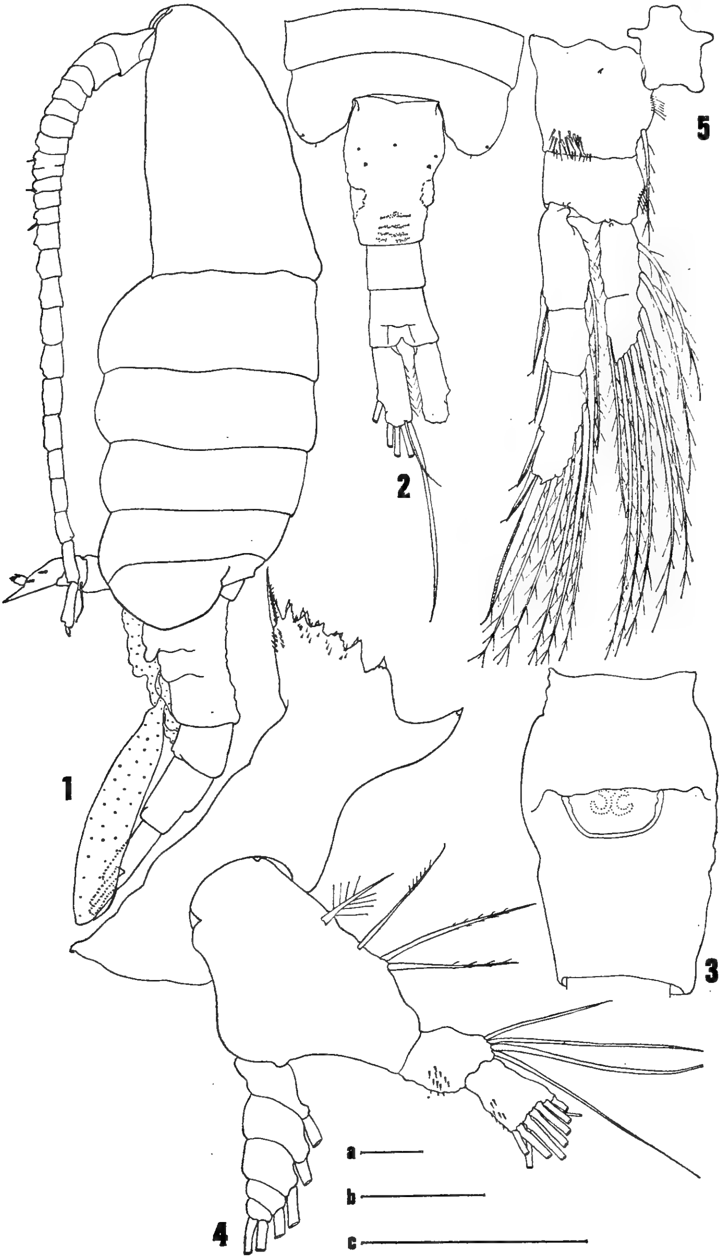
Female: Body with moderately stocky prosome (Fig. 1). Length about 1.74 mm (4 specimens, 1.68–1.80 mm). Last prosomal segment (Fig. 2) with rounded corners, hyaline margins slightly produced ventrolaterally. Cephalic segment with depression in lateral view. Genital segment (Fig. 2) lateral margins asymmetrical, with circumscribed hyaline areas where some *Eurytemora* species have protrusions; most surfaces rugose; rows of minute spinules on distal third of dorsal surface. Genital operculum protruding ventrally, about twice as wide as long (Fig. 3). Uropod length approximately equal to that of anal segment; inner marginal hairs. All specimens with damaged uropodal setae except dorsal and innermost terminal setae.

Rostral filaments extend to half the width of first antenna basal segment. First antenna reaching to distal adge of prosome, 25-segmented; 8–9 and 24–25 with incomplete sutures. Numerical armature (Table 3)

Table 2. Characteristics of *Eurytemora* species, compiled from literature.

	Length, mm		Metasomal wings	Anal segment/ Uropod*	Environment		
	Female	Male			Fresh	Brackish	Marine
E. affinis (Poppe, 1880)	0.80–1.90	0.75–1.65	+,o	7/17	+	+	+
E. americana Williams, 1906	1.14–1.85	0.75–1.60	+	4/7		+	
E. anadyrensis Borutsky, 1960	1.30–1.60	1.20–1.40	+	2/3	+		
E. arctica Wilson & Tash, 1966	1.85–2.02	1.56–1.65	+	6/11	+		
E. asymmetrica Smirnov, 1935	1.74–1.95	1.60–1.79	+	3/4		+	
E. bilobata Akatova, 1949	1.58		+	1/2	+		
E. canadensis Marsh, 1920	1.30–2.30	1.20–2.10	o	1/2	+	+	
E. composita Keiser, 1929	1.21–1.46	1.07–1.20	+	7/9	+	+	
E. foveola Johnson, 1961	1.12–1.25	1.00–1.20	+	1/2	+	+	
E. gracilicauda Akatova, 1949	1.54–1.65	1.16–1.33	+	1/2	+	+	
E. gracilis (Sars, 1898)	1.20–1.40	1.25–1.30	+	9/13		+	
E. grimmi (Sars, 1897)	1.50–1.70	1.30–1.40	o	11/17		+	
E. herdmani Thompson & Scott, 1897	1.05–1.60	1.16–1.50	+	6/11		+	+
E. kurenkovi Borutsky, 1960	1.23–1.40	1.02–1.12	+	2/5	+		
E. lacustris (Poppe, 1887)	1.10–1.40	1.10–1.30	o	2/3	+		
E. pacifica Sato, 1913	0.99–1.46	0.99–1.16	+,o	8/9		+	+
E. raboti Richard, 1897	1.20–2.20	1.10–2.10	+	1/2	+	+	
E. richingsi new species	1.68–1.80	1.40–1.56	o	1/1			+
E. velox (Lilljeborg, 1853)	1.30–2.20	1.20–1.80	+	10/11	+	+	
E. wolterecki Mann, 1940	1.09–1.16	0.97–1.04	+	12/13	+		
E. yukonensis Wilson, 1953	1.64	1.38	+	7/9	+		

* Relative lengths of anal segment and uropods (terminology after Bowman, 1971).


1
2
3
4
5
a
b
c

typical for the genus, except segment 10, with a seta in addition to the usual spine.

Mandible (Fig. 4) with wide gap on blade separating outer denticle. Hyaline setules between and at bases of some denticles and anterior edge. Second antenna, first maxilla, second maxilla, and maxilliped with setation and segmentation typical for the genus.

Leg 1 (Fig. 5) atypical for the genus: endopod with 8 instead of 6 setae, and incipient segmentation on anterior surface. Anterodistal cluster of setules on first basipod. Legs 2–4 (Figs. 6–8) with segmentation and setation typical for the genus; exopods with hyaline pointed cusps at anterior base of each spine. Legs 1–4 with outer exopod spines trowel-shaped, posterior view; each edge with hyaline serrated flange, usually apparent in anterior view. Sars' (1902) figure of *Eurytemora velox* leg 1, third exopod, is missing a spine, but his illustration of the species as *Temorella lacinulata* (Fischer) in 1897 correctly shows 1 long and 2 short spines.

Leg 5 (Fig. 9) with outer sclerotized margins, conspicuous at posterior articulation of exopod (Fig. 10). First exopod with 2 finely barbed outer spines; robust inner spinous process with anterior and posterior row of short spinules. Second exopod small, oval, with 2 outer and 1 terminal finely barbed, sinuate spines; 2 delicate setules on inner margin.

Male: Body with moderately stocky prosome (Fig. 11). Length about 1.49 mm (4 specimens, 1.40–1.56 mm). Last prosomal segment rounded, not produced. Uropod length about equal to combined length of preceding 2 segments (Fig. 12). Uropodal setae longer than uropod.

First antenna (Table 3) differs from other males in the genus with the additions of an esthete on segments 4 and 5, a seta on left segment 10, and a spine on right segment 10 (Fig. 13). Right and left segment 5 with 1 elongate and 1 short esthete; delicate setules on segments 4, 5, and 7. Esthetes on right and left segments 11, 13, and 15 elongate, with dilated bases. Left segment 17 with elongate esthete. Right segments 6–11 ridged and curved with dorsal coalescence; segments 13–16 expanded; segment 16 (Fig. 14) with 2 spinous protuberances partially covering 2 pores, a setule between them; segments 17–19 each with complex sclerotized pointed processes bearing scale-like modified setules, geniculation between 18, 19. Second antenna, mandible, first maxilla, second maxilla, and maxillipeds like those of female.

Legs 1–4 similar to those of female. Leg 5 (Figs. 15–16) with first basal segments fused left to right. Left ramus 3-segmented: second basal segment and first exopod robust; second exopod mitten-shaped

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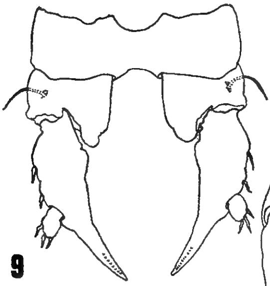
FIGS. 1–5. *Eurytemora richingsi* new species, female: 1, Lateral (a); 2, Posterior of prosome and urosome, dorsal (a); 3, Genital segment, ventral (b); 4, Right mandible (c); 5, Leg 1, anterior (b).



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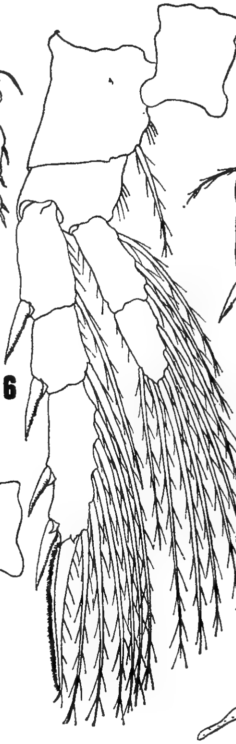

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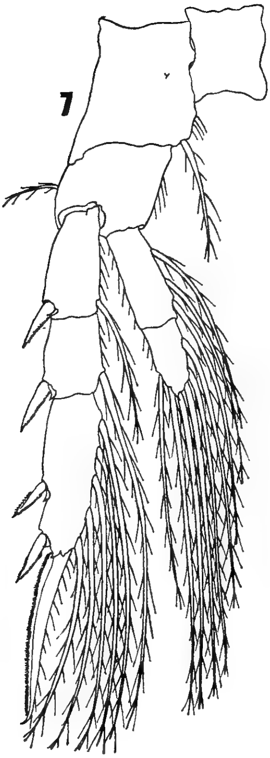

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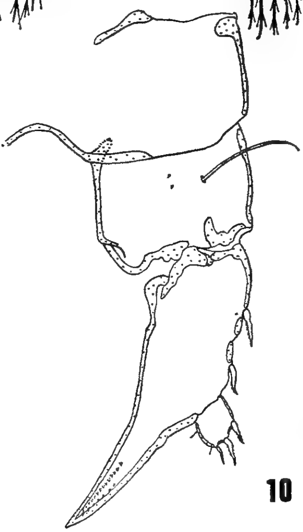

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Table 3. *Eurytemora richingsi* first antenna armature: s = seta; e = esthete; Sp = spine;) = adjacent segments fused.

				Male										Male					
	Female			Left			Right				Female			Left			Right		
Segment	s	e	Sp	s	e	Sp	s	e	Sp	Segment	s	e	Sp	s	e	Sp	s	e	Sp
1	3	1		3	1		3	1		13	2			2	1		2	1	
2	3	1		3	1		3	1		14	2	1		2	1		2	1	
3	2	1		2	1		2	1		15	2			2	1		2	1	
4	1			1	1		1	1		16	2	1		2	1		2	1	
5	2	1		2	2		2	2		17	2			2	1		1	1	
6	1			1	1		1	1		18	2			2	1		1	1	
7	2	1		2	1		2	1		19	2	1		2	1		1	1)	
8)			1		1	1		1	1	20	1			1			1	)	
9)	2	1		2	1		1	1	1	21	1			1			absent		
10	1		1	1	1	1		1	2	22	2			2			2	)	
11	2	1		2	1		1	1	1	23	2	1		2	*		2	1)	
12	1	1	1	1	1	1	1	1	1	24)	6	1		6	1		6	1)	
										25)									

* Only 1 male had a complete left antenna; lack of the typical esthete on segment 23 should be verified.

(Fig. 17), with 2 outer spines and 2 spines on the articulated thumb; dense clusters of setules on distal surfaces, margins heavily sclerotized. Right ramus 4-segmented: second basal segment robust, with prominent posterior boss; inner margin dilated, with 3 sclerotized petaloid flaps and 1 blunt hyaline spine. First exopod with distal sclerotized constriction. Second exopod with 1 setule and 1 spine on rugose inner margin. Third exopod a curved claw with a spine and 2 spinules on inner margin.

Etymology: This species is named for the late Michael Kent Richings, Department of Oceanography, University of Washington, in memory of his dedication to the Arctic field program, in which he participated for many years.

Remarks: *Eurytemora richingsi* was found in only 3 samples from a collection of 54 samples taken from May–September 1968. Most of these samples were taken in 500 m intervals between 3000–500 m; others

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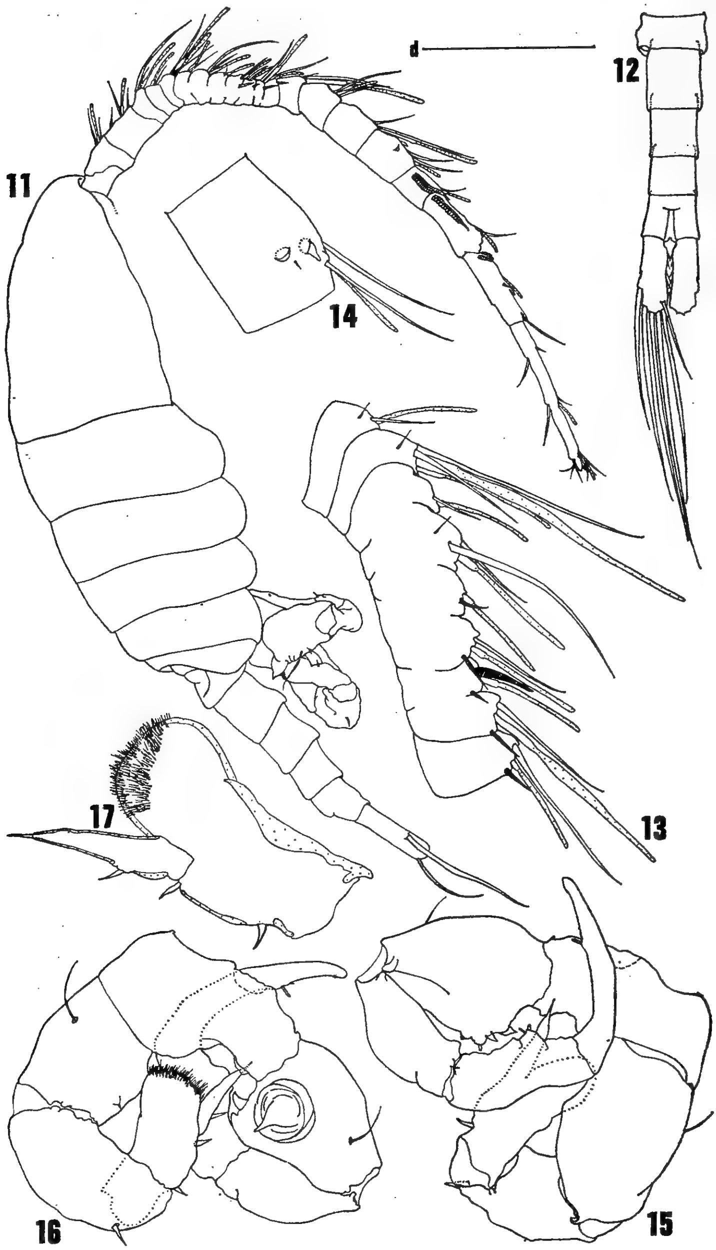
FIGS. 6–10. *Eurytemora richingsi* new species, female: 6, Leg 2, anterior (b); 7, Leg 3, anterior (b); 8, Leg 4, anterior (b); 9, Leg 5, anterior (b); 10, Left leg 5, posterior (c).


d
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15

were from shorter intervals from 500 m to the surface. Salinities at depth were: 34.607‰ (275 m), 34.751‰ (325 m), 34.857‰ (375 m), 34.927‰ (450 m), and 34.886‰ (1000 m). Three of the 4 females had a spermatophore attached to the ventral surface of the genital segment, each spermatophore fixed securely and similarly, with the distal part directed to the left (see Fig. 1).

Comparison with other species of Eurytemora: Only 3 other species have such short uropods in relation to the anal segment, *E. pacifica, E. velox,* and *E. woltereckі.* Leg 1 endopod differs from all other species of the genus with the presence in *E. richingsi* of an outer seta and an additional inner seta. *Eurytemora richingsi* is one of 4 species whose females have not been found with conspicuous wings. *Eurytemora affinis* and *E. pacifica* occur with and without wings (Gurney, 1931; Johnson, 1961; Heron, 1964) (Table 2).

Eurytemora richingsi female leg 5 has 3 short spines on exopod 2 in place of the typical 1 long and 1 shorter spine or seta. Male leg 5 left exopod 2 with distinctive mitten shape and articulated thumb. Several other *Eurytemora* species have bulbous projections on the left terminal exopod, but none is described as being articulate.

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FIGS. 11–17. *Eurytemora richingsi* new species, male: 11, Lateral (a); 12, Urosome, dorsal (a); 13, Right first antenna, segments 4–12, spines solid (d); 14, Right first antenna, segment 16 (d); 15, Leg 5, anterior (b); 16, Leg 5, posterior (b); 17, Left leg 5, second exopod, anterior (c).

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No. 9, pp. 137–146 25 June 1976

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

A NEW DWARF CRAWFISH (DECAPODA: CAMBARIDAE: CAMBARELLINAE) FROM SOUTHWEST ALABAMA AND ADJACENT MISSISSIPPI

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The dwarf crawfishes, genus *Cambarellus,* are essentially a group of species of the coastal area of the Gulf of Mexico within the United States, although they also occur on the central plateau and Pacific slope in Mexico. For a number of reasons, they are sufficiently distinct to be placed in the monogeneric subfamily Cambarellinae (Hobbs, 1974a). In all of the United States species the mesial process of the first pleopod of males is ungrooved, and only in *C. shufeldtii* (Faxon, 1884) are the three terminal elements straight. The extreme of curving occurs in *C. ninae* Hobbs (1950) in which the terminal elements are bent caudally at least 90° to the main plane of the pleopod. *C. texanus* Albaugh and Black (1973) is the only described species not keyed by Hobbs (1972) and also figured by him (1974b).

The species here treated was discovered by Leslie Hubricht in 1968 and elicited correspondence between Horton H. Hobbs, Jr. and the senior author, but only recently have sufficient specimens been collected to permit its description. Mr. Hubricht and Dr. Hobbs have generously lent their specimens for the preparation of this description. We are also indebted to the collectors indicated in the appropriate places.

This newly described species has appeared several times in the literature under the appellation *Cambarellus schmitti* (see synonymies). There is a close morphological similarity between it and *schmitti*; until recently the collections were limited in number and size, particularly with respect to first form males, and most of the citations are reiterations of earlier literature statements which had been based on even more limited knowledge. More extensive collecting and subsequent better understanding of *Cambarellus* in the southeast have revealed that some of the records for *C. schmitti* are based on misidentifications of *C. lesliei* and other, yet undescribed, taxa.

Cambarellus lesliei, new species

Figure 1

Cambarellus schmitti.—Hobbs, 1942: 151(part); Hobbs, 1968:K-12 (part); Hobbs, 1972:26(part), 145(part), 154(part); Hobbs, 1974b: 9(part).

Diagnosis: Body and eyes pigmented. Rostrum acuminate with margins slightly converging cephalically and terminating in strong, acute spines. Postorbital ridges well developed and terminating cephalically in acute spines. Suborbital angle prominent but obtuse. Single acute cervical spine on each side of carapace. Areola constituting 27.12–35.66 (av. 31.2)% of total length of carapace, 2.7–4.78 (av. 3.66) times longer than wide. Hooks on ischia of second and third pereiopods only, those of third pereiopod usually bifid; coxa of fourth pereiopod with transversely oriented boss on anteroventral margin. Chela markedly longer than wide; length of dactyl and length of inner margin of palm approaching subequal; chela surfaces not punctate and with only scarce setiferous ornamentation located chiefly along opposable margins of fingers; opposable margins of both fingers with crowded minute denticles along entire length but lacking tubercles. First pleopod of male terminating in 3 parts, all curved approximately 80° to main plane of pleopod: (1) central projection shortest of elements and sharply tapering along length to acute tip; (2) mesial process longest and stoutest of elements, lacking groove, tapering along length to acute tip, curved nearly 90° in Form I males; and (3) caudal process subsetiform, subparallel to central projection and only slightly longer. Annulus ventralis of female about twice as wide as long, highest point along cephalic margin; deep groove in centrocaudal face receiving flange from cephaloventral surface of subtriangular postannular sternite.

Holotypic male, Form I: Body subovate, slightly compressed laterally. Abdomen longer than carapace (13.59 and 9.63 mm, respectively). Areola moderately long (33.02% of total length of carapace), 3.21 times longer than wide, and with 4–5 punctations across narrowest part (Fig. 1h). Cephalic part of carapace 2.03 times longer than thoracic part. Rostrum only slightly depressed in distal fourth (Fig. 1b); with lateral margins slightly thickened and terminating cephalically in strong spines which extend half length of well developed acumen; excavate dorsally, with scattered setiferous punctations across entire surface and with usual submarginal row of punctations. Subrostral ridges well developed and visible in dorsal aspect to about level of suborbital angle. Postorbital ridges well developed, terminating cephalically in strong spine extending beyond postorbital margin of carapace. Branchiostegal spine small but acute. Single cervical spine on each side of carapace. Carapace punctate dorsally and laterally with low squamous tubercles developed cephalolaterally. Cephalic part of telson with 3 spines in right caudolateral corner and 2 in left.

Cephalic lobe of epistome (Fig. 1f) subtriangular in outline with slightly thickened margins; lacking cephalomedian tubercle.

Antennules of usual form; lacking spine on ventromesial surface of basal segment. Antennae broken; antennal scale (Fig. 1i) 2.24 times longer than wide, broadest near distal margin of lamellar portion, thickened lateral part terminating in strong acute spine.

Right chela (Fig. 1j) only moderately depressed; with palm inflated, subelliptical in cross-section, length of inner margin of palm longer than dactyl (in illustration palm somewhat foreshortened due to position when drawn). Opposable margin of both movable and immovable finger lacking tubercles but with crowded minute denticles along entire length; few setae arising just off margins; submedian ridges poorly defined on fingers above and below. Fingers curved gently downward (Fig. 1k). Entire palmar and dactylar surface relatively devoid of punctations and setae.

Carpus slightly longer than broad, lacking prominent punctations or spines, except strong, acute spine on distomesial margin. Merus with acute spine on distolateral margin; acute spine at base of distal fifth of upper surface; acute spine near midlength of lower surface. Margins of ischium entire.

Ischiopodites of second and third pereiopods with hooks (Fig. 1l); that of second pereiopod subrhomboidal and with cephalodistal third compressed; hook on third pereiopod larger, acute and extending beyond proximal margin of ischiopodite. Coxa of fourth pereiopod with strong cephalomesial boss directed laterally.

First pleopod reaching coxopodite of third pereiopod; pleopods symmetrical (e.g., Fig. 1m). Tip terminating in 3 distinct parts; only central projection corneous; cephalic process absent; parts arranged as in diagnosis (Figs. 1a,c).

Allotypic female: Differing from holotype only in minor respects except in proportions of chela (Fig. 1n): dactyl longer than inner margin of palm and palm slightly wider; right caudolateral corner of cephalic section of telson with only 2 spines.

Annulus ventralis subovoid (Fig. 1o); highly raised (ventrally), highest along cephalic margin; deep vertical groove in mid-caudal surface receiving flange from postannular sternite; sinus originating near right cephalolateral margin at about mid-height and arcing around caudal margin and disappearing in mid-caudal groove. Postannular sternite subtriangular in outline, with prominent median ridge becoming more

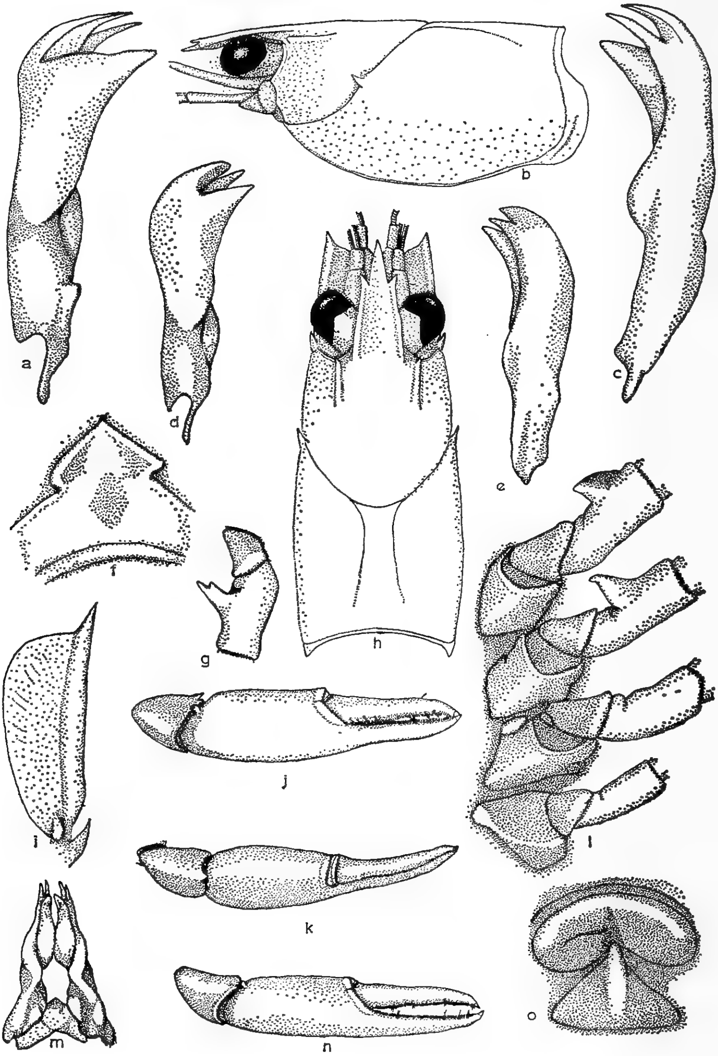

FIG. 1. *Cambarellus lesliei* new species (all holotype except d, e, g, m, n, o). a, Mesial view of first pleopod; b, Lateral view of carapace; c, Lateral view of first pleopod; d, Mesial view of first pleopod of morphotype; e, Lateral view of first pleopod of morphotype; f, Epistome; g, Ischium and basis of third pereiopod of paratypic male, Form I; h, Dorsal view of carapace; i, Antennal scale; j, Dorsal view of distal podomeres of cheliped; k, Mesial view of distal podomeres of cheliped;

TABLE 1. Measurements of type-specimens of *Cambarellus lesliei* n. sp. (in mm).

	Holotype	Allotype	Morphotype
Carapace—			
length	9.63	10.11	7.38
width	4.14	4.65	3.18
height	4.86	5.35	3.24
Areola—			
length	3.18	3.15	2.34
width	0.99	0.93	0.69
Antennal scale—			
length	2.82	2.46	1.77
width	1.26	0.99	0.84
Rostrum—			
length	2.97	2.94	2.64
width	1.38	1.74	1.14
Chela—			
length of inner margin of palm	3.12	2.82	1.80
width	1.86	1.71	1.20
total length	6.69	6.39	4.20
dactyl length	2.76	3.21	2.10

elevated cephalically and overhanging margin forming flange; except when abdomen fully extended, flange fitting into mid-caudal groove of annulus.

Morphotypic male, Form II: Differing from holotype in following respects: dactyl longer than inner margin of palm; hooks on ischia of pereiopods scarcely more than tubercles; boss on coxae of fourth pereiopods much less well-developed; right caudolateral corner of cephalic part of telson with 2 spines. Terminal elements of first pleopod (Figs. 1d,e) more blunt, all non-corneous; central projection and caudal process proportionately shorter.

Type-locality: 0.5 mi S of Alabama Port, Mobile County, Alabama.

Disposition of types: The holotypic male, Form I; the allotypic female; and the morphotypic male, Form II, are in the National Museum

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l, Proximal podomeres of third through fifth pereiopods; m, Caudal view of first pleopods of paratypic male, Form I; n, Distal podomeres of cheliped of allotype; o, Annulus ventralis of allotype.

of Natural History, Smithsonian Institution (USNM 146616, 146617, 146618, respectively). Paratypes are in the collections of NMNH (31 ♂♂I, 11 ♂♂II, 22♀♀, 6♀♀/ov., 5♀♀/young—including the topotypic series), Tulane University (6♂♂I, 8♂♂II, 20♀♀, 3♀♀/ov., 2♀♀/young) and the senior author (12♂♂I, 16♂♂II, 17♀♀, 4♂♂ juv., 1♀/ov.).

Specimens examined: ALABAMA: Baldwin Co.—Bayou Minette [Bay Minette Creek] on U.S. Hy. 31, T4S, R2E, 12 April 1941, Hubbs and Walker (12♂♂I, 3♀♀, 1♀/young); Creek on St. Rte 59, about 13.5 mi N of Stockton, 19 April 1970, Hollingsworth and Hobbs, Jr. (3♂♂I, 7♂♂II, 4♀♀, 1♀/ov., 2♀♀/young); Creek just N of L&N RR, 2.1 mi N of St. Rte. 138 on St. Rte. 225, 24 November 1973, JFF and BAL (1♂I, 5♂♂II, 1♀); d'Olide Creek at Spanish Fort, just S of U.S. Hy. I-10, 18 February 1974, L. Curtis (1♂II, 1♀, 1♀/ov.); Flat Creek at St. Rte. 59, 2 mi E of Stockton, 6 August 1960, J. Bohlke family (1♂I, 2♀♀); Mobile Co.— 2.5 mi S of Bucks on U.S. Hy. 43, 3 June 1940, Hobbs, Jr. and L. J. Berner (5♂♂I, 4♀♀/ov.); type-locality, 11 February 1968, Hubricht (2♂♂I, 3♂♂II, 5♀♀); Washington Co.—Bilbo [*sic*!] Creek on U.S. Hy. 43, T3N, R1E, 12 April 1941, Hubbs and Walker (7♂♂I, 6♀♀, 1♀/ov., 2♀♀/young); Bassett Creek, 5.1 mi E of Chatom on U.S. Hy. 84, 21 June 1966, J. F. Payne and S. M. Chien (11♂♂I, 10♂♂II, 15♀♀); Biloba Creek, 2.5 mi S of McIntosh on U.S. Hy. 43, 21 June 1966, JFP and SMC (6♂♂I, 8♂♂II, 20♀♀, 3♀♀/ov., 2♀♀/young); Bassett Creek, 1.6 mi N of Chatom on St. Rte. 16, 22 April 1970, E. Black and Hobbs, Jr. (1♂II, 1♀); Creek 9.1 mi N of McIntosh on U.S. Hy. 43, 25 November 1973, BAL and JFF (1♂I). MISSISSIPPI: George Co.—Creek under St. Rte. 26, 3 mi E of Pascagoula River, 5 August 1960, J. Bohlke family (2♂♂I, 1♂II, 1♀); 4.3 mi S of Greene County line on St. Rte. 57, 22 June 1966, JFP and SMC (1♂I, 14♂♂II, 12♀♀, 4♂♂ imm.).

Variations: Besides the usual variations in degrees of development of spinose ornamentation and the sexual and other differences noted in the descriptions of the types, the following variations were noted. The holotype is atypical in that the hooks of the third pereiopod are not bifid; indeed, in 81.8% of all Form I males the hooks are quite clearly bifid (Fig. 1g) and in only 13.6% are the hooks clearly simple. In 91.4% of the males a well-developed boss is to be found on the cephalomedian surface of the fourth pereiopodal coxa. This characteristic, not previously considered in descriptions of *Cambarellus*, is, none the less, present in several species. In response to a question, Hobbs, Jr. (personal communication) examined specimens of several United States species, finding a well-developed boss in *texanus* and *puer*, a moderately developed one in *ninae* and two undescribed species, and a vestigial one in *diminutus*; the boss is absent in *shufeldtii*.

In two females from Baldwin County, Alabama, (*ex* USNM 116004, Flat Creek; *ex* USNM 114213, Bayou Minette) the sinus is flanked by a ridge approaching the condition found in *schmitti*; and in another female from the latter locality the flange of the postannular sternite is markedly compressed laterally, making it bladelike. Although the prevalent situation is for the sinus of the annulus to be dextral (68.5%), a number of females have a sinistral sinus. Likewise, in many females the sinus is more widely gaping than in the allotype. This gaping cannot be associated with sexual maturity. Surely all ovigerous females and those bearing young are sexually mature, but both the gaping sinus and the closed one can be found in some specimens. No annulus examined had evidence of a sperm plug.

The Mobile River should provide a formidable barrier to dispersion of crawfishes of this size. The central projection of Form I males from east of the river is slightly more slender than in specimens from west of the river. To test the idea of geographic races, the ratios expressing areola length and width, antennal scale length and width and chela length were examined morphometrically in first form males. When tested using the F-statistic, the populations did not differ significantly at the 5% level.

The carapace length values for first form males ranged from 5.97 to 11.34 mm (av. 7.74), that of the maximum sized female was 11.73 (av. size 8.26), and of the largest second form male was 9.69 (av. 6.76); minimum sizes in the latter two catagories are not meaningful because of the difficulty in determining the precise time at which a juvenile becomes mature.

Relationships: *Cambarellus lesliei* is most closely related to *C. schmitti*, *C. puer* and an undescribed species which is located, geographically, between *schmitti* and *lesliei*. It may be distinguished from *schmitti* in that in males, Form I, the central projection and caudal process are bent caudally at an angle of nearly 90° to the main axis of the pleopod, and the latter process is proportionally longer. In females the sinus of the annulus ventralis almost always lacks flanking ridges in adult specimens. The rostral margins are more convergent in *lesliei* than in *schmitti*. First form males of *C. lesliei* may be distinguished from those of *C. puer* in that the mesial process is much broader at its base and the caudal process is subparallel to the central projection. The annulus ventralis of *lesliei* females is clearly broader than long, while the two measurements are subequal in *puer*; the lateral *parts* of the postannular sternite are much less attenuated in *lesliei*. Well-developed marginal rostral spines and a prominent acumen likewise distinguish *lesliei* from *puer*. *Cambarellus lesliei* differs from the undescribed species mentioned in that the central projection and caudal process of the latter are of subequal length. A fuller discussion of the differences will be more appropriate when the species is described.

Life history notes: *Cambarellus lesliei* is apparently a year-round breeder. Ovigerous females were taken in February, April and June, and females bearing young were in April and June collections. Whenever occurring, gravid females constituted 15–33% of the female population, suggesting that the major portion of the adult female population does not contribute to the reproductive activity in a single breeding season. The stated percentages are probably reasonable estimates of the activity of females, as sex ratios remained 1 : 1 in all months of collection. In every collection period, Form I males were present. These data would seem to be closer to those presented for *C. shufeldtii* by Black (1966) than those for *C. puer*. He is probably correct in his assumption that temperature is a prime factor in establishing the seasons of breeding activity in these crawfishes (p. 231). *C. lesliei* occupies a range not subject to a rigorous winter temperature, as does *shufeldtii*, and in breeding habits it more closely resembles distantly related *shufeldtii* than the more closely related *C. puer*, thus lending support to this temperature-cycle thesis.

Color: Although we have no specific color notes recorded in the field, the specimens were recognized as *Cambarellus* on collection. If there were significant deviations from the colors or color patterns already recorded for the genus, we are sure the field notes would reflect this.

Associates: In areas of sympatry, *C. lesliei* has been collected with *Procambarus* (*Ortmannicus*) *acutus acutus* (Girard), *P.* (*O.*) *bivittatus* Hobbs, *P.* (*O.*) *lecontei* (Hagen) and *P.* (*Leconticambarus*) *shermani* Hobbs. Interestingly, we have no record of it sharing a habitat with *Faxonella clypeata* (Hay), which crawfish is a common associate of *Cambarellus*. (References to descriptions of associates are omitted; interested parties may consult Hobbs, 1974b, for full bibliographic citations.)

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PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

STUDIES ON STOMATOPOD CRUSTACEA FROM THE INDIAN RIVER REGION OF FLORIDA. II. AN ANNOTATED CHECK LIST OF THE MANTIS SHRIMPS OF THE CENTRAL EASTERN FLORIDA COAST[1]

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Introduction

The stomatopod crustaceans, or mantis shrimps, are a large, variable, and distinctive component in the tropical western Atlantic fauna. Although published records indicate that at least 20 species may occur along the central eastern Florida coast (e.g., Manning, 1969), there has been, as yet, no comprehensive survey of stomatopod crustaceans in the region. This area has long been of interest to zoogeographers, many of whom consider it to be a transitional zone between the tropical West Indian faunal subprovince to the south, and the warm temperate Carolinian faunal subprovince to the north (see e.g., Bayer, 1961; Work, 1969; Briggs, 1974). The Indian River is a long, relatively narrow, estuarine lagoon bordered by barrier islands offshore. The lagoon extends for its entire length along this transitional zone and constitutes a major physiographic feature for the region. A 3-year period, sampling in both the Indian River, and in waters to slightly greater than 200 m depth on the adjacent Atlantic continental shelf, provided 17 species of stomatopod crustaceans, in 9 genera and 3 families. Total material consisted of 341 speci-

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[1] Scientific Contribution No. 56, from the Smithsonian Institution—Harbor Branch Foundation, Inc. Science Laboratories.

mens in 172 lots. Although no new species were found, the material filled several gaps in previous distributional records for this region, as well as providing one notable range extension for *Heterosquilla armata* (Smith, 1881), a species previously recorded only from boreal waters off the northeastern United States (Gore and Becker, 1975). Minor range extensions or first records for the Indian River area are also noted for the following 11 species previously known from north or southeastern Florida: *Meiosquilla quadridens, M. schmitti, M. tricarinata, Cloridopsis dubia, Squilla rugosa, S. neglecta, Pseudosquilla ciliata, Parasquilla coccinea, Gonodactylus oerstedii, G. spinulosus* and *Eurysquilla plumata* (Fig. 16).

MATERIALS AND METHODS

Specimens were collected using a variety of gear. In the shallow lagoonal estuary and vicinity (Fig. 1), collections were primarily by seine net, hand, or poison station, on intertidal grass and mudflats, and in associated mangrove stands and phragmatopomid worm reefs (Table 1). Continental shelf collections (Fig. 2) were made with 10 and 20 ft otter trawls, 5 ft Blake trawls, box and pipe dredges, in waters from 5 to approximately 215 m deep over sand, mud, coquinoid shell hash, and coralline rubble bottom (Table 2). A complete listing of all Indian River area stations and associated chemical and biological data are on file at the Smithsonian Institution, Ft. Pierce, Florida (SIFP).

All specimens were measured using either dial calipers, or a stage micrometer calibrated to an ocular reticle in a Wild M-5 stereomicroscope, and are expressed in millimeters (TL) or in millimeters rounded off to the nearest tenth (Rcl). The meristics used in the taxonomy of stomatopods are many and varied, and the reader is referred to Manning's (1969) monograph, or Camp's (1973) study on Hourglass Stomatopoda for definitions. In this report, however, we confine our measure-

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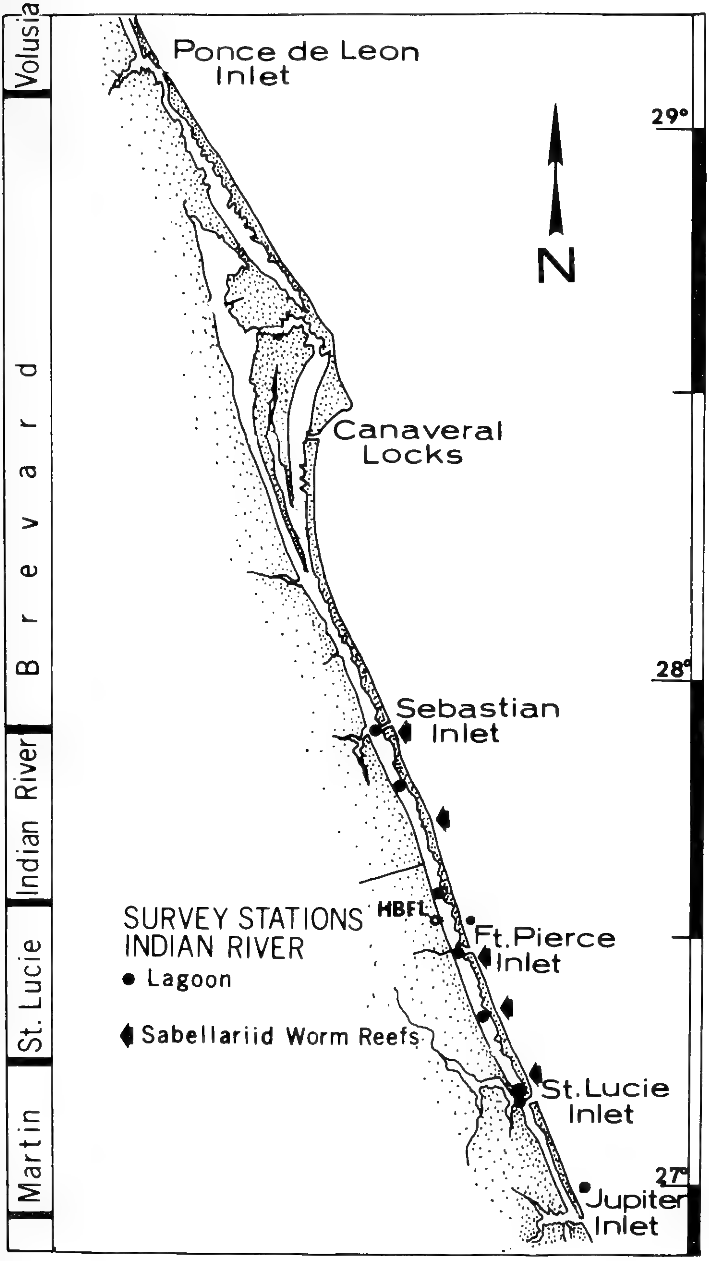
FIG. 1. Survey stations in the Indian River lagoon at which Stomatopoda were collected, November 1971 to December 1974. HBFL = Harbor Branch Foundation Laboratory, Link Port.


Volusia
Brevard
Indian River
St. Lucie
Martin
Ponce de Leon Inlet
29°
N
Canaveral Locks
28°
Sebastian Inlet
SURVEY STATIONS INDIAN RIVER
● Lagoon
Sabellariid Worm Reefs
HBFL
Ft. Pierce Inlet
St. Lucie Inlet
27°
Jupiter Inlet

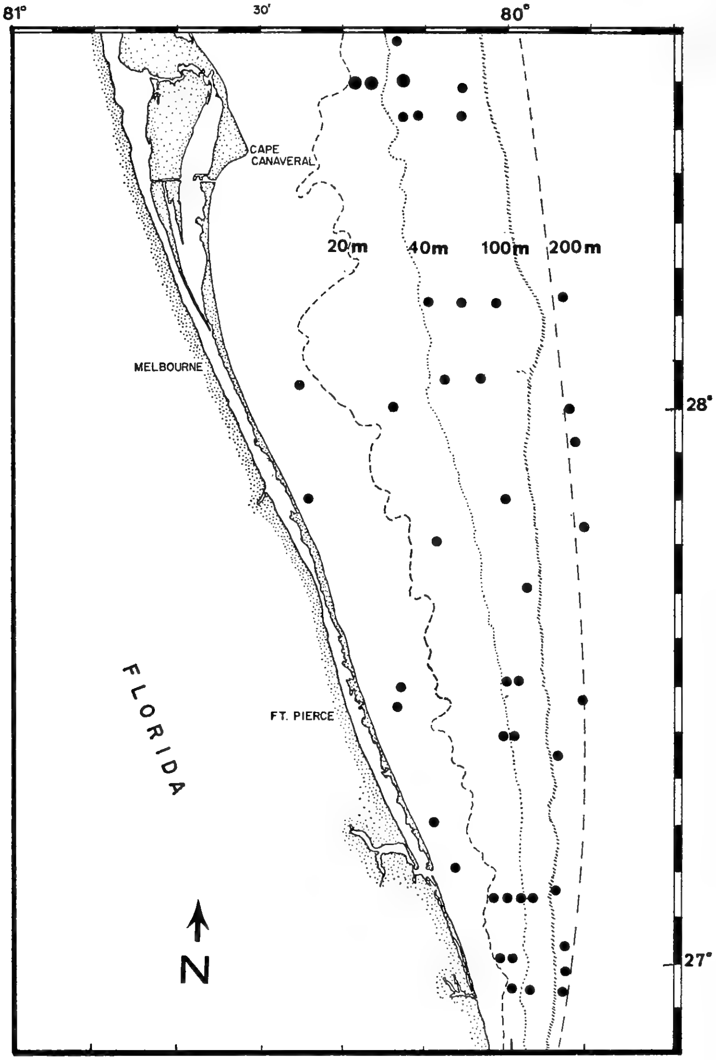


FIG. 2. Survey stations by R/V *Hernan Cortez* and R/V *Gosnold* on the continental shelf offshore of the Indian River region at which Stomatopoda were collected, January 1973 through December 1974. Large dots indicate DNR repetitive stations, Federal Rock Shrimp Project (see text).

ments to (1) total body length (TL) as defined in Manning (1969), even though this measurement may be quite subjective at times, depending on how the specimen is stretched out from its normally curled position in preservative, followed by (2) Rostral-carapace length (Rcl) defined as extending from the anterior margin of the rostrum to the posterior median margin of the carapace.

Synonymies are restricted to pertinent works which were omitted from, or appeared later than Manning's (1969) monograph on western Atlantic Stomatopoda.

Most of the material in this report is now accessioned into the Invertebrate Reference Museum, Smithsonian Institution, Ft. Pierce Bureau. Selected lots representative of some of the species from the Indian River area have been forwarded to the Reference Museum, Florida Department of Natural Resources, Marine Research Laboratory, St. Petersburg, Florida, and to the National Museum of Natural History, Washington, D.C. (USNM 152463 to 152469).

ACKNOWLEDGMENTS

We thank Drs. Raymond B. Manning, National Museum of Natural History (NMNH), Thomas E. Bowman (NMNH) and Austin B. Williams, National Marine Fisheries Service, for critically reviewing the manuscript, and for providing advice on several species identification or procedural points which we had overlooked or omitted. We also express our thanks to the many people of the Indian River Study at both the Smithsonian Institution, Ft. Pierce Bureau, and the Harbor Branch Foundation, Inc., Science Laboratory, for their aid in field collections both ashore and at sea. Special thanks are due to Capt. Harry Seibert and the crew of the R/V GOSNOLD, then on loan from the Woods Hole Oceanographic Institution, and to Capt. Robert Larson, R/V SEA HUNTER II, Florida Institute of Technology, Melbourne, Florida, for their complete, courteous and professional cooperation during collecting operations at sea. We also express our gratitude to Messrs. William Lyons, David Camp and Nick Whiting, as well as to the captain and crew of the R/V HERNAN CORTEZ, all of the Florida Depart-

TABLE 1. Indian River lagoonal and shallow off-shore stations at which stomatopods were obtained

Location	Depth	Date	Species
Atlantic Ocean off Jupiter Island, Fla.	10 m	June 1973	*Lysiosquilla scabricauda* *Squilla neglecta*
St. Lucie Inlet, Fla.	Intertidal	May 1972; Jan., Apr. to Aug. 1974 Jan. 1975	*Gonodactylus bredini* *G. oerstedii* *G. spinulosus*
Hutchinson Island, Fla.			
Bessie Cove	Intertidal	Oct. 1974	*Lysiosquilla* sp.*
Walton Rocks	Intertidal	Jan., May to Aug., Oct., 1974	*Gonodactylus bredini* *G. oerstedii* *G. spinulosus*
Big Mud Creek	Intertidal	Mar., Sept. 1974 Mar. 1975	*Cloridopsis dubia*
Ft. Pierce, Fla.			
Harbor	Subtidal Intertidal	June 1971 Apr. 1972; Feb., July, Oct. 1974	*Lysiosquilla scabricauda* *Gonodactylus bredini* *G. oerstedii* *Pseudosquilla ciliata*

* *Lysioerichthus* larval stage.

Table 1. (cont.)

Location	Depth	Date	Species
Inlet	Surface	Oct. 1974	*Lysiosquilla scabricauda*
Link Port	Intertidal	Aug. 1972 Apr. 1973	*Cloridopsis dubia*
Atlantic Ocean, Nearshore,			
St. Lucie Co., Fla.	3–6 m	May, July 1973	*Gonodactylus bredini*
Vero Beach, Fla.	3 m	Feb., June, July 1972	*Gonodactylus bredini* *G. oerstedii*
Wabasso, Fla.	Intertidal	Dec. 1972	*Cloridopsis dubia*
Sebastian Inlet, Fla.	Surface	Jan. 1972	*Lysiosquilla scabricauda*
	Intertidal	Feb. 1974	*Gonodactylus bredini*

Table 2. Research vessel stations and localities at which stomatopods were obtained*

Station	Date	Location	Depth (m)	Species
	1973			
G-209/041**	17 Nov.	27°24.9′N, 79°59.4′W	64	*Squilla empusa*
G-210/060	27 Nov.	27°42.8′N, 79°57.3′W to 27°45.2′N, 79°57.2′W	100–97	*Squilla deceptrix*
G-213/082	12 Dec.	27°49.9′N, 80°24.6′W to 27°51.1′N, 80°25.2′W	10	*Squilla empusa*
	1974			
G-216/128	17 Jan.	26°57.6′N, 79°59.4′W to 27°00.7′N, 80°01.2′W	48	*Squilla deceptrix*
/135	18 Jan.	27°27.4′N, 79°59.2′W to 27°30.3′N, 80°03.5′W	60–30	*Squilla empusa*
G-217/167	25 Jan.	27°01.3′N, 79°58.0′W to 27°03.6′N, 79°58.2′W	100–92	*Squilla empusa*
G-220/224	13 Feb.	27°28.8′N, 80°14.5′W to 27°32.6′N, 80°16.3′W	15	*Gonodactylus bredini*
/230	same	28°01.2′N, 80°14.8′W to 28°01.7′N, 80°12.3′W	22	*Gonodactylus bredini* *Gonodactylus* sp.
G-222/264	25 Feb.	26°56.6′N, 79°57.8′W to 26°56.5′N, 79°57.5′W	105	*Gonodactylus oerstedii*
G-224/351	13 Mar.	27°07.5′N, 79°59.7′W to 27°09.7′N, 80°00.6′W	66	*Squilla empusa*

* Data taken from corrected scientific cruise logs for each vessel.
** G = R/V Gosnold; HC = R/V Hernan Cortez; SH = R/V Sea Hunter II.

Table 2. (cont.)

Station	Date	Location	Depth (m)	Species
G-229/408	16 Apr.	27°10.7′N, 80°07.4′W to 27°10.7′N, 80°07.5′W	13	*Gonodactylus bredini*
G-230/423	17 Apr.	27°29.3′N, 80°00.5′W to 27°32.3′N, 80°01.5′W	53	*Squilla empusa*
G-237/497	10 June	27°16.7′N, 80°08.7′W	15	*Meiosquilla tricarinata*
/503	same	27°00.0′N, 79°57.7′W to 26°57.7′N, 79°57.8′W	100	*Squilla empusa*
/505	11 June	26°57.0′N, 79°53.7′W to 27°01.5′N, 79°55.9′W	198–148	*Squilla edentata edentata*
/507	same	27°08.5′N, 79°54.0′W	210	*Heterosquilla armata* *Squilla edentata edentata*
/510	11 June	27°28.3′N, 79°52.6′W to 27°33.0′N, 79°53.2′W	208	*Squilla edentata edentata*
/511	same	27°47.3′N, 79°52.9′W to 27°52.3′N, 79°53.2′W	215	*Squilla edentata edentata*
G-245/687	26 Aug.	26°56.8′N, 79°54.5′W to 27°00.5′N, 79°54.3′W	191–182	*Squilla edentata edentata*
/688	same	27°03.1′N, 79°54.0′W to 27°07.0′N, 79°55.0′W	200	*Squilla edentata edentata*
/690	27 Aug.	27°22.3′N, 79°53.0′W to 27°24.1′N, 79°52.8′W	193	*Squilla edentata edentata*
/695	28 Aug.	27°30.3′N, 79°59.0′W to 27°29.0′N, 79°59.5′W	72	*Squilla empusa* *Parasquilla coccinea*

TABLE 2. (cont.)

Station	Date	Location	Depth (m)	Species
G-246/705	4 Sept.	27°59.1′N, 79°53.6′W to 28°06.3′N, 79°53.4′W	185–212	*Squilla edentata edentata*
G-248/730	17 Sept.	28°11.8′N, 79°53.7′W to 28°16.4′N, 79°54.3′W	203–198	*Squilla edentata edentata*
/739	18 Sept.	27°56.5′N, 79°52.8′W to 27°58.0′N, 79°52.5′W	200	*Squilla edentata edentata*
/741	same	27°50.8′N, 80°01.0′W to 27°49.8′N, 80°00.4′W	50	*Meiosquilla quadridens*
/742	19 Sept.	27°46.2′N, 80°09.5′W to 27°44.1′N, 80°09.5′W	18	*Gonodactylus bredini*
	1975			
G-250/761	18 Feb.	27°51.6′N, 80°03.0′W	41	*Eurysquilla plumata*
G-262/780	13 Aug.	27°53.3′N, 80°09.2′W	20	*Meiosquilla schmitti*
	1973			
HC-6**	15 Jan.	28°34.8′N, 80°14.8′W	38	*Squilla empusa*
HC-17	16 Jan.	28°39.4′N, 80°13.2′W	43	*Squilla rugosa*
HC-23, 25, 27	17 Jan.	28°37.0′N, 80°11.2′W	45	*Squilla deceptrix* *Squilla empusa*
HC-41, 43 45	18 Jan.	28°32.5′N, 80°10.3′W	45	*Squilla empusa*
HC-47	23 Jan.	27°07.0′N, 79°59.6′W	65	*Squilla empusa*
HC-49	24 Jan.	27°07.9′N, 80°02.1′W	28	*Squilla neglecta*
HC-83	6 Feb.	28°37.1′N, 80°04.8′W	71	*Parasquilla coccinea*

TABLE 2. (cont.)

Station	Date	Location	Depth (m)	Species
HC-103	4 Mar.	28°37.0′N, 80°11.2′W	43	*Squilla empusa*
HC-114	5 Mar.	28°37,1′N, 80°04.8′W	70	*Parasquilla coccinea*
HC-151	8 Apr.	28°32.5′N, 80°10.3′W	40	*Squilla deceptrix* *Squilla empusa*
HC-181	13 Apr.	27°07.3′N, 80°00.4′W	45	*Squilla empusa*
HC-196	5 May	28°37.1′N, 80°04.8′W	65	*Squilla deceptrix*
198				*Parasquilla coccinea*
HC-202	same	28°35.9′N, 80°18.6′W	26	*Squilla empusa* *Squilla neglecta*
HC-216	6 May	28°37.0′N, 80°11.2′W	41	*Squilla empusa*
220				
HC-224	7 May	28°32.5′N, 80°10.3′W	40	*Squilla empusa*
HC-262	23 May	28°03.0′N, 80°03.5′W	46	*Squilla empusa*
HC-264	same	28°03.1′N, 80°07.4′W	37	*Squilla empusa* *Squilla rugosa*
HC-268	same	28°02.4′N, 80°25.6′W	18	*Squilla empusa*
HC-272	same	28°11.0′N, 80°01.0′W	55	*Squilla empusa*
HC-274	same	28°11.1′N, 80°05.0′W	46	*Squilla empusa*
HC-276	same	28°11.3′N, 80°10.1′W	37	*Squilla empusa*
HC-283	31 May	28°35.9′N, 80°18.6′W	26	*Squilla neglecta* *Squilla rugosa*
HC-290	1 June	28°37.0′N, 80°11.2′W	40	*Gonodactylus bredini*
HC-338	3 June	28°37.0′N, 80°11.2′W	40	*Squilla deceptrix*

TABLE 2. (cont.)

Station	Date	Location	Depth (m)	Species
HC-344	1 July	28°32.5′N, 80°10.3′W	40	*Squilla deceptrix* *Squilla empusa*
HC-356	same	28°37.1′N, 80°04.8′W	64	*Squilla deceptrix*
360				*Parasquilla coccinea*
HC-363	2 July	28°35.9′N, 80°18.6′W	26	*Squilla neglecta*
HC-395	14 Aug.	28°35.9′N, 80°18.6′W	26	*Squilla empusa* *Squilla neglecta*
HC-399	15 Aug.	28°37.0′N, 80°11.2′W	40	*Squilla deceptrix*
403				
HC-417	9 Sept.	28°37.1′N, 80°04.8′W	64	*Meiosquilla quadridens*
HC-439	10 Sept.	28°37.0′N, 80°11.2′W	40	*Squilla deceptrix*
HC-441	11 Sept.	28°32.5′N, 80°10.3′W	40	*Squilla deceptrix*
445				
HC-455	13 Sept.	28°59.6′N, 80°30.6′W	37	*Squilla deceptrix*
HC-472	15 Oct.	28°35.9′N, 80°18.6′W	26	*Squilla empusa*
HC-499	2 Nov.	28°37.0′N, 80°11.2′W†	40	*Squilla deceptrix*
HC-516	3 Nov.	28°37.1′N, 80°04.8′W†	64	*Squilla deceptrix*
HC-530	4 Nov.	28°35.9′N, 80°18.6′W	26	*Squilla empusa*
	1974			
HC-590	17 Jan.	28°35.9′N, 80°18.6′W	26	*Squilla empusa* *Squilla neglecta*
HC-728	10 Apr.	28°37.0′N, 80°11.2′W	40	*Squilla empusa*
HC-731	11 April	28°32.5′N, 80°10.3′W	40	*Squilla empusa*

† See remarks in text.

TABLE 2. (cont.)

Station	Date	Location	Depth (m)	Species
HC-750	20 Apr.	28°35.9′N, 80°18.6′W	26	*Squilla empusa*
HC-758	15 May	28°32.5′N, 80°10.3′W	40	*Gonodactylus bredini*
HC-894	17 July	28°32.5′N, 80°10.3′W	40	*Squilla deceptrix*
898				
HC-916	18 July	28°35.9°N, 80′18.6′W	26	*Squilla empusa*
920				*Squilla rugosa*
HC-924	19 July	28°37.1′N, 80°04.8′W	64	*Squilla deceptrix*
926				*Parasquilla coccinea*
HC-937	13 Aug.	28°37.1′N, 80°04.8′W	64	*Meiosquilla quadridens*
939				*Squilla deceptrix*
				Parasquilla coccinea
HC-941	14 Aug.	28°35.9′N, 80°18.6′W	26	*Squilla empusa*
945				*Gonodactylus bredini*
HC-948	same	28°37.0′N, 80°11.2′W	40	*Squilla deceptrix*
952				
HC-1007	15 Oct.	28°32.5′N, 80°10.3′W	40	*Gonodactylus oerstedii*
HC-1109	6 Dec.	28°37.0′N, 80°11.2′W	40	*Squilla empusa*
1111				
1113				
HC-1116	same	28°35.9′N, 80°18.6′W	26	*Squilla empusa*
1118				
1120				
	1973			
SH 001-73**	21 May	25°29.0′N, 80°13.0′W	17	*Lysiosquilla* sp.

ment of Natural Resources, for arranging for, and providing us with, specimens collected during their own biological survey on rock shrimp off Cape Canaveral, Florida. Mr. William Davenport of the Harbor Branch Foundation provided the photographic plates of the specimens. Facilities were provided by the Smithsonian Institution-Harbor Branch Foundation, Inc. Scientific Consortium at Link Port, Ft. Pierce, Florida.

Family LYSIOSQUILLIDAE Giesbrecht, 1910

Genus *Heterosquilla* Manning, 1963

Heterosquilla (*Heterosquilloides*) *armata* (Smith, 1881)

Heterosquilla (*Heterosquilloides*) *armata*.—Manning, 1974: 1, 3 [key], 4, figs. 7, 9.—Gore & Becker, 1975: 21, figs. 1–3.

Material examined: 1♀; 43 mm (TL); 9.5 mm (Rcl).

Remarks: This species has been previously treated by Gore and Becker (1975).

Distribution: From New England to the central, east coast of Florida, in 96 to 218 m.

Genus *Lysiosquilla* Dana, 1852

Lysiosquilla scabricauda (Lamarck, 1818)

Figure 3

Lysiosquilla scabricauda.—Hildebrand, 1955: 189, 220 [discussion].—Manning, 1972: 315 [listed].—Camp, 1973: 6, 7 [key], 10, fig. 2.—Zeiller, 1974: 69 and color plate.

Material examined: 2♂♂, 234 to 257 mm (TL); 46.2 to 49.8 mm (Rcl); 3♀♀, 131 to 148 mm (TL); 25.1 to 29.4 mm (Rcl); 1 ovigerous female, 148 mm (TL), 29.3 mm (Rcl).

Remarks: Three specimens including an ovigerous female collected in the Atlantic Ocean off Jupiter Island, Florida were thrown ashore by the dredges of the U.S. Army Corps of Engineers during a beach reclamation project. This crude means of collecting might account for the ovigerous female, which, if like other stomatopods, would not normally leave the burrow while carrying eggs (see Kaestner, 1970: 251).

Lysiosquilla scabricauda has also been collected by means of a dip net or hook and line while swimming at the surface. As Manning (1969) has noted, these animals can be found on an outgoing tide in the evening, associated with shrimp, and such was the case with the female collected at Sebastian Inlet.

Distribution: Widely distributed in the Atlantic from Bermuda to Southern Brazil and off west Africa, from the intertidal zone to 55 m.

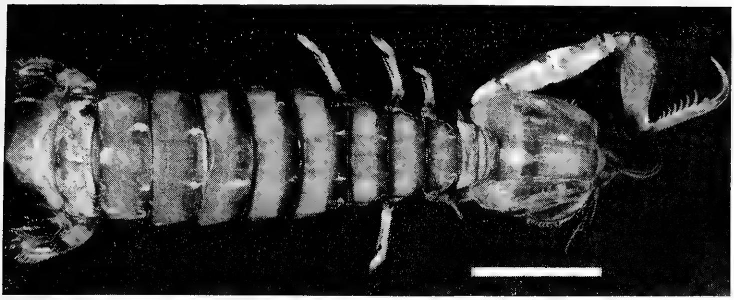


FIG. 3. *Lysiosquilla scabricauda* (Lamarck). Adult male, Indian River, Fort Pierce, Florida. Scale lines each equal 10 mm.

Lysiosquilla sp.

Material examined: 1 larva, 1 postlarva.

Remarks: The larval stage was determined to be a *Lysioerichthus* based on the characteristics of the telson and raptorial claw. In general morphological features the specimens appeared to be *Lysiosquilla scabricauda*, the only species of this genus collected in the survey.

Family SQUILLIDAE Latreille, 1803

Genus *Cloridopsis* Manning, 1968

Cloridopsis dubia (H. Milne-Edwards, 1837)

Figure 4

Cloridopsis dubia.—Manning, 1974a: 107, fig. 3.

Material examined: 1♂, 139 mm (TL); 29.7 mm (Rcl); 5♀♀, 68 to 143 mm (TL); 14.1 to 30.0 mm (Rcl).

Color: The following notes were made on either live or recently preserved specimens. Carapace overall light brown to grey-green. Carinae scarlet to crimson; cervical groove dull blue. Thoracic carinae crimson. Antennules and antennae grey, mottled with black chromatophores. Raptorial claw pale green to blue, flushed with blue green dorsally; margins of merus bright green; carpus brownish white outlined in green; propodus flushed with blue, with additional brown speckles on white background; dactylus white flushed with blue. Propodi of last 3 maxillipeds with scattered light yellow chromatophores. Dorsal surface of abdomen brown, with white or pink maculations, lateral margins dark blue. Telson overall light tan fading to grey around margins; all teeth distinctly dark blue, as are median carinae; tubercles adjacent to latter scarlet. Uropod ventral surface light yellow.

Remarks: According to Manning (1969: 140), the submedian teeth of the telson are without moveable apices, an error he corrected in

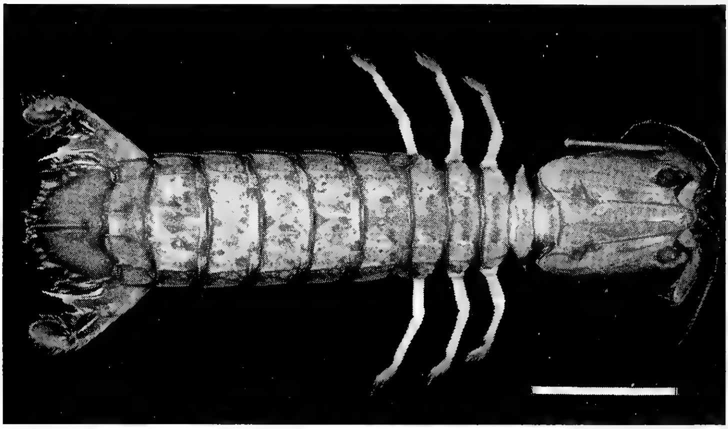


FIG. 4. *Cloridopsis dubia* (H. Milne Edwards). Adult female, Indian River, Link Port, Florida. Scale lines each equal 10 mm.

1974, noting, as did we in our material, that the movable spines can be very minute. Nearly all of the adult material we examined in this study had blunt teeth with fixed apices, whereas the three juvenile females in our material had movable apices on the submedian teeth of the telson. This fact should be considered when one uses the key provided by Manning (1969: 100). The adult forms also appear to be more highly sculptured than the younger forms.

Distribution: Intertidally, from Charleston, South Carolina to Brazil.

Genus *Meiosquilla* Manning, 1968

Meiosquilla quadridens (Bigelow, 1893)

Figure 5

Meiosquilla quadridens.—Manning, 1970: 104.—Camp, 1971: 125 [listed]; 1973: 8 [key], 18, fig. 6.

Material examined: 1♂, 27 mm (TL); 7.7 mm (Rcl); 2♀♀, 29 to 30 mm (TL); 6.8 to 8.1 mm (Rcl).

Color: The female specimen collected at the R/V GOSNOLD station while still alive was covered overall with scattered iridescent green and brown chromatophores.

Remarks: The specimens we examined agreed well with the description provided by Manning (1969).

Distribution: Although our material indicates that *M. quadridens* is now found in Florida as far north as Cape Canaveral, the species does not seem to be very common in the Indian River region. Elsewhere, it occurs from the Bahamas to Surinam, in the littoral zone to 137 m.

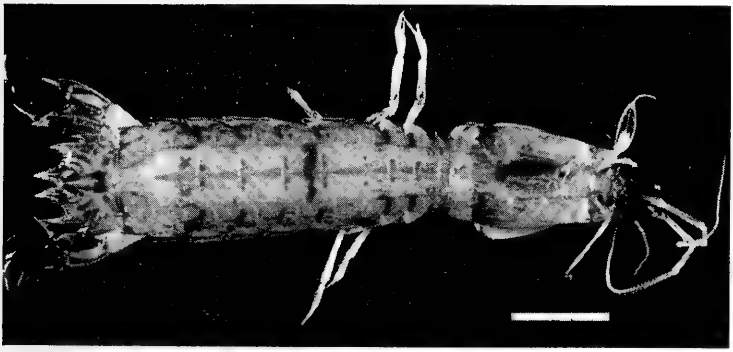


FIG. 5. *Meiosquilla quadridens* (Bigelow). Adult female, off Cape Canaveral, Florida. Scale lines in mm.

Meiosquilla schmitti (Lemos de Castro, 1955)

Meiosquilla schmitti.—Camp, 1973: 1 [abstract], 8 [key], 22 [remarks], 24, fig. 8, 77 ff [discussion, tables].

Material examined: 1♂, 31.1 mm (TL), 8.0 mm (Rcl).

Remarks: The fifth thoracic somite in our single specimen had a laterally projecting, blunt-tipped spine instead of a rounded lobe. We note that the specimen figured by Camp (1973: 25) also appears to have blunt-tipped spines present. Our specimen also differs from that figured by Manning (1969: 112, fig. 32e) and agrees in part with that noted above by Camp, in having the fifth abdominal somite intermediate carinae unspined, and the fourth and fifth marginal and lateral carinae, respectively, unarmed. Apparently, the species may exhibit some variability in this regard.

Distribution: Previously known from the Bahamas, southeastern and southwestern Florida, Texas, Yucatan Peninsula, Colombia, Venezuela, and Brazil. The Indian River specimen collected off Sebastian Inlet marks the northernmost record for the species. Sublittoral to 40 m.

Meiosquilla tricarinata (Holthuis, 1941)

Figure 6

Meiosquilla tricarinata.—Manning, 1969: 114, figs. 33*c*, 34.

Material examined: 1♀, 31 mm (TL); 7.5 mm (Rcl).

Remarks: Our material extends the known range north from the Miami area approximately 150 miles (240 km). The female had 2–3 as opposed to the usual 3–4 accessory carinae on the dorsal surface of the telson lateral to the submedian carinae. Of these carinae, Manning stated that 2–3 lie in a plane between the submedian and intermediate carinae. However, this specimen had only 1–2 carinae in such

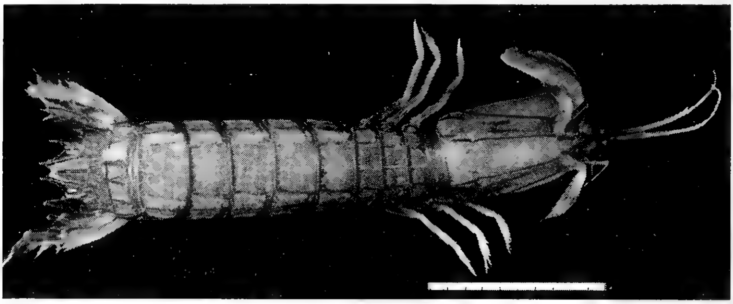


FIG. 6. *Meiosquilla tricarinata* (Holthuis). Adult female, off Jensen Beach, Florida. Scale lines in mm.

a location. Otherwise, the description of the species agreed in all respects.

Distribution: Off Jensen Beach, Florida to Brazil, including Fernando de Noronha, Mogiquiçaba, and the Abrolhos Islands; sublittoral to 48 m.

Genus *Squilla* Fabricius, 1787

Squilla deceptrix Manning, 1969

Figure 7, Table 3

Squilla deceptrix.—Camp, 1971: 125 [listed]; 1973: 8 [key], 33, fig. 12.

Squilla species.—Camp, 1973: 1 [abstract], 42, fig. 15 [postlarvae, = S. *deceptrix*?].

Material examined: 16♂♂, 30 to 55 mm (TL); 7.8 to 13.5 mm (Rcl); 17♀♀, 31 to 63 mm (TL); 7.6 to 14.5 mm (Rcl).

Remarks: Manning (1969: 170) noted the possibility of more than one species in the material he examined and described as *S. deceptrix*. However, the material we examined from the offshore Indian River region seemed to be well within the limits of variation described by Manning.

Distribution: *Squilla deceptrix* is known from North Carolina to Tobago between 37 and 346 m. We did not find any specimens in our sampling area in depths greater than 100 m.

Squilla edentata edentata (Lunz, 1937)

Figure 8, Table 3

Squilla edentata.—Manning, 1970a: 270 [discussion].—Camp, 1973: 6, 9 [key].

Material examined: 20♂♂, 68 to 135 mm (TL); 15.5 to 30.8 mm (Rcl); 53♀♀, 57 to 143 mm (TL); 13.8 to 31.5 (Rcl).

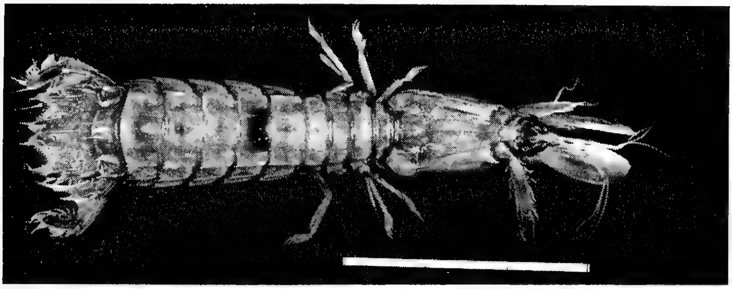


FIG. 7. *Squilla deceptrix* Manning. Adult female, off Cape Canaveral, Florida. Scale lines equal 10 mm.

Color: The following color notes are provided to supplement those of live specimens mentioned by Manning (1969: 224): Telson brown with usual orange spots lateral to median carinae; anterior margin of telson and median carinae iridescent blue; uropods yellow and white; eyes of living specimens bright iridescent green. This last feature, quite striking of itself, has also been noted in *Squilla empusa*, and is a good field character. Preserved specimens exhibited the orange spots on the telson for over a year in ethanol.

Remarks: The raptorial claw on some specimens collected at G-237/505 had 3 sharp tubercles, rather than the usual 2, on the carpus. On all but 2 specimens examined the abdominal carinae were spined in accordance with Manning's (1969: 223) description. Abdominal somite 1 may or may not have spined intermediate carinae and only a juvenile

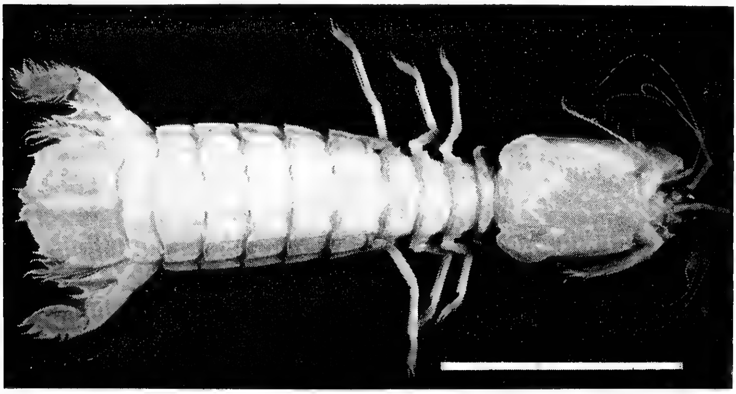


FIG. 8. *Squilla edentata edentata* (Lunz). Adult male, off Jupiter Inlet, Florida. Scale lines each equal 10 mm.

Table 3. Distinguishing morphological features in the species of Squilla collected from the Indian River Region of Florida

Character	*S. deceptrix*	*S. edentata edentata*	*S. empusa*	*S. neglecta*	*S. rugosa*
Rostral width × length	$W > L$	$W > L$	$W > L$	$W > L$	$W \cong L$
Carapace					
Median carina	Ill-defined	Well defined	Well defined	Well defined	Defined
Anterior bifurcation	None	Present	Present	Present	None
Raptorial claw, teeth	6	6	6	5	6
Thoracic somites, lateral projection					
5th	Curved spine	Curved spine	Curved spine	Spatulate lobe	Acuminate lobe
6th	Sharp, bilobed	Sharp, bilobed	Sharp, bilobed	Bluntly angular, bilobed	Sharp, bilobed
7th	Sharp, not bilobed	Sharp, faintly bilobed	Same	Same	Sharp, not bilobed
Abdominal somites 5 & 6					
Accessory spinules (s) and tubercles (t)	(s) lacking (t) present	(s) lacking (t) lacking	(s) lacking (t) lacking	(s) lacking (t) lacking	(s) present (t) lacking

TABLE 3. (cont.)

Character	*S. deceptrix*	*S. edentata edentata*	*S. empusa*	*S. neglecta*	*S. rugosa*
Telson					
Width × length	$W > L$	$W > L$	$W > L$	$W \cong L$	$W \cong L$
Dorsal armature*	Tubercles	Unarmed	Unarmed	Unarmed	Carinae
Denticle formula	5–7, 8–11, 1	2–5, 11–15, 1	3–5, 6–9, 1	2–4, 5–7, 1	4–6, 7–12, 1
Submedian denticles	Outer largest	Outer largest	Subequal	Inner largest	Subequal
Uropod					
Basal prolongation	Serrated	Serrated	Irregularly bluntly, serrated	Faintly dentate	Spined
Endopodite shape	Elliptically elongate	Tapering distally	Elliptically elongate	Elliptically elongate	Elliptically elongate

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* This armature is in addition to the standard armature on the median carina of this genus.

male in our material collected in 215 m had these carinae spined posteriorly. In other material, the first abdominal somite was sometimes armed on the intermediate carinae, but was always armed on the lateral and marginal carinae, again with the exception of one specimen out of 73 examined, which had no armature of any kind on the posterior margins of these carinae. This should be viewed in light of Manning's statement that all specimens of *Squilla edentata australis*, the southern subspecies from South America, had the lateral carinae armed, as opposed to only 6 specimens in his material of S. *edentata edentata* so armed. The Indian River material thus appears to be intermediate in this feature between the 2 subspecies.

Sometimes, the submedian denticles on the telson of our specimens of S. *edentata edentata* were rather swollen and appeared fused as one unit rather than the usual 2–5. This agrees with the formula in Manning (1969: 224) of (1), 2–5, (6) submedian denticles.

Distribution: *Squilla edentata edentata* appeared to be a typical Carolinian species, showing a classical disjunct distribution from South Carolina to Jupiter Inlet, in southeast Florida, and in the Gulf of Mexico, from Cape George, Florida to Texas; it has been collected from 55 to 319 m, although generally at less than 200 m in the Indian River region.

Squilla empusa Say, 1818

Figure 9, Table 3

Squilla empusa.—Hildebrand, 1954: 260, 261, 349 [discussion], table 29; 1955: 189, 220 [discussion].—Lemos de Castro, 1955: 19 [discussion], 21, 22.—Tabb & Manning, 1961: 594.—Tabb and Manning, 1962: 61, 62 [listed].—Dragovich & Kelly, 1964: 79, table 2.—Burrows, 1969: 362, [ethology].—Fingerman & Rao, 1969: 138, [physiology].—Rouse, 1969: 135.—Trevino & Larimer, 1969: 987 [physiology].—Manning, 1970a: 257, [discussion].—Godcharles, 1971: 26, 32 [listed].—Lyons, et al., 1971: 27.—Perret, et al., 1971: 61, tables 4, 7.—Manning, 1972: 315 [listed].—Camp, 1973: 6, 9 [key], 39, fig. 14.—Manning, 1974: 1, 2 [key], 4, figs. 3, 8.

Material examined: 27♂♂, 80 to 115 mm (TL); 18.1 to 33.9 mm (Rcl); 66♀♀, 56 to 141 mm (TL); 14.8 to 34.3 mm (Rcl).

Remarks: The specimens of S. *empusa* examined agreed well with the description provided by Manning (1969). Some slight variation was noticed in the anterior bifurcation on the dorsal surface of the carapace. Although usually well defined, one adult female collected at HC-202 (Florida Department of Natural Resources, catalog number I-9880) had this bifurcation poorly marked. In both a male and a female from HC-25 (Florida Department of Natural Resources, catalog number I-9794), the distance from the dorsal pit to the bifurcation was slightly greater than one-fifth the distance from the bifurcation to the anterior margin of the carapace. The male in this material had armed sub-

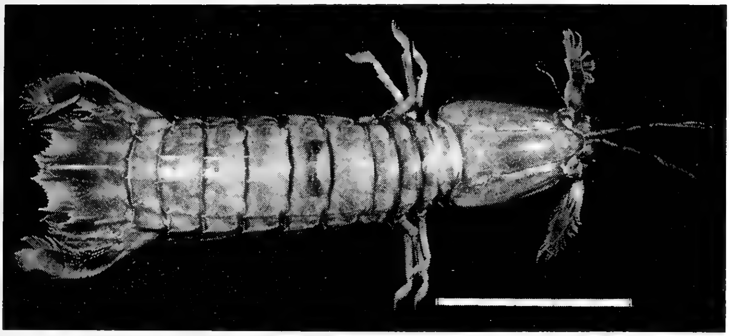

FIG. 9. *Squilla empusa* Say. Adult female, off Cape Canaveral, Florida. Scale lines each equal 10 mm.

median carinae on abdominal somite 4, which apparently is also a variable character.

The dactylus of the raptorial claw normally contains 6 teeth. Camp (1973: 40) examined a specimen obtained from the Hourglass Cruise which had 5 teeth on one claw and 6 on the other. One specimen we examined (HC-276, I-9773) had 7 and 6 teeth on the left and right claw, respectively.

The lateral spine of the 5th thoracic somite is defined as a sharp, anteriorly curved spine. Some specimens had spines which were very noticeably curved, and others curved only slightly more than a laterally directed spine. This minor variation should be kept in mind when considering growth variation between juvenile forms and mature adults of S. *empusa.*

Distribution: *Squilla empusa* is distributed from Maine southward along the eastern seaboard of North America to South America as far south as Surinam. There is a questionable record from Bermuda. The species occurs from the intertidal to 154 m. Even though extensive collecting was done along the 40 m line off the central eastern Florida coast, the specimens we examined were generally found at depths greater than 40 m (see Manning, 1969: 214).

Squilla neglecta Gibbes, 1850
Figure 10, Table 3

Squilla neglecta.—Godcharles, 1971: 26 [listed].—Lyons et al., 1971: 27.—Camp, 1973: 9 [key], 37, fig. 13.

Material examined: 7♂♂, 55 to 105 mm (TL); 13.8 to 27.5 mm (Rcl); 3♀♀, 87 to 100 mm (TL); 21.7 to 23.8 mm (Rcl).

Remarks: The 2 males collected off Jupiter Island and which were blown ashore as a result of dredging by the U.S. Army Corps of

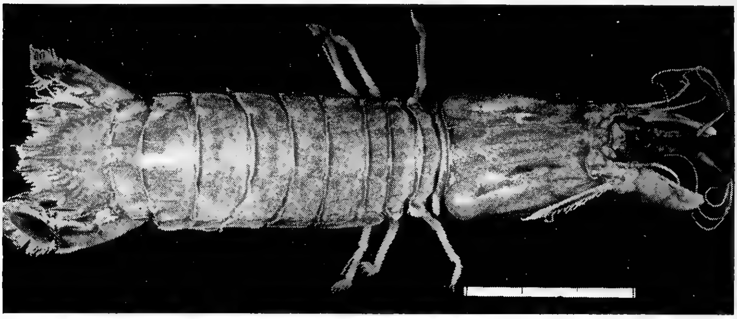

FIG. 10. *Squilla neglecta Gibbes.* Adult male, off Cape Canaveral, Florida. Scale lines each equal 10 mm.

Engineers, constitute the first record of the species from the southeastern coast of Florida. However, those collected by R/V HERNAN CORTEZ off Cape Canaveral lie within the previously noted distributional limits of northeastern Florida.

In all specimens, the outer margin of the raptorial claws had a definite sinuate curvature, a fact which inadvertently appeared contradictory in Manning's (1969: 211–212) discussion of S. *empusa.*

Distribution: From North Carolina to Jupiter Inlet, Florida, the Gulf of Mexico from western Florida to Texas, and southwest to Brazil, from the littoral zone to 64 m.

Squilla rugosa Bigelow, 1893

Figure 11, Table 3

Squilla rugosa.—Camp, 1973: 8 [key], 29, fig. 10.—Zeiller, 1974: 70 and color plate.

Material examined: 2♂♂, 62 to 76 mm (TL); 13.9 to 19.7 mm (Rcl); 5♀♀, 23 to 79 mm (TL); 6.1 to 19.7 mm (Rcl).

Remarks: This material extends the range of the species in Florida, from Miami to just north of Cape Canaveral, a distance of about 300 miles (485 km).

Variation exists in number of spines on the penultimate segment of the uropodal exopod. Manning (1969) noted 7–8, or occasionally as many as 13 spines, and Camp (1973) also noted variation in these numbers. The 3 animals collected at R/V HERNAN CORTEZ station 916 had 8 or 9 moveable spines on the exopod.

Distribution: *Squilla rugosa* is found from Little Bahama Bank and Florida to Surinam. Although the depth range for the species is littoral to 71 m, in the Indian River area it was collected only from offshore, in 26 to 43 m.

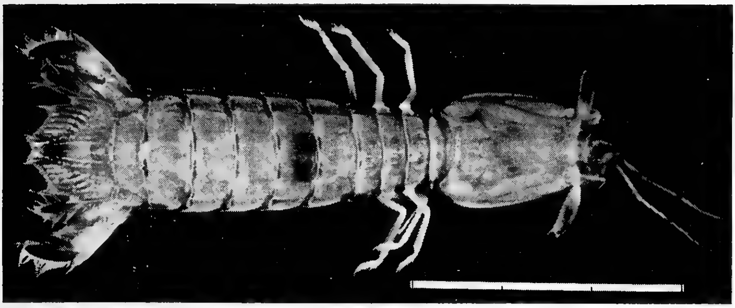

FIG. 11. *Squilla rugosa* Bigelow. Adult male, off Cape Canaveral, Florida. Scale lines each equal 10 mm.

Family GONODACTYLIDAE Giesbrecht, 1910

Genus *Eurysquilla* Manning, 1963

Eurysquilla plumata (Bigelow, 1901)

Eurysquilla plumata.—Camp, 1971: 125 [discussion]; 1973: 1 [abstract], 9 [key], 44, fig. 16, 77 ff. [tables, discussion].—Manning, 1975: 251 [discussion].

Material examined: 1♀, 31.9 mm (TL); 6.4 mm (Rcl).

Remarks: Both Manning (1969) and Camp (1973) have commented on the variability of some morphological features in this species. Our single female specimen, apparently the largest so far reported in the literature, also showed some variability when compared with published descriptions. The fifth abdominal somite lacked blunt intermediate carinae and had but one tubercle in the region where these carinae would be; there was no indication of even longitudinal swelling here. The carapace lacked posterolateral carinae, the ocular scales terminated in spiniform rather than acute lobes, and only 4 epipods were present.

On the other hand, the dark circles of patches posterolaterally on the fifth abdominal somite were distinct, and are characteristic for this species.

Distribution: The Indian River record from off Sebastian Inlet in 41 m of water extends the range northward from the Florida Keys. The species is also known from Puerto Rico and Brazil in shallow water to 55 m.

Genus *Gonodactylus* Berthold, 1827

Gonodactylus bredini Manning, 1969

Figure 12, Table 4

Gonodactylus bredini.—Dingle, 1969: 561 [ethology]; 1969a: 108 [ethology].—Dingle and Caldwell, 1969: 417, figs. 1–2 [ethology].—

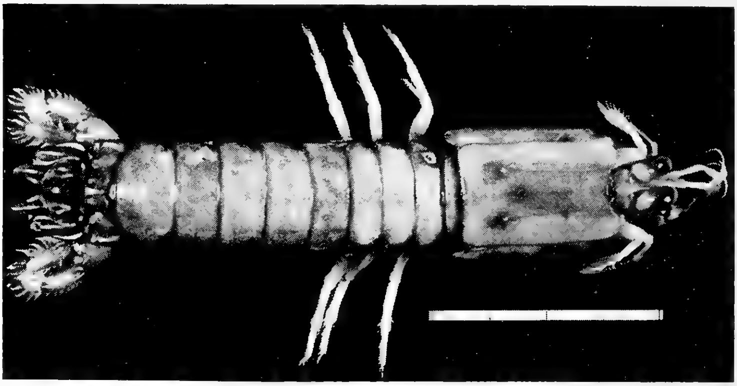

FIG. 12. *Gonodactylus bredini* Manning. Adult male, St. Lucie Inlet, Florida. Scale lines each equal 5 mm.

Camp, 1971: 125 [listed].—Lyons et al., 1971: 27.—Dingle and Caldwell, 1972: 417, ff [ethology].—Manning, 1972: 315 [listed].—Camp, 1973: 10 [key], 53, fig. 21.

Material examined: 37♂♂, 13 to 57 mm (TL); 3.8 to 15.5 mm (Rcl); 22♀♀, 2 ovigerous, 11 to 56 mm (TL); 3.0 to 15.5 mm (Rcl); smallest ovigerous female, 53 mm (TL), 14.0 mm (Rcl); 6 juveniles, 9 to 15 mm (TL); 2.4 to 3.9 mm (Rcl).

Color: Manning (1969: 321–322) and Camp (1973: 65–70) both provided detailed color patterns indicating the variability of *G. bredini* coloration. All except 2 of the specimens examined exhibited some form of coloration according to those descriptions. We provide herein the following additional color notes, based on live animals.

Male: Overall a purple-brown which appeared under magnification as dull rusty-pink, speckled with many minute red chromatophores. Dorsal surface of body with many indistinctly defined rounded white spots interspersed with white mottling and reticulation. Basal segments of antennules, antennae, and antennal scales with many pastel green chromatophores; antennal scales and setae dark blue. Eyestalks, diffused orange-brown, with many fine black lines; eyespots distinct bronze or copper color. Pereiopods with pastel green chromatophores and orange setae. Lateral and posterior regions of carapace, and thoracic and abdominal somites with white spots interspersed with mottling. Posterolateral margins of abdominal somites rimmed with pea green; carinae of somite 6 light dusky brown, irregularly banded with white. Pleopods with pastel green chromotophores; setae dark blue. Telson with irregular white spots; carinae light brown banded with white. Uropods and uropodal spines with pastel green chromatophores; former with dark blue setae.

Female: Overall color reddish. Dactylus on raptorial claw vinous rose-purple; ischiomeral area green. All other legs red to pink. Carapace and legs covered with white chromatophores, more prominent on latter than former. Telsonal carinae green. Uropods bright orange-red; exopod dorsally light green, ventrally white with pale green spots.

Remarks: We tend to agree with Camp (1973: 57), that the telsonal diagnostic characters are more valid for larger, more mature individuals. That is, the positions of the intermediate denticles relative to the apex of the intermediate teeth in juvenile forms of *G. bredini* and *G. oerstedii* are often difficult to ascertain. In many of these juveniles, the intermediate denticles were very small, although usually sufficiently discernible as being posterior to the tips of the intermediate teeth. Moreover, the intermediate teeth often appeared in close proximity to the submedians, a situation opposite to that seen in juvenile *G. oerstedii*. Camp (1973: 57) stated that all juveniles in the material he examined had moveable apices on the submedian teeth. Only 3 of the juvenile specimens we examined (which came from offshore stations) exhibited this character. In 2 of the juveniles the submedian denticles were totally absent.

Two ovigerous females were captured in May, 1972 and 1973. Two newly molted juvenile specimens, a male and a female, were collected in June and February, 1974, respectively.

One lot, HC-290, contained only a telson, which was identified tentatively as *G. bredini*.

Distribution: *Gonodactylus bredini* is distributed from Bermuda, and the continental United States from the Carolinas south through Florida and northern Gulf of Mexico, through the Caribbean to Aruba, Curaçao and Bonaire; litteral zone to 73 m. In the Indian River region, it is primarily found intertidally in the surf zone on phragmatopomid worm reefs.

Gonodactylus oerstedii Hansen, 1895

Figure 13, Table 4

Gonodactylus oerstedii.—Manning, 1969a: 147.—Camp, 1973: 6, 10 [key].

Gonodactylus oerstedi.—Voss & Voss, 1955: 216, 227 [listed].—McNulty, et al., 1962: 232 [listed].

Material examined: 9♂♂, 12 to 55 mm (TL); 3.2 to 15.5 mm (Rcl); 9♀♀, 17 to 67 mm (TL); 4.5 to 17.5 mm (Rcl); 1 juvenile, 12 mm (TL); 3.2 mm (Rcl); 1♀, (?), 10 mm (TL), 2.7 mm (Rcl).

Color: Manning noted that the color of live specimens is quite variable, and provided notes on some observed variations. We give, herein, yet another pattern which differs from those noted in Manning (1969: 331). Color overall light brown dorsally, finely speckled with tiny red chromatophores; ventrally white with dark brown or red highlights on all legs. Antennae, antennules, maxillipeds and pereiopods

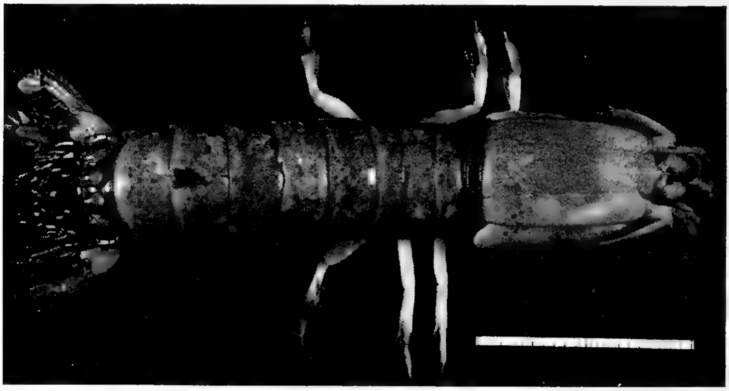

FIG. 13. *Gonodactylus oerstedii* Hansen. Adult female, St. Lucie Inlet, Florida, showing spotted color pattern. Scale lines in mm.

pale golden yellow speckled with white, or light blue-green on pereiopods, antennules and antennal scales. Raptorial claw purple; eyes light tan. One specimen, as were some noted by Manning, also had patches and mottlings of white dorsally and laterally and numerous large round black spots dorsally on the carapace, and thoracic and abdominal somites. Abdominal somite 6 flushed olive green; pleopods pale golden yellow. Carinae and teeth of telson olive green; uropods pale golden yellow or light blue-green speckled with white dots. All elongate setae on antennules, antennal scales, pereiopods, uropods, and uropodal spines dark blue.

Remarks: The telson carinae in 5 immature specimens varied slightly from Manning's (1969: 331) description, viz. the posterior margins of the median and anterior submedian carinae were more pointed, than rounded, tubercles. This is undoubtedly a juvenile feature which would become more rounded and swollen with age. Of these specimens, 1 juvenile (?) female also had pointed, rather than blunt, apices on the marginal teeth.

The intermediate denticles of the telson also showed some variation on 2 specimens. In a juvenile male, these denticles were not very well developed, but in spite of this the protuberance appeared anterior to the tips of the intermediate teeth, and was distinctly separated from the submedian teeth. In the second specimen, an adult female, 2 intermediate denticles occurred on the right side, the outer being small, but not sharp. The left side of the telson had only one intermediate denticle and it appeared as though the intermediate tooth might have been in the process of regenerating.

Distribution: In the western Atlantic, *G. oerstedii* occurs from central east Florida, through the Caribbean to Curaçao; in the littoral zone from

TABLE 4. Distinguishing morphological features in the species of *Gonodactylus* collected from the Indian River region of Florida

Character	*G. bredini*	*G. oerstedii*	*G. spinulosus*
Telson type	Bredini	Oerstedii	Oerstedii
Dorsal armature*	None	Tubercles	Spinules
Median carina	Unspined	Unspined-adult Spined-juvenile	Spined
Uropod endopodite	Oval	Tapering	Tapering

* This armature is in addition to the standard armature on the median, submedian, intermediate and lateral carinae found in this genus.

generally less than 5 m to 105 m. The majority of the specimens from the Indian River area were collected from surf zone phragmatopomid worm reefs although some of our offshore material occurred as deep as 76 m.

Gonodactylus spinulosus Schmitt, 1924

Table 4

Gonodactylus spinulosus.—Manning, 1972: 315.—Camp, 1973: 6, 9 [key].

Material examined: 2♂♂, 12 to 26 mm (TL), 2.9 to 6.7 mm (Rcl); 3♀♀, 19 to 37 mm (TL); 5 to 9 mm (Rcl).

Remarks: Only 5 specimens have been collected as yet during numerous day and night stations made on phragmatopomid worm reefs along the intertidal surf zone between Ft. Pierce and St. Lucie Inlet, and none has been taken from worm reef stations inside these inlets. This suggests that *G. spinulosus* cannot tolerate protected waters, such as the latter, which undergo high salinity fluctuations (22–36‰; von Zweck, unpublished) over typical tidal cycles.

This is yet another species now recorded for the first time in Florida north of the Florida Keys.

Distribution: From Bermuda and the Bahamas, and central east Florida to Aruba, off northeastern South America; intertidal to 10 m.

Gonodactylus sp.

Material examined: 1 juvenile, 12.8 mm (TL); 3.4 mm (Rcl).

Remarks: This specimen agrees in many respects with *G. bredini* even though some of the marginal teeth on the telson and the posterolateral portion of the fifth abdominal somite are rather sharply pointed. While these latter features are indicative, in part, of *G. curacaoensis,* they are presumably juvenile characteristics. The specimen was collected at the same offshore station at which a specimen of *G. bredini* was taken.

Genus *Parasquilla* Manning, 1961

Parasquilla (*Parasquilla*) *coccinea* Manning, 1962

Figure 14

Parasquilla (*Parasquilla*) *coccinea.*—Manning, 1970: 114 [listed].—Camp, 1971: 125 [listed]; 1973: 9 [key], 46, fig. 18.

Material examined: 3♂♂, 52 to 101 mm (TL); 13.8 to 26.9 mm (Rcl); 6♀♀, 50 to 110 mm (TL); 13.4 to 26.3 mm (Rcl).

Remarks: The carinae on the abdominal somites of the single female collected by R/V GOSNOLD were present but not prominent (cf. Camp, 1973).

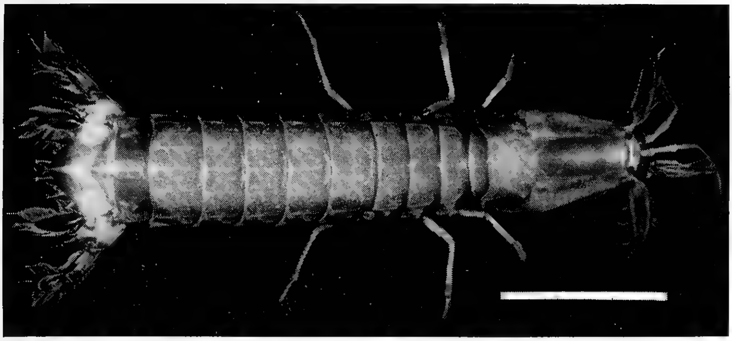

FIG. 14. *Parasquilla coccinea* Manning. Adult female, off Cape Canaveral, Florida. Scale lines each equal 10 mm.

The offshore waters in the general vicinity of Cape Canaveral now appear to be the northern limit of the range of *P. coccinea*.

Distribution: *Parasquilla coccinea* is distributed from central east coast of Florida to the Gulf of Campeche; 55 to 382 m.

Genus *Pseudosquilla* Dana, 1852

Pseudosquilla ciliata (Fabricius, 1787)

Figure 15

Pseudosquilla ciliata.—McNulty, et al., 1962: 232 [listed].—Manning, 1972: 315 [listed].—Camp, 1973: 9 [key].—Zeiller, 1974: 69 and 2 color plates.

Material examined: 1♂, 59 mm (TL); 13.2 mm (Rcl).

Remarks: This species predominantly inhabits shallow grassflat areas and was collected on such with a seine net, supporting Manning's contention that the species is more often encountered freely swimming than in hiding. *Pseudosquilla ciliata* is a rare species along this area of eastern central Florida since only the single male has been taken in 3 years of collecting.

Distribution: *Pseudosquilla ciliata* is widely distributed in the Atlantic from Bermuda to northern Brazil, and west Africa; littoral to 110 m.

DISCUSSION

Over 70 species of stomatopod crustaceans in 18 genera and 4 families have now been recorded from the western Atlantic. Recently published distributional records (e.g. Manning, 1969: Camp, 1973) show that at least 50 of these species occur in tropical or subtropical waters in the western North Atlantic. Floridan waters, in turn, support an abundant stomatopod fauna. In the eastern Gulf of Mexico, for example,

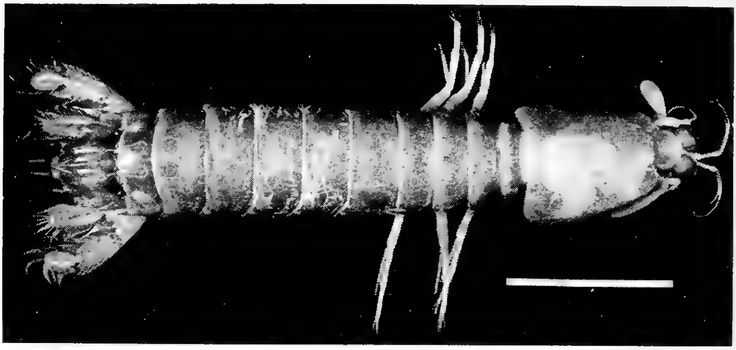

FIG. 15. *Pseudosquilla ciliata* (Fabricius). Adult male, Indian River, Ft. Pierce, Florida. Scale lines each equal 10 mm.

at least 28 species are known, including 3 species which may be endemic to the region (Camp, 1973). Along the tropical southeastern coast of Florida and the Florida Keys, 25 species have been recorded. Prior to the present study, only 10 species were known from the Indian River region along the central eastern Florida coast (i.e. between latitudes 27° and 28°30′N). Our material now indicates that at least 23 species either occur or would be expected to do so. Figure 16 lists these species and provides general distributional data for them throughout their respective ranges.

As might be expected, all the species collected and reported herein, with the exception of *Heterosquilla armata* and *Squilla edentata edentata,* were members of the West Indian fauna. This is a large tropical assemblage with components occurring from Brazil, throughout the Caribbean Sea, through the Indian River region, and, in many instances, into the Carolinian faunal subprovince. The most abundant species in the collections was *Squilla empusa,* a wide ranging eurythermic form, with 93 specimens collected in offshore waters between 12 and 100 m. *Squilla edentata edentata,* was the second most abundant species with 73 specimens collected entirely in offshore waters deeper than about 150 m. Although now known from deeper waters off Jupiter Inlet in southeastern Florida, this species may be more properly considered a member of the Carolinian fauna since it previously had been recorded only as far south as Ft. Pierce in the Indian River region, and it otherwise exhibits the classical disjunct distribution across the northern part of the State of Florida into the Gulf of Mexico. The next most abundant species was *Gonodactylus bredini,* an Antillean form with 68 specimens collected. This species was found primarily in phragmatopomid worm reefs in the surf zone along shore.

As can be seen from Figure 16, the majority of species (87%) seem to be primarily tropical forms most widely distributed throughout the

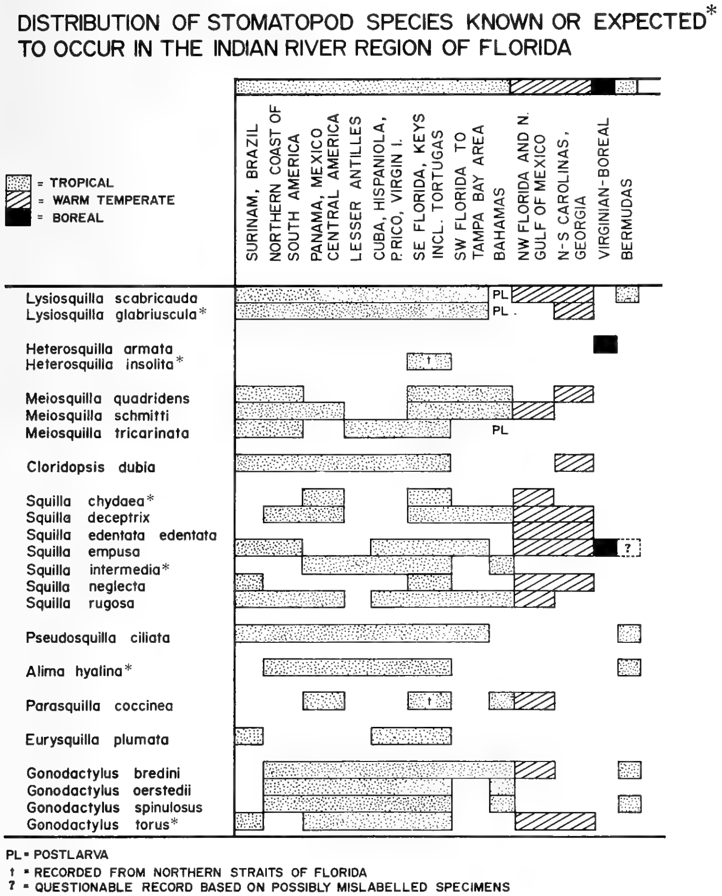

Fig. 16. Zoogeographical distribution of the species of Stomatopoda known or expected to occur on the central eastern Florida coast.

Caribbean, and occurring to as far north as the Bahama Islands. A second group which may be included with these species are those forms whose ranges extend from the lower Caribbean to the vicinity of Cape Hatteras in the Carolinian faunal subprovince. Briggs (1974: 215) has labelled such species "eurythermic tropicals" and considers them to be species which are able to withstand the winter temperatures of onshore waters. This group accounts for about 35% of those expected to occur in the Indian River area.

Within these assemblages 2 smaller groups may also be recognized.

The first, consists of *Squilla chydaea* (see below), *S. deceptrix,* and *S. empusa,* species which, based on available records, seem to be confined primarily to continental margins. Briggs (1974) considers species such as these to be members of the Caribbean [Sub-] Province which he defines as extending essentially along the eastern margins of central Florida, and middle America from southeastern Mexico, including the northern margin of South America to about Trinidad. Although *Squilla empusa* also has been collected from Cuba and Jamaica, some authors consider the island of Cuba at least, to be more "continental" in nature than the typical small Antillean Islands which make up the West Indies region (see e.g. Darlington, 1966).

The second group, consisting of *Meiosquilla quadridens* and *Squilla neglecta* shows a disjunct continental distribution, with records only from the coasts of North and South America, or the islands just offshore of the northeastern coast of the latter continent.

Six species which were not taken in our collections deserve some mention. These are *Squilla chydaea* Manning, 1962a, *S. intermedia* Bigelow, 1893, *Heterosquilla insolita* (Manning, 1963a), *Lysiosquilla glabriuscula* (Lamarck, 1818), *Alima hyalina* Leach, 1817, and *Gonodactylus torus* Manning, 1969. Although *Squilla chydaea* has been collected off Cape Canaveral in 146 m (Manning, 1969: 196) extensive shallow water trawling in that region by R/V HERNAN CORTEZ, and south of that area to depths greater than 200 m by R/V GOSNOLD, produced no specimens for our study. The species is primarily distributed throughout the Gulf of Mexico (Manning, loc. cit.). The Cape Canaveral record, thus, may be extralimital.

Squilla intermedia, a deep water species, has been recorded east of Ft. Pierce in water greater than 290 m. However, this species would not be expected in our sampling since its known depth range extends from about 300–600 m, along and down the continental slope, and thus well beyond the depths sampled both by R/V GOSNOLD and R/V HERNAN CORTEZ for this study.

Records for the remaining 4 species, 3 of which have been recorded in relatively shallow water, indicate that they also may occur in the Indian River region. *Heterosquilla insolita,* for example, has been reported by Manning (1969: 58) from the northern Straits of Florida in 238 m of water. The possibility that this deeper water species may also occur in similar depths off the central eastern Florida coastline cannot be dismissed.

Lysiosquilla glabriuscula has been collected (in presumably 1–2 m) at Lake Worth, Palm Beach County, Florida, just south of Jupiter Inlet, the mouth of the Indian River. Moreover, 2 other species, *Alima hyalina* and *Gonodactylus torus,* have both been recorded in relatively shallow water (55 m) off Palm Beach and all 3 of these species thus may be expected to occur occasionally in the shallow coastline waters of the lower Indian River region.

However, the exact reason as to why none of the last 3 species has been collected yet in the Indian River region must remain speculative at this point. The northward distribution of the shallow water species may be influenced in part by the directional flow of the Florida Current, the waters of which diverge away from the Florida coastline in the vicinity of Palm Beach County. Larval settlement thus would take place on a progressively wider and deeper shelf area proceeding northward, perhaps accounting for the few published records.

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PROCEEDINGS
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MIOSTEPHOS CUBROBEX, A NEW GENUS AND SPECIES OF COPEPOD FROM AN ANCHIALINE POOL IN CUBA (CALANOIDA: STEPHIDAE)

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Among the interesting and unusual crustaceans collected by L. Botosaneanu during the 1973 Cubo-Romanian Biospeological Expedition (Botosaneanu, 1973) was a tiny new copepod which is a serious contender for the distinction of being the smallest known calanoid. I am grateful to Mr. Botosaneanu for the privilege of studying this interesting copepod and for providing me with complete collection data.

Stephidae

Miostephos, new genus

Female urosome of 3 segments, male of 5 segments. Female 5th leg symmetrical, 3-segmented. Male 5th leg very asymmetrical; left leg slender, elongate, 6-segmented; right leg rudimentary, 3-segmented, similar to female 5th leg.

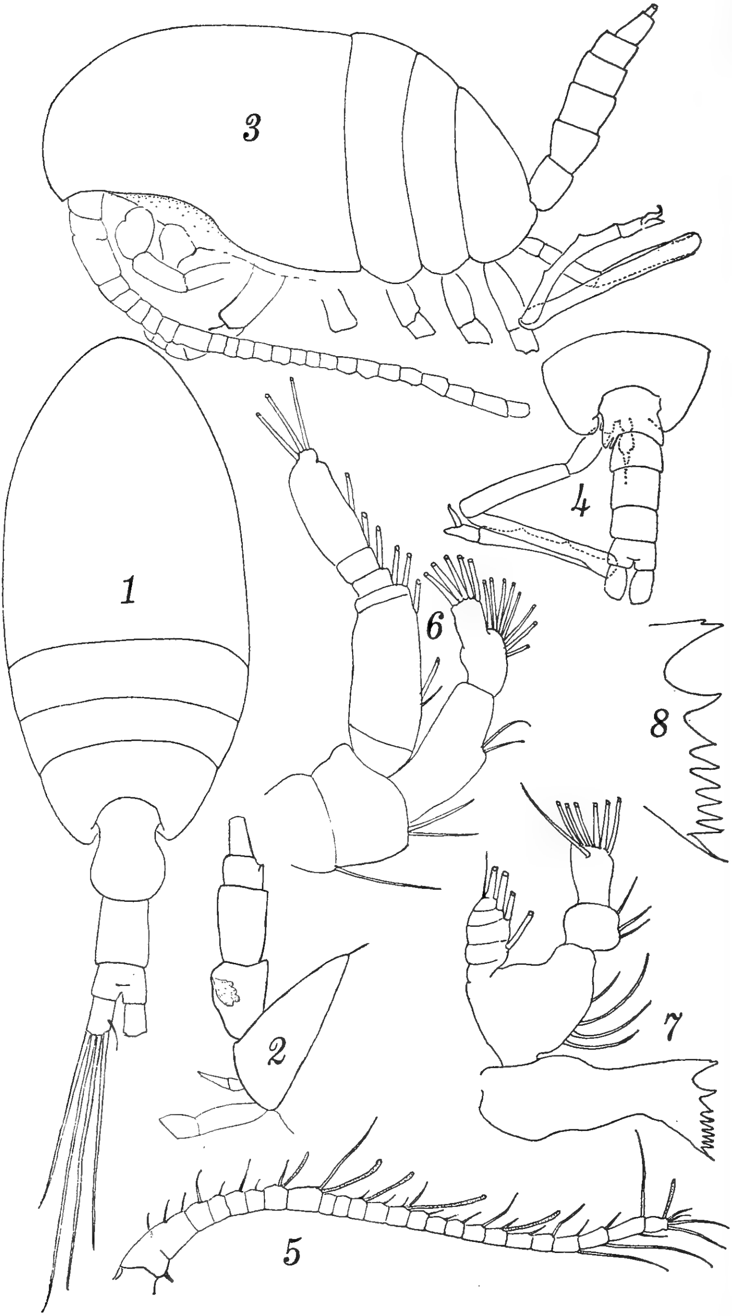
Type-species: *Miostephos cubrobex,* new species.

Etymology: The Greek prefix "mio-" = less, combined with *Stephos,* the type-genus of the family, referring to the small size.

Miostephos cubrobex, new species

Figures 1–15

Material: Cuba, near Playa Velázquez, Gibara area, northern coast of Oriente Province, 9–10 km W of Gibara, about halfway between Gibara and Playa Caleton, close to road connecting these 2 localities; "casimba", about 80 m inland from seashore, 10 March 1973, leg. L. Botosaneanu: male holotype, USNM 154436; 50+ paratypes, USNM 154437.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The "casimba" is a shallow anchialine pool (Holthuis, 1973), 5 m by 1.5 m, situated in an area with rich vegetation. Its bottom consists of sand, mud with an H_2S odor, and blocks of madreporarian coral. The maximum depth at the time of collecting was 25 cm, but the depth fluctuates with the tides. The temperature was 28°C and the water was distinctly brackish. The "casimba" is well exposed to the sun, but is shady in a few places.

The "casimba" has a rich population of the hippolytid shrimp, *Barbouria cubensis* (see Holthuis, 1974). The microfauna, collected with a small net, included in addition to the *Miostephos*, cyclopoid and harpacticoid copepods, ostracods, *Barbouria* zoeae, and praniza larvae of gnathiid isopods.

Etymology: The specific name, *cubrobex*, is a contraction of *Cubo-Romanian Biospeleological Expedition*.

Description: Length of male 0.36–0.38 mm, of female 0.38–0.40 mm. Prosome to urosome ratio 2.16–2.36 in male, 2.25–254 in female. Head vaulted anteriorly, without rostrum. Posterior corner of pediger 5[1] symmetrically rounded, ventral part produced into rudimentary rounded lobe. Urosome unarmed; in female 3-segmented, genital segment distinctly bulging laterally, only slightly protuberant ventrally, spermatheca rosette-shaped; 2nd segment subequal to genital segment, twice length of 3rd (anal) segment; caudal rami nearly twice as long as wide, symmetrical. Urosome of male 5-segmented; caudal rami slightly shorter than in female.

Antenna 1 reaching slightly beyond prosome; 24-segmented (suture between 1st and 2nd segments obscure). First segment with strong spine on posterior margin. Segments 2, 8, and 23 notably longer than other segments. Esthetes borne on segments 7, 8, 11, 13, 18 and 24.

Antenna 2, mandible, and maxilliped (Figs. 6–9) with setal armature conforming to pattern described for other species of Stephidae. Mandibular blade with sharp teeth.

Legs 1–4 (Figs. 10–12) with segmentation and spinal and setal armature characteristic for Stephidae. Surface spinules absent. No asymmetry observed in male leg 4.

Female leg 5 minute; segments unarmed. Right and left proximal segments fused medially; middle segment short; terminal segment narrowing in distal half, apex acuminate.

Male right leg 5 minute, similar to female leg 5. Male left leg 5

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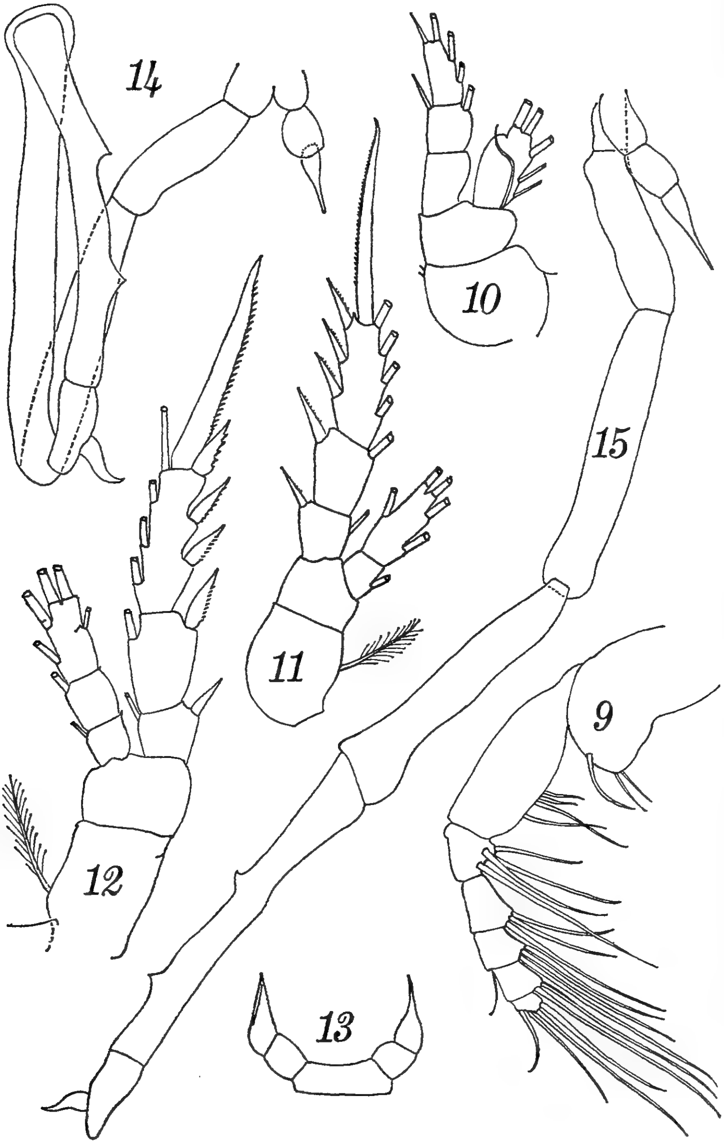
[1] The term "pediger", analogous to "setiger" of polychete worms, is proposed to replace "pedigerous segment" of Gooding (1957).

←

FIGS. 1–8. *Miostephos cubrobex*: 1, ♀, dorsal; 2, ♀ pediger 4 + 5 and urosome, lateral; 3, ♂, lateral; 4, ♂ pediger 4 + 5 and urosome, dorsal; 5, ♀ antenna 1; 6, Antenna 2; 7, Mandible; 8, Blade of mandible.



FIGS. 9–15. *Miostephos cubrobex*: 9, Maxilliped; 10, Leg 1; 11, Leg 2; 12, Leg 4; 13, ♀ leg 5; 14, ♂ leg 5, ventral; 15, ♂ leg 5, from right side.

composed of 6 slender segments. 1st segment short, fused medially to 1st segment of right leg. Segments 2–5 progressively longer; segment 5 with 1 margin divided into thirds by 2 teeth. Segment 6 short; sides parallel in proximal ⅔, then converging to triangular apex; strong spine with curved and pointed apex inserted at level where sides begin to converge.

Relationships: The family Stephidae includes 2 genera, *Stephos* Scott (1892) with about 15 species, and *Parastephos* Sars (1902) with 2 species. The species of both genera are bottom-living, and this may be presumed to be true also for *Miostephos*. *Stephos* and *Parastephos* are distinguished from each other by the structure of the male leg 5 and the tendency in *Parastephos* for the male leg 4 to be asymmetrical. *Miostephos* appears to be more widely separated from the other genera than they are from each other. Female *Stephos* and *Parastephos* both have 4-segmented urosomes, whereas the urosome of *Miostephos* is 3-segmented. In male *Stephos* and *Parastephos* the right leg 5 is well developed and usually ends in a claw, sharply contrasting with the rudimentary right leg 5 of *Miostephos*. The left leg 5 of male *Stephos* and *Parastephos* has inflated penultimate or antepenultimate segments, but all segments are slender in *Miostephos*.

The addition of *Miostephos* to the Stephidae necessitates emending the definition of the family as follows:

Body short and stout. Head and pediger 1, pedigers 4 and 5 fused. Rostrum and rostral filaments absent. Male urosome with 5 segments, female urosome with 3 or 4. Eye absent. 1st antenna 24-segmented in male and female; last 2 segments clearly separate. Male mouthparts not reduced. Maxilla 1 without sensory appendages. First segment of leg 1 without outer spine. Female leg 5 small, uniramous, 3-segmented; last segment ending in point. Male leg 5 large, uniramous; left leg larger, usually with 1 or more segments dilated; right leg usually well developed and ending in claw, sometimes rudimentary and similar to female leg 5.

Key to Genera of Stephidae

1. Female urosome 4-segmented. Both male 5th legs well developed.... 2
   Female urosome 3-segmented. Left male 5th leg rudimentary.... ....*Miostephos*
2. Male right 5th leg ending in claw armed with spines on concave margin ....*Parastephos*
   Male right 5th leg ending in unarmed claw or mittenlike segment ....*Stephos*

Miostephos cubrobex is the 5th species of Stephidae known to occur in the western Atlantic. The 4 previously recorded species are *Stephos deichmannae* Fleminger, 1957, from the Gulf of Mexico; *S. lucayensis* Fosshagen, 1970, and *S. exumensis* Fosshagen, 1970, from the Bahamas; and *S. arcticus* Sars, 1909, from northern Canada. *S. sinuatus* Willey, 1923, from Hudson Bay is a synonym of S. *arcticus*, according to Fosshagen.

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PROCEEDINGS
OF THE
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A NEW *PRIONOCIDARIS* (ECHINODERMATA: ECHINOIDEA) FROM THE MIDDLE MIOCENE OF FLORIDA

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A large number of cidaroid fragments, including a few isolated interambulacral plates but mostly pieces of radioles, were collected at several U.S. Geological Survey (USGS) localities in the Middle Miocene (Chipola Formation) of Florida by Dr. C. Wythe Cooke. A few radiole fragments from the Middle Miocene of Cuba which appear conspecific with the Florida specimens were found among a large number of cidaroid fragments collected by Dr. Robert H. Palmer and Dr. Pedro J. Bermúdez.

The specimens represent an undescribed species of *Prionocidaris,* a genus previously unreported from the Western Hemisphere except for a suggestion by Mortensen (1928:436) that *Cidaris mitchelli* Emmons from the Eocene of North Carolina may belong to this genus.

The new species is best described from Dr. Cooke's material from Florida. Since a publication on Caribbean fossil cidaroids, in which it is desired to give a specific name for the Cuban specimens, will precede one on the United States cidaroids, the species is described in this preliminary paper.

The Cooke collection, including the type specimens, is deposited in the National Museum of Natural History, Smithsonian Institution (USNM). The Palmer specimens are in collections of the Paleontological Research Institution (PRI), Ithaca, New York, and hopefully the Bermúdez specimens will be deposited there also.

Dr. Cooke, Dr. Bermúdez and the PRI very generously loaned their specimens for the duration of my studies, extending over some years now, of Cretaceous and Tertiary Cidaroidea of the Caribbean area and the southern and eastern United States. Support for these studies has come at various times from the Jersey Production Research Company, Tulsa, Oklahoma, the National Science Foundation (G-15902), and the University of Puerto Rico, Mayaguez campus (69-24, 70-28). Dr. David L. Pawson and Dr. Thomas E. Bowman, National Museum of Natural History, Washington, D.C. checked over the manuscript. All this help is gratefully acknowledged.

Order CIDAROIDA Claus, 1880
Family CIDARIDAE Gray, 1825
Subfamily RHABDOCIDARINAE Lambert, 1900 (Emend. Fell, 1966)

Prionocidaris cookei, new species

Figures 1–2

Diagnosis: Test medium size. Primary areoles more than half width of plate, those near peristome confluent. Scrobicular tubercles round, separated; secondary tubercles otherwise well spaced, of decreasing size to sutures, not horizontally aligned. Radioles moderately long, slender, tapered, sometimes dark-banded, and with regular longitudinal series of uniformly small or small and medium sized spinules. Collar often long, mottled, with low, oval nodules. Oral radioles not "capped."

Description: Isolated interambulacral plates (Fig. 1D) are from tests estimated 35–40 mm in horizontal diameter. Areole not depressed, 55–75 percent width of plate; tubercle high with smooth parapet and fairly large and perforate mamelon. Median area 14–22 percent width of plate, 20–38 percent width of areole. Scarely a full row of scrobicular tubercles at horizontal margins of largest, probably ambital, plates; areoles of adoral plates apparently confluent. Scrobicular tubercles round, separated by space (about equal in width to diameter of scro-

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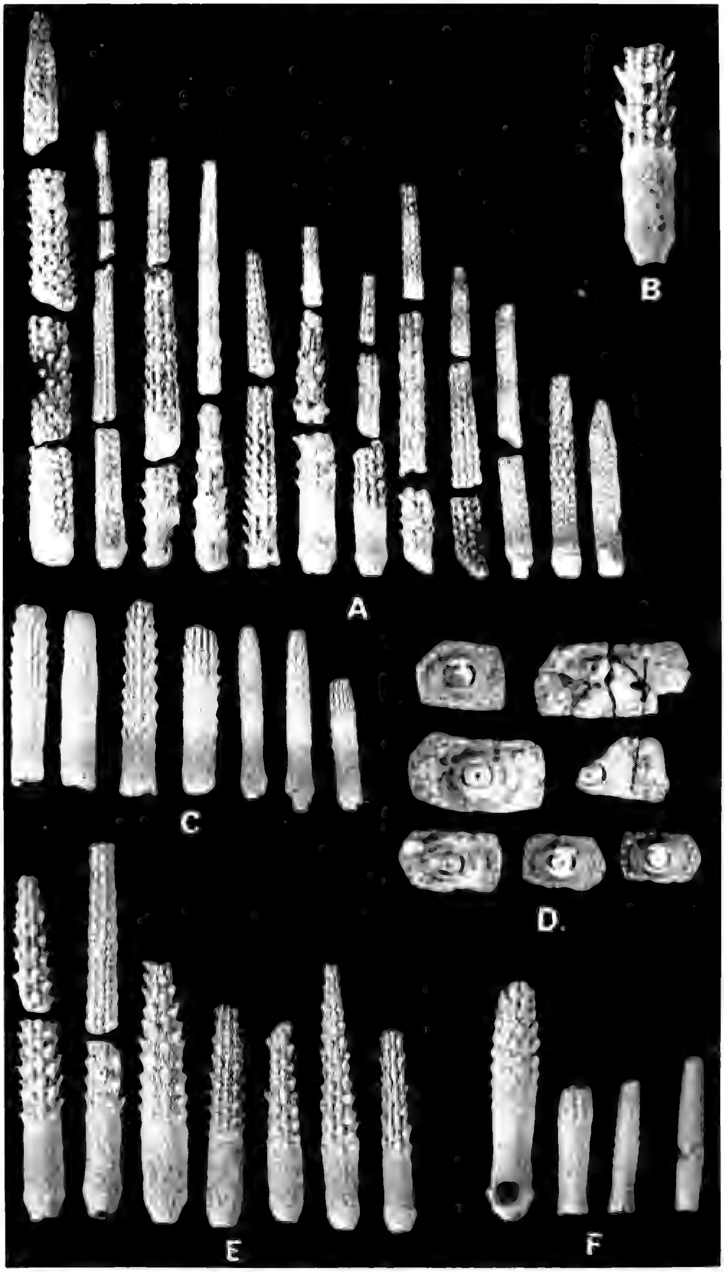
FIG. 1. *Prionocidaris cookei* n. sp. A, radiole fragments from USGS 2564, × 2; B, holotype, basal fragment of radiole from USGS locality 2564, × 3; C, oral radioles from USGS locality 2564, × 3; D, interambulacral plates from USGS locality 2564, × 2; E, long-collared radioles from USGS locality 3419, × 3; F, oral radioles (3 at left) and secondary spine from USGS locality 3419, × 3. All from the Middle Miocene (Chipola Formation), Florida.


B
A
C
D.
E
F

bicular areole), this space occupied by small tubercle or ridge. Smaller, widely spaced tubercles outside scrobicular ring decrease in size to sutures. Ten indentations for ambulacral plates on largest plates.

Radiole fragments (Figs. 1–2) mostly from radioles estimated 30–40 mm long but some probably 50 mm long, to 3.5 mm wide, tapered, straight, slightly flattened. Tip acute, narrowly obtuse or sometimes finely coronate. Shaft with 10–14 quite regular longitudinal series of peaked nodules or small spinules often joined into ridges. Spinules on some fragments uniformly small, 0.15–0.4 mm wide, spaced transversely about 0.3–0.6 mm tip to tip, projecting to about 0.4 mm, the smallest in 4–6 series on oral surface of radiole. Other fragments with larger spinules about 1 mm wide and projecting up to about 1–1.5 mm interspersed among smaller spinules on aboral and lateral surfaces, especially prominent in lateral series. Surface of shaft otherwise with minute nodules between and up sides of spinules, apparently remnants of hair coat. Some shafts with traces of dark transverse bands. Junction between shaft and collar sometimes rather oblique or irregular. Collar 2.5–3.8 mm long, about same width throughout or gradually widened toward milled ring; some specimens with faint, dark mottling and low, oval, nodular protuberances between mottling. Milled ring not especially prominent. Base 1–1.5 mm long; acetabular edge smooth on most basal fragments but with what may be faint traces of crenulations on a few.

Oral radioles (Fig. 1C,F) very slightly flattened and curved, with rather inconspicuous, serrate, lateral ridges and several series of smaller serrations on other surfaces, particularly near tip. Tip obtuse or truncate. Collar usually long but not longer than shaft, that is not "capped."

One secondary, apparently ambulacral, spine (Fig. 1F) present with other specimens, 7 mm long, tip and base missing, 1.2 mm wide, slightly flattened, and rather lanceolate in outline.

Measurements of holotype: Basal fragment of radiole, 10 mm long, 2.2 mm wide, 2 mm thick at base of shaft, 1.7 mm wide and 1.5 mm thick where broken distally. Shaft with 10 series low spinules 0.15–0.3 mm wide and, interspersed among them, larger spinules ca. 0.5 mm wide through base and projecting to 1 mm. Collar 3.8 mm long, 2.2 mm wide distally, 2.1 mm, proximally. Milled ring 2.3 mm wide. Base 1 mm long, 1.9 mm wide distally, 1.4 mm, proximally.

Etymology: The species is named for Dr. C. Wythe Cooke who collected most of the known specimens.

Material examined: Holotype, USNM 232503, basal fragment of radiole from USGS locality 2564, "Burns' typical locality" in the right bank of Chipola River, on the McClelland Farm one mile below the

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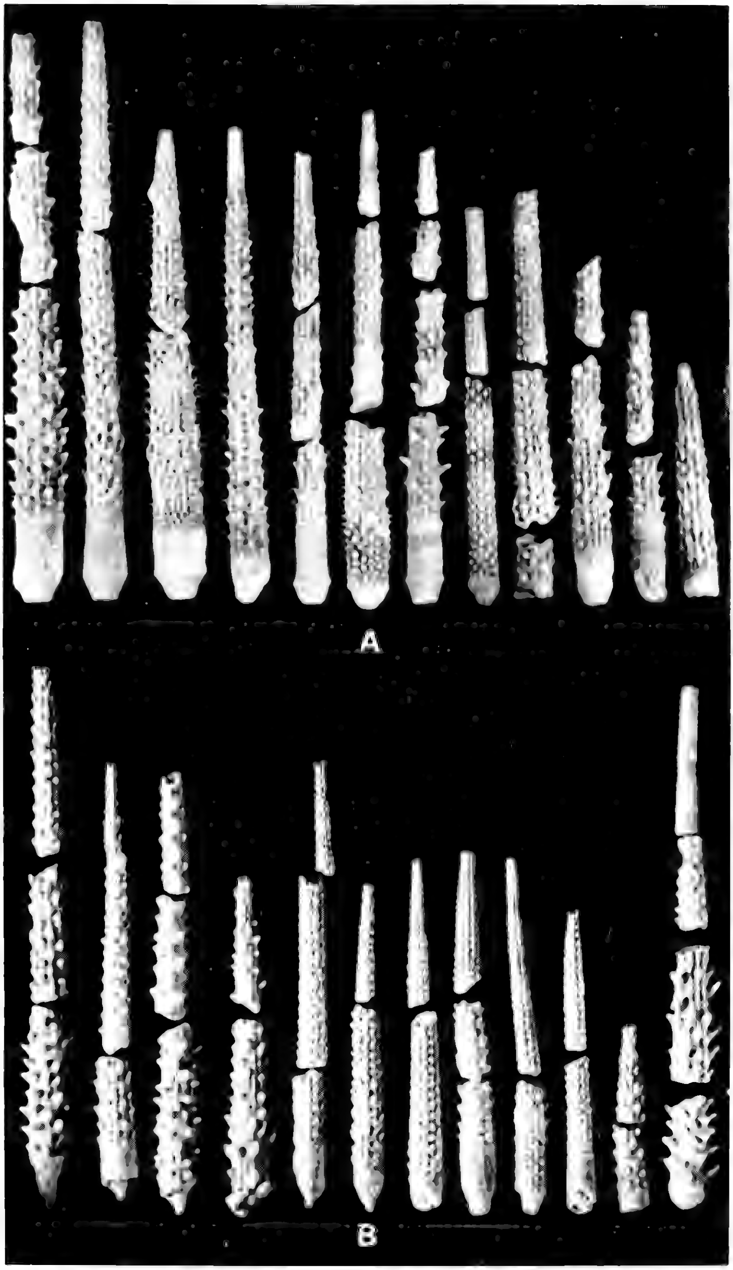
FIG. 2. *Prionocidaris cookei* n. sp. A, radiole fragments from USGS locality 3419, × 2; B, radiole fragments from USGS locality 2213, × 2. All from the Middle Miocene (Chipola Formation), Florida.


A
B

bridge at the old Bailey Ferry, Calhoun County, Florida, 10 miles west of Blountstown.

Paratypes: USNM 232504, 19 interambulacral plates and 32 radiole fragments from USGS locality 2564, as above. USNM 232505, 987 radiole fragments from USGS locality 2213, one mile below Bailey's Ferry on the Chipola River, Calhoun County, Florida, collected from the banks of the river above white limestone beds. USNM 232506, 2 interambulacral plates and 374 radiole fragments from USGS locality 3419, McClelland's Farm on west bank of Chipola River one mile below Bailey's Ferry and new bridge.

All above specimens collected by C. W. Cooke.

A number of radiole fragments which probably are conspecific with those of *P. cookei* were collected by Drs. Robert H. Palmer and Pedro J. Bermúdez at several localities in Cuba: 3 fragments, Palmer 378, N.W. end of Yumurí Gorge series, on N. side, lowest, Matanzas Province; 40 fragments, Palmer 1034, Central Highway cut, both sides, km 425.5 E. of Habana or km 36.1 W. of Ciego, marly limestone, Camagüey Province; 2 fragments, Bermúdez 48, Tejar el Abra, Abra de Yumurí, Cojímar Formation, Matanzas Province; 3 fragments, Bermúdez 83, Tejar Zayas, Matanzas, Cojímar Formation, Matanzas Province; 46 fragments, Bermúdez 147, 1 km S. of Turbina, Central Constancia, Santa Clara Province. The Palmer specimens are in collections of the Paleontological Research Institution, Ithaca, New York, and permission is being sought to deposit there also the Bermúdez material.

Stratigraphic occurrence and localities: Middle Miocene (Chipola Formation), Florida; probably also Middle Miocene, Cuba.

Remarks: Although described and otherwise previously recorded in other genera, there are three other species of *Prionocidaris* known from the Caribbean Miocene: *Prionocidaris spinidentatus* (Palmer *in* Sánchez Roig, 1949), *Prionocidaris cojimarensis* (Lambert and Sánchez Roig *in* Sánchez Roig, 1926), and *Prionocidaris clevei* (Cotteau, 1875). Interambulacral plates of *P. cookei* differ from those of the other three species in having generally a narrower median area in relation to plate width. *P. spinidentatus* was a much larger species than *P. cookei* with much more massive and grossly spinulose radioles. Test size of *P. cojimarensis* was probably near that of *P. cookei*, but radioles of the former species reached greater maximum width and had spinules commonly in distinct whorls while spinules of *P. cookei* apparently almost never were so arranged. *P. clevei* was a smaller species than any of the others with radioles, to be described for the first time in a later publication, even more tightly whorled than those of *P. cojimarensis.*

As far as is known at present, *P. cookei* was the only *Prionocidaris* in the southern and eastern United States during the Miocene, but there probably were at least two living there in the Eocene, *Cidaris mitchelli* Emmons (1858) and *Cidaris carolinensis* Emmons (1858). Both of these species were referred to *Phyllacanthus mortoni* (Conrad, 1850) by Cooke (1941, 1959) but are distinct. Not only the tests (types) but radioles associated with some test specimens conspecific with the *mitchelli* and *carolinensis* types indicate both species are prionocidarid. Their radioles are quite different from those of *P. cookei*; the tests are larger, and the median areas of the interambulacral plates are wider with respect to plate width.

Rather than other fossil species, *P. cookei* bears most resemblance to *Prionocidaris hawaiiensis* (A. Agassiz & H. L. Clark, 1907) now living in Hawaiian waters. The tests of the two species probably were of similar size, and the tapered, dark-banded radioles with mottled, nodulose collars in *P. cookei* are strikingly like those of the Recent species. However, in *P. hawaiiensis* interambulacral plates apparently are all separated by at least one series of scrobicular tubercles; there are more ambulacral plates (13–14) adjoining interambulacral plates than in plates of comparable size in *P. cookei*; the radioles reach a greater maximum length (91 mm), and the adoral radioles are "capped" (shaft much shorter than collar).

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PROCEEDINGS
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CIRRISALARIAS BUNARES, NEW GENUS AND SPECIES OF BLENNIID FISH FROM THE INDIAN OCEAN

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The description of the new genus that follows is the first to appear in the Tribe Salariini since Smith-Vaniz and Springer's (1971) synopsis of the Tribe. The new genus, and species, is widely distributed in the Indian Ocean, where it is known from Ceylon and Grand Comore Island. It has probably escaped notice heretofore because of its small size (maximum known: 22.0 mm SL).

I follow the methods, abbreviations, and mode of presentation used by Smith-Vaniz and Springer (1971).

I wish to thank J. F. McKinney, formerly National Museum of Natural History (USNM) for alerting me to the existence of recently collected specimens of the new form at the California Academy of Sciences (CAS), and to the officials of that institution and the Academy of Natural Sciences, Philadelphia (ANSP) for the loan and gift of specimens. The collection of Comoran specimens was made possible by a grant from the Charline H. Breeden Foundation, John E. McCosker, principal investigator.

Cirrisalarias, new genus

Diagnosis: Dentary a closed capsule with replacement teeth entering functional series through foramina in bone. Anterior and posterior canines absent. Premaxillary and dentary teeth immovable or nearly so, numbering 23 to 28 in upper jaw and 22 to 26 in lower jaw (based on ten specimens 12.5–22.0 mm SL). Vomer toothless. Dorsal-fin spines X to XII (rarely X or XI), segmented rays 16 or 17. Anal fin II,17 to

19 (rarely 17). Segmented caudal-fin rays 13, none branched. Pectoral-fin rays 14, dorsalmost ray reduced, difficult to detect except in skeletal preparations. Pelvic fin I,3. Vertebrae 10 + 26 or 27. Last epipleural rib on vertebra 13 to 15. Terminal anal-fin ray bound by membrane to caudal peduncle. Lateral-line reduced, consisting of 1 or 2 disconnected, bipored tubes on body in region below anteriormost one or two dorsal-fin spines. No scalelike flaps covering lateral-line pores. Preoperculo-mandibular pores without cirri. Single mid-dorsal supratemporal commissural pore. Upper lip without free dorsal margin. No cup-shaped fleshy disk or appendage behind lower lip. Gill membranes forming free fold across isthmus (gill opening not restricted to side of head). Fleshy, median occipital crest absent. Nuchal cirri absent. Supraorbital cirri varying from slender and simple to ribbonlike with palmately branched distal end, and small cirri on medial edge. Numerous cirri on rims of anterior and posterior nostrils. No cirri on interorbital region that are not associated with rims of posterior nostrils. Postcleithra consisting of two elongate bones, dorsal end of ventral element overlapping ventral end of dorsal element. Lateral extrascapular not fused with pterotic. Median ethmoid present. Infraorbital bones 4 (includes dermosphenotic of Springer, 1968). Rostral cartilage ossified (kinethmoid of Springer, 1968). Frontals fused together, at least anteriorly. Ventral hypural plate fused to urostylar centrum; hypural 5 autogenous; one epural, broad, apparently the result of fusion of two epurals. Nasal bones greatly compressed, curving laterally anteriorly and providing support for anteromesial margin of anterior nostril (all cirri of posterior nostril arising from skin above nasal bone). Anterior and posterior nostrils relatively large, each with greatest diameter equal to about one-third orbital diameter.

Relationships: *Cirrisalarias* is a member of the group 21 Salariini (see Smith-Vaniz and Springer, 1971, p. 51, fig. 51), which includes those genera that have relatively few premaxillary and dentary teeth, and have the dentary replacement teeth generally making their appearance through foramina in the bone. All of the species belonging to this group are relatively small, have the terminal anal-fin ray bound by membrane to the caudal peduncle, and usually have 14 pectoral-fin rays (except *Medusablennius*, which has 13). *Cirrisalarias* will key to couplet 20 in Smith-Vaniz and Springer's (1971, p. 9) key, which separates *Medusablennius* and *Litobranchus*. *Cirrisalarias* will key to neither of these two genera, but because of its superficially close resemblance to *Medusablennius* might be mistaken for that genus (only *Medusablennius* and *Cirrisalarias* in the Blenniidae have such large nos-

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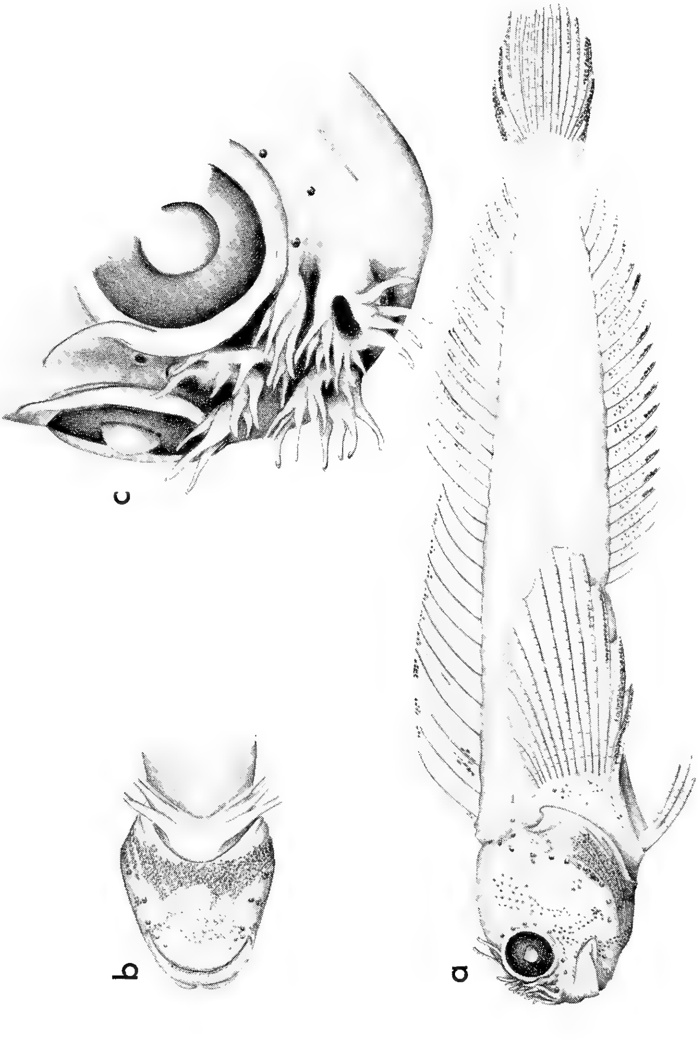
FIG. 1. *Cirrisalarias bunares*, CAS 34623, male, paratype 17.3 mm SL. a, Lateral view; b, Ventral view of head; c, View of snout region. Drawn by J. R. Schroeder.


c
b
a

trils and so many cirri associated with the nostrils; they are also the two smallest-sized genera of blenniids: largest specimen of *Medusablennius*, 15.4 mm SL; largest specimen of *Cirrisalarias*, 22.0 mm SL). The following key couplets replace couplet 20 in Smith-Vaniz and Springer's key to the Salariini:

20. Head conspicuous for numerous cirri, which cover snout region; no nape cirri present; nostrils relatively enormous (but obscured by cirri), greatest dimension three times or less in orbital diameter; upper jaw teeth fewer than 30; infraorbital bones 2 or 4 .... 20A

Head with simple cirrus on rim of anterior nostril, above eye and on nape (nape cirrus minute); nostrils small, porelike, greatest dimension more than five times in orbital diameter; upper jaw teeth more than 35; infraorbital bones 5 .... *Litobranchus* Smith-Vaniz and Springer

20A. Upper lip without free dorsal margin extending around snout; pectoral-fin rays typically 14; no cirri in interorbital region that are not associated with rims of posterior nostrils; one mid-dorsal supratemporal commissural sensory canal pore; more than 20 teeth in either jaw; infraorbital bones 4 .... *Cirrisalarias* Springer

Upper lip with free dorsal margin extending around snout; some cirri in interorbital area but not associated with rims of posterior nostrils; two mid-dorsal supertemporal commissural sensory canal pores (arranged one behind the other); less than 20 teeth in either jaw; infraorbital bones 2 .... *Medusablennius* Springer

Etymology: A combination of the Latin *cirri,* meaning tufts of hair, and *Salarias,* a genus of Blenniidae, referring to the numerous cirri on the head of this new salariinine genus. Gender: masculine.

Type-species: *Cirrisalarias bunares* Springer, new species.

Cirrisalarias bunares, new species

Figure 1

Description: A small species (largest known specimen, 22.0 mm SL) with characters of the genus.

In preservative, males tend to be more heavily pigmented than females and usually have a dark smudge or chevron, which females lack, beneath the head. The body of neither sex shows evidence of color pattern, although specimens under 14 mm SL may exhibit indications of three or four faintly dusky bands separated by broader, pale interspaces in the region above the anal fin. The spinous dorsal fin of males and some females has a narrow distal dark margin, and in males much of the proximal portion may also be darkly pigmented. The segmented-ray portion of the dorsal fin exhibits dusky pigment dorsally. The anal fin of males is dusky with a dark distal margin; that of females is immaculate. Both sexes have conspicuous dark pigment on the ventral rays of the pectoral fin and both lobes of the caudal fin; the other rays of theses fins are less pigmented or immaculate.

Distribution: Known only from Grand Comore Island and Ceylon.

Etymology: From the Latin prefix *bu-*, meaning large, and *nares*, meaning nostrils, in reference to the large nostrils characterizing the genus; here used as a noun in apposition.

Holotype: CAS 33598, male, 19.8 mm SL; Grand Comore Island: N'Gouni Reef, about 0.5 km N of Iconi; in surge channel at far end of small cove; rock and coarse coral sand bottom; depth: to 5 m; Pronoxfish. Collected by J. E. McKosker, S. Mead, D. Powell and J. Breeden, 1 March 1975. Original field number: JEM 75-29.

Paratypes: CAS 34623, 106 specimens, 10.8–20.1 mm SL, collected with the holotype. USNM 214974, 5 specimens, 16.5–22.0 mm SL, all cleared and stained, collected with the holotype. CAS 33607, 13.4 mm SL; Grand Comore Island: lava flow tidal flats about 1 km N of Hotel Coelacanthe; depth: to 2 m; original field number JEM 75-4. USNM 214975, 3 specimens, 16.9–19.0 mm SL, same locality as CAS 33607; original field number JEM 75-2. ANSP 13400, 20 specimens, 10.4–16.6 mm SL, same locality as CAS 33607; surge channels, tidepools and over edge of dropoff; depth: to 5 m; original field number JEM 75-11. USNM 205453, 20.5 mm SL; Ceylon: Trincomalee (outside harbor), rocky area opposite Fort Frederick; depth: 0.6–6.1 m; original field number SV-69-121.

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PROCEEDINGS
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DISTINCTION BETWEEN A GULF OF MEXICO AND A CAROLINIAN ATLANTIC SPECIES OF THE SWIMMING CRAB *OVALIPES* (DECAPODA: PORTUNIDAE)

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In their revision of *Ovalipes* Rathbun, 1898, Stephenson and Rees (1968) distinguished two forms of what they and Williams (1962, 1965) called *Ovalipes guadulpensis* (Saussure, 1858), and Rathbun (1930) called *Ovalipes ocellatus guadulpensis* (Saussure). They found *Form a* in the Carolinian Province off the southeastern United States, *Form b* in the Gulf of Mexico, and gave an analysis of each form with illustrations but felt that more study was needed before two species could be recognized.

Türkay (1971) discovered, from study of type-specimens in collections of the Muséum d'Histoire Naturelle, Geneva, that Saussure's *guadulpensis* does not belong to *Ovalipes*, but to *Macropipus*, and was named for the locality Guadaloupe on the island of Graciosa in the Azores. *Macropipus* does not occur in the Western Hemisphere. The next available name for the western Atlantic taxon mistakenly attributed to Saussure, is *Ovalipes ocellatus floridanus* Hay and Shore, 1918, which Türkay continued to recognize as a subspecies.

Reviewing the evidence again, I still regard the spotted *O. ocellatus* (Herbst) of the western North Atlantic as a full species and in addition formally recognize the unspotted, yellow *Ovalipes Forms a* and *b* of the Carolinian Atlantic and Gulf of Mexico respectively as separate species. The analysis is based on study of material in collections of the National

Museum of Natural History, Smithsonian Institution (USNM), a considerable part of which was collected by vessels of agencies parent to the present National Marine Fisheries Service (*Albatross, George M. Bowers, Combat, Delaware, Fish Hawk, Oregon, Oregon II, Silver Bay*), as well as collections of the Marine Research Laboratory, Florida Natural Resources Department, St. Petersburg (FSBC), Texas A & M University Oceanographic Collection, College Station (TAMAC), Moody College of Marine Studies, Galveston (MCMS), and University of North Carolina Institute of Marine Sciences (UNC).

Ovalipes floridanus Hay and Shore

Figures 1 *a–d*

Ovalipes ocellatus floridanus Hay and Shore, 1918, p. 427, pl. 32, fig. 8. Türkay, 1971, p. 139, fig. 3.

Ovalipes ocellatus guadulpensis: Rathbun, 1930, p. 23, pl. 4 (part, the Pensacola, Alabama and Gulf of Mexico specimens).—Hildebrand, 1954, p. 275.

Ovalipes guadulpensis (*Form b*): Stephenson and Rees, 1968, p. 243, pls. 37D, 40F, 41E, 42K; fig. 1K.

Ovalipes guadulpensis: Felder, 1973, p. 54, pl. 8, fig. 2.

Description: As in Stephenson and Rees (1968). Recapitulating their diagnosis in part, the characters are:

Carapace with granulation generally fine but more pronounced anteriorly, lacking narrow tract of slightly enlarged granules in midline.

Chelipeds with dorsal surface of carpus smooth or sparsely granular; dorsal surface of palm between ridges considerably strewn with moderately fine granules except along smooth tract on dorsal aspect of outer ridge; dorsal surface of dactyl between ridges smooth or with sparse fine granules. Outer surface of palm granular, with inconspicuous granular carina; fixed finger granular and pitted. Inner surface of palm with scattered fine granules dorsally and moderately to coarse granules ventrally; dactyl and fixed finger granular.

Merus of third maxilliped with distal projection short, nearly as broad as long, its anterolateral border nearly straight.

Male first pleopod with proximal ¾ broad and platelike, its lateral expansion abruptly narrowing distally to slender terminal ¼ which tapers through broad arc to slightly recurved, narrowly flared tip; terminal ¼ bearing many short, sharp, reflexed spinules.

Measurements in mm: Carapace: holotype ♀ (USNM 47959) cl 31, cb 37; large ♂ (USNM 98153) cl 71.6, cb 88.

Variation: Some individuals show faint development of a narrow tract of slightly enlarged granules in the midline of the carapace as is characteristic of *O. stephensoni*. Many specimens have scattered, dorsal granules

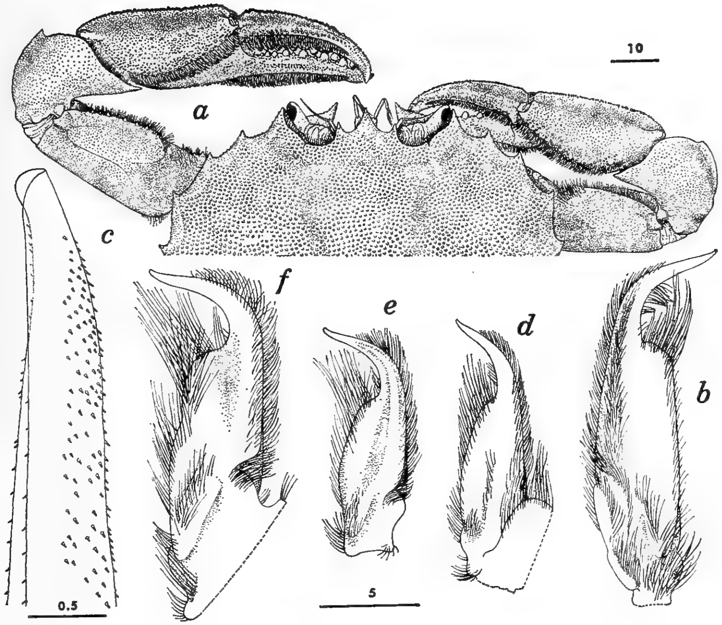

FIG. 1. *a*, *Ovalipes floridanus* Hay and Shore, anterior part of carapace and chelipeds, male in dorsal view, USNM 98153, NW Fla. Male first pleopods in ventral view: *O. floridanus; b*, Large adult, left, USNM 101427, NW Fla.; *c*, Tip magnified, same specimen; *d*, Young adult, right, FSBC EJ-65-34, NW Fla. *O. stephensoni*, n. sp.; *e*, Young adult, right, USNM 136890, Ga. f, Large adult, right, USNM 155124, NE Fla. Scales: *a* = 10 mm; *b*, *d*, *e*, *f* = 5 mm; *c* = 0.5 mm.

on the palm that are slightly larger, somewhat smoother and more elevated than the majority of granules, and (in preserved specimens) often each colored by a light orange basal ring that not only surrounds the granule but imparts an orange color to it. A few crabs have these granules on the carpus as well.

Type-locality: Pensacola, Florida.

Distribution: Gulf of Mexico from southwest Florida, 13.7 km WSW Gordon Pass Sea Buoy, 26°03.1'N, 81°57.7'W, to off Port Aransas, Texas; surface to 31 m, once near surface over depth of 1692 m.

Type-series: The holotype ♀ (47959) and paratypes, 10♂, 9♀ (17915), are in the crustacean collection of the USNM.

Material: 76 specimens. USNM, 14 lots (21♂, 13♀, 2 juvs., 2 unsexed); TAMOC, 5 lots (4♂, 1♀); MCMS, 1 lot (1♂); FSBC, 15 lots (6♂, 3♀, 13 juvs.).

Remarks: From collections for which months are recorded (J2, F3, M4, A1, M3, J5, J6, A0, S1, O1, N1, D2), ovigerous females are known only in February from Florida.

Ovalipes stephensoni, new species

Figures 1*e*,*f*, 2

Platyonichus ocellatus (var.): Smith, 1887, p. 632.

Ovalipes ocellatus guadulpensis: Rathbun, 1930, p. 23 (part, the North Carolina and Georgia specimens).

Ovalipes guadulpensis: Williams, 1962, pp. 39–41.—1965, p. 161.

Ovalipes guadulpensis (*Form a*): Stephenson and Rees, 1968, p. 243, pls. 37C, 40E, 41D, 42J; figs. 1J, 2I, 3I, 4I.

Description: As in Stephenson and Rees (1968). Recapitulating their diagnosis in part, the characters are:

Carapace with relatively coarse granulation behind frontal margin and inside anterolateral borders, median elongate tract of slightly but variably enlarged granules extending from mesogastric to anterior cardiac region.

Chelipeds with dorsal surface of carpus finely and densely granular; dorsal surface of palm between ridges densely granular, mostly fine, but often with scattered enlarged granules; dorsal surface of dactyl between ridges very finely and densely granular. Outer surface of palm finely to obsolescently granular, fixed finger becoming smooth or microscopically pitted. Inner surface of palm similar to outer surface or smooth and microscopically granular ventrally, but becoming granular in very large males; dactyl smooth or microscopically pitted, fixed finger partly granular.

Merus of third maxilliped with distal projection relatively long and narrow, its anterolateral border straight or very slightly curved.

Male first pleopod with proximal ¾ platelike, its lateral expansion narrowing distally to slender terminal ¼ which tapers through broadly diverging arc to slightly recurved, narrowly flared tip; terminal ¼ bearing many short, sharp, reflexed spinules.

Measurements in mm: Carapace: holotype ♂, USNM 155110, cl 65, cb 76; ovigerous ♀ paratype, USNM 99723, cl 50, cb 61; mature ♀ paratype, USNM 152583, cl 63, cb 78.

Variation: Juvenile specimens do not have well developed granules along the tract just inside the dorsal outer ridge of the palm, but granulation on the ridge and remaining upper surface is coarser than in *O. floridanus* of comparable size. (The right first walking leg and dactyl of left third walking leg are missing from the holotype.)

Color: The color described by Williams (1962; 1965) was from specimens taken off North Carolina.

Type-locality: South of Beaufort Inlet, North Carolina, 31°11′N, 76°42′W, 35m, *Silver Bay* 2945.

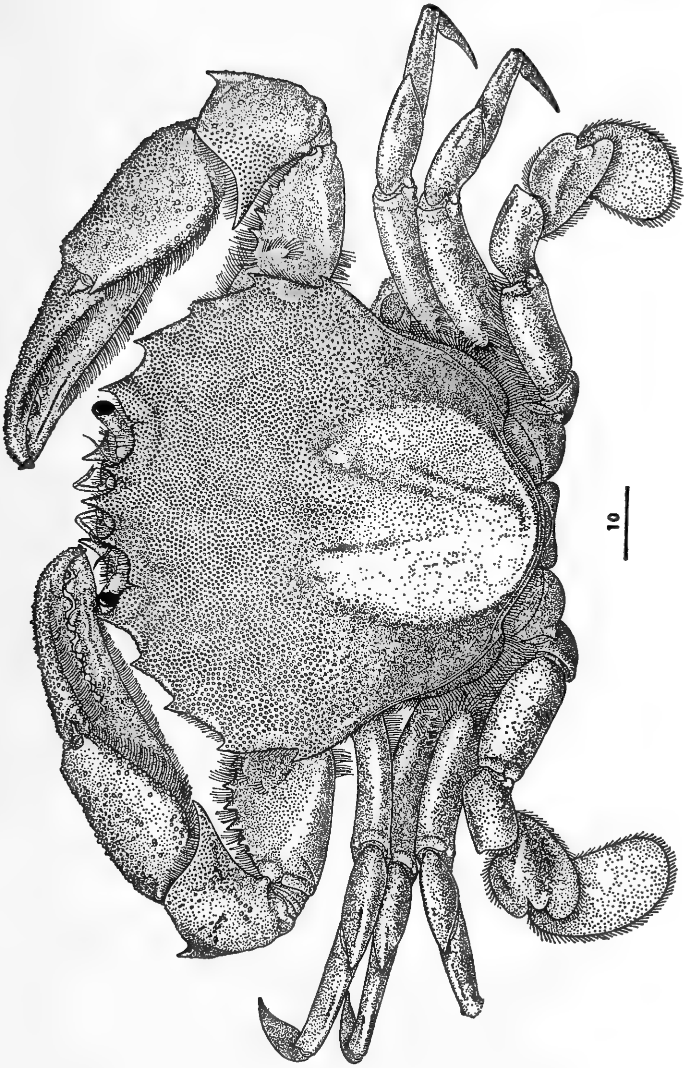

FIG. 2. *Ovalipes stephensoni*, new species, male holotype in dorsal view. Scale = 10 mm.

Distribution: Off Accomack Co., Virgina, 37°31′N (Musick and McEachran, 1972) to near Biscayne Bay, Florida (Park, 1969); surface to 183 m.

Disposition of types: The holotypes ♂ (155110), and paratypes, 1♂, 1♀ (152583), 4♂, 6♀ (3 ov.) (99723) are placed in the USNM. The following as paratypes have been transferred to other museums: USNM 155112, 1♀, Muséum d'Histoire Naturelle, Genèva; USNM 155111, 1♂, Museum of Comparative Zoology, Harvard University; USNM 155113, 1♂, 1♀, 15 juvs., Rijksmuseum van Natuurlijke Historie, Leiden.

Material: 156 specimens. USNM, 33 lots (28♂, 20♀, 75+ juvs.); FSBC, 1 lot (1♂); UNC, 13 lots (10♂, 7♀, 15+ juvs.).

Remarks: From collections for which months are recorded (J6, F5, M3, A2, M7, J2, J4, A2, S3, O3, N3, D5), ovigerous females are known only in December and January in North Carolina, and Florida in March.

DISCUSSION

The Carolinian Atlantic species *O. stephensoni*, can be separated from the Gulf of Mexico species, *O. floridanus*, easily because the anterior part of its carapace and particularly its chelipeds are much more granular than in the Gulf species (Fig. 1*a* and Fig. 2). These differences may be another expression of the marked tendency in *Ovalipes* for development of stridulatory surfaces (Stephenson and Rees, 1968; Stephenson, 1969).

The type-series of *O. floridanus* consists of a young female holotype and several similar sized paratypes. Granular patterns on the carapace and chelipeds and shape of the distal projection on the merus of the third maxillipeds fit Stephenson and Rees's (1968) description well, but characters on inner and outer surfaces of the fingers seem less distinctive than they indicated, both on specimens in the type-series and on other specimens studied. The smooth dorsal areas on carpus, palm and dactyl of the chelipeds are especially well developed in large specimens, iridescence being pronounced there as well as on anterior parts of the carapace and in the semicircular spots between the anterolateral teeth.

The illustrations in Rathbun (1930) refer to *O. floridanus*. The dorsal view of the holotype (Plate 4, fig. 1 USNM 47959) is unquestionable, but the ventral view of an immature female labelled USNM 17959 (Plate 4, fig. 2) presents a slight problem in that the latter number refers to a *Macrocoeloma* in the crustacean catalogue. It is almost certain that the number cited (17959) should have been 47959, for the holotype in ventral view has the same angular displacement of antennules and slight discoloration on sternites 1–4 (yellowed) as the specimen in Plate 4, fig. 2. More remote is the possibility that the --- 59 of the holotype was substituted for --- 15 of one of the paratypes.

Comparison of first male pleopods in the two species does not confirm distinctions noted by Stephenson and Rees (1968) which are possibly attributable to individual variation. In both species, the tract of plumose hairs extending along the sternomesial (inner) surface terminates beyond, often well beyond the region of greatest curvature. In both, the sternolateral (outer) surface, indeed the whole divergent distal part of the appendage, is armed with tiny, sharp, reflexed spinules. The chief difference between first male pleopods of the two species lies in the narrowing of the proximal expanded part into the slender, divergent tip. Shape of the proximal part changes in both species, the distal narrowing being gradual in the young (Figs. 1*d* and 1*e*) but increasingly abrupt with age (Figs. 1*b* and 1*f*). However, the abruptness is more pronounced in *floridanus* (Figs. 1*b*, 1*d*) that in *stephensoni,* (Figs. 1*e*, 1*f*) with tendency toward formation of a shoulder at the region of narrowing in the former.

The distal projection of the merus of the third maxilliped is comparable in the two species, the difference described by Stephenson and Rees (1968) representing an average condition subject to variation.

Distribution of these closely related swimming crabs in two discrete populations confined to the Gulf of Mexico and warm temperate Atlantic parallels that of many species of decapod crustaceans from the Carolinian Province that are not found in southern Florida (Hedgpeth, 1953). In most such cases, as in the closely related *Ovalipes ocellatus* which has a known distribution reaching from Prince Edward Island, Canada, to Georgia, and along the northern Gulf of Mexico from Mississippi to Texas, no differences between the two populations have been detected. But differences have been documented in a few, such as *Neopanope sayi* and *N. texana* (Abele, 1972), *Uca pugnax pugnax* and *U. p. longisignalis* (Crane, 1975), and among fishes in certain seabasses of the genus *Centropristes* (Miller, 1959) and the butterfishes *Poronotus triacanthus* and *P. burti* (Collette, 1963). Distributions such as these indicate that the region of southern Florida acts as a selective barrier to dispersal or genetic continuity, although it would seem that drift of larvae if not occasional adults around the southern tip of Florida might maintain continuity between the populations. Length of larval life of *O. ocellatus*, fairly representative of crabs in temperate waters, seems long enough to accomplish this. Under experimental conditions larvae developed from hatching to first crab stage in 26.1 to 27 days at 20°C and approximately 18 days at 25°C (Costlow and Bookhout, 1966). However, temperature or some other factor in southern Florida waters may prove inimical to survival of either these larvae or larvae of other *Ovalipes* species in the area which might have similar tolerances. Even if such larvae could survive, water circulation in the region may not favor movement eastward around southern Florida. Results of extensive study of the dispersal of penaeid shrimp larvae on the Tortugas fishing grounds and adjacent region (Rehrer, Jones and Roessler, 1967; Munro, Jones, and Dimitriou, 1968; Jones, Dimitriou, Ewald, and Tweedy, 1970) indicate that decapod crustacean larvae there would either be entrained in a clockwise gyre or meander through channels between the Florida Keys into Florida Bay and toward the mainland, but not be carried eastward around the tip of the peninsula. Thus, a combination of conditions in southern Florida seems to divide *Ovalipes* populations in the Carolinian Province.

NOMENCLATURAL NOTE

Cancer Ciri Apoa, seu Aratii Pinima, Brasiliensis Seba, 1759, p. 44, pl. 18, fig. 9 attributed to Saussure's *guadulpensis* by both Rathbun (1930) and Stephenson and Rees (1968), as well as Williams (1965) and Coelho and Ramos (1972), has been mistakenly associated with *Ovalipes*. Both Seba's figure and his notation, "Color of all parts light shining yellow" (translation), gave credence to this association, but there is no evidence of a continuous distribution of any North American *Ovalipes* species far into the Caribbean Sea or tropical west Atlantic Ocean. Holthuis and Sivertsen (1967) and Holthuis (personal communication) point out that the specimen represented in Seba's figure belongs to the European species *Macropipus holsatus* (Fabricius, 1798); therefore this old record off Brazil should be disregarded. Dates of Seba's work are given by Holthuis (1969).

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PROCEEDINGS
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A REDESCRIPTION OF *CLORIDA MAUIANA* (BIGELOW), A STOMATOPOD CRUSTACEAN NEW TO THE AMERICAN FAUNA

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Among the stomatopods in the collections of the Muséum National d'Histoire Naturelle, Paris (MNHNP), and the Allan Hancock Foundation, Los Angeles (AHF), are one specimen each of a small squillid identifiable with a species originally described from Hawaii, *Clorida mauiana* (Bigelow). The specimen from Paris was taken from Vanikoro Island, southwestern Pacific, a considerable but not altogether surprising range extension, but that in the Hancock collections originated from the Gulf of California, a considerable and very surprising range extension. These specimens and the previously unique holotype from the Smithsonian collections (USNM) form the basis for a needed redescription of the species.

I thank J. Forest, Muséum National d'Histoire Naturelle, Paris, and John S. Garth and Janet Haig, Allan Hancock Foundation, Los Angeles, for the loan of material. The illustrations were prepared by my wife Lilly. Terms used in the account have been explained elsewhere (Manning, 1969).

Clorida mauiana (Bigelow, 1931)

Figure 1

Squilla mauiana Bigelow, 1931: 177, fig. 10.—Manning, 1968a: 124 [listed].

Clorida mauiana.—Manning, 1968b: 5 [key].

Material: Puerto Escondido, Baja California, Mexico (west coast of Gulf of California); 25°48′10″N, 111°17′55″W; 14–18 fms (26–33 m); sand and coral; AHF Sta. 1097–40; 11 February 1940: 1♂ TL (total length) 17 mm (AHF).—Auau Channel, between Maui and Lanai

Islands, Hawaiian Islands; 28–43 fms (51–79 m); sand and gravel; *Albatross* Sta. 3876; 14 April 1902: holotype, 1♂ TL 21 mm (USNM 64906).—Vanikoro Islands, Santa Cruz Islands (11°36′S, 166°53′E); Quoy and Gaimard: 1♀ TL 27 mm (MNHNP).

Description: Eye (Fig. 1*a*, *b*) small, subtriangular, extending almost to or slightly beyond end of first segment of antennular peduncle. Stalk not dilated, width about 0.6 times eye length. Cornea broader than, and set almost transversely on, adjacent stalk. Corneal indices 385–425. Ocular scales fused medially, sloping posterolaterally.

Antennular peduncle short but more than half as long as carapace. Antennular processes visible lateral to rostral plate as slender, anteriorly-directed spines.

Antennal protopod with rounded projection proximally on inner margin of distal segment. Antennal peduncle extending beyond eye, proximal segment longer than distal. Antennal scale very small, about ⅓ as long as carapace.

Rostral plate (Fig. 1*a*) with length and width subequal or length slightly greater, lateral margins converging on rounded apex. Median carina absent.

Carapace strongly narrowed anteriorly, lacking median and intermediate carinae. Short reflected marginal and lateral carinae present on posterolateral parts of carapace. Anterolateral angles of carapace unarmed.

Raptorial claw (Fig. 1*c*) slender, dactylus with 5 teeth. Outer margin of dactylus sinuate, with 2 obtuse lobes basally; proximal smaller. Dorsal ridge of carpus undivided, terminating in blunt tooth. Inferodistal angle on outer face of merus unarmed.

Mandibular palp absent. Two epipods present.

Exposed thoracic somites (Fig. 1*d*) lacking longitudinal carinae. Lateral process of fifth thoracic somite an anteroposteriorly compressed lobe, rounded in anterior view, inconspicuous in dorsal view. Small ventrolateral spine present on each side under lateral process of fifth somite. Lateral processes of sixth and seventh thoracic somites not bilobed, broadly rounded laterally, unarmed. Eighth thoracic somite with very low median prominence ventrally.

Abdomen broad (width at fifth somite slightly greater than carapace length), depressed, loosely-articulated, anterior 5 somites lacking submedian carinae. Anterior 4 somites with faint lateral and sinuous marginal carinae only, marginals set above margin. Fifth abdominal somite with laterals and marginals, and, between them, an oblique, curved carina. Sixth somite with low but distinct submedian, intermediate, and lateral carinae. Abdominal carinae spined as follows: submedian 6, intermediate 6, lateral 6, marginal 5 (on 1 side only in specimen from Vanikoro). Sixth somite with 1–3 small supplementary spinules on posterior margin between spines of submedian and intermediate carinae, and with ventrolateral spine anterior to articulation of each uropod.

Telson (Fig. 1*e*, *f*) inflated, broader than long, with 3 pairs of

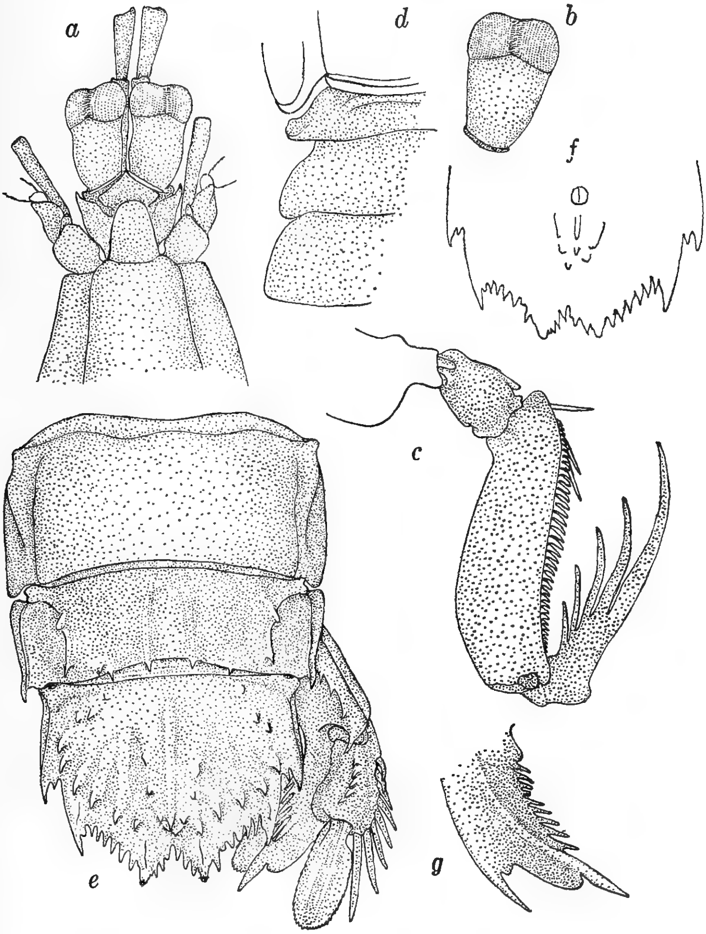

FIG. 1. *Clorida mauiana* (Bigelow), female, TL 27 mm: *a*, Anterior part of body; *b*, Eye; *c*, Carpus, propodus, and dactylus of claw; *d*, Lateral processes of fifth, sixth, and seventh thoracic somites; *e*, Posterior two abdominal somites, telson, and uropod; *f*, Telson, ventral view; *g*, Basal prolongation of uropod. (Setae omitted in all figures).

marginal teeth, submedians with movable apices. Prelateral lobes absent. Dorsal surface with posteriorly-spined median carina, and, on each side, a curved submarginal row of 5 sharp spines, each with short dorsal carina, lateralmost flanked anteriorly by 1–2 spinules, and a submedian row, converging posteriorly with apical spine of median carina, comprising 2–3 low tubercles or spinules. Apical spine of median carina flanked ventrally by median spinule in some specimens. Dorsal carinae of submedian and intermediate teeth short, lateral carinae long. Denticles 4–5, 7–9, 1; inner submedian and outer intermediate rounded in 1 specimen, remainder spiniform. Ventral surface of telson with tubercles lateral to and short lines of tubercles posterior to anal pore.

Basal segment of uropod (Fig. 1*e*) with entire lateral carina; dorsal surface with 3 spinules on carina leading to distal spine. Proximal segment of uropodal expopod shorter than distal, with line of 1–5 fixed spines dorsally and row of 7–8 movable spines laterally, distalmost extending to or slightly beyond midlength of distal segment. Basal prolongation of uropod (Fig. 1*g*) with 2 rounded lobes between apical spines and 7–12 fixed spinules on inner margin.

Color pattern completely faded in all specimens.

Measurements: Males (2), total length 17–21 mm; only known female, total length 27 mm. Bigelow (1931: 181) gave other measurements of the male holotype. Other measurements of female, in mm: carapace length 5.1; cornea width 1.2; eyestalk width 1.1; eye length 1.8; antennular peduncle length 3.8; antennal scale length 1.4; rostral plate length 1.0, width 0.8; fifth abdominal somite width 5.3; telson length 3.4, width 4.3; uropod exopod lengths, proximal 1.4, distal 1.7.

Remarks: Bigelow (1931: 179) correctly pointed out the affinities of this species with *C. incerta* (Hansen, 1926). These two species, which are very similar in basic facies, are the only two species of *Clorida* which lack both the mandibular palp and the anterolateral spines of the carapace. *Clorida mauiana* differs from Hansen's species in having 2 rather than 4 epipods, 5 rather than 6 teeth on the claw, supplementary spinules on the posterior margin of the sixth abdominal somite, lower, less prominent carinae on the abdomen and telson, and dorsal spinules on the basal segment as well as on the proximal exopodal segment of the uropod.

These two species appear to be correctly assigned to *Clorida*, which may yet prove to include several groups of species which share morphological features but which developed them independently. Variation in the mandibular palp and the epipods is the exception rather than the rule in stomatopods. Few genera include species with as well as species without the palp, and, in few genera, is there variation in the number of epipods.

Clorida mauiana is only the second stomatopod to occur in both the Eastern Pacific and the Indo-West-Pacific regions. The other species, which is pantropical, is *Heterosquilla mccullochae* (Schmitt, 1940). Whether *C. mauiana* has become established in the Eastern Pacific, as well as its direction of migration, remain to be determined. The species has not been taken in numerous other collections from the Eastern Pacific made by the Hancock Foundation.

Although the type-locality of *C. mauiana* is the Hawaiian Islands, the species was not included in a recent report on Hawiian stomatopods (Townsley, 1953).

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PROCEEDINGS
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NOTES ON SOME EASTERN PACIFIC STOMATOPOD CRUSTACEA, WITH DESCRIPTIONS OF A NEW GENUS AND TWO NEW SPECIES OF LYSIOSQUILLIDAE

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Part of the material upon which this report is based was collected off Panamá, Colombia, and Ecuador in 1961 by the Argosy Expedition, sponsored by Alfred C. Glassell and carried out by staff members and students of the Rosenstiel School of Marine and Atmospheric Sciences, University of Miami, Florida. The collection includes two undescribed species of *Coronida*, one of which had been known previously but had not been recognized as a distinct species, and five species already known from the Eastern Pacific. Background on the expedition has been published by DeSylva (1972), and station data and a list of the species taken at each station are summarized here in Table 1. These materials were supplemented in the present study with additional material of *Coronida* from the Eastern Pacific region.

The five species previously known from the Eastern Pacific which are represented in the Argosy collection are: *Gonodactylus bahiahondensis* Schmitt, 1940, *Gonodactylus zacae* Manning, 1972a, *Pseudosquilla adiastalta* Manning, 1964 (Family Gonodactylidae), *Meiosquilla oculinova* (Glassell, 1942), and *Squilla hancocki* Schmitt, 1940 (Family Squillidae). The records for the first four of these species from La Plata Island are extensions of range for these species to the south as well as their first occurrence off that island. *Meiosquilla oculinova*, one of the rarest of the Eastern Pacific species, is represented in the collection by 10 specimens from Panamá, Colombia, and La Plata Island, Ecuador; it previously was known from two specimens taken from Chamela Bay and Manzanillo, Mexico. Additional records for and illustrations of these five species may be found in the papers cited above as well as in Manning (1972c, 1974).

In addition to describing two new species from the Argosy collection, the opportunity is taken to transfer *Coronida cocosiana* Manning, 1972b, the only other Eastern Pacific stomatopod referred to that genus, to a new genus, *Neocoronida*, defined herein.

Measurements given in Table 1 are total length (TL), measured from the anterior margin of the rostral plate to the apices of the submedian teeth of the telson. Carapace length is measured in the midline, and does not include the rostral plate. All measurements are in mm. Most of the material has been deposited in the collections of the National Museum of Natural History, Smithsonian Institution (USNM). Some of the specimens of one of the new species of *Coronida*, including the holotype, are in the collection of the Allan Hancock Foundation (AHF). The illustrations were prepared by my wife Lilly. I thank Janet Haig, Curator of Crustacea at the Allan Hancock Foundation, for the loan of all of their material of *Coronida* for inclusion in this report.

Neocoronida, new genus

Definition: Size small to moderate, TL 50 mm or less; body depressed, loosely articulated, most of dorsal surface smooth; eye triangular, cornea strongly bilobed, ocular scales produced into 2 separate subquadrate lobes; rostral plate rounded or subrectangular; antennal protopod with 1 ventral papilla; carapace narrowed anteriorly, carinae and spines absent, cervical groove indicated on lateral plates only; exposed thoracic somites lacking longitudinal carinae, eighth somite lacking longitudinal median ventral keel; mandibular palp and 5 epipods present; propodi of third and fourth maxillipeds broader than long, lacking marked ventral ribbing; raptorial claw stout, small, dactylus inflated basally, armed with 4 teeth; propodus of claw with proximal ⅔ of opposable margin pectinate, with 3 movable spines basally; dorsal ridge of carpus of claw terminating in 2 teeth; ischiomeral articulation of claw terminal, merus longer than ischium; endopods of walking legs 2-segmented, strap-shaped on all legs; abdomen depressed, articulated anterolateral plates present; anterior 4 somites lacking sharp carinae or spines, fifth somite with posterior half roughened dorsally and with

TABLE 1. Station data and list of stomatopods taken at each station by the Argosy Expedition.

Station	Date 1961	Location	Depth	Habitat	Species	
13	10 Sept.	Panamá, Pinas Bay, cove in west part of harbor; 07°35.5′N, 78°12′W	20′–30′ (6.1–9.2 m)	bedrock, boulders, gravel, sand	*G. bahiahondensis* *M. oculinova*	3♂, 12–41 mm; 3♀, 29–40 mm; 4 juvs., ca. 7 mm. 1♂, 19 mm; 5♀, 14–27 mm.
16	12 Sept.	Panamá, 200′ E of Morro de Pinas, mouth of Pinas Bay; 07°32.5′N, 78°13′W	12′–60′ (3.7–18.3 m)	rocks with crevices	*M. oculinova*	1♂, 28 mm; 1♀, 33 mm.
23	16 Sept.	Colombia, Bahia Solano, 4 mi NW of Ciudad Mutis; 06°16.5′N, 77°25′W	0′–15′ (0–4.6 m)	hard bedrock, boulder, rubble	*M. oculinova*	1♂, 9 mm.
27	21 Sept.	Colombia, Gorgona Island, NE tip; 03°00.5′N, 78°11′W	35′–42′ (10.7–12.8 m)	coral, sand, rubble, detritus	*G. bahiahondensis* *P. adiastalta* *C. glasselli*, n. sp.	1♂, 34 mm. 1♀, 64 mm. 2♂, 19–36 mm.
34	22 Sept.	Colombia, Gorgona Island, ¼ mi NNE of Punta Mona; 02°57.5′N, 78°12′W	15′–20′ (4.6–6.1 m)	branching coral, some coral heads	*G. bahiahondensis* *P. adiastalta*	1♂, 37 mm. 1♂, 58 mm.
38	23 Sept	Colombia, 5 mi S of Gorgona Island; 02°39′N, 78°38′W	300′ (91.5 m)		*S. hancocki*	1♂, 42 mm.
58	30 Oct.	Ecuador, La Plata Island, NE part, 01°15.5′S, 81°05′W	10′–20′ (3.1–6.1 m)	silt, coral stacks, debris	*G. bahiahondensis* *P. adiastalta*	2♀, 30–31 mm. 1♂, 70 mm; 1♀, 61 mm.
68	6 Oct.	Ecuador, La Plata Island, NE part, 01°16′S, 81°05′W	8′–20′ (2.4–6.1 m)	boulders, talus, talus debris	*G. zacae* *P. adiastalta* *C. schmitti*, n. sp.	1♀, 22 mm. 2♀, 43–73 mm. 1♂, 20 mm.
71	7 Oct.	Ecuador, La Plata Island, NE side, 01°15.5′S, 81°05′W	30′–90′ (9.2–27.6 m)	coral, silt, sand in deeper water	*M. oculinova*	1♂, 31 mm.

posterior spinules; sixth somite completely covered dorsally with tubercles and with sharp, ventrally directed process anterior to articulation of each uropod; telson broader than long, surface completely covered with irregular tubercles; posterior margin of telson without median spine or submedian denticles, with movable submedian teeth as well as other sharp and blunt teeth laterally; uropod flattened, basal segment with distal, dorsal spine and numerous dorsal tubercles; proximal segment of uropodal exopod with blunt movable spines on outer surface, inner margin setose; endopod of uropod lacking strong fold proximally on outer margin; basal prolongation of uropod produced into 2 flattened, divergent spines, inner longer, with row of sharp spinules on inner margin.

Type-species: *Neocoronida cocosiana* (Manning, 1972b).

Name: The name has been formed by combining the Greek prefix, neo-, with the generic name *Coronida.* The gender is feminine.

Remarks: *Neocoronida* superficially resembles *Coronida*, but differs in several important respects: the ocular scales are produced into 2 large, subacute lobes, almost as wide as the rostral plate instead of being fused into an inconspicuous bilobed plate as in *Coronida*; the propodi of the third and fourth maxillipeds lack the prominent ventral ribbing found in *Coronida*; the marginal armature of the telson is quite different, for there is no posterior median spine and there are fewer fixed marginal teeth lateral to the movable submedians; and the basal prolongation of the uropod is very different, being a flattened process terminating in 2 divergent spines with a row of spinules on its inner margin rather than 2 triangular, subparallel spines lacking the inner row of spinules.

Neocoronida contains only two species, *N. trachurus* (Von Martens, 1881) (see Holthuis, 1967, for references), from the Red Sea, Mauritius, and Palau, Caroline Islands, and *N. cocosiana* (Manning), from Cocos Island in the Eastern Pacific.

Coronida glasselli, new species

Figure 1

Material: Gorgona Island, Colombia; Argosy Sta. 27: 2♂ TL 19 and 36 mm; larger is holotype (USNM 125328), smaller is paratype (USNM 125329).

Description: Eye (Fig. 1*a*) elongate; cornea bilobed, slightly broader than stalk and set obliquely on it; eyes not extending to end of second segment of antennular peduncle; ocular scales fused into bilobed plate.

Antennular peduncle short, less than half as long as carapace; antennular processes produced into slender, triangular spines, directed anteriorly; shortest antennular flagellum with 10–25 segments.

Antennal scale small, ovate, about ⅓ as long as carapace; distal segment of protopod with short anterointernal spine; protopod with 1 ventral papilla.

Rostral plate (Fig. 1*a*) subquadrate, broader than long, lateral margins

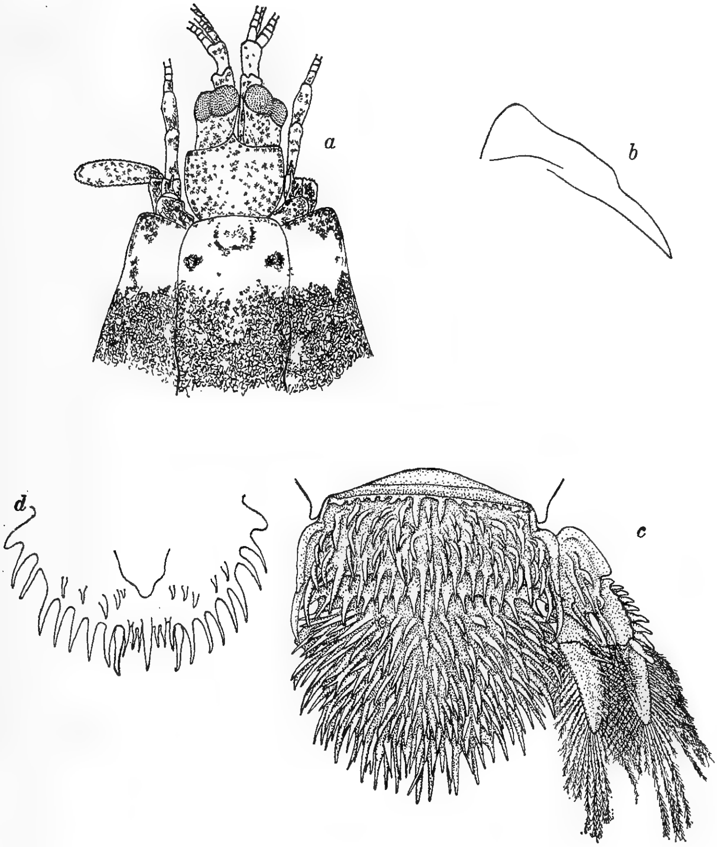

FIG. 1. *Coronida glasselli*, new species, male holotype, TL 36 mm: *a*, Anterior portion of body (setae omitted); *b*, Margin of sixth abdominal somite, lateral view; *c*, Sixth abdominal somite, telson, and uropod; *d*, Telson, ventral view.

convex, anterolateral angles rounded; anterior margins straight; apex acute.

Dactylus of claw with 4 teeth; outer margin of dactylus inflated.

Mandibular palp and 5 epipods present.

Abdomen smooth, depressed, loosely articulated, anterior 5 somites unarmed dorsally, fifth somite unarmed posteriorly; sixth somite (Fig. 1*c*) completely covered with long, erect spines, inclined posteriorly, with 4–6 spines present on any antero-posterior line on somite; anterior margin of sixth somite with pair of broad, flattened, submedian projections, flanked laterally by 4–6 smaller, rounded projections, no more than 14 projections present on anterior margin of somite; lateral margin of sixth somite (Fig. 1*b*) a broad carina, tapering distally, continuing into strong posterolateral spine (bifurcate in smaller specimen), posterior half of ridge lower than anterior half; posterior margin of sixth somite with 13–14 erect spines, slightly inclined but not directly posteriorly.

Telson (Figs. 1*c*,*d*) broader than long, dorsal surface completely covered with long, erect spines, all directed dorsally; anterior border of telson with 14–15 erect spines; posterior margin of telson with large median spine, and, on each side, 3 smaller submedian denticles, 1 movable submedian tooth, and 7 large, slender, fixed lateral teeth, separated into a group of 5 and 2 teeth; ventral surface with 2–3 denticles on submedian area, 0–2 denticles on intermediate area, lateral area and carina around anal pore unarmed.

Basal segment of uropod (Fig. 1*c*) with 6–8 slender, dorsal spines and irregular dorsal carina terminating in erect spine; 2 spines on basal segment overhanging articulation of endopod, 1 erect, 1 directed along longitudinal axis of endopod; exopod unarmed dorsally, with 8 short, blunt, movable spines on outer margin of proximal segment; endopod with 5 erect spines on outer dorsal surface; inner spine of basal prolongation much longer than outer.

Color: Anterior appendages speckled with dark chromatophores; middle third of carapace with broad, dark brown band, anterior and posterior margins of carapace light; band of carapace extending onto claw; each body segment dark, mottled; each abdominal somite with posterolateral white spot.

Measurements: Males only known, TL 19–36 mm. Other measurements of male holotype, TL 36 mm: carapace length 6.1; cornea width 1.4; antennal scale length 2.2; rostral plate length 2.1, width 2.4; fifth abdominal somite width 6.7; telson length 5.5, width 6.2 (both approximate).

Discussion: *Coronida glasselli* can be distinguished easily from both *C. bradyi* (A. Milne-Edwards, 1869) from the Cape Verde Islands and the Gulf of Guinea (Manning, in press), and from the other eastern Pacific species of the genus, *C. schmitti*, described below. Both *C. bradyi* and *C. glasselli* can be distinguished from *C. schmitti* by the presence of 2 enlarged submedian prominences on the anterior margin of the sixth abdominal somite; these are always absent in *C. schmitti*, present in all specimens examined of the other 2 species. *Coronida glasselli* can be distinguished from *C. bradyi*, which it closely resembles, by the following features: (1) the shorter antennular flagellum is composed of 25 segments in the adult (10 segments in the younger male) whereas in *C. bradyi* it is composed of 10–16 segments in adults, 6–16 segments in specimens of all sizes; (2) in *C. glasselli* there are 2 spines overhanging the articulation of the uropodal endopod, whereas only 1 erect spine is present there in *C. bradyi*; and (3) in *C. glasselli* the segments of the uropodal exopod are unarmed dorsally whereas in

C. bradyi the distal segment is always armed with 1–2 small, erect dorsal spinules.

The smaller paratype of *C. glasselli* differs from the holotype in having the posterolateral spines of the sixth abdominal somite bifurcate; in other respects the 2 specimens are very similar.

Other differences between *C. glasselli* and *C. schmitti* are discussed below under the account of the latter species.

It is clear that the number of segments on the antennular flagellum increases with age at least to some extent. In the material from Annobón Island in the Gulf of Guinea used for comparison, a female of *C. bradyi*, CL 6.3 mm, has but 10 segments on the shorter flagellum in comparison with the holotype of *C. glasselli*, a male, CL 6.1 mm, in which the flagellum comprises 25 segments.

The obvious similarities between this new species and the eastern Atlantic *C. bradyi* add convincingly to the evidence for an earlier, distinct Atlanto-East-Pacific shallow-water marine fauna (Ekman, 1953; Briggs, 1974). The distribution of these two species of *Coronida* parallels that of *Squilla aculeata* Bigelow which has subspecies in the eastern Pacific (*S. a. aculeata*) and eastern Atlantic (*S. a. calmani* Holthuis) (Manning, 1970), and, like *Coronida*, does not occur in the western Atlantic.

This species is named for Alfred C. Glassell, Jr., the generous sponsor of the Argosy Expedition.

Coronida schmitti, new species

Figure 2

Coronida bradyi.—Schmitt, 1940: 202, fig. 24 [not *Coronida bradyi* (A. Milne-Edwards, 1869)].

Material: Tagus Cove, Albemarle Island, Galápagos Islands; 12–15 fms (22–27 m); AHF Sta. 148–34; 13 January 1934: 4 lots, ♀ TL 31 mm, holotype (AHF); 4♂ TL 17–25 mm, 6♀ TL 15–33 mm, paratypes (AHF); 6♂ TL 13–29 mm, 3♀ TL 26–34 mm, paratypes (USNM 76034); 1♀ TL 48 mm (figured; USNM 76035).—Same locality; 20 fms (37 m); AHF Sta. 149–34; 13 January 1934: 2 lots, 1♂ TL 26 mm, 2♀ (one broken) TL 36.5 mm, paratypes (AHF); 2♀ TL 19–33 mm, paratypes (USNM 76036).—Sullivan Bay, James Island, Galápagos Islands; 50–70 fms (92–128 m); AHF Sta. 183–34: (2 lots), 1♂ TL 27 mm, 1♀ TL 30 mm, paratypes (AHF); 1♂ TL 29 mm, 1♀ TL 22 mm, paratypes (USNM 76039).—Charles Island, Galápagos Islands; 8–10 fms (15–18 m); 29 January 1934; AHF Sta. 196–34: 1♀ TL 31 mm, paratype (AHF).—La Plata Island, Ecuador; Argosy Sta. 68: 1♂ TL 20 mm, paratype (USNM 125331).—San Cristobal Bay, Baja California, Mexico; 7.5 fms (14 m); "Searcher" Sta. 271; 24 October 1971: 1♂ TL 44 mm, paratype (AHF).

Description: Eye (Figs. 2*a*,*b*) elongate, cornea bilobed, broader than

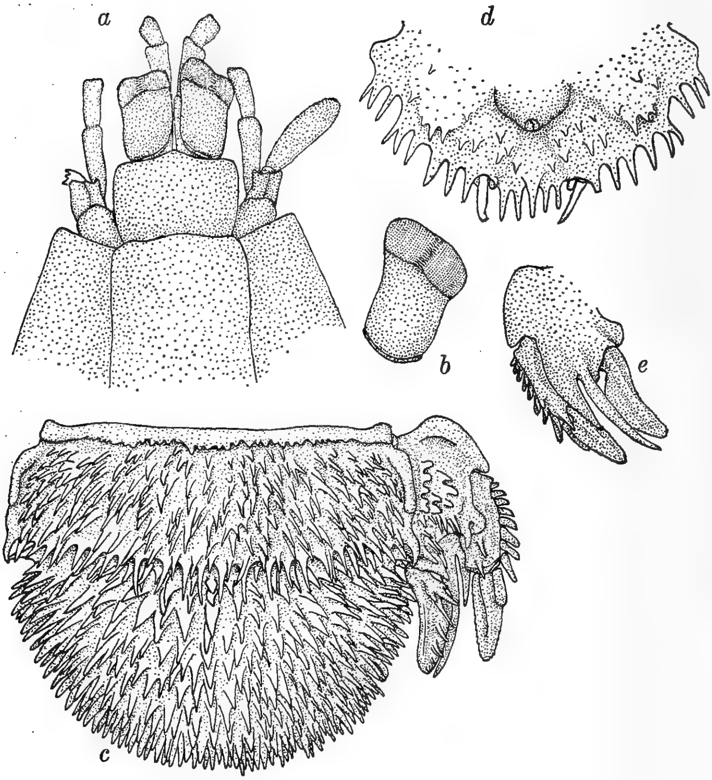

FIG. 2. *Coronida schmitti*, new species, female paratype, USNM 76035, TL 48 mm: *a*, Anterior portion of body; *b*, Eye; *c*, Sixth abdominal somite, telson, and uropod; *d*, Telson, ventral view; *e*, Uropod, ventral view. (Setae omitted in all figures).

and set obliquely on stalk; eyes not extending to end of second segment of antennular peduncle; ocular scales fused into bilobed plate.

Antennular peduncle short, about half as long as carapace; antennular processes produced into slender, triangular spines, directed anteriorly; shortest flagellum with 4–17 segments.

Antennal scale small, ovate, about ⅓ as long as carapace; distal segment of protopod with short, anterointernal spine; protopod with 1 ventral papilla.

Rostral plate (Fig. 2*a*) subquadrate, broader than long, lateral margins convex, anterolateral angles broadly rounded; anterior margins, lateral to obtusely pointed apex, straight or slightly concave; plate lacking dorsal carina.

Dactylus of claw with 4 teeth, outer margin of dactylus inflated.

Mandibular palp and 5 epipods present.

Abdomen smooth, flattened, loosely articulated, anterior 5 somites unarmed dorsally; fifth somite with 0–4 spines laterally on posterior margin; sixth somite (Fig. 2*c*) completely covered with erect, posteriorly inclined spines, 6–8 spines present on any anteroposterior line on the somite; anterior margin of sixth somite with 14–34 (usually more than 20 on specimens larger than 20 mm), sharp, erect spines, lacking enlarged submedian projections; anterior part of lateral margin of sixth somite higher than posterior, margin unarmed dorsally, lower, posterior part of carina terminating in sharp spine; posterior margin of sixth somite with spines directed both dorsally and posteriorly.

Telson (Figs. 2*c*,*d*) broader than long; dorsal surface completely covered with long, erect spines, none directed posteriorly; marginal armature of telson consisting of a large median spine, and, on each side, 2–3 smaller submedian spines, 1 movable submedian tooth, and 6–7 large, slender fixed lateral teeth, usually arranged in intermediate group of 5 lateral group of 2, fifth and seventh teeth often bifurcate; ventral surface of telson with denticles on submedian and intermediate areas; carina flanking anal pore unarmed.

Basal segment of uropod (Fig. 2*c*) with 15–25 slender, dorsal spines and irregular dorsal carina terminating in erect spine; 1 spine on basal segment overhanging articulation of endopod; exopod with 1–3 fixed dorsal spines and 8–9 blunt, movable spines laterally on proximal segment, distal segment unarmed; endopod with 6–7 erect dorsal spines; inner spine of basal prolongation of uropod (Fig. 2*e*) longer than outer.

Color: Similar to that reported for other species of the genus, with light background and mottled brown pigment, including a broad, dark band on the carapace extending onto claws. The pattern was figured in Schmitt (1940, fig. 24).

Measurements: Males, TL 13–44 mm; females, TL 15–48 mm. Other measurements of female holotype, TL 31 mm: carapace length 6.2; cornea width 1.3; antennal scale length 2.0; rostral plate length 1.7, width 2.5; fifth abdominal somite width 6.9; telson 3.8, width 6.7 (both approximate).

Discussion: *Coronida schmitti* differs from both of the other species of *Coronida* in numerous features, as follows: there are no enlarged submedian projections on the anterior margin of the sixth abdominal somite; there are more dorsal spines on the sixth abdominal somite and telson; the posterior margin of the sixth abdominal somite is lined with both dorsally and posteriorly directed spines; and there are more erect spines on the basal segment of the uropod as well as on the proximal segment of the uropodal exopod. This species can be separated from either *C. bradyi* or *C. glasselli* by the absence of the enlarged pair of submedian projections on the anterior margin of the sixth abdominal somite.

The original figure of this species (Schmitt, 1940, fig. 24) errs in showing 4 antennal flagella (all stomatopods have 3). Similarly, the original illustration of *C. bradyi* (see A. Milne-Edwards, 1869, pl. 17 fig. 11) also was wrong in showing this same feature.

Coronida schmitti has an interesting distribution pattern in the Eastern Pacific, where it is known to occur in the Gulf of California, at La Plata Island, Ecuador, and in the Galápagos Islands. *Pseudosquillopsis marmorata* (Lockington, 1877) has a similar distribution pattern, with populations in southern Californian and Galapagan waters, but it is replaced off the South American mainland by another species, *P. lessonii* (Guérin, 1830) (Manning, 1969); *C. schmitti* is not known to occur off the South American mainland.

This species is named for Waldo L. Schmitt, Zoologist Emeritus at the National Museum of Natural History, Smithsonian Institution, whose studies of the extensive stomatopod collections made in the Eastern Pacific by the Allan Hancock Expeditions laid the foundation for current studies on the American fauna.

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PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

THE GREATER ANTILLEAN SPECIES OF *POLYCENTROPUS* (TRICHOPTERA: POLYCENTROPODIDAE)

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Although the aquatic insects of the West Indies have received increasing attention in recent years, there are still many surprises awaiting to be uncovered by further collecting. For example, the last check list of Antillean Trichoptera (Flint, 1968b, p. 80) listed five species of *Polycentropus* from the Greater Antillean Islands; one each from Puerto Rico, Jamaica, and Hispaniola, and two doubtfully distinct species from Cuba. This then, appeared to be a probable case of one species per island.

On my short trip to the island of Hispaniola in June of 1969 I was delighted to recognize examples of *Polycentropus* coming to the light, and assumed that they represented the known species, *P. domingensis* Banks. Upon further study after my return it was immediately apparent that two species were represented, neither being *domingensis.* My colleagues Dr. and Mrs. D. R. Davis made further collections on the island in May of 1973, resulting in further examples of *Polycentropus.* However, all of these, save one, pertained to a third undescribed species of the genus! As a result I now recognize four species on Hispaniola, but comparison of types has resulted in the synonymy of the two names from Cuba. Undoubtedly more collecting, especially on Cuba, will reveal more unknown species.

As a result of the preparation of the descriptions of these three new species, I became very interested in the evolution and dispersal of what is obviously a monophyletic group in the Greater Antilles. This paper, then, is a summary of the present state of the taxonomy of *Polycentropus* on the Greater Antilles as well as a preliminary exposition of their probable phylogeny and zoogeography.

Genus *Polycentropus* Curtis

This genus is almost worldwide in distribution, although apparently most diverse in the North Temperate Zone. It contained by 1960 nearly 150 species, recent and fossil (especially from the Baltic amber), placed under the several generic names that were lumped by Ross (1944). Until the entire world fauna is studied in a rigorously phylogenetic manner there seems little reason to attempt to place species under *Holocentropus*, *Plectronemia*, or *Polycentropus*.

Regardless of the problems at the generic level, the Greater Antillean species all belong to a single monophyletic group, which I here name the nigriceps group, defined as follows:

> Male. Tenth tergum sclerotized ventrally, with a pair of ventromesal lobes. Cercus variable, but always with a long, slender inner lobe and a broader, flattened outer lobe, and sometimes a third, central lobe between these two. Clasper with a finger-like dorsomesal appendage borne from the dorsal margin of a thin, broad vertical support, that is connected to a more broadly terete ventral lobe. Aedeagus rather lightly sclerotized, tubular; with an internal sclerite, basally terete, and apically rather hookshaped in lateral aspect. Female. Ninth sternum strongly sclerotized and trilobate apically. Vagina with variable lateral plates, generally, a pair of cuplike structures, and a ringlike anteromesal plate with a central opening.

At this time little can be said about the immature stages of this group, although the larvae of *P. jamaicensis* Flint and *P. zaneta* Denning have been figured. These and the larvae of an unknown Hispaniolan species do not show any obvious differences between themselves, nor from most other species of the genus.

The larval habitat, in all the material taken up to now, is in rather slowly flowing reaches and pools, in smaller streams in the mountains and hills. The larval nets have the appearance of "cobwebs" over and between the rocks and stones on the bottoms of the pools. The larvae are found in denser masses of silk on the undersides of the rocks. The pupae are generally found attached to the undersides of the same rocks, partially sheltered in some angle of the rock, within a silk and stone shelter.

Key to adult males

1. Cercus consisting of two distinct lobes (fig. 2, 8) 2
   Cercus consisting of three distinct lobes (fig. 4, 6) 6
2. Outer lobe of cercus bilobate, without area of short, flattened setae
   (fig. 1, 2) (Cuba) ....*nigriceps* Banks

Outer lobe of cercus bilobate to elongate, with inner, ventral area bearing shortened, flattened setae (fig. 7–14) 3

3. Outer lobe of cercus clearly with a basoventral flap (fig. 7, 8) (Hispaniola) ....*domingensis* Banks

Outer lobe of cercus without a basoventral flap (fig. 9–13) 4

4. Outer lobe of cercus in dorsal aspect with a distinct apicomesal flap; inner lobe without a mesal spinous process (fig. 9–10) (Hispaniola) ....*jeldesi,* new species

Outer lobe without a distinct apicomesal flap; inner lobe with a mesal spinous process (fig. 11–14) 5

5. Outer lobe of cercus long, tip not directed mesad (fig. 11, 12) (Hispaniola) ....*marcanoi,* new species

Outer lobe with tip strongly upcurved and directed mesally (fig. 13–14) (Jamaica) ....*jamaicensis* Flint

6. Cercus with two long, slender lobes, and one thin, broad lateral lobe (Fig. 3, 4) (Puerto Rico) ....*zaneta* Denning

Cercus with 1 long slender lobe, and 2 thinner, broad lobes, central one covered with short, broad setae (fig. 5, 6) (Hispaniola) ....*vanderpooli,* new species

Polycentropus nigriceps Banks

Figures 1–2

Polycentropus nigriceps Banks, 1938, p. 301.—Fisher, 1962, p. 90.—Flint, 1967, p. 6; 1968b, p. 80.

Polycentropus rosarius Kingsolver, 1964, p. 257. (New synonymy).

I have compared the lectotype of *nigriceps* with a paratype of *rosarius.* Although some small differences are apparent these are of the magnitude that appear as variation in other species, or are due to change in orientation or compression of the specimens, etc.

The figures here presented were prepared from the paratype of *rosarius.*

The female is not known with certainty; it is quite probable that it is described below as species 1.

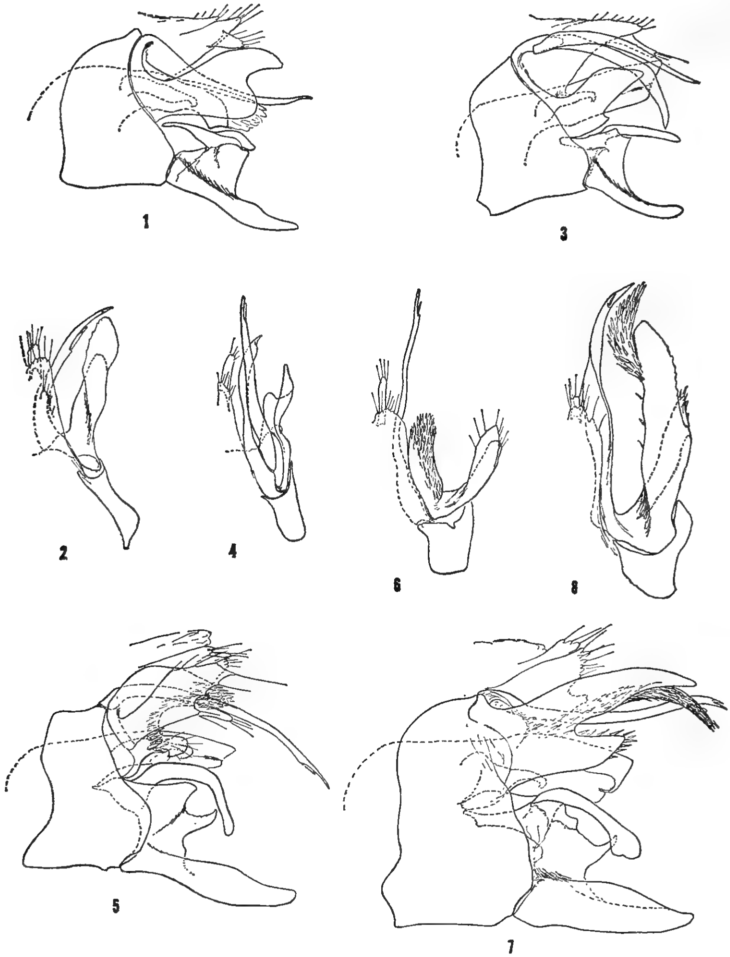
Material: Cuba, Pinar del Rio, Soroa, June 1963, 1♂. Moa, Oriente. 3–16 Nov. 1945, J. Acuña, 1♂ (paratype of *P. rosarius* K., INHS). Cienfuegos, Soledad, Apr. 1936, Darlington, 1♂ (lectotype of *nigriceps*), 1 without abdomen (MCZ).

Polycentropus zaneta Denning

Figures 3–4, 16

Polycentropus zaneta Denning, 1947, p. 660.—Wolcott, 1950, p. 93.—Flint, 1964, p. 32; 1968b, p. 80.—Fischer, 1972, p. 35.

This rather distinct species has been taken only on Puerto Rico. In addition to the rather extensive material recorded (Flint, 1964) from the



FIGS. 1–8. Male genitalia lateral, tenth tergum and cercus, right side dorsal, respectively of *P. nigriceps* Bks. 1–2, *P. zaneta* Denn. 3–4, *P. vanderpooli* n. sp. 5–6, *P. domingensis* Bks. 7–8.

island a few more specimens have been taken in recent years. These are from the mountains in the center and west of the island where the species is already well known, and are therefore not recorded here.

New figures have been prepared to facilitate comparison with the other species of the genus.

Polycentropus vanderpooli, new species

Figures 5–6

Although this species is clearly a member of the nigriceps group, it is the most distinctive in the structure of the cerci. Only in *vanderpooli* is there a broad, ear-shaped lobe between the inner, rod-like and outer flattened lobes of the cercus. In addition there are other smaller differences in the shape of the claspers and tenth tergum between this species and the others in the group.

I take pleasure in dedicating this most remarkable new species to Mr. Wynant D. Vanderpool, Jr. for his support of the Smithsonian Institution.

Adult: Length of forewing, 7–8 mm. Color brown; venter, legs and antennae stramineous, head dorsally fuscous; forewings brown with many very small spots of golden hairs scattered overall. Male genitalia: Ninth segment with anterodorsal angle strongly developed, anterior margin strongly sinuate. Tenth tergum lightly sclerotized ventrally, ending in many small lobes; ventromesal lobe long. Cercus consisting of three lobes; inner very long, almost straight; outer, broad and thin, with margins very irregular; central lobe, bilobate with outer face bearing broad, flattened spines. Clasper with dorsal appendage long, apical half angled ventrally; vertical support bearing a strong spine from posterior margin; ventral lobe long. Aedeagus lightly sclerotized, with a central tubular sclerite hooked apically.

Material: Holotype, male: Dominican Republic, Convento, 12 km. south of Constanza, 6–13 June 1969, Flint & Gomez. USNM type 73736. Paratypes: LaPalma, 12 km. east of El Rio, 2–13 June 1969, Flint & Gomez, 31♂. Constanza, 2–6 June 1969, Flint & Gomez, 1♂. La Estrella Prov., 4 km. southeast of Rio Limpio, 760 m. elev., 24–25 May 1973, D. & M. Davis, 1♂.

Polycentropus domingensis Banks

Figures 7–8

Polycentropus domingensis Banks, 1941, p. 399.—Flint, 1967, p. 6; 1968b, p. 80.—Fischer, 1972, p. 27.

No new material of this species has been taken in recent collections made on Hispaniola. The new figures here presented were prepared from the lectotype.

Material: Dominican Republic, Loma Rucilla, 5–10,000 feet elevation, June 1938, Darlington, ♂ lectotype, ♂ lectoparatype (MCZ). Valle Nuevo, southeast of Constanza, c. 7,000 feet elevation, August 1938, Darlington, ♂ lectoparatype (MCZ).

Polycentropus jeldesi, new species

Figures 9–10

This species is a member of the nigriceps group, most closely related to *P. domingensis* Bks. *P. jeldesi* is easily recognized by the lack of a well developed ventrobasal flap and reduction of the apicomesal flap of the outer cercal lobe, as well as the shorter inner lobe of the cercus. The form of clasper, especially its dorsal appendage and vertical support, is also distinctive in the two species.

I am pleased to dedicate this species to Dr. Fidel Jeldes of the Universidad Autonomia de Santo Domingo who aided me during my collecting trip to the island.

Adult: Length of forewing, 8 mm. Color brown; legs and venter stramineous, head fuscous dorsally; forewing brown with many small spots of golden hair scattered overall. Male genitalia: Ninth segment with slightly sinuate anterior margin, arising directly from anteromost connection of cercus. Tenth tergum lightly sclerotized ventrally, with ventromesal lobe short. Cercus 2 lobed: inner lobe slender, nearly straight, shorter than outer lobe; outer lobe enlarged basally, curved, with a small apicomesal flap and bearing ventromesally, short, broad spines. Clasper with dorsal appendage long, decurved apically; vertical support with posterior margin bearing a short spine; ventral lobe elongate. Aedaegus lightly sclerotized, with an internal tubular sclerite hooked apically.

Material: Holotype, male: Dominican Republic, Convento, 12 km. south of Constanza, 6–13 June 1969, Flint & Gomez. USNM type 73737.

Polycentropus marcanoi, new species

Figures 11–12, 18

This member of the nigriceps group is a very close relative of *P. jamaicensis* Flint. From *jamaicensis, marcanoi* differs in the longer, more evenly curved lateral lobe of the cercus, and in slight differences in the shape of the clasper.

I dedicate this species to Professor Eugenio de Jesus Marcano F., who aided both me and the Davises during our collecting trips to Hispaniola.

Adult: Length of forewing, male 6–7 mm., female, 8 mm. Color dark brown; legs stramineous, head fuscous dorsally; forewing brown, with many small spots of golden hairs scattered overall. Male gentalia: Ninth segment with anterodorsal angle evenly rounded, anterior margin nearly straight. Tenth tergum sclerotized ventrally with a long ventromesal lobe. Cercus 2 lobed; inner long, tip slightly curved mesally, with inner face bearing a short spinous process; outer long (surpassing inner lobe), arched, mesoventral face bearing a region of broad, flattened spines. Clasper with dorsal appendage arched, not surpassing vertical support which bears a small apicodorsal hook; ventral lobe only slightly longer than vertical support. Aedeagus lightly sclerotized with central tubular sclerite hooked apically. Female genitalia: Lateral lobes of eighth sternum broad, tapering apically. Ninth sternum trilobate posteriorly. Vagina with a lateral pocket-like sclerite, mesad of which is a small quadrilateral sclerite, basally with a rounded sclerite bearing a rimmed central opening.

Material: Holotype, male: Dominican Republic, Dajabon Prov., 13 km. south of Loma de Cabrera, 400 m. elev., 20–22 May 1973, D. & M. Davis. USNM type 73738. Paratypes: Same data, 4♂ 1♀. La Estrella Prov., 4 km. southeast of Rio Limpio, 760 m. elev., 24–25 May 1973, D. & M. Davis, 3♂. El Seibo Prov., 15 km. south of Miches, 500 m. elev., 31 May 1973, D. & M. Davis, 1♂.

Polycentropus jamaicensis Flint
Figures 13–14, 17

Polycentropus jamaicensis Flint, 1968a, p. 25; 1968b, p. 80.

This species is known only from the island of Jamaica. No material has been seen beyond that recorded in the original description.

Polycentropus species 1, probably *nigriceps* Banks
Figure 15

This female from Cuba would seem, of necessity, to be that of *nigriceps*. However, the possibility of undescribed species is ever present, and for this reason I do not feel absolutely certain of the association.

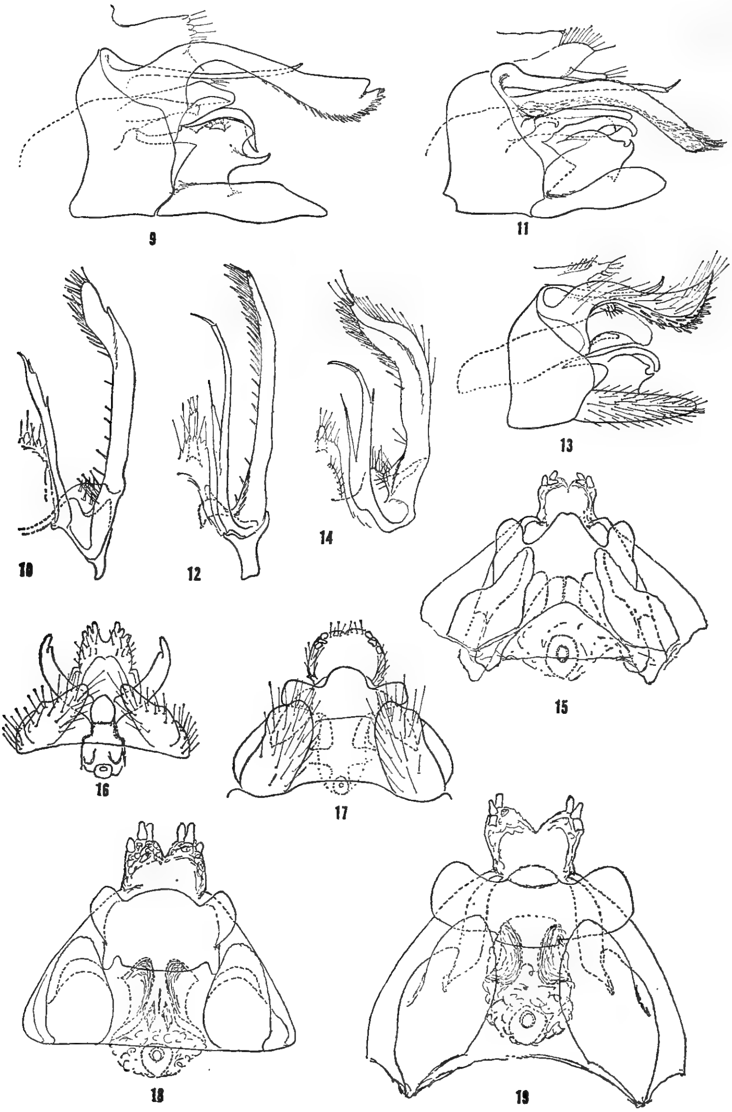
Adult: Length of forewing, 7 mm. Color brown; mostly denuded, but apparently similar to that of other species of the group. Female genitalia: Lobes of eighth sternum elongate, narrowed at midlength with apices markedly narrowed. Ninth sternum trilobate, with lateral lobes directed posteriad and with anterolateral angles produced and strongly sclerotized. Vagina lightly sclerotized with a pair of contiguous plates mesally, with pouchlike sclerites indistinct and produced into rounded anterolateral lobes; anteromesal rounded sclerite with a central, rimmed opening.

Material: Cuba, Pinar del Rio, S. Cajalbana, June 1956, F. de Zayas, 1♀ (INHS). Trinidad Mts., Mina Carlota, 24 Mar. 1925, Geo. Salt, 1♀ (MCZ).

Polycentropus species 2, possibly *jeldesi* Flint
Figure 19

This series of females was collected in association with one male each of *P. jeldesi* and *P. vanderpooli*. However, on the basis of the similarity in genitalia to *P. jamaicensis* it would seem most likely that they are the females of *jeldesi* which is more closely related to *jamaicensis* than to *vanderpooli* which seems much less closely related.

Adult: Length of forewing, 9–11 mm. Color as in *jeldesi*. Female genitalia: Lobes of eighth sternum ovoid, elongate, with anterolateral angle produced. Ninth sternum trilobate, with lateral lobes longer than wide, mesal lobe not sclerotized. Vagina bearing a pair of rounded,



Figs. 9–19. Male genitalia lateral, tenth tergum and cercus, right side dorsal, respectively of *P. jeldesi* n. sp. 9–10, *P. marcanoi* n. sp. 11–12, *P. jamaicensis* Flint 13–14. Female genitalia ventral of *P.* species 1 15, *P. zaneta* Denn. 16, *P. jamaicensis* Flint 17, *P. marcanoi* n. sp. 18, *P.* species 2 19.

pouch-like lateral sclerites, and anteromesally a rounded sclerite bearing a rimmed opening.

Material: Dominican Republic, Convento, 12 km. south of Constanza, 6–13 June 1969, Flint & Gomez, 6♀.

PHYLOGENY

As has been mentioned previously, the nigriceps group is clearly monophyletic. There are several synapomorphic characters which unite the group: the presence of a fingerlike appendage dorsally on the clasper, a thin, vertical plate which supports this appendage and is united to the ventral lobe, and finally in the females the apex of the ninth sternum is trilobed.

An inspection of the known *Polycentropus* species from Mesoamerica, South and North America, and a more superficial survey of the Old World species does not uncover any other species of this group. The species, *P. insularis* Bks., the single known congeneric species from the Lesser Antilles, is clearly a sister species of *P. altmani* Yamamoto, known from southern Central and northern South America. It is no way directly involved in the nigriceps group.

The Nearctic group of species centered on *P. confusus* Hag. would appear to be the only group presently known that might bear a relationship to the nigriceps group. The ninth segment lacks a dorsal connection in the two groups. The tenth tergum is membranous with a pair of submesal process in both although the processes are longer in the confusus group. The cerci of the two groups are comparable although superficially very distinctive. Both consist of a long rodlike inner lobe which is greatly displaced mesad and partially separated in the nigriceps group. The outer lobe is barely developed in the confusus group but a large separate lobe in the nigriceps group. The claspers are also comparable in the two groups. Both have similar ventral lobes, and support for a dorsal appendage. However, the shapes of the supports and dorsal appendage are quite different in the two groups. Finally the aedeagus is a rather simple tubular structure in the two, without especially complex internal sclerites.

In the female genitalia there is less in common. However, the ninth sternum is an elongate lobe, rounded apically in the confusus group, from which it is not too difficult to develop the trilobed apex of the nigriceps group.

The nigriceps and confusus groups, then, are probable sister groups.

Within the nigriceps group, I would consider *nigriceps* to be the closest to the ancestral form. The following characteristics appear to be pleisiomorphic: a mitten-shaped outer lobe of the cercus, an unornamented, vertical posterior margin of the dorsal support of the clasper, with a short posterior extension of the dorsal appendage. *P. nigriceps* has developed a specialization in the form of a heavily sclerotized ventral lip on the aedeagus.

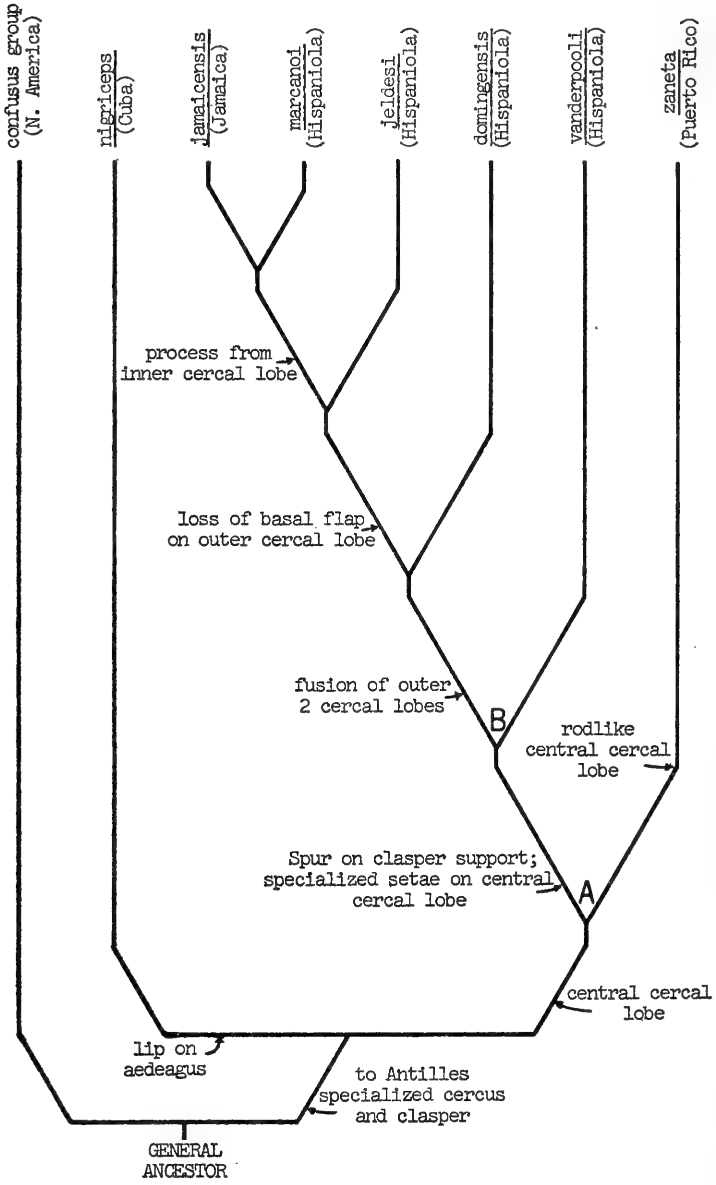


Diagram 1. Phylogenetic tree of the nigriceps group.

From this stage two apomorphic conditions developed in Ancestor A: first, a third, central lobe arose between the inner and outer lobes of the cercus; and, second, the dorsal appendage of the clasper elongated posteriorly. *P. zaneta* appears to be a descendant from Ancestor A. From this ancestor the central lobe of the cercus has become specialized into a long, rodlike process.

The descendant of A, Ancestor B, has specialized in the modification of the setae on the central lobe of the cercus into flattened, shortened setae, and the development of a spine from the posterior margin of the vertical support of the clasper. *P. vanderpooli,* possessing these characteristics, would appear to be a direct descendant of Ancestor B.

After Ancestor B there is a phenocline in the evolution of the outer and central lobes of the cercus. This begins with the fusion dorsobasally between these lobes. As the fusion continues apically, the resultant lobe lengthens and soon equals and then surpasses the inner lobe in length. One early stage is shown by *P. domingensis* in which the basal flap of the outer cercal lobe is still present and the apices of the two lobes are not completely fused. However, the ventromesal face of the fusion lobe bears a long band of the specialized, flattened setae originally found on the central lobe. The next stage is represented by *P. jeldesi,* which has lost the basoventral flap of the outer lobe of the cercus, and the fusion of the outer and central lobes has proceeded further, but the central lobe still projects from the apex mesally.

P. marcanoi and *P. jamaicensis* represent the ultimate stage and are clearly sister species. They share two apomorphic characters. First, the inner lobe of the cercus has developed a small inner spinous process. The second characteristic is the process on the posterior margin of the vertical support in the clasper which has been reduced in size and moved dorsad, becoming a small hook approximate to the tip of the dorsal appendage. From this point each species has specialized slightly in the structure of the outer lobe of the cercus.

DISPERSAL

Assuming that the confusus group, which is limited to eastern and central North America, and the nigriceps group, which is limited to the Greater Antilles, are sister groups, then the form ancestral to both must have been widespread in North America including Mexico. This ancestral form may have entered the proto-antillean islands, probably a member of the Cuban complex, in early Tertiary times through nuclear Central America (cf. Malfait & Dinkelman, 1972). In support of this hypothesis, *P. nigriceps,* the most primitive member of the group, is presently found on Cuba.

Afterwards, dispersal would have proceeded down the chain of islands, with ancestral form A becoming widespread. One of the descendants of this form has remained on Puerto Rico and resulted in *P. zaneta.*

The other descendant of Ancestor A, Ancestor B, must have been

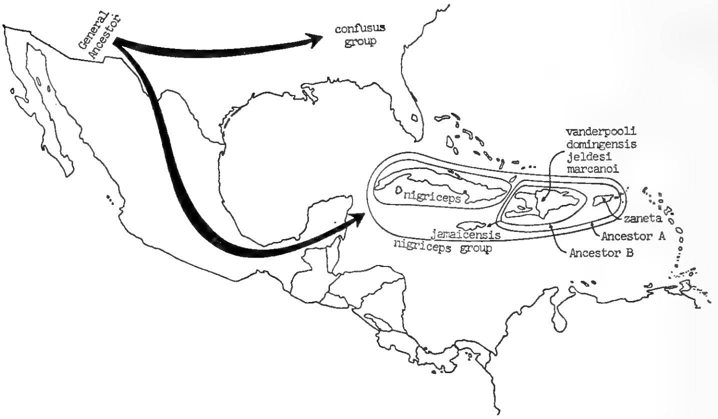


DIAGRAM 2. Distribution of the nigriceps group.

isolated in the Hispaniolan region, where it underwent a long evolutionary history, with *P. vanderpooli*, *P. domingensis*, and *P. jeldesi* marking various steps. Undoubtedly much of this evolution must have occurred in comparative isolation on various proto-islands and/or mountain ranges during the ensuing geological periods, with the present island form uniting these entities.

It is difficult to understand why a similar geological history on Cuba has not produced a similar swarm of species. Perhaps further collecting will uncover such species.

In comparatively recent times the form ancestral to *P. marcanoi* and *P. jamaicensis* must have dispersed from Hispaniola to Jamaica, thus completing the presently seen pattern of distribution on the Greater Antilles.

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PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

PRELIMINARY DIAGNOSES OF TWO EXTRAORDINARY NEW GENERA OF BIRDS FROM PLEISTOCENE DEPOSITS IN THE HAWAIIAN ISLANDS

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Since 1971, the Bernice P. Bishop Museum (BBM) of Honolulu, Hawaii, has been forwarding to the Smithsonian Institution large numbers of fossil bird bones for identification and study. Most of this material is from dunes of Pleistocene age on the island of Molokai. Stearns (1973) has written an account of the geology of these fossil deposits. A few of the specimens were taken from a lava tunnel on the neighboring island of Maui. The avifauna represented is quite varied and contains many undescribed species. Two of these birds are so anomalous as to have excited a fair amount of popular attention (Anonymous, 1972a, 1972b, 1974; Benson 1972, 1973; Pratt, 1972; and United Press International releases appearing in many mainland newspapers), with illustrations of specimens of one of the species already having been published. The Bishop Museum is planning public displays featuring these much-publicized fossil birds.

A complete account of all the fossil birds will require some time for preparation due to the extent of the material so far collected. It is desirable to describe the two well-publicized forms at this time. A more complete discussion of the affinities and morphology of these forms will appear at a later date.

THRESKIORNITHIDAE

Apteribis, new genus

Type: *Apteribis glenos*, new species.

Diagnosis: A rather small ibis with much reduced wings and pectoral girdle and virtually keelless sternum; hindlimb elements proportionately much shorter and heavier than in any other known member of the family. Tarsometatarsus short and broad, distal foramen small, hypotarsus narrow with 2 nearly equally developed ridges and an intervening groove but with no closed canal. Tibiotarsus short with heavy shaft; inner and outer cnemial crests notably better developed than in living genera, the former being more deeply excavated on the internal side. Femur with rotular groove very wide and deep, neck more elongate, head less bulbous and more distinctly set off from shaft than in other ibises. Scapula small, strongly curved, acromion reduced. Coracoid small, coraco-humeral surface much reduced, with details indistinct, procoracoid reduced, apparently not much curved but with foramen still present. Humerus reduced and twisted, deltoid crest very small and produced distally in a bulbous knob, head low, external tuberosity much reduced. Sternum with 4 shallow notches, carina only a slight ridge, coracoidal sulci widely separated, spina externa absent, costal facets indistinct. Mandible narrow, with dorsal and ventral median groove typical of ibises, flattened dorsally, decurved, not constricted at base of symphysis as in *Threskiornis*, nor very narrow as in *Hagedashia*.

Etymology: Gr. *a*-, privative prefix, *pteron*, wing and *ibis*, f. a wading bird, an ibis—in allusion not only to the reduced wings of the bird, but also to the resemblance of the proportions of the hindlimb to those of *Apteryx*, the kiwi of New Zealand.

Apteribis glenos, new species

Figures 1–3

Holotype: Complete right tarsometatarsus BBM-X 147986. Collected in spring, 1975, by Joan Aidem, 2.0 miles west of Moomomi Beach northwestern coast of Molokai, Hawaiian Islands (collector's site No. 6, about 23 m elevation, 140 m from ocean).

Measurements of holotype: Length 55.4 mm, proximal width 13.1, proximal depth 12.3, least width of shaft 11.9, distal width 13.7, depth through trochleae 9.9, width of middle trochlea 5.3.

Paratypes: Left tarsometatarsus BBM-X 146485, left tibiotarsus 146484, right femur 146482, right humerus 147240, left scapula 146530, fragment of rostrum 146543, all from the same immediate locality as the holotype and very likely from the same individual since the paratype tarsometatarsus is identical in size to the holotype. Also, 49 bones or fragments of bone (BBM-X 147127–147175) from Lower Waihoi Valley Cave, approximately 425 m elevation, about 3 miles south of Hana, Maui, Hawaiian Islands, collected 20 March 1974 by W. C. Gagné and B. C. Harrison. These appear to be from a single individual and include the following: sternum, complete right femur and tibiotarsus, right tarsometatarsus (2 pieces); left femur, tibiotarsus and tarsometatarsus (6 pieces total); right and left

FIG. 1. *Apteribis glenos,* new genus and species, holotype right tarsometatarsus BBM-X 147986, anterior, proximal, distal, and posterior views. End views 2×, others 1×.

humeri (3 pieces total); 6 pedal phalanges; 4 fragments of pelvis; a proximal fragment of radius; a distal fragment of ulna; a fragment of clavicle; incomplete right coracoid; 10 vertebrae; 6 fragments of ribs; 4 fragments of mandible; and a right quadrate. The hindlimb elements of this specimen are somewhat more slender than those from Molokai but the differences appear to be due to individual variation only. A few other specimens from Molokai are referable to this species, but as most of them have not yet been cleaned and are less perfect, they have not been considered here.

Measurements of paratypes: Molokai specimens—length of tibiotarsus 98.4 mm, length of femur 63.5, length of humerus 65.5, length of scapula 42.8. Maui specimen—length of femur 63.8 mm, length of tibiotarsus 101.0, length of sternum through midline 43.6, width of sternum at anterior costal facet 27.7.

Age: The age of the precise locality on Molokai from which the ibis specimens were taken has not been determined. A nearby dune site yielding the holotype of the goose described beyond is reported to be about 25,000 years old (Stearns, 1973). However, the ibis bones appear to be less mineralized than the goose specimen and may be younger.

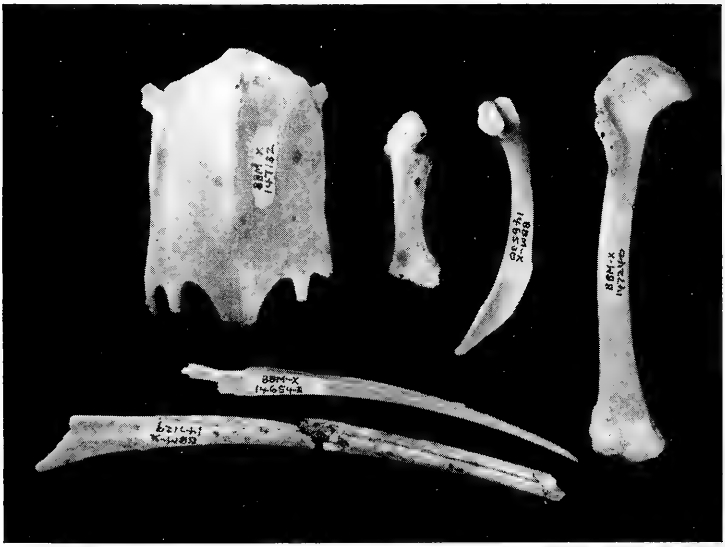

FIG. 2. *Apteribis glenos*, new genus and species, paratype pectoral and cranial elements. Left to right and top to bottom: sternum BBM-X 147132 (ventral view); right coracoid BBM-X 147133 (ventral); left scapula BBM-X 146530 (dorsal); right humerus BBM-X 147240 (anconal); fragment of rostrum BBM-X 146543 (right lateral); two fragments of mandible, the distal portion turned dorsally to show groove, BBM-X 147129 and 147128. Reduced about 20%.

The bones from the Maui lava tunnel are unmineralized, friable, and probably comparatively recent in age.

Diagnosis: As for the genus.

Etymology: Gr. *glēnos*, a thing to stare at, a wonder. The specific name is a neuter noun in apposition.

Remarks: *Apteribis* is remarkable in being the only ibis known from Oceania, apart from *Threskiornis aethiopicus pygmaeus* Mayr from Rennell Island in the Solomons, and also in being the only certainly flightless member of the order Ciconiiformes. Contrary to Hachisuka (1937), the morphology of the fossil heron of Rodrigues Island in the Indian Ocean (*Nycticorax megacephalus*) does not seem to indicate that it was entirely flightless, as the sternal carina was still fairly well developed and the wing elements were not greatly reduced.

The hindlimb of *Apteribis* is so modified from that of typical ibises as almost to defy identification. At first we had only the femur, tibiotarsus, and tarsometatarsus to work with, and of all modern birds the proportions of these elements most closely approached those of

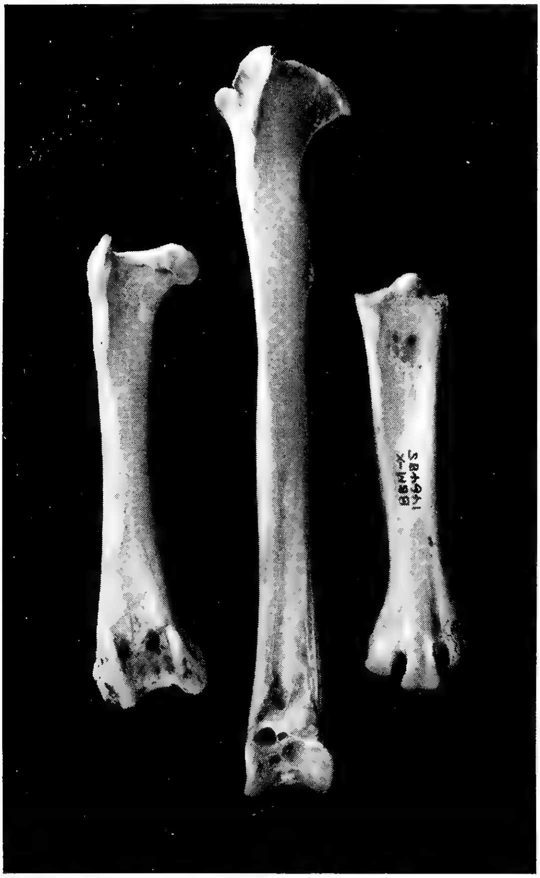

FIG. 3. *Apteribis glenos*, new genus and species, paratype hindlimb elements in anterior view: right femur BBM-X 146482, left tibiotarsus BBM-X 146484, left tarsometatarsus BBM-X 146485. Natural size.

the kiwis (*Apteryx*, Apterigidae), although there are a number of differences between the two. After prolonged comparisons with an extensive series of modern bird skeletons we were able to identify the hindlimb of *Apteribis* only tentatively as that of an ibis, and it was not until we received the associated material from Maui, including fragments of mandible, that our suspicions were confirmed. *Apteribis* is so modified from its ancestral stock that it would be fruitless to speculate on its origins at this time.

ANATIDAE

Thambetochen, new genus

Type: *Thambetochen chauliodous*, new species.

Diagnosis: A large, flightless goose with heavy hindlimbs, minute wings, and keelless sternum. Distinguished from all other members of the family by possessing blunt, bony, toothlike projections on both jaws. Ventral surface of rostrum with 2 pronounced ridges separated by a deep median groove. Mandibular symphysis long and tapering, dentary portion of mandible very heavy, with an expanded lateral ridge, contrasting sharply with the posterior portions of the rami which are weak and delicate. Clavicles apparently absent. Coracoid with entire acrocoracoid absent, there being nothing above the level of the glenoid facet; scapular facet perpendicular to the shaft. Wings extremely small; digits I and III probably lacking. Sternum with virtually no trace of a carina and with the posterior two-thirds not fused along the midline; 2 large notches in posterior border. Pelvis heavy, posterior portions of ilia very deep and expanded laterally. Femur with flattened trochanter, lacking the proximal crest; head elevated above trochanter; external condyle not greatly produced distally as in *Cnemiornis*. Tibiotarsus heavy, much expanded proximally; outer cnemial crest broad and thick; fibular crest indistinct. Tarsometatarsus squat; inner cotyla much larger and deeper than outer; intercotylar prominence high; inner tendinal groove of hypotarsus not closed.

Etymology: Gr. *thambētos*, astonishing, and *chēn*, m. goose.

Thambetochen chauliodous, new species

Figures 4–6

Holotype: Associated skeleton BBM-X 146029. From sand dune 1.7 miles west of Moomoni Beach, northwestern coast of Molokai, Hawaiian Islands (collector's site No. 1; about 3 m elevation, 45 m from ocean). The skull and some cervical vertebrae were collected by Joan Aidem and the remainder of the skeleton was collected later by A. C. Ziegler. The specimen consists of the skull, lacking the interorbital area, so that the braincase is detached from the rostrum; mandible; both quadrates; both pterygoids; most or all of the hyoid bones; axis and 9 other cervical vertebrae; the first 10 vertebrae anterior to the synsacrum, with their vertebral and sternal ribs and uncinate processes; complete pelvis; seven caudal vertebrae and part of an eighth (the pygostyle?) both coracoids and scapulae; both wings (each with only 1 free carpal and lacking digits I and III); both hindlimbs, the right with 6 associated phalanges, the left lacking phalanges; 1 ungual phalanx; pieces of tracheal rings and other fragments. Pieces of eggshell directly associated with the holotype may

FIG. 4. *Thambetochen chauliodous*, new genus and species, holotype rostrum BBM-X 146029, left lateral view above and ventral view below. Natural size.

indicate that it was a female, with an egg in the oviduct at the time of entombment.

Measurements of holotype: Length of rostrum from naso-frontal hinge 55 mm, depth of rostrum at naso-frontal hinge 32, greatest length of nostril 19.1, width of rostrum at anterior of nostril 19.9, least width of internarial bar 6.0, depth of quadrate 23.2, width of cranium through temporal fossae 36.6, height and width of foramen magnum 11.9 × 9.1, total length of mandible 98.6, length of mandibular symphysis 20.9, width of mandible at posterior margin of symphysis 19.8, length of coracoid 38.7, width of sternal end of coracoid 25.5, chord of scapula 74.2, anterior width of scapula 11.6, greatest length of sternum 90.0, width of sternum through penultimate costal facets 65.6, length of preacetabular ilium 68.6, length of postacetabular ilium 102.3, height of acetabulum 18.3, width of pelvis through antitrochanters 75.0, length of synsacrum 152.0, length of ulna 37.3, length of radius 35.3, length of carpometacarpus 17.9,

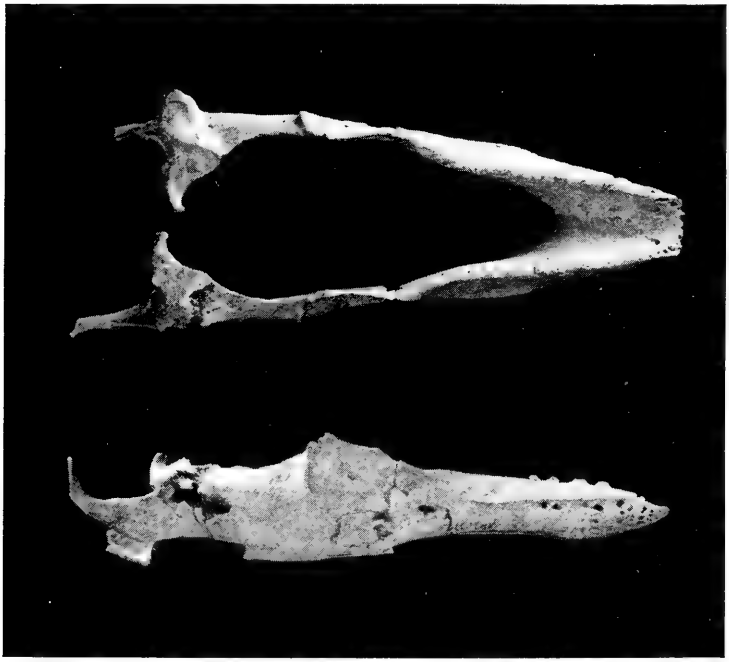

FIG. 5. *Thambetochen chauliodous*, new genus and species, holotype mandible BBM-X 146029, dorsal view above and right lateral view below. Reduced about 20%.

length of phalanx 1 digit II of wing 10.0, length of phalanx 2 digit II of wing 7.1, length of fibula 80.5, proximal width of fibula 16.9. Lengths of pedal phalanges: 1 of digit II 34.1, 1 of digit III 33.7, 2 of digit III 23.8, 1 of digit IV 26.9, 2 of digit IV 17.4, 3 of digit IV 13.6. For each long bone the following measurements represent length, proximal width, least width of shaft, and distal width, respectively: humerus 56.5, 13.9, 5.4, 10.6; femur 102.7, 36.3, 14.0, 36.3; tibiotarsus 172.0, 38.0, 12.0, 25.7; tarsometatarsus 92.4, 27.4, 13.3, 30.4.

→

FIG. 6. *Thambetochen chauliodous*, new genus and species, holotype pectoral girdle and appendicular elements BBM-X 146029. Left to right and top to bottom: sternum (ventral view), left scapula (dorsal), left coracoid (ventral), right wing (dorsal), left femur, tibiotarsus and tarsometatarsus (anterior views). Scale = 5 cm.

Age: Pleistocene; land snail shells directly associated with holotype dated at about 25,000 years B.P. (Stearns, 1973).

Diagnosis: As for the genus.

Etymology: Gr. *chauliodous*, with prominent teeth.

Remarks: Wetmore (1943) described an extinct goose, *Geochen rhuax*, from Pleistocene ash (Pahala Formation) underlying 80 feet of lava on the island of Hawaii. This was based on poorly preserved fragments of tibiotarsus, femora, and pelvis. Wetmore believed *Geochen* to be related to the living Australian goose *Cereopsis novaehollandia* and the very large subfossil flightless goose of New Zealand, *Cnemiornis calcitrans*. *Thambetochen chauliodous* is much larger than *Goechen rhuax* and differs further from it as follows: tibiotarsus with less of a depression between the cnemial crests, tendinal bridge narrower and the opening distal to it rounded rather oval, groove for M. peroneus profundus much less distinct, external ligamental prominence absent, fibular crest much less developed and the nutrient foramen distal to it much smaller; trochanter of femur flattened and groove between trochanter and head virtually absent, whereas in *Geochen* the trochanter is raised and there is a distinct groove; ventral surface of head of femur not excavated. *Thambetochen* and *Geochen* may well be in some way related, but they are clearly different species and, as far as can be determined from the scanty available material of the latter, are generically distinct as well.

Thambetochen, although a large goose, is considerably smaller than *Cnemiornis*, from which it also differs in the much more reduced wings, utterly different bill structure, and in many other details. *Thambetochen* evidently evolved most of its manifest peculiarities after reaching the Hawaiian Islands, probably long before the arrival of the ancestors of the extant Nene Goose, *Branta sandvicensis*, to which it bears no relationship. *T. chauliodous* appears to have been rather common on Molokai, since there are remains of several individuals other than the holotype among the material collected so far.

ACKNOWLEDGMENTS

We wish to thank Dr. Alan C. Ziegler of the Bishop Museum, who has aided in collecting specimens and has been instrumental in forwarding them to us; Ms. Joan Aidem, who originally discovered the Molokai fossils and has made many subsequent collections; Dr. Francis G. Howarth, who discovered the Maui deposits; and Dr. Wayne C. Gagné and Betsy C. Harrison, who collected the Maui fossils. For their comments on the manuscript we are grateful to Mr. Murray D. Bruce, Mr. John Farrand, Jr., and Dr. Alan C. Ziegler. The holotype of the Molokai goose was expertly prepared by Mr. Franklin L. Pearce in the laboratory of the Division of Vertebrate Paleontology, Smithsonian Institution, and we are most grateful to the curators of that Division for this consideration. The photographs are by Victor E. Krantz.

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9, No. 19, pp. 259–264 12 October 1976

PROCEEDINGS
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A JACANA FROM THE PLIOCENE OF FLORIDA (AVES: JACANIDAE)

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The seven or eight living species of jacanas (Jacanidae) form a distinctive pantropical charadriiform family, highly specialized for locomotion on floating vegetation. A single genus, *Jacana*, is found in the New World, where it is endemic. Its forms extend from Argentina north through Mexico to southernmost Texas and the Greater Antilles.

The only Tertiary bird ever thought to be related to the Jacanidae was *Rhegminornis calobates* Wetmore from the Lower Miocene of Florida. Wetmore (1943) made this the type of a new family, the Rhegminornithidae, which Brodkorb (1967) later retained as a subfamily of the Jacanidae. The affinities of *Rhegminornis* were subsequently determined to lie with the Meleagrididae in the order Galliformes (Olson and Farrand, 1974). The only remaining fossil record of the Jacanidae is a late Pleistocene occurrence of the living species *Jacana spinosa* in Brazil (Winge, 1888). The discovery of a jacana among the avian material collected at a Middle Pliocene locality in north-central Florida is therefore of considerable interest.

In the present paper, the name *Jacana spinosa* is used in the broad sense to include all living forms of the genus. The populations from western Panama northward (*J. spinosa, sensu stricto*) are often considered specifically distinct from those to the south (*J. jacana*), and the exact nature of the interaction between these forms where they come in contact in Panama is not yet fully understood (Wetmore, 1965). If indeed two species are involved, they are very closely related and certainly constitute a superspecies. The compara-

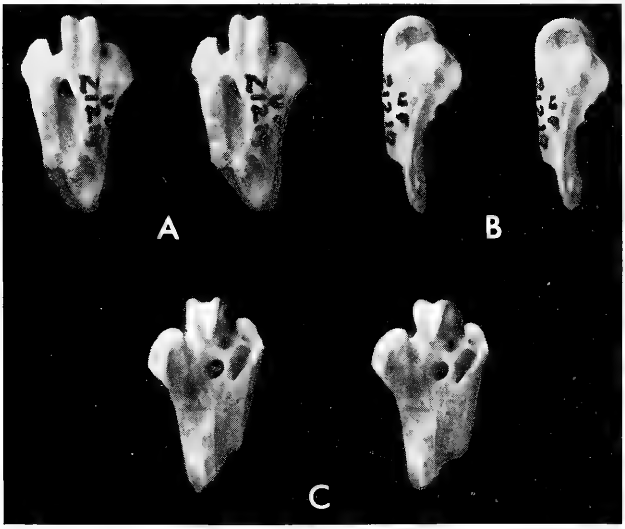

FIG. 1. *Jacana farrandi*, new species, stereo pairs of holotype left tarsometatarsus UF 21219: a, anterior view; b, internal view; c, posterior view. Twice natural size.

tive series of skeletons in this study consisted of 11 males and 6 females of *J. spinosa* from Cuba, Hispaniola, Guatemala, Venezuela, Brazil, and Argentina, as well as specimens of *Actophilornis africanus*, *Metopidius indicus*, and *Hydrophasianus chirurgus*.

Jacana farrandi, new species
Figures 1 and 2

Holotype: Distal end of left tarsometatarsus lacking much of the outer trochlea, Florida State Museum UF 21219.

Locality and horizon: "Rhino Hole," McGehee Farm, 3.6 miles north of Newberry, Alachua County, Florida. Collected by S. David Webb and field crew, April 1967. Alachua Formation, early Hemphillian land mammal stage, Middle Pliocene.

Measurements of holotype: See Table 1.

Paratype: Topotypical left coracoid lacking part of the procoracoid and sterno-coracoidal processes, UF 11108. Collected 4 May 1965 by S. David Webb, Robert Allen, and Jesse S. Robertson.

Etymology: To my friend and sage counsellor in all matters ornithological, John Farrand, Jr., of the American Museum of Natural History, in recognition of his interest in the Jacanidae.

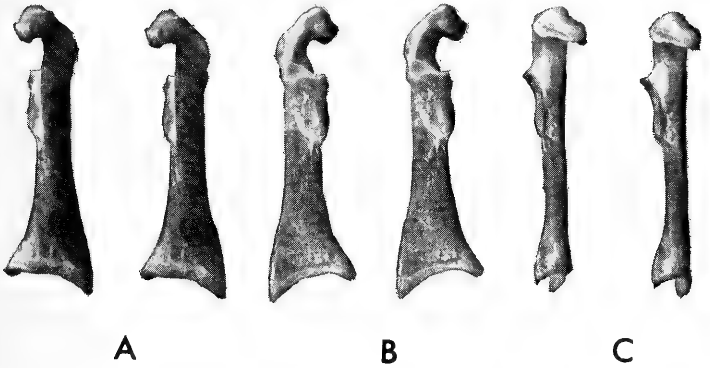

FIG. 2. *Jacana farrandi*, new species, stereo pairs of paratype left coracoid UF 11108: a, ventral view; b, dorsal view; c, internal view. Twice natural size.

Diagnosis and description: The holotype tarsometatarsus is immediately recognizable as that of a jacana by the extremely large distal foramen and the very deep tendinal groove leading to it. The type of *farrandi* agrees with *Jacana* and differs from the other genera examined in having a much deeper pit on the medial surface of the internal trochlea.

The tarsometatarsus of *J. farrandi* differs from that of *J. spinosa* as follows: middle trochlea decidedly longer, projecting farther beyond the internal trochlea and bearing a deeper median groove; in posterior view, area between distal foramen and inner trochlea not deeply excavated as in the modern form; scar for hallux without prominent medial lip; tendinal groove wider and deeper; inner trochlea proportionately wider and deeper, lacking the distinct projection on the proximal corner of the posterolateral surface seen in *J. spinosa*, and with posterior crest more prominent.

The coracoid of *J. farrandi* differs from that of *J. spniosa* as follows: acrocoracoid rotated laterally so that it projects much farther ventrally; furcular facet much narrower with much less of an overhanging ossified lip; protuberance on dorsal surface of sternal end of procoracoid more prominent; neck not as excavated.

Jacana farrandi is distinctly larger than *J. spinosa* (Table 1). In the Jacanidae there is marked sexual dimorphism in size, the females being much larger; in the series of *J. spinosa* used here, there was virtually no overlap in size beween the two sexes (Table 1). The holotype tarsometatarsus of *J. farrandi* is larger than in any of the available specimens of *J. spinosa* and is probably from a female. The paratype coracoid is smaller than in females of *J. spinosa* but larger

TABLE 1. Measurements of *Jacana spinosa* (11♂♂, 6♀♀) compared with *Jacana farrandi*, new species.

		range	mean	s.d.
Distal width of tarsometatarsus	♂	5.8– 6.5	6.3	0.23
	♀	7.0– 7.5	7.2	0.18
	Fossil	7.8		
Width of middle trochlea	♂	1.9– 2.2	2.0	0.09
	♀	2.2– 2.5	2.3	0.09
	Fossil	2.7		
Depth of middle trochlea	♂	2.6– 2.9	2.7	0.10
	♀	3.1– 3.5	3.3	0.14
	Fossil	3.7		
Distance from distal foramen to distal edge of middle trochlea	♂	3.3– 3.7	3.5	0.12
	♀	3.6– 4.4	3.9	0.27
	Fossil	4.6		
Greatest length of coracoid	♂	18.2–20.1	19.4	0.56
	♀	21.6–23.4	22.7	0.68
	Fossil	20.5		

than in males and is therefore probably from a male. Both specimens thus reflect the larger size of the fossil species.

Remarks: Numerous other vertebrates have been found at the McGehee Farm site (Hirschfeld and Webb, 1968). The most intensively studied of these are tortoises (Auffenberg, 1966), edentates (Hirschfeld and Webb, 1968) and canids (Webb, 1969). Birds previously recorded from this locality include a cormorant *Phalacrocorax wetmorei*, a night heron *Nycticorax fidens*, and a sandpiper *Ereunetes* (= *Calidris*) *rayi* (Brodkorb, 1963). Although Brodkorb's paper refers to the McGehee deposits as being Lower Pliocene, Webb (1969:305) now considers them to be of early Hemphillian (Middle Pliocene) age.

It is difficult to envision a better paleoecological indicator than a jacana. By analogy with living forms, we may assume that the climate in Florida in early Hemphillian time was warm and tropical, probably the year round since jacanas are not migratory. Furthermore, we can be sure that when the remains of *Jacana farrandi* were deposited, not only was fresh water present, but abundant floating vegetation, probably including water lilies (Nymphaeaceae), as well, since all modern jacanas require such a habitat.

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PROCEEDINGS
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FOSSIL WOODCOCKS: AN EXTINCT SPECIES FROM PUERTO RICO AND AN INVALID SPECIES FROM MALTA (AVES: SCOLOPACIDAE: *SCOLOPAX*)

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An Extinct Woodcock from Puerto Rico

Among the bird remains collected from caves in Puerto Rico by H. E. Anthony in 1916 was a distinctive charadriiform bird that Wetmore (1920) named as a new species of snipe, *Gallinago anthonyi.* This species and other Puerto Rican fossil birds were treated further in subsequent publications (Wetmore, 1922; 1927). Following the current AOU Check-list of North American birds (American Ornithologists' Union, 1957), the generic name *Capella* is substituted for *Gallinago.*

Remains of *Capella anthonyi* came from two caves (Cueva Catedral and Cueva Clara) near the town of Morovis and are housed in the American Museum of Natural History (AMNH) and the National Museum of Natural History (USNM). This material consists of a right humerus (AMNH 4922, holotype), two left humeri (AMNH 2909, USNM 241262), two right tarsometatarsi (AMNH 2911, 2912 and 14 [2 pieces of the same bone]), a left tarsometatarsus (USNM 241261), an incomplete left tibiotarsus (AMNH 2915), an incomplete right tibiotarsus (USNM 241260), a right coracoid (AMNH 2913), and a left carpometacarpus (AMNH 2910). At least four individuals are represented. The age of the deposits from which this material was derived is uncertain, but probably ranges from late Pleistocene to relatively recent times.

My first examination of *Capella anthonyi* suggested that it was not a snipe, but a woodcock, *Scolopax.* Later I compared it with specimens of the living species *Capella gallinago*, *C. paraguaiae*, *C. nobilis*, *C. stenura*, *Scolopax rusticola*, and *S. minor*. *Capella anthonyi* differs from *Capella* and agrees with *Scolopax* in the following details. Humerus with shaft proportionately heavier, distal end more expanded, olecranal fossa much wider and markedly shallower, ectepicondylar prominence reduced and much lower on the shaft (as noted by Wetmore, 1920; 1922), head broader and not as pointed, external tricipital groove virtually absent (distinct in *Capella*), internal tuberosity not produced as far anconally and much heavier in proximal view, internal condyle heavier and more rounded. Coracoid larger and proportionately heavier, internal portion of sternal facet in end view thicker. Carpometacarpus stouter, intermetacarpal space wider. Tarsometatarsus markedly stouter relative to its length, shaft much heavier, intercotylar prominence lower, distal end relatively wider, internal and external trochleae more divergent from line of shaft, external hypotarsal canal open (closed in *Capella*), internal cotyla in proximal view narrower and extending farther medially. The specimens of tibiotarsi are worn and incomplete and do not preserve many characters; nevertheless, they are too short and stout for *Capella*, although they are not as heavy as in either species of *Scolopax* examined.

These comparisons establish that the species *anthonyi* belongs in the genus *Scolopax* rather than in *Capella* and should now be known as *Scolopax anthonyi*.

Scolopax anthonyi is smaller than the European Woodcock, *Scolopax rusticola*. On the other hand, the measurements of its humerus and tarsometatarsus are considerably above the average for the American Woodcock, *S. minor* (Table 1). Until recently, *S. minor* has usually been placed in a monotypic genus *Philohela*, the basis for which lay mainly in the distinctively attenuated outer primaries. Although it seems not to have been noted previously, this modification is accompanied by marked specializations of the bones of the wing and pectoral girdle—specializations that are not found in *S. anthonyi*.

Although the humerus of *S. anthonyi* is about the size of

Table 1. Measurements of three species of *Scolopax*.

	S. minor				*S. anthonyi*	*S. rusticola*			
	n	range	mean	s.d.	range	n	range	mean	s.d.
Humerus									
length	30	39.8–45.8	42.6	1.96	42.8, 44.2, 44.3	8	54.0–56.2	55.2	.81
proximal width	14	9.8–11.1	10.4	.45	10.4, 11.1, 11.1	6	13.1–14.4	13.6	.44
least width shaft	14	3.0– 3.5	3.2	.17	3.2, 3.6, 3.5	6	4.0– 4.6	4.4	.20
distal width	14	7.1– 8.3	7.6	.36	7.1, —, 8.2	6	9.8–10.6	10.1	.25
Tarsometatarsus									
length	30	30.1–35.9	32.7	1.79	34.6, 35.5, 35.7	7	37.7–40.6	39.4	.92
proximal width	13	5.2– 6.4	5.7	.31	—, 6.7, 7.2	5	7.0– 7.6	7.3	.24
least width shaft	13	1.9– 2.5	2.1	.20	2.7, 2.6, 2.6	5	2.6– 3.1	2.7	.19
distal width	13	5.2– 6.3	5.7	.28	6.5, 6.7, 6.8	5	7.2– 7.6	7.4	.15
Carpometacarpus									
length	30	32.8–38.1	35.5	1.23	27.6	8	37.0–40.1	38.9	.90
Coracoid									
greatest length	30	23.1–27.9	25.3	1.14	25.6	8	28.3–30.8	29.8	.69
Tibiotarsus									
length from distal end of fibular crest	14	32.8–37.0	35.2	1.71	39.5, 40.5	5	41.2–43.3	42.6	.73
least width shaft	14	2.2– 2.9	2.4	.23	2.6, 2.5	4	2.9– 3.3	3.2	.16

FIG. 1. Anconal (top row) and palmar (bottom row) views of humeri of woodcocks and snipe. Left to right: *Scolopax rusticola, S. anthonyi, S. minor, Capella gallinago.* Natural size.

that of *S. minor,* in a number of its characters it more closely resembles that of *S. rusticola* (Fig. 1). The large ectepicondylar process typical of most shorebirds is reasonably well-developed in *S. rusticola,* projecting externally in a dis-

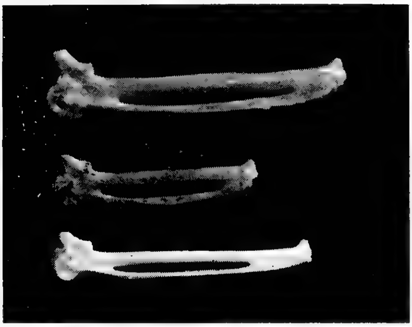

Fig. 2. Internal view of carpometacarpi of woodcocks. Top to bottom: *Scolopax rusticola*, *S. anthonyi*, *S. minor*. Natural size.

tinct point situated fairly high on the shaft. S. *minor* is peculiar among the Scolopacidae in having this process reduced to a low, rounded tubercle. S. *anthonyi* is nearly intermediate, the ectepicondylar process being higher and projecting farther than in S. *minor* but not as well developed as in S. *rusticola*. S. *anthonyi* differs from S. *minor* and is closer to S. *rusticola* in having a deeper brachial depression, shorter deltoid crest, heavier and more rounded internal condyle, and much thicker internal tuberosity with a more expanded anconal surface.

The carpometacarpus of *Scolopax minor* is highly peculiar in being very narrow and elongate with the distal metacarpal symphysis greatly lengthened and tapered (Fig. 2). Although the proximal end is much smaller, the overall length of the bone is nearly as great as in the much larger S. *rusticola*, which has a fairly typical scolopacid carpometacarpus. The carpometacarpus of S. *anthonyi* shows none of the specializations of S. *minor* and is shorter and much heavier (Fig. 2). It is more similar to that of S. *rusticola* but is proportionately shorter (62% of humerus length vs. about 72% of humerus length in S. *rusticola*), with the intermetacarpal space wider, the distal symphysis shorter, and the carpal trochlea smaller.

The coracoid of S. *anthonyi* agrees with that of S. *rusticola* and differs from S. *minor* in the prominent ventrally projecting extension of the head (Fig. 3), the heavier shaft, and proportionately larger articular surfaces. It differs from either

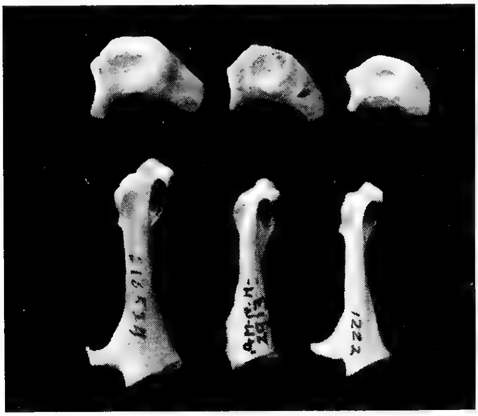

FIG. 3. Coracoids of woodcocks: end-on view of head (top row; 2×) and ventral view (bottom row; 1×). Left to right: *Scolopax rusticola*, *S. anthonyi*, *S. minor*.

species in the more expanded base of the procoracoid and the deeper sterno-coracoidal impression.

The tarsometatarsi of *S. anthonyi* are more robust than in *S. minor* whereas the tibiotarsi have longer and more slender shafts than in that species (Fig. 4).

Scolopax anthonyi is of particular interest in that it is more similar to the Old World populations of *Scolopax* than to *S. minor* of eastern North America. This similarity is not necessarily indicative of closer relationship, however. In its wing and shoulder girdle, *S. minor* is clearly the most specialized species of woodcock, although the osteology and myology of these specializations are in need of much more detailed study. R. L. Zusi (pers. comm.) informs me that in its skull morphology *S. minor* shows an even further advance on the specializations found in *S. rusticola*. Thus, *S. minor* is not merely a small New World geographical representative of *S. rusticola* (Mayr and Short, 1970: 45), but the most highly specialized species of the genus. It may be prudent to recognize *Philohela* at the subgeneric level.

It is obvious that *S. anthonyi* is not just a recent insular derivative of *S. minor*. Although it was surely derived from North America, its ancestors must have reached Puerto Rico

FIG. 4. Anterior view of hindlimb elements of woodcocks and snipe. Left to right: tibiotarsi of *Scolopax rusticola*, *S. anthonyi*, *S. minor*, *Capella gallinago*; tarsometatarsi of *S. rusticola*, *S. anthonyi* (2 individuals), *S. minor*, *C. gallinago*. Natural size.

before the North American population of *Scolopax* had evolved the advanced conditions now seen in *S. minor*. Thus, *S. anthonyi* preserves the primitive features still found in the Old World forms of *Scolopax*. It must have been resident in Puerto Rico for a considerable period of time.

Woodcocks are usually confined to forested areas and according to Wetmore (1922:298–299) the vicinity of Morovis would have been suitable for them. That *Scolopax anthonyi* was relatively common is attested to by the presence of at least four individuals in the rather limited material examined by Wetmore (much more unsorted material at AMNH awaits further study) and by the presence of the species at two different localities. There can be little question that *S. anthonyi* was a resident rather than a migrant form. Its reduced carpometacarpus appears to have been an adaptation to the reduced flight requirements of a sedentary insular species in an environment with few predators.

Although it might at first seem strange that there was once a woodcock in the West Indies, it is not so anomalous when one takes into account the distribution of Old World woodcocks, particularly in the East Indies. Resident populations of S. *rusticola* are found on Madeira, the Canary Islands and the Azores, while distinctive insular species, presumably derived from S. *rusticola* stock, are found in the Ryu Kyus (S. *mira*), Celebes (S. *celebensis*), Java, Sumatra, and New Guinea (S. s. *saturata* and S. s. *rosenbergii*), and in the Moluccas (S. *rochussenii*). In view of this, it would not be unexpected if new forms of *Scolopax* were to be found in the fossil record of other Antillean islands.

A Supposed Fossil Woodcock from Malta

Fischer and Stephan (1974) reported a small collection of avian remains of Middle and Upper Pleistocene age from Ghar Dalam Cave on the island of Malta in the Mediterranean. A single tarsometatarsus from the Middle Pleistocene layers was described as a new species of woodcock, *Scolopax ghardalamensis*. A distal end of a tarsometatarsus from the younger layers was also referred to this species. All other bird fossils from these deposits were assigned to modern species, the most abundant non-passerine taxon being the quail *Coturnix coturnix* (Galliformes, Phasianidae).

The material of C. *coturnix* from Ghar Dalam consisted of coracoids, ulnae, portions of pelvis, and femora, but did not include a tarsometatarsus. Suspicion is aroused by the extremely small size of the holotype tarsometatarsus of *Scolopax ghardalamensis* (26.7 mm), which exactly equals the dimensions of that element in *Coturnix coturnix* (average of 6 modern specimens in USNM = 26.8 mm). In addition to its small size, Fischer and Stephan (1974) diagnosed *Scolopax ghardalamensis* as having the hypotarsus narrower, with the medial crest thin and sharp, ending distally in a canal rather than a ridge, and with the portion lateral to the medial crest extending distally as a ridge where in S. *rusticola* there is a canal. In these particulars *S. ghardalamensis* differs significantly from *Scolopax* and agrees precisely with *Coturnix coturnix.* As determined from the photographs published in Fischer and Stephan (1974), the holotype of *S. ghardalamensis* differs further from *Scolopax* and agrees with *Coturnix* in the following characters: proximal end narrower relative to shaft, the internal cotyla much less medially produced; medial edge of internal cotyla sharper and raised proximally well beyond the level of the intercotylar prominence, the latter being lower and much less bulbous than in *Scolopax*; lateral edge of external cotyla less produced proximally; fossa containing proximal foramina narrower and deeper; posteromedial surface of proximal end more excavated; distal foramen larger; trochleae less divergent from each other, the middle one more constricted at the base.

The obvious conclusion is that Fischer and Stephan identified several skeletal elements correctly as *Coturnix coturnix* but then went on to describe the tarsometatarsus of the same species as that of a new woodcock. *Scolopax ghardalamensis* Fischer and Stephan (1974) as a consequence must become a synonym of *Coturnix coturnix* (Linnaeus, 1758), and may be disregarded in any consideration of the evolution of woodcocks.

ACKNOWLEDGMENTS

I am indebted to Malcolm C. McKenna for allowing me to study the material of *Scolopax anthonyi* in the collections of the American Museum of Natural History. For their comments on the manuscript, I am grateful to Murray D. Bruce and John Farrand, Jr. Ingrid A. Cruz helped with measurements and Victor E. Krantz took the photographs.

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PROCEEDINGS
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SIMILARITY OF THE DINOFLAGELLATES *PERIDINIUM TROCHOIDEUM*, *P. FAEROËNSE* AND *SCRIPPSIELLA SWEENEYAE* AS DETERMINED BY CHROMOSOME NUMBERS, CELL DIVISION STUDIES AND SCANNING ELECTRON MICROSCOPY

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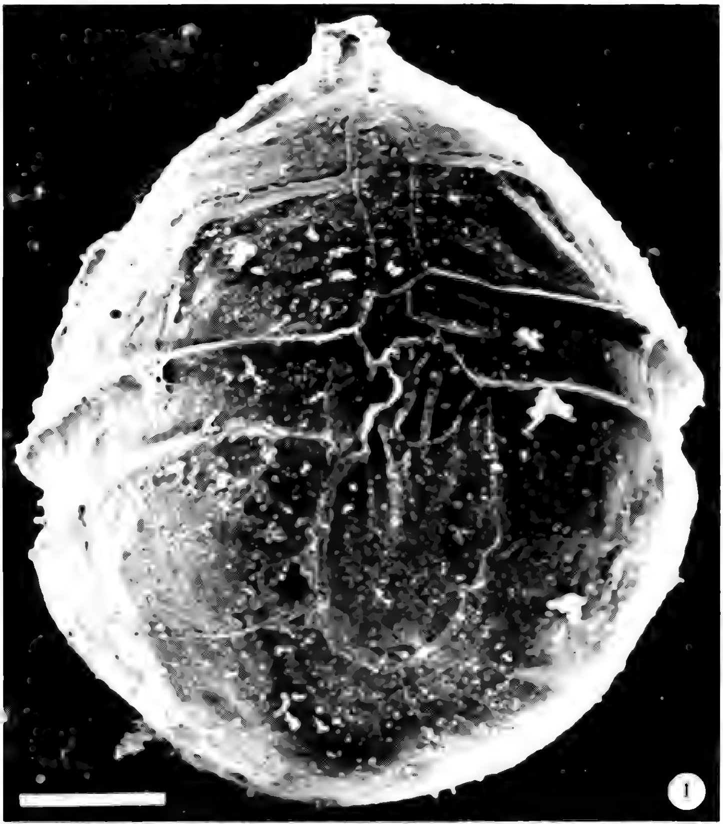
The proper systematic placement of the common, marine dinoflagellates (*Glenodinium trochoideum* Stein, 1883, *Peridinium faeroënse* Paulsen, 1905 and *Scrippsiella sweeneyae* Balech ex Loeblich, 1965) has been the subject of several studies with varying conclusions. Early systematic investigations focused exclusively on the cell wall features of cells from natural populations. However, more recent research has involved cultured strains. In order to clarify the systematics of these species we grew and compared material obtained from culture collections, reexamining cell morphology but also making use of cell life cycle information and numbers of chromosomes per cell.

History of Previous Investigations

Peridinium trochoideum (Stein) Lemmermann, 1910

Stein originally described *Glenodinium trochoideum* from the plankton of the Kiel harbor, West Germany. The magnifications for his plate illustrations varied from 450–690×, setting the length of his *G. trochoideum* cells at 45–69 μm and the width at 28–42 μm. Lemmermann (1910) transferred the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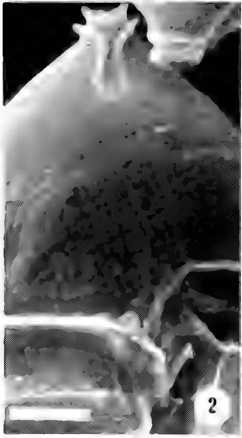
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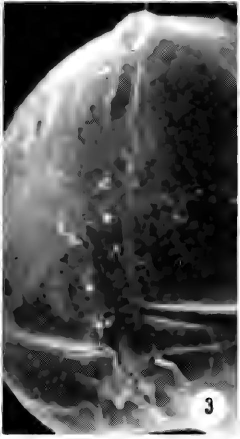
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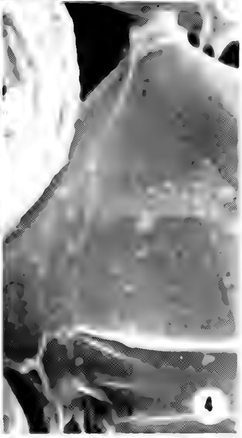
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species to the genus *Peridinium.* Braarud (1958) recorded observations of cell division in a Norwegian strain of *P. trochoideum* and figured spiny cysts formed in culture media. Sousa e Silva (1962) also depicted (plate 10, fig. 3) a spiny cyst for *P. trochoideum*, described as having formed in her cultures of Portugese material. Dodge (1963) wrote that each *P. trochoideum* cell contains 44 chromosomes. Balech and Soares (1966) compared preserved material collected off the coast of Brazil with descriptions of *P. trochoideum* and *P. faeroënse* and concluded that these two species are synonymous. They reassigned both to the genus *Scrippsiella*, but in uniting the species, incorrectly chose the junior epithet *faeroënse.* Although similar in description to *S. sweeneyae*, *S. faeroënse* was considered unique due to details in the arrangement of the sucal plates and the narrowness of the first apical plate. Wall and Dale (1968) and Wall *et al.* (1970) collected spiny calcareous cysts off Bermuda and Woods Hole, Massachusetts. They identified the germinated cells as *P. trochoideum.* One cell arose from each cyst. Dickensheets and Cox (1971) examined isolate IUCC 1017, determining the plate pattern and illustrating the surface features of the cell wall. They mistakenly followed Balech and Soares in using the junior epithet. Kalley and Bisalputra (1970) examined the surface features of *P. trochoideum* (IUCC 1017) and confirmed Braarud's observations on the manner of cell division (Kalley and Bisalputra, 1975).

The source of the Woods Hole *P. trochoideum* (Strain "Peri") is recorded as "M. Parke (?)" presumably meaning the Plymouth strain 104 which is on deposit in the Indiana Culture Collection as No. 1017.

Peridinium faeroënse Paulsen, 1905

Paulsen described this species as *Peridinium faeroënse* from samples taken off the Faeroes. As mentioned above, Balech and Soares (1966) transferred this species to the genus *Scrippsiella.*

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FIGS. 1–4. Scanning electron micrographs of *Peridinium trochoideum*, Strain "Peri." 1. Ventral view. Scale line = 5 μm. 2–4. Enlargements of plate 1′ region. 2–4, Scale line = 3 μm.

FIG. 5. Scanning electron micrograph of *Peridinium trochoideum*, Strain "Peri" illustrating dorsal side of apical pore and plate 3′. Scale line = 2 μm.

Plymouth isolate 180 listed as *P. faeroënse* is also on deposit in the Culture Centre of Algae and Protozoa, Cambridge, England as No. 1134/4.

Scrippsiella sweeneyae Balech ex Loeblich, 1965

Balech (1959) erected the genus *Scrippsiella* with *S. sweeneyae* as the type. His material was originally isolated by B. M. Sweeney from the San Diego region. Balech (1959) stated that there was a superficial resemblance between *S. sweeneyae* and *P. trochoideum*, however he concluded that the cingular and sulcar plate formation of *S. sweeneyae* warranted the establishment of a new genus. Wall and Dale (1968) collected smooth, lobed calcareous cysts from Woods Hole, Bermuda

Table 1. Cell dimensions in μm

Organisms	Length	Width	Reference
Peridinium trochoideum	45–69	28–42	Stein, 1883[a]
	18–40	—	Sousa e Silva, 1962
	34–47	25–36	Wall and Dale, 1968
	21–32.5 (26.8)	17.5–25 (20.8)	this paper[b]
Peridinium faeroënse	32–36	—	Paulsen, 1905
	30–38	18–22.5	Balech and Soares, 1966
	20–30.2 (26.6)	17.5–27.5 (21.4)	this paper[b]
Scrippsiella sweeneyae	24–32.5	19–24	Balech, 1959
	32–36	28–29	Wall and Dale, 1968
	21.2–30 (26.3)	17.5–27.5 (21.6)	this paper[b]

[a] Range of magnifications is due to variations of original plates. The actual sizes occur within this range.

[b] Twenty living cells (logarithmically growing) were measured at 400×. The mean is in parentheses.

and the Western Arabian Sea and these hatched yielding organisms determined to be *S. sweeneyae.*

The original strain of *S. sweeneyae* used by Balech remains on deposit at the Indiana University Culture Collection (IUCC No. 1656).

MATERIALS AND METHODS

Peridinium trochoideum (strain "Peri") was obtained from R. R. L. Guillard, Woods Hole, Massachusetts. The isolate of *Peridinium faeroënse* came from the Culture Centre of Algae and Protozoa (No. 1134/4). *Scrippsiella sweeneyae* was procured from the Indiana University Culture Collection (No. 1656) and is a subculture of the type material used by Balech (1959). All cultures were grown in GPM medium (Loeblich, 1975) and were maintained at 21° C under a light intensity of about 250 foot-candles. Cultures were synchronized on a 12:12 hour, light-dark cycle for studies of cell division. Samples for chromosome counts were taken from logarithmically growing and stationary cultures. Nuclei were fixed, stained and squashed according to the acetocarmine technique of Cave and Pocock (1951). A through-focus series of photographs was taken of each cell on high contrast copy film and one composite tracing made of each set of finished photos. Chromosomes were counted from the tracings. For scanning electron microscopy, cells from logarith-

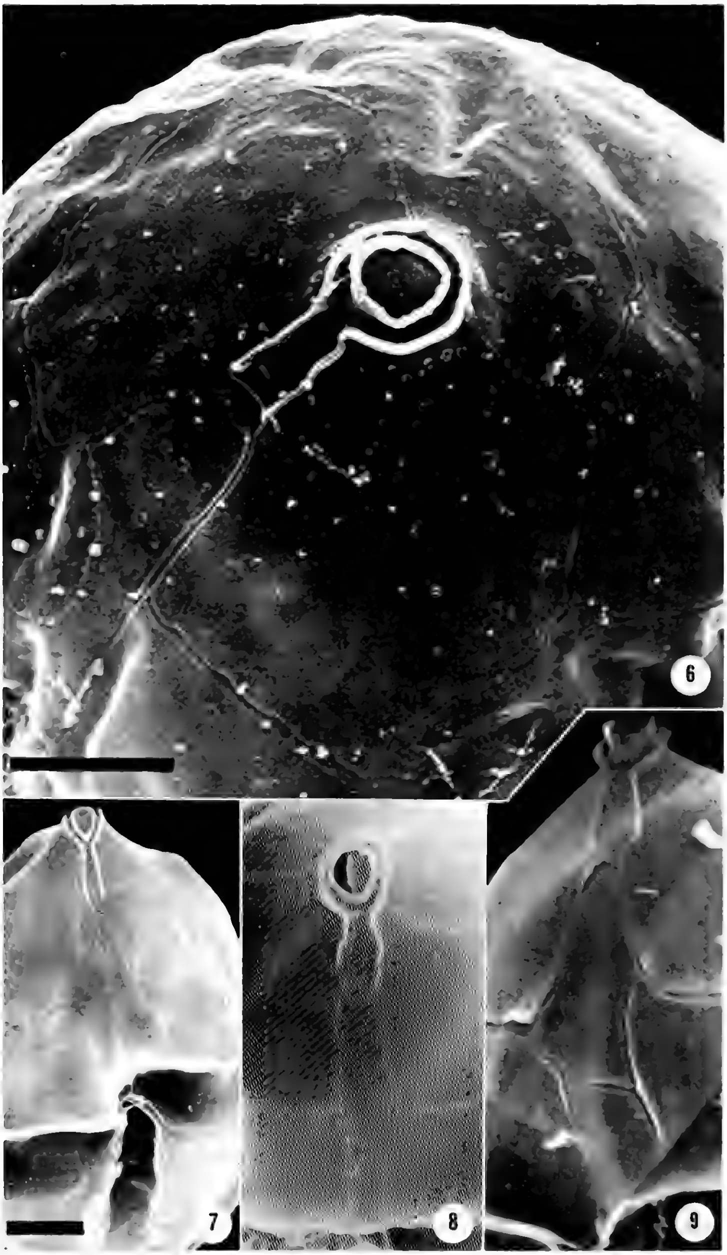
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Table 2. Chromosome counts

Organism	Culture phase	Chromosome number	Number of cells counted
Peridinium trochoideum	log	80–90	2
	log	94	1
	Stationary	80–90, 100	2
Peridinium faeroënse	log	100	1
	Stationary	80–90	1
Scrippsiella sweeneyae	log	80–90	2

mically growing cultures were collected on 8 μm pore size (SCWP Millipore filter, 49 mm) by gravity filtration. When all but 2 or 3 ml of culture had passed through the filter, 20 ml of the fixative (4% glutaraldehyde in 0.05 M cacodylic acid (pH 7) and 0.15 M sucrose at 25° C) was added. Then, after most of this solution had filtered, the cells were rinsed in three cacodylate washes of decreasing concentration (0.1 M, 0.075 M, 0.04 M). Using a pasteur pipette and the remains of the final wash suspension the cells were washed off of the filter paper into centrifuge tubes. Dehydration was by means of an increasing ethanol series (25%, 50%, 75%, 95%, 100%, 100%). This was replaced by a Freon 113 series (25%, 50%, 80%, 100%, 100%, 100%, 100%) and critical point drying was performed using the Freon 13 procedure (Cohen, Marlow and Garner, 1968). Cells were coated with carbon and a gold-palladium mixture and examined with either the AMR 100 or JEOL JSM-35 scanning electron microscope.

RESULTS

Cell Morphology: The results of the cell measurements appear in Table 1. The mean widths of cells of the three species are within less than 1% of one another while the mean lengths vary within about 2%. Fig. 1 provides a ventral view of *P. trochoideum* showing the cell shape, girdle position and apical pore characteristic of all three species. In particular it allows examination of plates in the sulcal region and the width of the first apical plate. The first apical plate appears long and narrow and extends from the bottom of the canal plate to the top of the anterior sulcal and transitional plates. The longitudinal flagellum emerges

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FIGS. 6–9. Scanning electron micrographs of *Peridinium faeroënse* Plymouth isolate 180. 6. Apical view. Scale line = 2 μm. 7–8. Enlargements of plate 1′ region. 9. Individual with plate 1′ split transversely. 7–9, Scale line = 3 μm.

FIG. 10. Scanning electron micrograph of *Scrippsiella sweeneyae*, isolate IUCC No. 1656. Ventral region with frayed longitudinal flagellum. Scale line = 2 μm.

below these and is covered on the right side of the cell by a flange of the right sulcal plate. The first apical plates of three additional *P. trochoideum* cells are illustrated in Figs. 2–4. Fig. 5, a close-up of the second and third apical plates and apical pore of *P. trochoideum* reveals the apical pore structure with the inner flange protruding beyond the exterior flange and the random distribution of the trichocyst pores. The typical apical plate arrangement of *P. faeroënse*, similar to that found in *P. trochoideum* and *S. sweeneyae* is depicted in Figs. 6–8. Fig. 9, also of *P. faeroënse*, however, shows a wider first apical plate, split across the

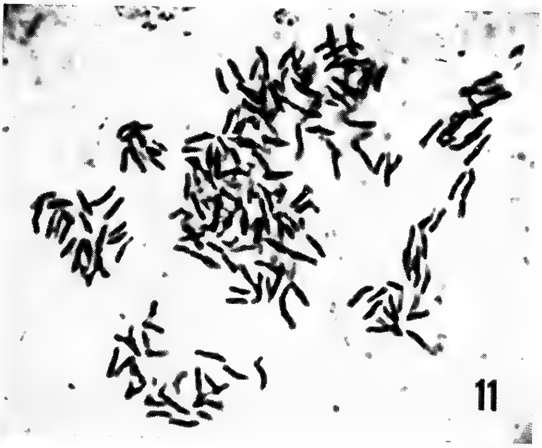


FIG. 11. Acetocarmine stained and squashed nucleus of *Peridinium trochoideum*, Strain "Peri" stationary phase cell at selected focal level. Note presence of V-shaped chromosomes.

center—an abnormality observed in more than one *P. faeroënse* specimen. Fig. 10 illustrates the ventral region of *S. sweeneyae.*

Chromosome Counts: Table 2 contains the results of the chromosome counts. There is no significant difference in chromosome number between exponentially growing cells and cells from stationary phase cultures. All counts for the three isolates ranged from 80 to 100. Fig. 11 shows the fixed, stained and squashed chromosomes of a cell taken from a stationary culture of *P. trochoideum.* Note the presence of both V-shaped and straight chromosomes.

Life Cycles: Cultures of the three species examined contained swimming pairs of what appeared to be fusing cells. However, despite continual observation we found no cysts of the type described by Wall and Dale.

The mode of cell division was determined with results in agreement with the earlier studies of Braarud (1958) and Kalley and Bisalputra (1975). Fig. 12, a scanning electron micrograph, shows a *P. trochoideum* cell shedding its theca. As the light microscopy study revealed, in each of the three strains the theca is shed prior to cytokinesis after splitting dorsally in the sutures between the epitheca and cingulum. Figs. 13–21 illustrate the final stages in the division cycle, identical in all three strains. A dividing cell throws off its theca permitting the emergence of a "peanut-shaped" cell presumably still covered by the pellicular layer and bearing its flagella. The flagella are soon discarded and the non-motile cell settles to the bottom of the flask where cell division occurs. As is apparent here, the daughter cells are often of unequal size.

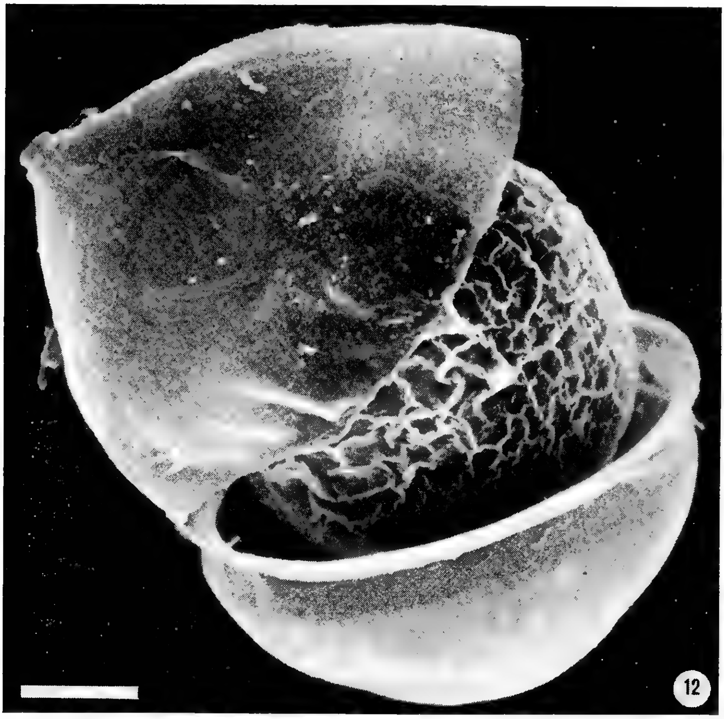


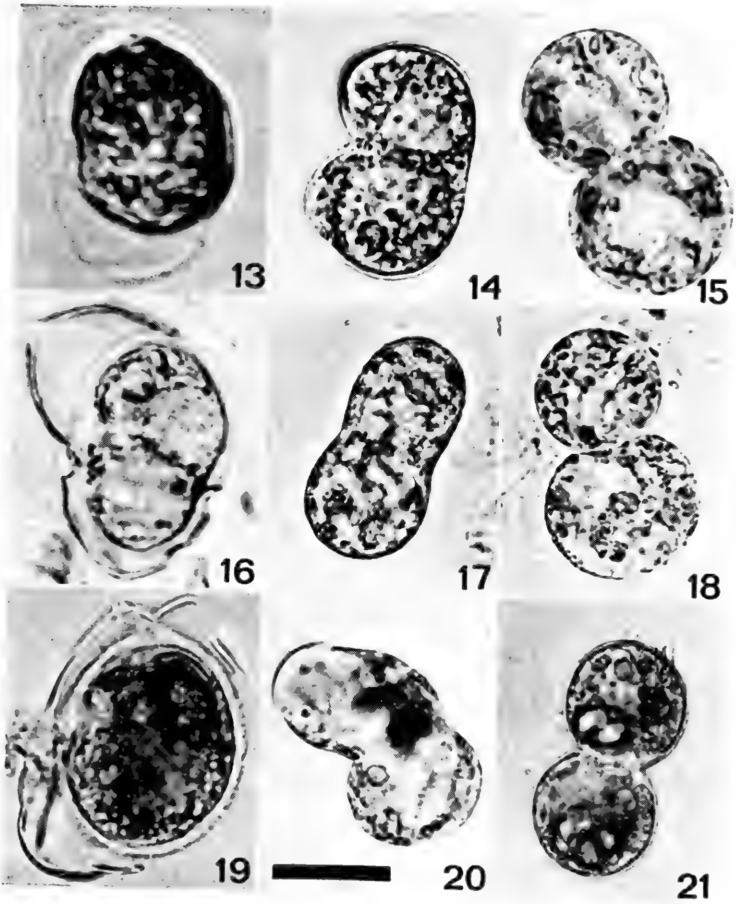
FIG. 12. Scanning electron micrograph of *Peridinium trochoideum*, Strain "Peri," cell undergoing ecdysis. Scale line = 5 μm.

DISCUSSION AND CONCLUSIONS

Our cultures of *P. trochoideum*, *P. faeroënse* and *S. sweeneyae* display no consistent differences while exhibiting striking similarities in morphology, size, chromosome number and life cycle.

The range in chromosome number for a given nucleus is due to procedural difficulties. We attribute the chromosome variation between species to the same cause. The overlap of chromosomes which results from squashing combined with the occurrence of V-shaped chromosomes makes accurate counting difficult. Dodge's count was done using unsquashed cells which may explain why our figure (80–100) differs with his (44) by a factor of two. A count made from an intact nucleus should be viewed as only an estimate. Differences in the chromosome numbers of the three species are not of sufficient magnitude to warrant the separation of these species.

With scanning electron microscopy, the greatest morphological varia-



FIGS. 13–21. Light micrograph of dividing cells. Scale line = 20 μm. 13–15. *Peridinium trochoideum*, Strain "Peri." 16–18. *Peridinium faeroënse*, Plymouth isolate 180. 19–21. *Scrippsiella sweeneyae*, isolate IUCC 1656.

tions were found not between the different strains but within a culture of *P. faeroënse* cells taken from a single flask. The presence of an extra suture in the first apical plate found in two *P. faeroënse* specimens illustrates the occurrence of abnormal thecal plate patterns in dinoflagellates, underscoring the danger in relying solely on thecal morphology when distinguishing species. An extra suture seems a more dramatic deviation from the norm than the imperceptible width difference of the first apical plate cited by Balech and Soares as the basis for the species separation of *S. sweeneyae* and *P. faeroënse.*

On the basis of the similarities in cell size, cell morphology, thecal plate patterns, chromosome counts and type of cell division we conclude that the strains identified as *P. trochoideum* and *P. faeroënse* are conspecific with the type material of *S. sweeneyae.* The Wall and Dale (1968) findings, however, conflict with this conclusion.

Wall and Dale isolated from the ocean two morphologically distinguishable types of calcareous cysts which hatched organisms identified as *S. sweeneyae* and *P. trochoideum.* The cysts with numerous, low-rounded ridges gave rise to specimens identified as *S. sweeneyae* and the spiny cysts hatched organisms classified as *P. trochoideum.* That one species would produce such drastically distinct cysts seems unlikely. But there is a possible explanation. The organism attributed to *S. sweeneyae* by Wall and Dale may not be conspecific with any of the three strains we studied.

Wall and Dale's (1968) plate pattern diagrams of *S. sweeneyae* differ from the original description of the typical plate pattern (Balech, 1959, Figs. 1a–f) and atypical plate arrangements (Balech, 1959, Figs. 2a–c). Specifically, plate 1'''' never touches plate 3''' in the Wall and Dale material. In addition, the size of their *S. sweeneyae* specimens exceeds all of the measurements reported for the three isolates including that of the type material (Table 1). Although size represents a variable characteristic among dinoflagellates, we believe that the absence of any overlap may be meaningful.

We are assuming that the three strains studied are conspecific. We are also assuming that they are conspecific with the type material represented in Stein's description of *Glenodinium trochoideum* since—

1. Stein's drawings of *G. trochoideum* are so sketchy as to allow our isolates to be circumscribed by the original description.
2. for over 12 years the Plymouth isolate 104 has been considered *P. trochoideum.*

We believe that the strains belong to the genus *Scrippsiella* rather than to other genera of the Peridiniaceae, *e.g., Peridinium* or *Protoperidinium* where they might have been placed. The isolates differ from the type of *Peridinium* in being marine, possessing an apical pore and in their production of calcareous cysts. They differ from the type of *Protoperidinium* in calcareous cyst production and number of cingular plates. Adopting the oldest species' name, the isolates should be called *Scrippsiella trochoidea* (Stein) Loeblich, 1976, p. 25.

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A NEW DWARF SALAMANDER OF THE GENUS *BOLITOGLOSSA* (PLETHODONTIDAE) FROM COSTA RICA

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Amongst several apparently unique plethodontids in the collection of the Museo de Zoología, Universidad de Costa Rica (UCR), one, due to the somewhat unusual circumstances of its discovery, can be described at the present time. The specimen was taken by the author from a mat of liverworts, *Hepatica foliosa,* adhering to a small branch which had evidently fallen recently, and was accompanied by eggs, thus reasonably establishing it as an adult.

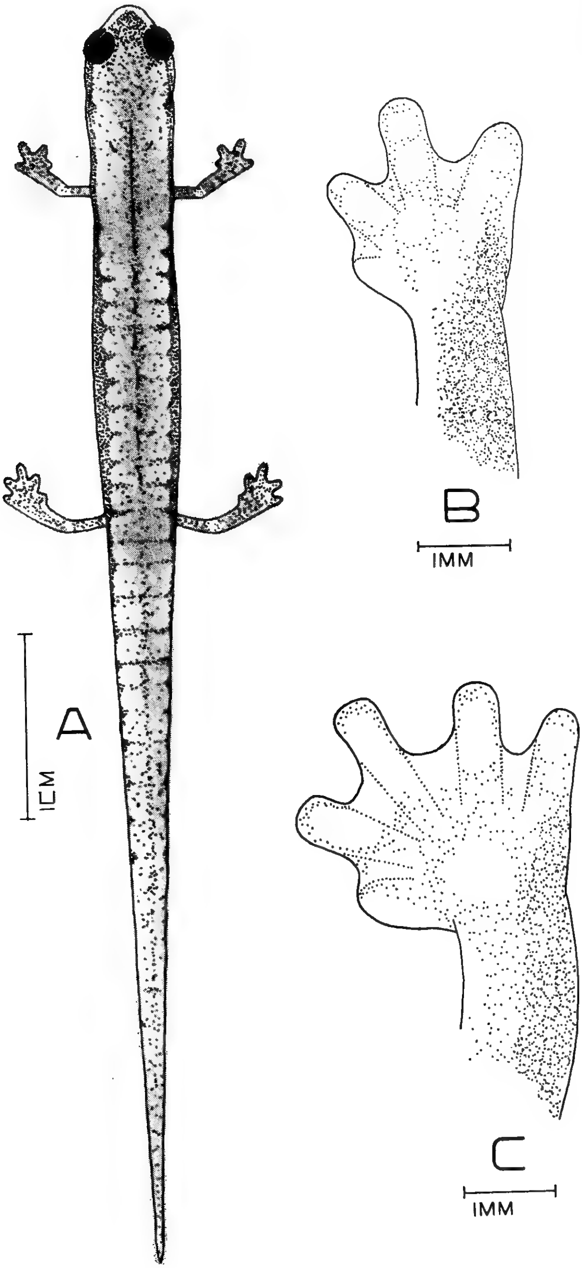
Bolitoglossa diminuta, new species

Figure 1

Holotype: UCR 5217, an adult female from Quebrada Valverde, a precipitous stream 8.8 km NE by road from the bridge crossing the Río Grande de Orosi near Tapantí, Cartago Province, Costa Rica at an altitude of approximately 1555 m, taken by Douglas C. Robinson on August 11, 1968. The stream is neither named nor shown on available maps. The exact site of the stream was determined from aerophotos to be 9° 43′ 18″N latitude and 83° 41′ 48″W longitude.

Additional Material: Two unhatched and five hatched salamanders, taken as eggs with the adult, are specified as non-paratypic corroborative material in the Museo de Zoologia.

Diagnosis: The species is assigned to the genus *Bolitoglossa* on the basis of the presence of 13 costal grooves (counting one each in the axilla and groin) and the absence of a discernible sublingual fold. *Bolitoglossa diminuta* is immediately distinguishable from adults of all other described Costa Rican species by its diminutive standard length (SL), 31.1 mm. *Bolitoglossa epimela* and *B. colonnea* are relatively small species, adult females of which usually exceed 40 mm SL. The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first may be further distinguished from the new form by its much more fully webbed digits, while the second has a distinctive interorbital crest. Other small species (average or unique female SL less than 40 mm) thus far known in the genus are *B. cuchumatana* (Guatemala), *B. minutula* (western Panamá), *B. peruviana* (Peru) and *B. rufescens* (México to Honduras). The type of *B. riletti* from México was reported to be 31.9 mm snout-vent by Holman (1964). The sex was not mentioned and a cited table of additional measurements of the original series was apparently inadvertently omitted. Wake and Brame (1969) however, place the species in the *rostrata* group stating that ". . . the members of which are large . . . ." It will not be further considered here. *Bolitoglossa chica*, previously believed to be diminutive (Wake and Brame, 1963) has been shown by Neill (1964) to reach 50 mm snout-vent in a female lacking maxillary teeth. Either of these traits distinguishes that species from the new form. *Bolitoglossa cuchumatana* has a much shorter tail (41% of total length, *B. diminuta*, 53%, both females). *Bolitoglossa minutula* has a shorter tail (♀♀-48%), more digital webbing and a higher number of maxillary teeth (range: 33–51: $\bar{x} = 41.7$ for females, 34 in *B. diminuta*). The patterns are also distinctive, although highly variable in *B. minutula* (Wake, et al., 1973). The type of *B. peruviana* has 30 vomerine teeth (12 in *B. diminuta*) but a second specimen tentatively assigned to this species by Brame and Wake (1963) has only 13. Pending better definition of this form, it would seem that locality alone would suffice to insure its distinctness. *Bolitoglossa rufescens* has much more extensively webbed digits and differs in numerous other traits.

Description of Holotype: Adult female, snout moderately short. Nostril small; no labial protuberances of nasolabial groove. Canthus rostralis weakly developed. Standard length 6.5 times head width; standard length 3.9 times snout-gular fold length. Deep groove below eye extends from a point below anterior corner of eye to a point slightly anterior to posterior corner and following curvature of the eye, without communicating with lip. Eye moderately large. A well defined postorbital groove extends posteriorly from eye becoming continuous with the dorsal-lateral band. From this groove, a ventral ramus descends 1.5 mm behind eye, and crosses 2.8 mm anterior to the gular fold to the opposite side. Vomerine teeth 12, arranged in single row of 6 on each side, extend from posterior border of choanae in strongly arched curve toward midline, separated from parasphenoid

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FIG. 1. Dorsal views of (A) *Bolitoglossa diminuta*, new species, (B) front foot, (C) hind foot, all of holotype, UCR 5217. The drawing of the hind foot is based on the left foot, due to an aberrant condition of the right foot.

tooth patch by 0.7 mm. Premaxillary teeth 3, maxillary teeth 34 (17–17) extending posteriorly to a point parallel to the midpoint of the eyeball tunic. Tail long, 1.14 times standard length, not strongly compressed laterally, with a weak basal constriction. Postiliac gland not evident. Limbs of medium length, three costal grooves exposed between adpressed limbs; standard length 4.7 times right forelimb, 4.6 times right hind limb, and 10.7 times right foot width; hands and feet about two-thirds webbed, the inner digit of both hand and foot completely included in web, the remaining digits freely projecting (Fig. 1B, C), subterminal pads weak, more evident on feet. Fingers in order of decreasing length: 3, 4, 2, 1; toes in order of decreasing length: 3, 2–4, 5, 1. The second and third digits of the right hind foot appear somewhat joined, an apparently aberrant condition, for which reason the left foot has been illustrated, and inverted to facilitate comparison with other descriptions.

Measurements (in mm): Head width 4.8; snout to gular fold (head length) 8.0; head depth at posterior angle of jaw 2.9 (specimen preserved with mouth opened); eyelid length 2.1; eyelid width 1.2; anterior rim of orbit to snout 1.9; horizontal orbital diameter 1.6; interorbital distance 1.7; distance between vomerine teeth and parasphenoid tooth patch 0.7; snout to forelimb 9.6; distance separating internal nares 1.0; distance separating external nares 1.4; snout projection beyond mandible not determined (mouth opened); snout to posterior angle of vent (SL) 31.1; snout to anterior angle of vent 28.6; axilla to groin 17.1; tail length 35.3; tail width at base 2.6; tail depth at base 2.7; forelimb length 6.6; hind limb length 6.7; width of right hand 2.3; width of right foot 2.9.

Coloration in Alcohol: The dorsum of the head and trunk is brown. Lateral darker brown bands extend from the posterior margin of the orbit, in a straight line, passing above the forelimb insertions and along the trunk where the darker pigment extends mediad in the costal grooves to give a slightly scalloped pattern. The bands pass dorsal to the hind limb insertions and become indistinguishable from the ground coloration on the anterior third of the tail. Elbows and knees lack pigment. Scattered melanophores on the gular region, the ventral region of the trunk, limbs and base of tail, especially dense in the cloacal region and sparse on the distal portion of tail.

Range: Known only from the type locality, in Lower Montane Rain Forest according to the ecological map of Tosi (1969).

Etymology: From the Spanish word diminuta, meaning exceedingly small.

Comments: Until more specimens become available, observations on osteology must be deferred. Generic allocation is tentatively to the genus *Bolitoglossa*. The species, by virtue of its low costal groove count, is obviously not a member of the genus *Oedipina*. Although no sublingual fold can be discerned, the species shares a number of characteristics reminiscent of *Chiropterotriton*. These include an unusually long, strongly tapered tail, foot structure and webbing, and diminutive size. The species currently known as *Parvimolge richardi* has a totally different foot structure, the digits being fused. If indeed, the only known adult of *B. diminuta* and its eggs fell with the branch from a high tree, it may be some time before the species is rediscovered, a possibility which prompted its description at this time. Some four days passed between the hatching of the first eggs and preservation date of these when two eggs still had not hatched. A hatched salamander measures 8.0 mm snout-vent and 3.2 mm tail length. Other species taken at the locality include *B. epimela*, *B. robusta* and *Oedipina poelzi*.

Sumario: Se describe una nueva especie de salamandra, *Bolitoglossa diminuta* sp. n. (Plethodontidae) de Costa Rica. Junto con *B. minutula* de adyacente Panamá, estas especies constituyen los miembros más pequeños conocidos del género, y pueden distinguirse facilmente por la presencia de membranas interdigitales mucho más completas en *B. minutula*.

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I wish to thank Pedro León for his field companionship on this and many other collecting trips, and innumerable students who shared many hours with me searching, albeit fruitlessly, for additional material. Federico Valverde, with his usual attention to detail, prepared the drawings. Luís Diego Gómez identified the liverwort. Floyd L. Downs and David B. Wake read the manuscript and offered valuable suggestions.

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PROCEEDINGS
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BIOLOGICAL SOCIETY OF WASHINGTON

COMMENTS ON GENERIC NAMES OF FOUR-EYED OPOSSUMS (FAMILY DIDELPHIDAE)

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The name *Philander* Tiedemann, 1808, currently applied to the pouched four-eyed opossums belongs, according to Pine (1973), to the pouchless four-eyed opossums universally known by the name *Metachirus* Burmeister, 1856. The correct name for the pouched form, Pine affirms, is *Metachirops* Matschie, 1916, currently treated as a junior synonym of *Philander* Tiedemann.

As understood by Pine (1973, p. 391 ff.), pouched four-eyed opossums are grayish or blackish on upper parts of body with "considerable extension of fur onto the base of the tail." The pouchless forms, seen by the same authority, are reddish brown dorsally with "little extension of fur onto the base of the tail." Whatever the characters, resolution of the problem of the correct generic name for each group of four-eyed opossums depends on the definition of its type species.

It is generally agreed that the first valid name for a species of pouched four-eyed opossum is *Didelphis opossum* Linnaeus 1758. Sole basis for the name is an adult male and female described and figured by the Dutch naturalist collector, Albert Seba (1734, p. 56, pl. 36, fig. 1 [male], fig. 2 [female]). The male, according to Seba, is dark chestnut on upper parts of body, its tail base furred for the length of a human finger, roughly 7–9 cm. External characters of the female, figured with 3 young protruding from her pouch, are undescribed except for the pouch.

It is clear that Linnaeus (1758, p. 55) based the name

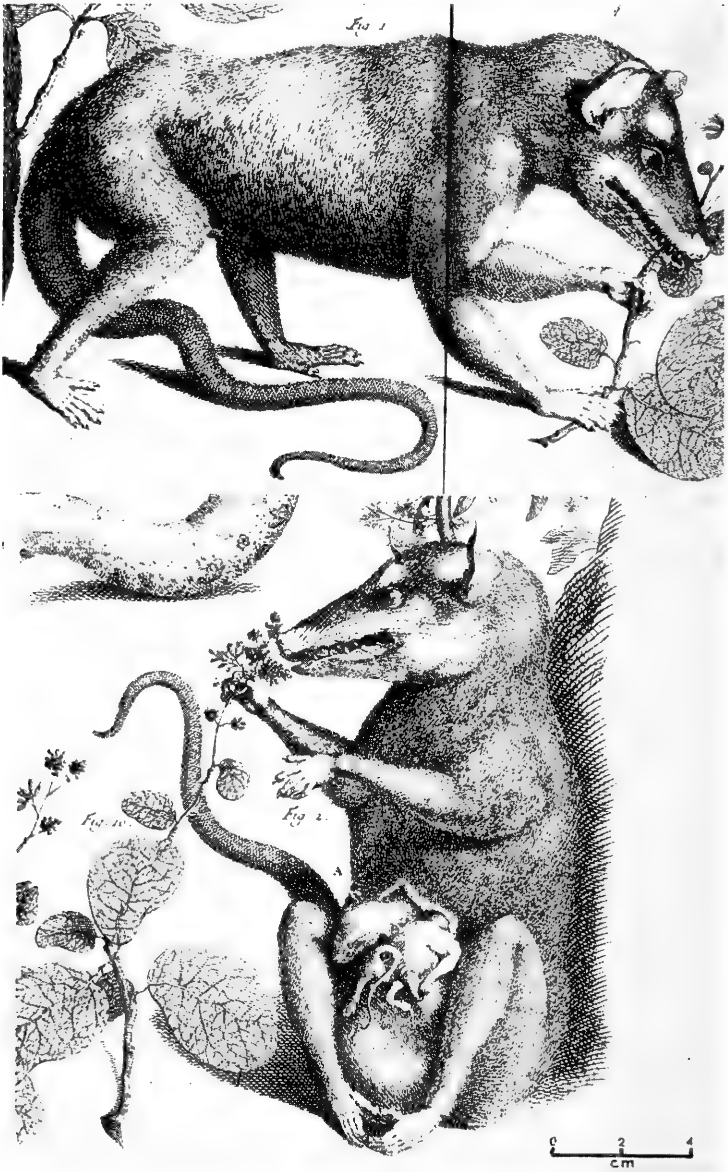

FIG. 1. Male and female pouched four-eyed opossums reproduced from Seba (1734, pl. 36) and rearranged. Upper figure, adult male, labelled "Num. 1. *Philander, Opassum, sive Carigueja, Brasiliensis; mas.*" Lower figure, adult female with pouch young, labelled "Num.

Didelphis opossum no less on the female than the male. His diagnosis and description of the species, "*D*[*idelphis*] cauda semipilosa, superciliorum regione pallidiore, mammis binis," and "*abdomen circa mammas contrahitur in marsupium; policis postici mutici,*" leave no doubt on that point. Color is not mentioned but the phrase "cauda semipilosa" can be translated either as hairy for half its length or as partially furred. Whatever the wording used by Linnaeus, the interpretation derives solely from Seba's figures of the animals (Fig. 1).

Although nothing in the original description of *Didelphis opossum* Linnaeus suggests anything other than the well-known pouched four-eyed opossum, Pine (1973, p. 394) accedes for "reasons of nomenclatural stability" but only if the color of the animal is regarded as grayish. In Pine's mind the "combination of characters [brown dorsal surface, extensively furred tail base, and pouch] as described and figured by Seba fit no known opossums and the identity of his material will almost certainly remain unknown (assuming it does not represent an unrecognized species)."

There is no such ambiguity. Seba's "*Philander, Opassum, sive Carigueja, Brasiliensis; mas.*" and "*Philander, Americanus, seu Carigueja, cum catulis, saccum ventris intrantibus; fœmina,*" are universally known and recognized as *Didelphis opossum* Linnaeus. They cannot be anything else. To eliminate a possible source of contention, the female is here designated lectotype.

Pine's belief that the pouched four-eyed opossum, *Didelphis opossum* Linnaeus, is invariably grayish and the pouchless four-eyed species, *Didelphis nudicaudatus* E. Geoffroy, is invariably brownish, discounts the considerable amount of individual and geographic variation natural to both species. The type locality of *Didelphis opossum* had been restricted

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2. *Philander, Americanus, seu Carigueja, cum catulis, saccum ventris intrantibus; fœmina.*" Vertical line across upper figure is center fold of double page display; scale added to indicate size of figures on original plate.

by J. A. Allen (1900, p. 195) to Suriname, formerly Dutch Guiana, where most of Seba's South American or "Brazilian" animals originated, and was further restricted to Paramaribo, by Matschie (1916, pp. 266, 268). Among representatives of *D. opossum* preserved in the Field Museum, those collected by me in Suriname are buffy like most *D. nudicaudata.* Other specimens, notably of *Philander opossum melanurus* Thomas from western Ecuador, and many of *P. o. fuscogriseus* J. A. Allen, to use the current names, can be described as "dark brown." In contrast, *Metachirus nudicaudatus modestus* Thomas, southernmost race of the pouchless species, is characterized as "grey." Indeed, Thomas (1901, p. 545) left no grounds for differentiation between the species on gross color when he described *Metachirus nudicaudatus phaerus* as being the "usual buffy grey brown."

The only consistent anatomical character of taxonomic value mentioned in 18th and early 19th century descriptions of four-eyed opossums is the presence or absence of a pouch in the female. The densely pilose basal portion of the tail, never precisely quantified in early descriptions or by Pine, ranges in Field Museum material from 2–4 cm in the pouchless species (40 samples with m4 fully erupted), and from 3–8 cm in the pouched forms (48 samples with m4 fully erupted). The overlap is 67% in the first species, 33% in the second. Color of upper parts is variable and its description in published accounts is subjective. Furthermore, old types of four-eyed opossums mounted and exhibited in natural light, were often faded when described, and those long preserved in spirits, usually rum or brandy, are stained brown. Nothing is said of the manner of preservation of Seba's philanders but the artist's rendition suggests they were spirit preserved. Linnaeus wisely refrained from mentioning general body color in his diagnosis of *Didelphis opossum* and none is needed for defining the species.

In 1949 I showed that the original description of *Philander* Tiedemann, includes 3 nominal species. Tiedemann's diagnosis of the first, "Das Virginische Opossum. P. virginianus (Did. opossum L[innaeus]) (le sarigue Buff[on] T. X. p. 279). Körper röthlich braun. Ueber jedem Auge ein gelblich weiser

Flecken. Schwanz so lang als der Leib. 1 Fuss und 3 Zoll lang ohne den Schwanz. In Virginien, Mexico, Peru u. s. w.," is of a four-eyed opossum. Color pattern, measurements, and the equation of *P. virginianus* with the Linnaean *Didelphis opossum* and the sarigue of Buffon, actually Daubenton in Buffon (1763, p. 311, pl. 45 [male], pl. 46 [female]) unequivocally identifies it with the pouched species. Tiedemann's vague notions of geographic distribution and the misleading toponym he substituted for the earlier *Didelphis opossum* do not alter the taxonomic status of the species. The remaining forms included by Tiedemann in his *Philander* are "P. murinus (Did. murina L.)," a *Marmosa,* and "P. brachyurus (Did. brachyuros Penn.)," a *Monodelphis.*

My (1949, p. 12) designation of "*P[hilander] virginianus* Tiedemann = *Didelphis opossum* Linnaeus" as type of *Philander* Tiedemann 1808, conforms to stipulations of Article 69 (a) of the International Code of Zoological Nomenclature (1961). In this case, however, the formal designation of a type is superfluous. The generic name *Philander* Tiedemann derives from the primary vernacular name, "*Philander, Opassum* [sic], *sive Carigueja,*" used by Seba (1734) for the animals and cited by Linnaeus in his description of *Didelphis opossum.* Hence, *P[hilander] virginianus* (*Did. opossum,* L.)" is *ipso facto* type by Linnaean tautonomy (Hershkovitz, 1949, p. 11; Int. Code Zool. Nomencl., 1961, Art. 68 (d) (i).

Pine (1973, p. 398) queries my 1949 interpretation of the rules of nomenclature but no other is valid. On the other hand, Pine's opinion that the real type of *Philander* Tiedemann 1801, is the animal "presently known as *Metachirus nudicaudatus,*" lacks merit. This species is not mentioned by any name or in any guise in the original description of the genus *Philander* and likely was unknown to Tiedemann. It cannot be the type of *Philander* Tiedemann under any published and accepted rules of zoological nomenclature.

Metachirops Matschie, 1916, a junior synonym of *Philander* Tiedemann, was established to contain 9 didelphid species. Pine (1973, p. 398) states that "*D[idelphis] quica* was the only species mentioned on the occasion of the first proposal of the name [*Metachirops*]." Pine also declares he is "unable to find a formal proposal of a species to be regarded as the type-species of *Metachirops*." If only one species were originally included in the genus, as Pine believes, that species is type by monotypy (Art. 68 [c]) and no proposal is necessary. In the present case Matschie (1916, p. 268) listed 9 species by name and formally designated "[*Metachirops*] *quica* Temminck . . . Typus" (= "type by original designation," Art. 68 (a) Int. Code Zool. Nomencl., 1961). Compilers and cataloguers (*e.g.*, G. M. Miller, 1923, p. 7; Hall and Kelson, 1959, p. 10) routinely cite *Didelphis quica* Temminck as type but Pine (1973, p. 399) thinks his proclamation of the type species is the first and only valid designation.

The genus *Metachirus* was erected by Burmeister (1854, pp. viii, 135) to contain 4 species (Pine, 1973, p. 397, counted only 2). These are (1) "*Didelphys myosurus*" attributed to Temminck, (2) "*Didelphys quica* Natt[erer]," the manuscript name adopted by Temminck for his description of *Didelphis quica*, a pouched four-eyed opossum now type of *Metachirops* Matschie, (3) "*Didelphys cinerea* Temminck," currently *Marmosa cinerea*, and (4) "*Didelphys incana* Lund," now *Marmosa incana* Lund.

Burmeister's diagnosis of *Metachirus* and his concept of "*Didelphys myosurus*" agree with what was known of the pouchless *Didelphis nudicaudatus* E. Geoffroy. Burmeister had seen no specimens of "*myosurus*" but he followed Wied-Neuwied (1826, p. 400, pl. 2, fig. 5 [skull]) who described two male *D. nudicaudatus* from Comechatibá, Bahia, Brazil, under the name *D. myosuros*. Burmeister's use of the emendation *myosurus* with *D. nudicaudata* cited as a senior synonym follows Wagner (1843, p. 43).

In 1856, Burmeister (p. 67) reviewed *Metachirus* and noted the presence of a fully developed pouch in females. The three species admitted in the revised genus are *Metachirus opossum* Linnaeus, "*M. myosurus* Temminck" with *Didelphys nudicaudata* E. Geoffroy cited as a senior synonym, and *M. quica* Temminck. His description and colored figure of *Metachirus myosurus* are those of a pouchless four-eyed opossum.

A type species of the genus was not designated in either the revised or original description of *Metachirus.*

The name *Metachirus* fell into disuse until resurrected by Thomas (1888, p. 329) as a subgenus of *Didelphys* (= *Didelphis* Linnaeus, emended), with *D. nudicaudata* E. Geoffroy designated type. This action conforms to Article 69 (a) of the International Code of Zoological Nomenclature: "If an author [Burmeister] established a nominal genus [*Metachirus*] but did not designate or indicate its type-species, any zoologist [Thomas, 1888] may subsequently designate as the type-species one of the originally included nominal species." As explained in Article 69 (a) (i), "the 'originally included species' comprise only those actually cited by name in the nominal genus, either as valid names (including subspecies, varieties, and forms), as synonyms [*D. nudicaudatus* = '*Didelphys myosurus*' Burmeister, not *Didelphis myosuros* Temminck] or as stated misidentifications of previously established species."

The status of *Didelphis myosuros* Temminck (not Burmeister) needs clarification. Temminck (1825) based the name on an unspecified number of four-eyed opossums the females of which "ont une poche complete." Temminck (1825, p. 39) rejected the idea that his myosure might be conspecific with the pouchless *Didelphis nudicaudatus* E. Geoffroy by pointing out that "il est dit dans le texte que le queue de cet animal est toute nue, et le femelle n'a point de poche." At the same time, Temminck drew attention to a poorly preserved skin of a young female in the Paris Museum labelled *Didelphis nudicaudatus* with seemingly all the characters of *D. myosuros* but he questioned whether that specimen might be the actual type of *D. nudicaudatus* E. Geoffroy.

Temminck (1825, p. 40) also examined specimens of *D. myosuros* in the museums of Leiden, Vienna, Frankfurt and Prince Maximilian Wied-Neuwied. There is no evidence, however, that the two males of *D. nudicaudatus* collected in Comechatibá (= Comoxatibá) and recorded in 1826 by Wied-Neuwied as *D. myosuros,* were among those seen by Temminck. In any event, all authors beginning with Wied-

Neuwied (1826) and Desmarest (1827) assumed that Temminck himself had identified his *D. myosuros* with *D. nudicaudata.* In 1959 (p. 343) I pointed out that the name *Didelphis myosuros* Temminck is based on pouched four-eyed opossums. I erred, however, in treating the Comoxatibá opossums as syntypes and my designation of one of them as lectotype is invalid (cf. Art. 73, International Code of Zoological Nomenclature, 1961).

A taxonomic review of *Philander* and *Metachirus* is in preparation for publication elsewhere. The foregoing shows that the generic names of the similar appearing but unrelated four-eyed opossums are the following:

Philander Tiedemann 1808—type, *Philander virginianus* Tiedemann = *Didelphis opossum* Linnaeus (type by Linnaean tautonomy [cf. Hershkovitz, 1949, p. 12, and above]); pouched four-eyed opossums.

Metachirus Burmeister, 1854—type, *Didelphis nudicaudatus* E. Geoffroy (subsequent designation by Thomas, 1888, p. 329); pouchless four-eyed opossums.

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PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

THE SUBSPECIES OF *THYROPTERA DISCIFERA* (LICHTENSTEIN AND PETERS)

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In describing *Hyonycteris* (= *Thyroptera*) *discifera* in 1855, Lichtenstein and Peters listed the type-locality as: "Habitatio: Puerto Cabello (America Centralis)." In a subsequent publication discussing *Thyroptera tricolor* Spix, Peters (1866) stated: "Diese Art ist grösser und hat auch einen längern und auffallend mehr hervorragenden Schwarz als die van mir beschriebene *Th.* (*Hyonycteris*) *discifera* aus Puerto Cabello in Venezuela."

Apparently misled by the "America Centralis" in the original description and unaware of the 1866 work, Miller (1896) listed the type-locality as "Puerto Caballos, Honduras" in his redescription of the species. Subsequent workers (Goodwin, 1942, 1946; Miller and Kellogg, 1955; Cabrera, 1958; Hall and Kelson, 1959) have continued to place the type-locality in Honduras.

Three specimens of *Thyroptera discifera* collected by J. E. Mitchell on the Escondido River at a point about 50 mi from Bluefields, Nicaragua, and now in the National Museum of Natural History, were used by Miller as a basis for his (1896) redescription of the species. In 1931, Miller described *Thyroptera discifera major* based on a series of specimens collected at San Julian, Venezuela by Robinson and Lyon (1901). This action was based on his belief that the nominate form was from Central America, but in fact *T. d. major* is a junior synonym of *T. d. discifera* and the Nicaraguan population is without a name.

This paper provides a redescription of the species and a description of the Central American subspecies.

Thyroptera discifera (Lichtenstein and Peters)

Hyonycteris discifera Lichtenstein and Peters, 1855:335.

Th. (*Hyonycteris*) *discifera* Peters, 1866:581.

Thyroptera discifera major Miller, 1931:411.

Lectotype: An adult male, Zoolisches Museum der Humboldt-Universitat zu Berlin number 59067, spirit-preserved with skull in place, collected by Appun.

Type-locality: Puerto Cabello, Venezuela.

Distribution: Known from Nicaragua (Miller, 1896), and northern South America from French Guiana to Peru (Cabrera, 1958).

Measurements: Measurements of the lectotype and paralectotype are given in Table 1.

Definition: A small bat with cinnamon brown pelage dorsally, and slightly paler pelage on the venter. Circular suctorial discs present on the thumbs and hind feet. The calcar is about 9 mm long, keeled, and has a single cartilaginous lobule projecting posteriorly. The skull is small and delicate with an inflated braincase rising abruptly from the rostrum (Fig. 1). The upper incisors are bifid and the lower incisors are trifid.

Diagnosis: The only other species in the family is *Thyroptera tricolor* Spix. *Thyroptera discifera* averages slightly smaller than *T. tricolor* in almost all external measurements. *Thyroptera tricolor* has a white or partly white venter, whereas that of *T. discifera* is only slightly paler than the dorsum. In addition, most *T. tricolor* are darker dorsally than *T. discifera.*

In *T. tricolor*, the tail projects 5–8 mm beyond the interfemoral membrane, whereas in *T. discifera* only the last two caudal vertebrate (2 mm) project beyond the free edge of the membrane. *Thyroptera tricolor* usually has two cartilaginous lobules on the posterior edge of the calcar and *T. discifera* has only one.

The skulls and dentitions of the two species are similar, although *T. discifera* averages smaller. Both upper incisors are usually distinctly bifid in *T. discifera*, but in *T. tricolor* often only the inner upper incisor is distinctly bifid.

Thyroptera discifera shows considerable color variation. The series of specimens collected by Robinson and Lyon from San Julian, Venezuela contains one animal which is almost black above and below and one which is pale yellowish brown dorsally and grayish white ventrally. A variety of yellowish and cinnamon browns are displayed by the remainder of the series. In most cases, the venter is only scarcely paler than the dorsum, regardless of the dorsal coloration.

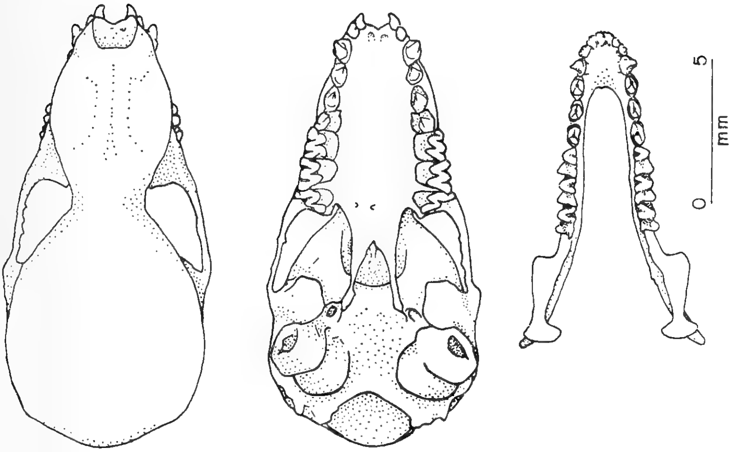

FIG. 1. Lateral views of skull and mandible and occlusal views of mandibular and maxillary toothrows of *Thyroptera discifera.*

Table 1 provides measurements of *T. discifera.* Additional descriptive features were given by Lichtenstein and Peters (1855b) and Miller (1896).

Remarks: Lichtenstein and Peters (1855a) based the original description on three specimens, all males, collected by Appun in Puerto Cabello, Venezuela. Two of these syntypes remain in the collection of the Zoologisches Museum der Humboldt-Universitat zu Berlin and are herein designated the lectotype and paralectotype. Both the specimen labels and the catalog refer to the locality of collection as "Puerto Cabello, Venezuela." That the actual type locality is Puerto Cabello, Venezuela, and not Puerto Caballos, Honduras, as interpreted by Miller (1896) seems certain. Appun included other material from Puerto Cabello, Venezuela, in his shipment to the Berlin Museum, most notably the holotype of *Vampyrops vittatus* (see Gardner and Carter, 1972).

Thyroptera discifera abdita, new subspecies

Holotype: An adult female, USNM 51538, fluid-preserved with skull and mandibles removed and cleaned, collected July 25, 1892, by J. E. Mitchell. The skin is in good condition except for a slight slippage of fur on the dorsum and around the ventral incision. The colors have probably become paler after more than 80 years in preservative. The mandibles are separated and the left zygomatic arch is broken.

Type-locality: Escondido River, 50 mi east of Bluefields, Nicaragua.

Distribution: Known only from the type-locality.

Measurements: See Table 1.

Definition: A small yellowish brown bat, slightly paler ventrally. Externally, it resembles South American *T. discifera* except for smaller size (Table 1).

Diagnosis: *Thyroptera discifera abdita* needs comparison only with *T. d. discifera* from South America. The smaller size of *T. d. abdita* indicates that it represents a population morphologically distinct from the South American members of this species. This, and the large hiatus between northern South American and Nicaraguan populations, warrant the recognition of the Central American form as a distinct subspecies.

Description: This description is primarily based on the holotype since the paratypes (USNM 51539 and USNM 51540, female and male, respectively) are immatures. The posterior edge of the calcar has a strongly defined keel supported by one cartilaginous process. The terminal 2 mm of the tail project belond the uropatagium. The uropatagium is sparsely furred with long hairs, some of which form a fringe along the posterior border.

The feet are small (4 mm) and delicate with each toe composed of two phalanges. All of the digits of the hind foot are connected by skin, and the third and fourth are syndactylous. The circular sucking disk on each hind foot is somewhat smaller than those on the thumbs.

The membranes are thin and transparent. The wing membranes attach to the middle of the digits of the hind feet. Sparsely distributed hairs cover the wings near the sides of the body and along the humerus and forearm. The proximal part of the forearm and the entire upper arm are densely haired.

The funnel-shaped ears are short, with the tips acutely pointed and not projecting beyond the muzzle when laid forward. A large lower lobe is isolated from the rest of the pinna by a distinct basal notch. The tragus is short and broad with a thickened tip.

The skull is light and delicate, with the globose braincase rising abruptly from the rostrum. The inner upper incisor is twice the size of the outer and both are bifid. The premolars are contiguously in line in the toothrow with no spaces separating them from the canine or first molar. The second molar is the largest and the third the smallest. The lower incisors are small and trifid.

Remarks: The name *abdita* means hidden or secret, and refers both to the confused nomenclatural history of the species and to the fact that the subspecies has not been collected since the holotype and paratypes were taken in 1892.

The bats collected by Robinson and Lyon in Venezuela were captured in two groups, one of 10 individuals and a second of 7. Both tightly clustered groups were found by natives who captured them by hand as the bats clung to the under surface of dead banana leaves.

This roosting habit is quite different from that of *T. tricolor*, which

TABLE 1. Measurements (mm) of *Thyroptera discifera*. Original description (1), lectotype (2) and paralectotype (3).

Character	*T. d. discifera*			Venezuelan range (n)	*T. d. abdita*
	1	2	3		Holotype
Total length	70	70.9	66	70 – 80 (6)	61
Ear length	11.5	11.7	10.7	11 – 12 (3)	11
Forearm length	33	34.0	33.8	33.4 – 35.4(9)	31.1
Metacarpal III	31	32.8	34.3	31 – 34.5(2)	29.7
Digit III, phalanx 1	15	15.5	14.8	14.7 – 16.7(2)	14.5
Digit III, phalanx 2	10.25	10.6	9.8	9.6 – 10.0(2)	8.5
Metacarpal IV	30	31.8	33.2	29.8 – 33.8(2)	29.1
Digit IV, phalanx 1	10.5	11.1	10.1	9.3 – 10.5(2)	10.0
Digit IV, phalanx 2	7	7.3	6.3	6.3 – 6.5(2)	5.1
Metacarpal V	28	30.7	30.6	27.1 – 31.4(2)	26.7
Digit V, phalanx 1	8.75	8.6	8.1	8.7 – 8.9(2)	8.6
Digit V, phalanx 2	7	7.4	6.9	6.8 – 7.2(2)	5.8
Tibia length	15	16.3	15.8	16.2 – 16.4(2)	14.0
Tail length	32	30.7	29.8	28 – 33 (8)	24
Condylocanine length				12.6 – 12.9(4)	12.05
Mastoid breadth				6.80– 7.00(4)	6.70
Zygomatic breadth				6.95– 7.10(4)	6.90
Braincase breadth				6.7 – 6.8 (4)	6.6
Interorbital breadth				2.50– 2.75(5)	2.55
Rostral breadth				3.95– 4.25(4)	3.95
Maxillary toothrow				5.60– 5.85(5)	5.40
Width across canines				2.70– 2.85(4)	2.85
Width across molars				4.65– 5.10(4)	4.85

roosts in rolled *Heliconia* leaves (Findley and Wilson, 1974). *Thyroptera* are notoriously difficult to capture in mist nets and probably only a careful search for roosting sites will yield additional specimens.

Specimens examined: *Thyroptera discifera discifera*: VENEZUELA. Puerto Cabello, 2 (ZMB-59067, lectotype; ZMB-437, paralectotype); San Julian, 14 (USNM 105419, holotype of *T. d. major* Miller; USNM 102923-8; USNM 105420-3; USNM 143782-4). COLOMBIA. La Guayacana, 1 (USNM 309067). *Thyroptera discifera abdita*: NICARAGUA. Escondido River, 50 mi from Bluefields, 3 (USNM 51538-40).

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I am grateful to Hans Hackethal of the Zoologisches Museum der Humboldt-Universitat zu Berlin for the loan of the lectotype and paralectotype. Drs. Charles O. Handley, Jr. and Dilford Carter provided valuable information on *Thyroptera*. John R. Weske and John S. Weske translated several articles from German for which I am indeed grateful. The manuscript was improved by the critical reading of Michael A. Bogan and Alfred L. Gardner.

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PROCEEDINGS
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BUCEROCOPHORUS, A NEW GENUS OF ISCHNOCERAN MALLOPHAGA FROM AFRICAN HORNBILLS (BUCEROTIDAE)

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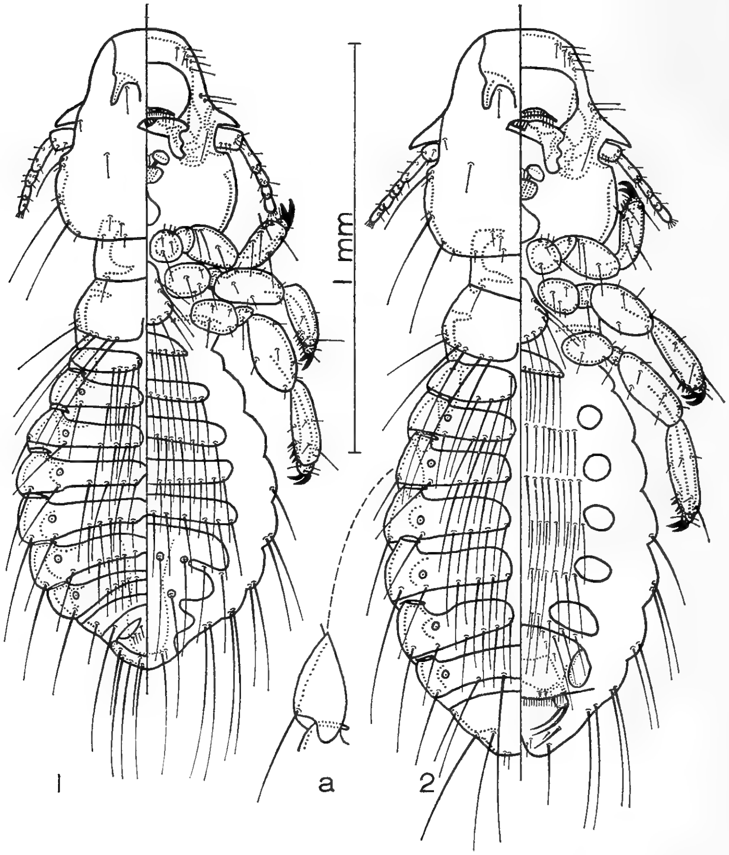
In revising the Hornbill ischnoceran Mallophaga, 3 species could not be included in either *Buceronirmus* or *Paroncophorus.* The new genus *Bucerocophorus* is described here for the species *Oncophorus latifrons* Piaget, 1885, *Docophorus pachycnemis* Giebel, 1876, and a new species, *B. watsoni.* For the loan of specimens appreciation is expressed to: Dr. Theresa Clay, British Museum (Natural History) (BMNH), Dr. K. C. Emerson, Smithsonian Institution (USNM), Dr. J. A. Ledger, South African Institute of Medical Research (SAIMR), and Dr. Savo Brelih, Yugoslavian Prirodoslovni Musej Slovenije (PMS). I obtained dried material from museum skins at the USNM, American Museum of Natural History (AMNH), and the Field Museum of Natural History (FMNH). Special thanks are extended to: Dr. L. T. Nielsen, Department of Biology, University of Utah, for providing space and facilities for this study, Drs. Clay and Emerson for their helpful suggestions, and Drs. Mary LeCroy, AMNH, and G. E. Watson, USNM, for supplying host and locality information. Mallophagan terminology follows Clay (1958) and nomenclature of the hosts is that of Sanft (1960).

Bucerocophorus, new genus

Figures 1 and 2

Dorsal anterior plate of forehead with 3 posterior extensions, 2 lateral and 1 medial. Antennae filiform, similar in both sexes. Pronotum with a short seta on each lateral margin. Pterothorax with posterior marginal row of 10–12, normally 10, long setae and a short seta



FIGS. 1–2. *Bucerocophorus pachycnemis* (Giebel), dorsal-ventral views, drawn to same scale: 1, Male. 2, Female; a, pleurite of abdominal segment IV.

on each lateral margin. Metasternal plate triangular, expanded posteriorly, with 10–14, normally 12, setae. Abdominal segments with tergites, sternites, and pleurites, the latter prolonged posteriorly on II–IV (Fig. 2a) and with setae on margins on IV–X or V–X. Tergites II–IV, II–V, or II–VI in male and II–VII in female divided medially, remainder complete; on II–VIII both sexes with a posterior marginal row of setae, the most laterad on III–VII being the post-spiracular seta. Sternites II–VI in male and II in female complete, III–VII in female circular or oval in shape, and on II–VII of both sexes a posterior marginal row of setae. Terminal segments as illustrated for each species; male with 6–8, normally 6, dorsal setae on posterior margin and sternites VII–XI fused into single genital plate; female vulval margin with posterior marginal row of short setae and 4–6 spines; postvulval sclerite similar in shape for each species; fused IX–XI with 5 sternal setae each side, the anterior 2 stout and curved, arising from sclerite at lateral edge of vulval margin.

Bucerocophorus with 3 extensions of the dorsal anterior plate resembles most closely *Buceronirmus* with 1 dorsomedial extension of the marginal carina. Both genera lack the hyaline margin of *Paroncophorus* which is unique in having a median groove and 2 small chitinous plates on the marginal carina. These differences were described and illustrated by Piaget (1885) for *Oncophorus latifrons* Piaget and "*O. cephalotes* Nitzsch" *sensu* Piaget, the type species of *Paroncophorus* (Hopkins and Clay, 1952). *Bucerocophorus* resembles *Paroncophorus* in the posterior prolongation of pleurites II–IV which are not prolonged in *Buceronirmus.* On each lateral margin of fused IX–XI in the female, *Bucerocophorus* has the anterior 2 sternal setae stout and curved and arising from a sclerite at the lateral edge of the vulval margin but both *Buceronirmus* and *Paroncophorus* have a vertical line of sternal setae none of which arise from a sclerite at the vulval margin.

The male genitalia and number of pleural setae on segments IV–X are the best characters for separating species.

Type species: *Docophorus pachycnemis* Giebel, 1876.

Bucerocophorus latifrons (Piaget)
Figures 3–5

Oncophorus latifrons Piaget, 1885:36, pl. 4, fig. 6.

Type host: *Buceros semifasciatus* = *Tockus fasciatus semifasciatus* (Hartlaub).

Paroncophorus latifrons (Piaget). Hopkins and Clay, 1952: 265.

A lectotype female (BM 1928-325) is designated hereby from the Piaget collection in the BMNH. The slide has been so labeled.

Both sexes are about the same size as corresponding sexes of *B. pachycnemis.*

Male: Abdominal tergites II–V often VI divided medially; remainder complete. Tergocentral setae: II–V range 8–12; VI–VIII range 10–16; normally 10 on II–IV, 12 on V–VIII. Pleural setae each side: IV dorsally and ventrally 0–1, normally 0; V–VII dorsally 1–2, normally 1 on V, 2 on VI–VII; V–VII ventrally 1–3, normally 2; VIII–X ventrally 2–4. Sternal setae: II–VI range 10–16, normally 12, except 14 on III; VII range 8–14; VIII range 2–4. Normal chaetotaxy of terminal segments as in Figure 4. Genitalia as in Figure 3; penis with circular opening on posterior tip and endomeres with large lateral anterior lobes almost reaching anterior end of each lateral arm.

Female: Differs from male as follows. Tergocentral setae: II–VII range 8–12; VIII range 6–8; normally 10, except 8 on II and VIII. Sternal setae: II–VII range 10–16, normally 10 on II and VII, 12 on V–VI, 14 on III–IV. Normal chaetotaxy of terminal segments as in Figure 5; vulval margin with 30–38 short setae and 4–6 spines.

Measurements in mm: Head width, ♂ 0.42–0.47 ♀ 0.47–0.51; head length, ♂ 0.48–0.54 ♀ 0.53–0.56; pterothorax width, ♂ 0.31–0.36 ♀ 0.35–0.40; abdomen width, ♂ 0.56–0.64 ♀ 0.60–0.70; total length, ♂ 1.36–1.57 ♀ 1.66–1.83. Measurements given by Piaget (1885) for the female fall within the above ranges except for pterothorax width, 0.34. Males were unknown to him.

Material examined: Lectotype ♀, *Tockus fasciatus semifasciatus*, BM 1928-325, Piaget, in BMNH; 1 ♀, USNM skins, Mt. Coffee, Liberia, Africa, Feb.–Mar. 1897, R. P. Currie; 2 ♂ ♂ 2 ♀ ♀, *T. f. fasciatus* (Shaw), Luachimo River, Dundo, Angola, Africa, 4 Apr. 1971, SAIMR; 1 ♀, FMNH skin, Kyetume, Uganda, Africa, 1909, V. G. L. van Someren; 1 ♀, FMNH skin, Mt. Tandon, Mouila, Gabon, Africa, 6 Jun. 1951, H. A. Beatty; 2 ♂ ♂ 2 ♀ ♀, USNM skins, Omboue, Gabon, Africa, 1917, C. R. Aschemeier; 2 ♂ ♂ 2 ♀ ♀, *T. p. pallidirostris* (Finsch and Hartlaub), Cuango River, Cafunfo, Angola, Africa, 12 May 1971, S. A. Peles, SAIMR; 1 ♂ 1 ♀, *T. a. alboterminatus* (Buttikofer), AMNH skins, Kasai River, Luluabourg, Zaire, Africa, 1923–1924, R. Callewaert; 1 ♀, AMNH skins, Golungo Alto, Angola, Africa, Jan. 1904, W. J. Ansorge; 1 ♀, *T. a. geloensis* (Neumann), AMNH skin, Entebbe, Uganda, Africa, R. Grauer; 4 ♂ ♂ 5 ♀ ♀ AMNH skins, Uganda, Africa, 1918–1919, V. G. L. van Someren; 1 ♂, *T. a. suahelicus* (Neumann), AMNH skin, Monkey Bay, Malawi, Africa, 19 Sep. 1895, P. Rendall; 1 ♂, FMNH skins, Sokoke Forest, Kenya, Africa, Jun. 1932, V. G. L. van Someren; 1 ♀, USNM skins, Taveta, Kenya, Africa, Jun.–Aug. 1888; 7 ♀ ♀, *T. alboterminatus australis* (Roberts), Coguno, Mozambique, Africa, 25 Apr. 1964, A. L. Moore, USNM.

Bucerocophorus pachycnemis (Giebel)

Figures 1, 2, 6–8

Docophorus pachycnemis Giebel, 1876: 248.

Type host: *Buceros leucopygus* = *Bycanistes fistulator sharpii* (Elliott).

Paroncophorus pachycnemis (Giebel). Hopkins and Clay, 1952: 266.

Hopkins and Clay stated that the generic position of *pachycnemis* was doubtful. Specimens examined are not congeneric with *Paroncophorus*. Since Giebel's type series does not now exist, a USNM male from the type host is designated hereby as neotype of *B. pachycnemis* and the slide has been so labeled.

Male: About the same size as *B. latifrons*; slightly smaller than *B. watsoni*, n. sp., in head width. Normal chaetotaxy as in Figure 1.

Abdominal tergites II–IV often V divided medially; remainder complete. Tergocentral setae: II–VIII range 8–10, except 6–10 on V. Pleural setae each side: IV–VII dorsally 1; V ventrally 1–2; VI–X ventrally 2–3. Sternal setae: II and VI range 10–14; III–V range 12–20; VII range 8–10; VIII 2. Terminal segments as in Figure 6. Genitalia as in Figure 8; penis with circular opening on posterior tip and endomeres with small lateral anterior lobes reaching about half way to anterior end of each lateral arm.

Female: About the same size as *B. latifrons*; slightly smaller than *B. watsoni* in both head measurements. Normal chaetotaxy as in Figure 2. Differs from male as follows. Tergocentral setae: II–VII range 6–8; VIII range 4–6. Sternal setae: VII range 10–12. Terminal segments as in Figure 7; vulval margin with 30–36 short setae and 4 spines.

Measurements in mm: Head width, ♂ 0.42–0.47 ♀ 0.48–0.54; head length, ♂ 0.49–0.55 ♀ 0.54–0.59; pterothorax width, ♂ 0.34–0.40 ♀ 0.37–0.45; abdomen width, ♂ 0.53–0.72 ♀ 0.58–0.79; total length, ♂ 1.32–1.65 ♀ 1.53–1.93.

Type-material: Neotype ♂, *Bycanistes fistulator sharpii*, USNM skins, Omboue, Gabon, Africa, 1917–1918, C. R. Aschemeier, in USNM; neoparatypes: 5 ♂ ♂ 6 ♀ ♀, same data as neotype; 1 ♂, Ambam, Cameroon, Africa, 1955, J. Mouchet, BMNH; 5 ♂ ♂, FMNH skins, Gabon, Africa, Jan.–Jun. 1951, H. A. Beatty.

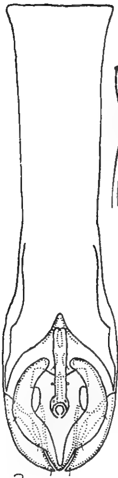
Other specimens: 1 ♂, *B. f. duboisi* (W. Sclater), FMNH skin, Ntotoro, Bwamba, Uganda, Africa, 3 Aug. 1944, V. G. L. van Someren; 1 ♂ 1 ♀, *B. bucinator* (Temminck), Zululand, Natal, South Africa, Nov. 1934, Meinertzhagen 2726, BMNH; 1 ♂ 1 ♀, Amani, Tanzania, Africa, R. E. Moreau, BMNH; 1 ♂, AMNH skin, Natal, South Africa, F. B. Cowles; 2 ♂ ♂ 1 ♀, AMNH skin, Lake Nyasa, Malawi, Africa, 23 Aug. 1895, P. Rendall; 1 ♀, AMNH skin, Hectorspruit, Transvaal, South Africa, 20 Dec. 1901, W. C. Giffard; 1 ♀, AMNH skins, Nsuguru, Tanzania, Africa, 11 May 1929, R. and L. Boulton; 1 ♂, FMNH skin, Zululand, Natal, South Africa, 6 Jan. 1904, C. H. B. Grant; 1 ♂, FMNH skin, Ukamba, Kenya, Africa, 14 Aug. 1918, V. G. L. van Someren; 1 ♂ 3 ♀ ♀, FMNH skin, Ndola, Zambia, Africa, 8 Apr. 1948, E. L. Button.

Bucerocophorus watsoni, new species

Figures 9–11

Type host: *Bycanistes cylindricus albotibialis* (Cabanis and Reichenow).

Male: Slightly larger than *B. pachycnemis* in head width. Abdominal tergites II–IV rarely V divided medially; remainder complete. Tergocentral setae: II range 8–12, normally 10; III–VIII range 10–16, normally 12 on III–VI. Pleural setae each side: IV–VII dorsally 1; VI ventrally 1–2, normally 1; VII–X ventrally 2–4. Sternal setae: II and



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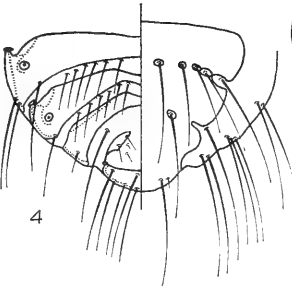

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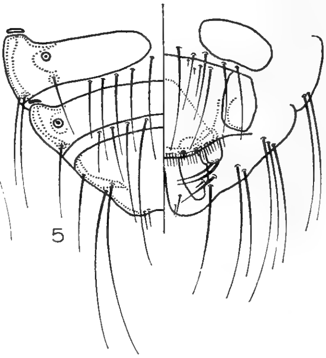

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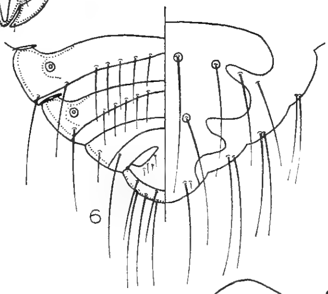

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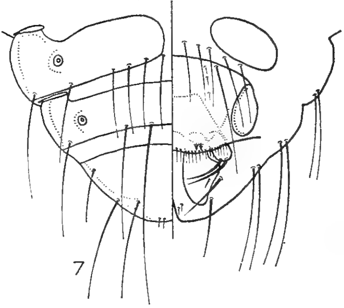

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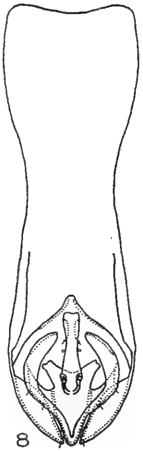

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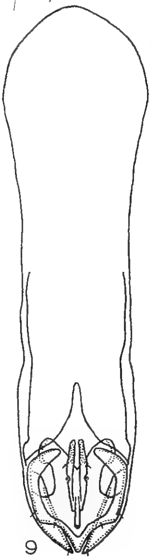

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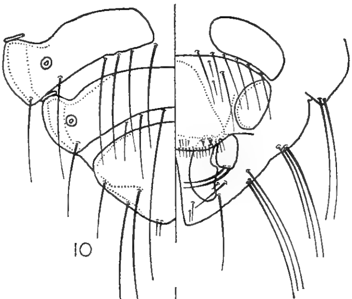

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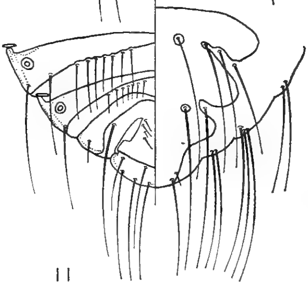

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VI range 12–16, normally 14; III–IV range 18–24, normally 20; V range 16–20, normally 18; VII range 8–12; VIII 4. Normal chaetotaxy of terminal segments as in Figure 11. Genitalia as in Figure 9; penis with rod on posterior tip and endomeres with large lateral anterior lobes reaching ahead of each lateral arm.

Female: Slightly larger than *B. pachycnemis* in both head measurements. Differs from male as follows. Tergocentral setae: II–VI range 8–10, normally 8, except 10 on III; VII range 6–8; VIII range 4–8. Sternal setae: VII range 12–14. Normal chaetotaxy of terminal segments as in Figure 10; vulval margin with 36–48 short setae and 4–6 spines.

Measurements in mm: Head width, ♂ 0.46–0.53 ♀ 0.53–0.59; head length, ♂ 0.52–0.59 ♀ 0.59–0.64; pterothorax width, ♂ 0.35–0.43 ♀ 0.41–0.49; abdomen width, ♂ 0.60–0.75 ♀ 0.62–0.81; total length, ♂ 1.51–1.80 ♀ 1.75–2.11.

Type-material: Holotype ♂, allotype ♀, *Bycanistes cylindricus albotibialis*, Mbalmayo, Cameroon, Africa, J. Mouchet, in BMNH; paratypes: 1♂ 2♀♀, FMNH skins, Uganda, Africa, 1945–1946, V. G. L. van Someren; 2♂♂ 1♀, FMNH skins, Cameroon, Africa, 1948–1952, A. I. Good; 1♂ 1♀, FMNH skin, Fougamou, Gabon, Africa, 11 Aug. 1957, H. A. Beatty; 2♂♂, USNM skin, Cameroon, Africa, 20 Aug. 1910, G. L. Bates; 1♂, USNM skins, Ogooue River, Nkama, Gabon, Africa, 1918, C. R. Aschemeier.

Other specimens: 2♂♂ 1♀, *B. c. cylindricus* (Temminck), AMNH skin, Yonnibanna, Sierra Leone, Africa, 22 Sep. 1912, Kelsall; 1♂ 3♀♀, FMNH skins, Ganta Forest, Liberia, Africa, Feb.–Jun. 1948, H. A. Beatty; 2♀♀, *B. subcylindrus subquadratus* Cabanis, FMNH skins, Cameroon, Africa, 1940–1948, A. I. Good; 8♂♂ 9♀♀, Kampala, Uganda, 5 Oct. 1932, G. H. E. Hopkins, BMNH; 3♂♂ 3♀♀, Uganda, Africa, Apr. 1936, Meinertzhagen, BMNH; 2♂♂ 2♀♀, Cuango River, Cafunfo, Angola, Africa, 3 Jun. 1971, S. A. Peles, SAIMR; 4♀♀, FMNH skins, Kampala, Uganda, Africa, 1918–1933, V. G. L. van Someren; 5♀♀, *B. brevis* Friedmann, Mt. Kilimanjaro, Tanzania, Africa, Meinertzhagen 10862, BMNH; 2♀♀, Awassa, Ethiopia, Africa, 7 Nov. 1960, S. Brelih, PMS; 1♀, USNM skin, Mt. Kilimanjaro, Tanzania, Africa, 17 Sep. 1889; 1♂ 3♀♀, USNM skins, Nairobi, Kenya, Africa, Jun.–Aug. 1909,

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FIGS. 3–11. Male genitalia, ventral views, drawn to same scale: 3, *Bucerocophorus latifrons* (Piaget); 8, *B. pachycnemis* (Giebel); 9, *B. watsoni*, new species. Terminalia, dorsal-ventral views, drawn to same scale: *B. latifrons* (Piaget)—4, male; 5, female. *B. pachycnemis* (Giebel)—6, male; 7, female. *B. watsoni*, new species—10, female; 11, male.

TABLE 1. Distribution of *Bucerocophorus* and *lophocerus* species-group, genus *Chapinia* (Elbel, 1967, 1969a), on African Hornbills (Bucerotidae) arranged according to Sanft (1960).

Host[1]	*Bucerocophorus*	*Chapinia*
Tockus n. nasutus		*C. lophocerus*
T. n. forskalii		
T. n. epirhinus		*C. lophocerus*
T. n. dorsalis		
T. e. erythrorhynchus		*C. lophocerus*
T. e. rufirostris		*C. lophocerus*[2]
T. e. damarensis		
T. deckeni		*C. lophocerus*
T. f. flavirostris		*C. lophocerus*
T. f. somaliensis		
T. f. elegans		
T. f. leucomelas		*C. lophocerus*
T. p. pallidirostris	*B. latifrons*	
T. p. neumanni		
T. c. camurus		*C. camuri*
T. c. pulchrirostris		
T. h. hartlaubi		
T. h. granti		*C. fasciati*[2]
T. f. fasciatus	*B. latifrons*	*C. fasciati*
T. f. semifasciatus	*B. latifrons*	
T. a. alboterminatus	*B. latifrons*	
T. a. geloensis	*B. latifrons*	*C. fasciati*
T. a. suahelicus	*B. latifrons*	*C. fasciati*
T. alboterminatus australis	*B. latifrons*	*C. fasciati*
Ceratogymna elata		*C. robusta*
C. atrata	*B. watsoni*	*C. robusta*
Bycanistes f. fistulator		
B. f. sharpii	*B. pachycnemis*	*C. bucerotis*
B. f. duboisi	*B. pachycnemis*	*C. bucerotis*
B. bucinator	*B. pachycnemis*	*C. bucerotis*
B. c. cylindricus	*B. watsoni*	*C. bucerotis*
B. c. albotibialis	*B. watsoni*	*C. bucerotis*
B. s. subcylindricus		
B. subcylindricus subquadratus	*B. watsoni*	*C. bucerotis*
B. brevis	*B. watsoni*	*C. bucerotis*

[1] Species not included are 5 of *Tockus* and 1 of *Tropicranus* from which no *Bucerocophorus* or *lophocerus* species-group, genus *Chapinia*, were found.

[2] American Museum of Natural History and South African Institute of Medical Research specimens not reported previously.

Loring and Mearns; 2♂♂ 4♀♀, *Ceratogymna atrata* (Temminck), Cameroon, Africa, J. Mouchet, BMNH; 2♂♂ 2♀♀, Luachimo River, Dundo, Angola, Africa, 25 Apr. 1971, S. A. Peles, SAIMR; 2♀♀, FMNH skin, Cameroon, Africa, 11 Jul. 1907; 2♂♂ 1♀, FMNH skins, Gabon, Africa, May–Aug. 1951, H. A. Beatty; 2♂♂ 1♀, USNM skins, Omboue, Gabon, Africa, Jul.–Nov. 1917, C. R. Aschemeier.

Etymology: This species is named for Dr. G. E. Watson, Curator of Birds, USNM, in appreciation for permission to examine skins in that museum and for suggestions on presentation of the aviparasitological relations.

DISCUSSION

Bucerocophorus watsoni is slightly larger than either *B. latifrons* or *B. pachycnemis* in head width of corresponding sexes and in head length of females. Male abdominal tergite VI is often divided medially only in *B. latifrons.* There are normally more tergocentral setae on VIII of *B. latifrons* and *B. watsoni* than corresponding sexes of *B. pachycnemis* (Figs. 4–7, 10–11). Both *B. pachycnemis* (Figs. 1 and 2) and *B. watsoni* have a pleural seta on IV which is often absent in *B. latifrons.* The following pleural setae for segments VII–X are illustrated in Figures 4–7 and 10–11. *B. latifrons* normally has 2 dorsal pleural setae on VI–VII compared to 1 each for *B. pachycnemis* and *B. watsoni.* Ventrally on each side of V–VII *B. latifrons* normally has 2 pleural setae, *B. pachycnemis* has 1 on V, 2 on VI–VII, and *B. watsoni* has 1 on VI, 2 on VII. Both *B. latifrons* and *B. watsoni* have 3 ventral pleural setae each side of VIII but *B. pachycnemis* has 2. *B. watsoni* female normally has 3 ventral pleural setae each side of X but *B. latifrons*, *B. pachycnemis*, and *B. watsoni* male normally have 2. Sternal setae on III–V are more numerous in *B. watsoni* than in corresponding sexes of *B. latifrons. B. pachycnemis* male (Fig. 6) has 2 sternal setae on VIII but males of *B. latifrons* and *B. watsoni* normally have 4 (Figs. 4 and 11). The fused male genital plate has a shallower indentation between VII–VIII and VIII–X in *B. latifrons* (Fig. 4) than in *B. pachycnemis* or *B. watsoni* (Figs. 6 and 11). The male genitalia has the penis ending posteriorly in a rod for *B. watsoni* (Fig. 9) but a circular opening for both *B. latifrons* (Fig. 3) and *B. pachycnemis* (Fig. 8); endomeres have large lateral anterior lobes in *B. latifrons* that almost reach the anterior end of each lateral arm but in *B. pachycnemis* these lobes are small and reach about halfway to the anterior end of each lateral arm; lateral arms in *B. watsoni* do not reach the anterior end of each large lateral lobe. The female vulval margin normally has more setae in *B. watsoni* (Fig. 10) than in *B. latifrons* or *B. pachycnemis* (Figs. 5 and 7).

AVIPARASITOLOGICAL RELATIONS

Species of the ischnoceran genus *Bucerocophorus* infest Hornbill hosts only in the genera *Tockus, Bycanistes,* and *Ceratogymna* of the Ethiopian region. As shown in Table 1, this distribution corresponds with that of the *lophocerus* species-group in the amblyceran genus *Chapinia* (Elbel, 1967). *Bucerocophorus latifrons* and *Chapinia fasciati* are found on the same species of *Tockus* but no *Bucerocophorus* infests species of *Tockus* inhabited by *C. lophocerus* and *C. camuri.* Infestation of *Bycanistes* is by *Chapinia bucerotis* on all species, *Bucerocophorus pachycnemis* on 2 species, and *B. watsoni* on 3 additional species as well as on a species of *Ceratogymna* inhabited by *Chapinia robusta.* The dissimilarity in infestation in the 2 mallophagan genera is expected since Clay (1957) stated that speciation rates in the Amblycera and Ischnocera have been so different that comparisons on the same host group have little value. Elbel (1969b) showed different speciation rates in the ischnoceran genera *Buceronirmus* and *Paroncophorus* than in the amblyceran genus *Chapinia* on 2 species of *Rhyticeros.* The genus *Tockus* is widely separated from *Bycanistes* and *Ceratogymna* in Peters' (1945) phylogenetic arrangement of the Hornbills. Sanft (1960) placed the latter 2 genera near *Tockus* and *Tropicranus albo-cristatus* so his arrangement more nearly agrees with that based on morphological similarities of the Mallophaga. He placed *Ceratogymna* between *Tockus* and *Bycanistes* but mallophagan taxonomy indicates that *Ceratogymna* should follow *Bycanistes* (Peters, 1945). *Bucerocophorus latifrons,* found on *Tockus,* resembles most closely *B. pachycnemis,* found on the first 2 species of *Bycanistes; Bucerocophorus watsoni* infests the last 3 species of *Bycanistes* and *Ceratogymna atrata* (Table 1). One would expect similarities among Mallophaga to parallel those of their hosts since Mallophaga spend their entire lives on the host bird and new hosts are infested by migration of lice from one bird to another during copulation, nesting, or roosting (Kellogg, 1896). Mallophaga become isolated when their hosts become isolated and with time speciation might occur in both host and Mallophaga (Elbel, 1969b). The environment of the Mallophaga, the physical and chemical composition of the feathers and blood, presumably changes slower than do other factors leading toward speciation of the bird; until the feathers and blood change, Mallophaga remain unchanged (Clay, 1949). According to Kellogg (1896) the ancestral bird species spread and gave rise to geographical races which eventually became distinct species, often distinguished only by superficial differences in color, etc. but the Mallophaga remained nearly the same because their environment was essentially the same. In the *lophocerus* species-group, *Chapinia lophocerus* infests 7 hosts in 4 species of *Tockus, C. fasciati* infests 5 hosts in 3 species of *Tockus, C. bucerotis* infests 7 hosts in 5 species of *Bycanistes,* and *C. robusta* infests both species of *Ceratogymna* (Table 1). Similarly, *Bucerocophorus latifrons* infests 7 hosts in 3 species of *Tockus*, *B. pachycnemis* infests 3 hosts in 2 species of *Bycanistes*, and *Bucerocophorus watsoni* infests 5 hosts in 4 species and 2 genera, *Bycanistes* and *Ceratogymna*.

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PROCEEDINGS
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AMMOCRYPTOCHARAX ELEGANS, A NEW GENUS AND SPECIES OF RIFFLE-INHABITING CHARACOID FISH (TELEOSTEI: CHARACIDAE) FROM SOUTH AMERICA

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The new genus and species, *Ammocryptocharax elegans*, described here first came to our attention in 1970 in a small collection of fishes received from the Brazilian-Bolivian border region. Since that time we have acquired additional collections from Brazil, Colombia, and Venezuela. The elongate body and head, and the ventral mouth superficially resemble these features in the sand darters of the North American genus *Ammocrypta* Jordan. This again attests to the remarkably divergent evolutionary radiation of South American characoids (see Weitzman, 1962). *Ammocryptocharax elegans* has been described in life as being bright "grass green" and occurring among water plants in small riffles where it was taken in the Caño Muco, Colombia (J. Thomerson, pers. comm.). It is not known if the fish burrows in sand or dives in among rocks and stones although its slender body shape, ventral mouth, and conic snout would suggest such ability.

The new genus described here belongs to the Characidiinae, a group of primarily South American characoid fishes (one species, *Characidium marshi* Breder, is known from the Tuira basin in Panama) of uncertain family affinities and here tentatively assigned to the Characidae. Géry (1971) recognized the Characidiinae to be of family rank and proposed and described three subfamilies in his Characidiidae, the Characidiinae, Elacocharacinae, and Geisleriinae. In our opinion, his subfamilies Elacocharacinae and Geisleriinae represent specialized lineages within the Characidiinae, and are in part characterized by reductive trends present to a minor degree in the Characidiinae of Géry. We currently are preparing a discussion of the relationships of the genera of the Characidiinae and for the present accept only one taxon at the family-group level, the Characidiinae.

The methods of counting and measuring specimens used below are those described by Fink and Weitzman (1974). Standard length (SL) body measurements are in mm. Other measurements are expressed as percentages of standard length. Specimens have been deposited in the following museums: Academy of Natural Sciences, Philadelphia (ANSP); British Museum (Natural History) (BMNH); California Academy of Sciences, San Francisco (CAS); Field Museum of Natural History, Chicago (FMNH); Florida State Museum, Gainesville (F); Instituto Nacional Pesquisas da Amazonia, Manaus (INPA); Museo de Biologia, Universidad Central de Venezuela, Caracas (MBUCV-V); Museu de Zoologia da Universidade de São Paulo (MZUSP); National Museum of Natural History, United States National Museum (USNM); and the Zoological Museum of Amsterdam (ZMA). Specimens borrowed from Dr. J. Géry were from his private collection.

The abbreviation EPA refers to the Expedição Permanente da Amazonia, a program for collecting Amazonian biota under the direction of Dr. Paulo Vanzolini and financially supported by the Fundação de Amparo à Pesquisa do Estado São Paulo.

Ammocryptocharax, new genus

Type-species: *Ammocryptocharax elegans*, new species.

Diagnosis: This new genus may be distinguished from other genera in the Characidiinae by the following combination of characters. Anterior ventral border of maxillary bones with a single row of up to ten conic or tricuspid teeth; premaxillary with a single row of conic or tricuspid teeth; dentary with an outer row of conic or tricuspid teeth and an inner row of conic teeth, sometimes inner and outer rows may form three irregular rows of small conic teeth where they converge on posterior dentary ramus; ectopterygoid teeth present, sometimes covering entire surface of bone, mesopterygoid teeth present or absent; fewer than 17 dorsal-fin rays; mouth ventral; posterior part of parietal cranial fontanel present, moderately well-developed; anterior two infraorbital bones flattened plates with well-developed sensory canals; remaining infraorbitals represented by bony laterosensory tubes; lateral line complete; adipose fin present.

Discussion: *Ammocryptocharax* appears most closely related to the monotypic *Klausewitzia* Géry (1965b) and like the latter possesses maxillary teeth. *Ammocryptocharax* noticeably differs from *Klausewitzia* in having the mouth ventral (rather than terminal) and in having an elongate body and head. These characters might seem to be of little importance and a fuller realization of why we consider *Ammocryptocharax* a distinct genus requires a comparative discussion of its morphological characters. In the following discussion we attempt to establish the evolutionary relationships of *Klausewitzia* and *Ammocryptocharax*. The significance of characters are evaluated in the terms of phylogenetic systematics in which shared advanced (synapomorphic) characters at a given taxonomic "level" are considered appropriate for determining relationships. See Weitzman and Fink (in press) for a discussion of the problem of advanced vs. primitive characters in characoids.

Eigenmann (1917) in his key used, among several morphological features, character states of the maxillary teeth for separation and definition of characid genera. Some of his dichotomies were based on such character states as the (1) absence of maxillary teeth, (2) possession of a few teeth along the anterior ventral border of the posterior maxillary ramus, or (3) presence of many teeth along the entire or nearly entire ventral border of the posterior ramus. Except for the presence or absence of teeth, the difference between character states two and three is sometimes very subjective. In evaluating the presence or absence of maxillary teeth as a character in the Characidiinae, it should be noted that most characoids have maxillary teeth and their presence is probably plesiomorphic (primitive) for characoids as a whole and for the Characidiinae as well.

Maxillary teeth were unknown in the subfamily Characidiinae until Géry (1965b) described them in a new species, *Klausewitzia ritae*, and based his new genus *Klausewitzia* primarily on its possession of maxillary teeth. Of the nearly 30 species of Characidiinae we have examined, only the new species described below, *Ammocryptocharax elegans* (Figs. 1–4) as well as *Ammocryptocharax vintoni* (Eigenmann) (1912:pl. 38, figs. 1, 2, and 5) (see also Fig. 5) have maxillary teeth.[1] We have not seen *K. ritae* but have no doubt about the presence of these teeth in this species. As discussed below, we propose that *A. vintoni* and *A. elegans* are closely related. Comparison of *A. elegans*, Figures 1 and 2, on the one hand with *K. ritae* in Géry (1965b:pl. 18, fig. 17) on the other, shows very different kinds of *Characidium*-like fishes. *A. elegans* and *A. vintoni* are elongate, slender, and rather circular in cross section with long snouts, ventral mouths, and similar color patterns. *K. ritae* has a much shorter, relatively slab-sided body with a nearly terminal mouth and comparatively short snout. In these characters *K. ritae* is more like *Characidium* Reinhardt.

Géry (1971) was uncertain about the presence or absence of maxillary teeth in another of his new species, *Geisleria junki.* We seriously doubt that his single specimen (unavailable to us) has such teeth because in almost all cases where we have been in doubt about the presence of such teeth, alizarin staining has shown them to be absent. Furthermore we did not find maxillary teeth in two specimens of an apparently closely related undescribed species of *Geisleria* (USNM 215288). We do not consider any of the above three species with maxillary teeth to be closely related to *Geisleria. Geisleria junki* as discussed by Géry (1971) appears to be close in two characters at least (high total dorsal fin-ray count of 16 rays and low number of pored lateral-line scales, eight), to *Elacocharax pulcher* Myers and *Elacocharax georgiae* Géry. The bodies of *G. junki* and the undescribed species of *Geisleria* noted above are, like those of *Elacocharax* species, relatively short, slab sided, with a terminal mouth and short snout. They are not at all like the long, cylindrical body and long head and snout displayed by the two species of *Ammocryptocharax.* Thus in the Characidiinae there appear to be only two genera posi-

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[1] *Characidium vintoni* Eigenmann (1909) was synonymized by Schultz (1944:277) with *Characidium laterale* Eigenmann (1909). Schultz stated that *C. laterale*, the name having priority, was the young of *C. vintoni*, both having similar fin-ray counts and color pattern. We agree with Schultz's determination after examining the types of both nominal forms. We find both to be alike in all observable characters, including possession of maxillary teeth.

As mentioned by Trewavas (1960:361), *Characidium laterale* Eigenmann (1909) is a junior homonym of *Characidium lateralis* Boulenger (1895). According to Article 53 of the International Code of Zoological Nomenclature, any name that is a junior homonym of an available name is to be rejected. Thus *Characidium laterale* Eigenmann must be rejected. According to Article 60 of the International Code of Zoological Nomenclature, if the rejected homonym has one or more available synonyms, the oldest of them must be adopted. Therefore the available name for the species in question is *Characidium vintoni* Eigenmann (1909).

tively bearing maxillary teeth, one with two species and the other with one species If some species of *Geisleria* prove to bear maxillary teeth, this will require a reconsideration of the relationships of *Klausewitzia*, *Ammocryptocharax*, *Elacocharax*, and *Geisleria*.

Since we consider loss of maxillary teeth a reductive apomorphic state in the Characidiinae and since we agree with Hennig (1966) that primitive characters or character states for a given group cannot be used to relate members within that group, we find the presence of maxillary teeth to be of no value in relating the species *K. ritae*, *A. vintoni*, and *A. elegans*. On the other hand, the presence of these teeth in *Klausewitzia* and *Ammocryptocharax* indicates that they are primitive at least in this character in regard to the other known genera of the Characidiinae and therefore may be considered closer in this respect to the common ancestor of the subfamily than the other genera.

In certain other respects, *Ammocryptocharax* and *Klausewitzia* appear to be primitive members of the Characidiinae. For example, as in *Characidium*, both have a complete or nearly complete lateral line and both have ectopterygoid teeth. *A. vintoni* bears mesopterygoid teeth, which among the characoids are otherwise known only in *Hoplerythrinus unitaeniatus* (Spix) (*in* Spix and Agassiz, 1829), an erythrinid, and *Brittanichthys axelrodi* Géry (1965a), a characid. Retention of mesopterygoid teeth should be considered primitive for characoids but the problem is complicated by their presence in *Brittanichthys axelrodi*.[2] Both *Ammocryptocharax* and *Klausewitzia* have a relatively low number of dorsal-fin rays (11). These tend to be

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[2] *Hoplerythrinus unitaeniatus* is a member of a possibly primitive characoid family, Erythrinidae see Weitzman (1964) and Roberts (1969). The possession of mesopterygoid teeth is quite understandable in *Hoplerythrinus* if, as would be expected, the presence of such teeth is a primitive character for characoids as a whole. *Ammocryptocharax vintoni* is a specialized offshoot of a primitive section of the Characidiinae, a specialized subfamily of characoids as yet of uncertain relationship, but here tentatively assigned to the Characidae. *Brittanichthys axelrodi* is a highly specialized small characid fish (about 25 mm in standard length) characterized by highly innovative specializations of the caudal-fin rays and by certain peculiar reductions of the bones and laterosensory system of the head, see Weitzman and Fink (in press). The presenece of mesopterygoid teeth in these three widely divergent characoid genera may be explained by the hypothesis that teeth and bony tooth patches remain a genetic potential for nearly any oral surface in characoids. If this is true, the use of such characters in proposing relationships should be subject to great caution. All other reports of palatine teeth in characoids investigated by us have turned out to be ectopterygoid teeth, including those of *Xenagoniates bondi* Myers (1942).

more numerous in some other genera of the subfamily, for example 9–12 in *Characidium*, 10–14 in *Jobertina,* 17–21 in *Elacocharax,* and 19 in *Geisleria.* Both *Ammocryptocharax* and *Klausewitzia* have an adipose fin which is absent, so far as known, only in *Geisleria* among the genera of the Characidiinae.

Thus *Klausewitzia* and *Ammocryptocharax* have a few of what appear to be primitive characters not retained by other genera in the Characidiinae. On the whole, *Klausewitzia* appears the more primitive of the two, lacking the ventral mouth and elongate body and head found in *Ammocryptocharax.* Each of these genera, although sharing several characters primitive for the Characidiinae, appears to be on its own line of evolution. *Klausewitzia* appears primitive except for its reduced number of pectoral-fin rays, their lack of branching and possibly their relatively long length; see Géry (1965b).

An examination of the branchiostegal rays in the Characidiinae has shown that their usefulness in providing information about the relative state of specialization in member genera and species is questionable. The number of branchiostegal rays has at various times been ascribed a considerable importance in the interpretation of fish evolution; see Hubbs (1920) and McAllister (1968). Characoids have a low number, three to five, and the number is often stable and characteristic of different subfamilies and families, see Weitzman (1962 and 1964). We assumed the same would be true in the Characidiinae, or at least expected that different species having three, four, or five rays would display a constant number. Examination indicates otherwise since we found variation in single population samples of some species and the number sometimes varies between left and right sides of a single specimen.

For example, *A. elegans* usually has three branchiostegal rays while *A. vintoni* has four (one alizarin preparation and 12 paratypes). A survey of the literature and an examination of alizarin preparations of 15 species of the genus *Characidium* indicate that most species have four, or sometimes five, branchiostegal rays. *A. elegans,* so far as has been observed, usually has three, but one specimen (of 5 alizarin preparations) of this species from the Guaporé river had four such rays, an extra anterior ray being attached to the hypohyal on each side. This species usually has two attached to the ceratohyal and one attached between the ceratohyal and epihyal. A ray attached to the hypohyal is normally present in species with five rays [for example, paratypes of *Characidium japuhybensis* Travassos (1949) have four or five rays and paratypes of *Characidium chupa chupa* Schultz (1944) always have five]. Species with four rays have three attached to the ceratohyal and one attached between the ceratohyal and epihyal. We found one specimen of *Characidium bolivianum* Pearson (1924) with four rays on one side, five on the other side. The extra ray was attached to the hypohyal. With this kind of variation present within a species and also with the differeneces noted between what appear to be closely related species, *A. vintoni* and *A. elegans*, we can place little confidence in the stability of this character in Characidiinae.

In summary, *Klausewitzia* and *Ammocryptocharax*, in certain respects at least, appear to be the most primitive genera in the Characidiinae with *Klausewitzia* probably the more primitive of the two. *Klausewitzia* has a modified pectoral fin, its only obvious specialization other than perhaps its relatively small size. *Ammocryptocharax* may be a specialized "offshoot" from a primitive characidiin, having evolved a relatively slender body which is round in cross section, a ventral mouth, and conical protruding snout. Correlated with these differences in morphology are apparent differences in behavior enabling *Ammocryptocharax* to live in riffles and/or cascades; the latter being the only known habitat of *A. vintoni.*

Etymology: The name *Ammocryptocharax* is a combination of the generic names *Ammocrypta*, a genus of North American darters, family Percidae, and *Charax*, a genus of South American characid fishes. The name is established in reference to the superficial resemblance of the two known species of *Ammocryptocharax* to the members of the genus *Ammocrypta.*

Ammocryptocharax elegans, new species

Figures 1–4, Tables 1–2

Holotype: USNM 210692, male, 32.5 mm SL: Colombia, State of Meta, Vichada river basin, Caño Muco about 15 km west of Puerto Gaitán toward Puerto Carreno, J. E. Thomerson, D. C. Hicks, and J. E. Vaques, 2 April 1974.

Paratypes: USNM 214364, 6 specimens (34.5–39.0 mm, SL): same data as holotype; FMNH 80401, 7 (32.0–40.5): same data as holotype.

[*The following specimens are not types*]: ANSP 128336, 2 (37.0–38.5): Colombia, State of Meta, Caño Emma, Finca El Viento, about 33.5 km northeast of Puerto Lopez, J. E. Böhlke, W. Saul, and W. Smith-Vaniz, 18 March 1973; USNM 210691, 36 (28.0–39.8): Brazil-Bolivian border region between Guajara-Mirim and Mato Grosso, Guaporé river drainage, B. von Graeve, 1970; the following series of specimens have the same data as USNM 210691: ANSP 131725, 6 (31.1–35.4); BMNH 1975-7-3.1-6, 6 (31.6–35.5); CAS 33298, 6 (32.1–34.4); FMNH 80402, 6 (31.1–34.8); ZMA 113.747, 6 (29.2–35.7).

FMNH 80419, 3 (27.5–32.5): Venezuela, State of Bolivar, Orinoco River, 13 km south of Puerto Nuevo on road to Puerto Ayacucho, J. E. Thomerson, D. C. Hicks, and D. Taphorn, 1 January 1975; FMNH 80420, 4 (35.0–51.5): Venezuela, Federal Territory of Amazonas, Orinoco River, small stream about 27.6 km north of Puerto Ayacucho, J. E. Thomerson, D. C. Hicks, and D. Taphorn, 13 January 1975; MBUCV-V 7552, 4 (33.5–49.5): same data as preceding specimens;

Fig. 1. *Ammocryptocharax elegans*, new species, USNM 210692, male, 32.5 mm SL, holotype, Colombia, State of Meta, Vichada River basin, Caño Muco about 15 km west of Puerto Gaitán toward Puerto Carreno, April 2, 1974.

deposited at MBUCV-V, 4 (37.1–44.6): Venezuela, Federal Territory of Amazonas, Orinoco River, below a bridge, Guayabal II, just south of Puerto Ayacucho, Agustin Fernández Yépez, 7 May 1969; F 21322, 10 (30.5–42.5): Colombia, State of Meta, Meta River basin, tributary to Yucao River about 4.7 km west of Puerto Gaitán, H. Boshung and party, 5 January 1973; 1 (deposited at INPA, 41.0): Brazil, Amazonas, igarapé Tarumazinho, approx. 45 km north of Manaus, Graciella Cannella and party, 7 January 1976; MZUSP 7443, 17 (28.4–34.1): Brazil, Amazonas, rio Sanabani, Municipio of Silves, Heraldo Britski (EPA), 7 to 8 December 1967; MZUSP 7910, 8 (28.9–37.1): Brazil, Pará, igarapé of rio Jamari near Terra Santa, Heraldo Britski (EPA), 14 December 1967; MZUSP 7912, 4 (17.4–18.8): same data as MZUSP 7910; the following four collections are from the private collections of J. Géry, 2 (45.0–51.0): Brazil, State of Rondonia (Guaporé), Novo River near Porto Velho, R. Geisler, 10 October 1967; 9 (23.5–42.5): Brazil, State of Pará, igarapé de Pereua, 182 km from Manaus on road to Itacoatiara, R. Geisler, 6 August 1967; 5 (24.0–30.0): Brazil, State of Guaporé, Madeira River at Guajara-Mirim, R. Geisler, 20 September 1967; 8 (19.5–50.5): Brazil, State of Pará, Curucumba River, 3 km north of Obidos airstrip (9 km north of Obidos), R. Geisler, 9 December 1967.

Diagnosis: The following combination of characters will distinguish this species from the other known species in the genus *Ammocryptocharax*. All teeth conical, 2 rows on dentary, never 3 rows near posterior termination of both dentary tooth rows. Pectoral-fin rays ii,5,i to ii,7,i, usually ii,6,i. Snout longer than horizontal diameter of eye. Usually 3 branchiostegal rays present. Supraneurals absent and mouth totally inferior.

In the description below, when counts vary, the first number given is for holotype unless otherwise designated. Figures in parentheses are for paratypes only (from Caño Muco) unless otherwise designated. When a number is spelled out, it refers to the number of specimens bearing the given counts.

Description: See Table 1 for a summary of morphometrics and meristics. Body elongate, sides moderately compressed, greatest depth at anterior dorsal-fin origin. Predorsal body profile nearly straight to head, gently convex to acute snout. Body profile along base of dorsal fin slightly convex. Body profile posterior to termination of base of dorsal fin nearly straight. Posterior to adipose fin body profile slightly concave. Ventral body profile very gently convex from tip of lower jaw to posterior termination of anal-fin base. Remaining ventral body profile slightly concave to ventral base of caudal fin. Head elongate, snout acutely conic, tip of snout overhangs anterior edge of lower jaw, mouth totally ventral. Posterior extreme of maxillary extends to a point ventral to anterior border of posterior nostril, not reaching eye. With mouth closed, maxillary bone nearly parallel with profile

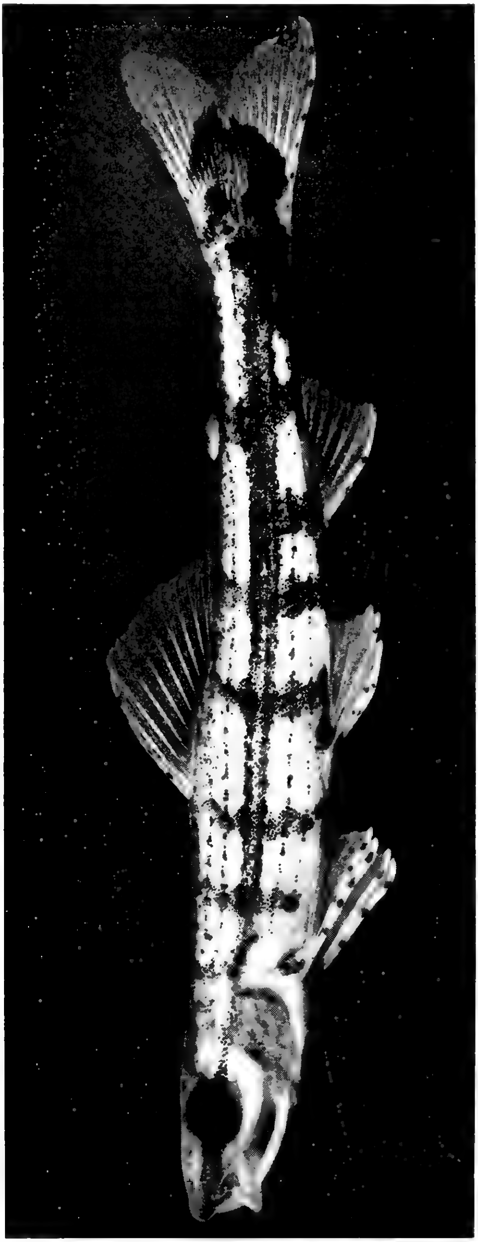

FIG. 2. *Ammocryptocharax elegans*, new species, USNM 210691, 32.3 mm SL Brazil-Bolivian border region between Guajaro-Mirim and Mato Grosso, Guaporé River drainage, 1970.

of head just ventral to maxillary. Eyes small in proportion to standard length (see Table 1).

Teeth simple, conic (all counts of teeth and gill arch structures from alizarin preparations; two specimens [paratypes] from Caño Muco given first, followed in brackets by five specimens [not paratypes] from Guaporé River). Rows of teeth on dentary 2, anterior (outer) row with 14 and 17 [12–15, usually 13] teeth, inner row with 18 and 21 [15–19, usually 17] teeth; premaxillary with 1 row of 11 [9–10, usually 10] teeth; maxillary with 1 row of 5 [4–7, usually 5] teeth; ectopterygoid with 1 row of 16 and 19 [4–22, highly variable, usually between 11 and 22 in specimens 35.4–38.7 mm SL, fewer, 4–6, in slightly smaller specimen, 34.2 mm SL]. Branchiostegal rays 3, ceratohyal with 2 of these rays, and 1 between ceratohyal and epihyal (for significance of variability of this count see discussion above); gill rakers short except for raker at angle of arch, 3 [2–3, usually 3 in Guaporé River specimens] on upper limb; 8 gill rakers, 2 without bony supports [6–7, usually 6 in Guaporé River specimens], on lower limb of first arch. Frontal-parietal fontanel absent between frontal bones; small and confined to junction with supraoccipital between parietal bones. First (anterior) circumorbital bone well ossified, antorbital and supraorbital well ossified and with laterosensory tubes in larger specimens, poorly ossified except for tubes in smaller specimens examined.

Scales cycloid with 5–10 radii on exposed field; lateral line complete, with a single unbranched tube on each scale; 41 (39–41) lateral-line scales; 4 scale rows above lateral line to dorsal-fin origin; 3 scale rows below lateral line to pelvic-fin origin in all specimens; 12 scale rows around caudal peduncle in all specimens; 11 (10–12, usually 11) predorsal scales; area on belly anterior to pectoral-fin base completely covered with scales in all specimens.

Dorsal-fin rays ii,9 (ii,9 but ii,10 in one specimen); dorsal-fin origin anterior to pelvic-fin origin and closer to tip of snout than to caudal-fin base; third dorsal-fin ray longest; distal fin margin slightly convex. Adipose fin present.

Anal-fin rays ii,7 (ii,7 but iii,5,i in one specimen); second ray longest; distal fin margin slightly concave.

Pectoral fin inserted low on body but not flattened at base to provide a flat surface to substrate as in some species of *Characidium*; pectoral-fin rays ii,6,i (ii,6,i in one, ii,7 in one, ii,8 in nine, and ii,8,i in one specimen). Posterior tip of longest ray not reaching pelvic fin.

Pelvic-fin rays ii,5,ii (ii,5,i in seven, ii,5,ii in two, ii,6,i in four specimens); pelvic fin large, but when adpressed to body, distalmost ray tip not reaching anus.

Caudal fin forked, with 17 branched rays in all specimens, principal ray count 10/9.

TABLE 1. Morphometrics of *Ammocryptocharax elegans* from the Río Orinoco basin.

		Río Muco, Colombia specimens		Caño Emma, Colombia specimens		Puerto Nuevo, Venezuela specimens		Puerto Ayacucho, Venezuela specimens		Rio Yucao, Colombia specimens	
	Holotype	Range (n = 14)	x̄	Range (n = 2)	x̄	Range (n = 3)	x̄	Range (n = 8)	x̄	Range (n = 10)	x̄
Standard length	38.5	32.0–40.5	36.8	37.0–38.5	37.5	27.5–32.5	29.7	35.0–51.5	41.1	30.5–42.5	36.9
Greatest depth	12.7	11.8–13.9	12.9	14.8–14.9	14.8	12.9–13.8	13.5	12.9–15.2	14.0	12.5–15.5	14.3
Snout to dorsal-fin origin	39.7	39.3–43.2	41.0	41.6–41.8	41.7	42.2–43.3	42.7	39.6–42.9	41.1	40.5–44.3	42.5
Snout to pelvic-fin origin	45.5	43.2–47.1	45.7	45.7–48.1	46.9	46.2–46.9	46.6	43.9–47.9	45.9	43.6–48.5	46.4
Snout to anal-fin origin	70.1	67.5–71.2	69.8	71.4–72.4	71.9	67.6–70.8	69.3	66.6–70.8	68.8	65.5–71.8	69.3
Caudal peduncle depth	7.3	6.8–7.9	7.4	7.5–7.6	7.6	6.9–7.6	7.2	7.3–8.2	7.8	6.5–7.8	7.3
Caudal peduncle length	22.1	21.8–23.6	22.7	20.8–21.8	21.3	22.2–23.1	22.5	20.6–23.2	21.6	20.5–23.2	21.7
Pectoral-fin length	14.8	14.6–17.8	16.3	14.3–16.5	15.6	16.0–18.3	17.2	12.6–16.9	15.3	14.0–17.1	15.8
Pelvic-fin length	13.5	13.0–16.4	14.7	14.0–15.1	14.6	14.5–14.8	14.6	12.8–15.2	14.2	13.8–16.1	15.0
Head length	23.1	23.1–25.6	23.9	23.4–24.3	23.9	24.9–26.9	25.9	23.0–25.9	24.6	23.9–25.8	24.8
Eye diameter	5.9	5.0–6.1	5.3	5.2–5.4	5.3	5.5–6.2	6.0	4.4–5.7	5.2	4.9–5.9	5.4

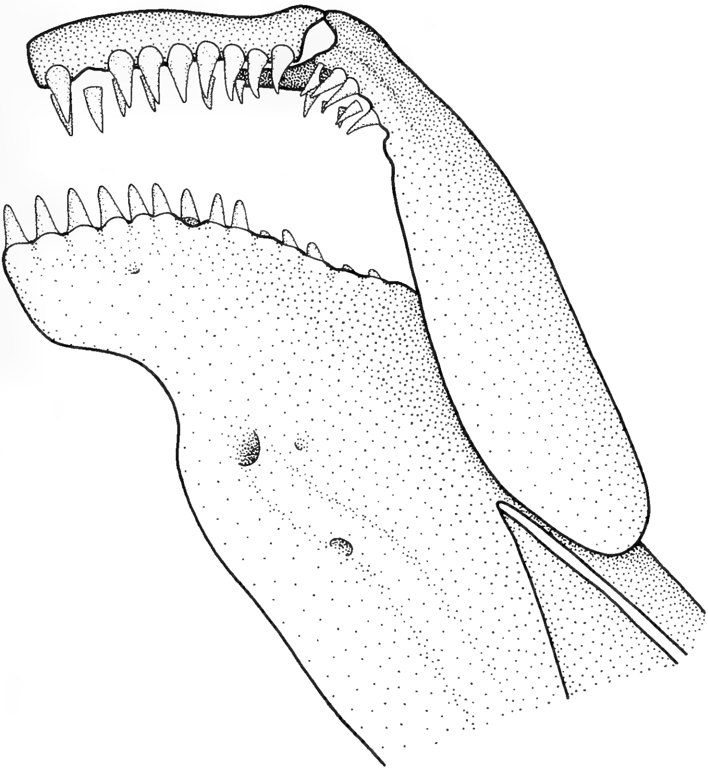

FIG. 3. *Ammocryptocharax elegans*, new species, USNM 214364, 38.5 mm SL, paratype, Colombia, State of Meta, Vichada River basin, Caño Muco about 15 km west of Puerto Gaitán toward Puerto Carreno, April 2, 1974. Ventral and slightly lateral view of premaxillary and maxillary (placed anteriorly towards top) and dentary bones. This illustration shows anterior placement of premaxillary bone in relation to dentary. Note replacement teeth in premaxillary dorsal (behind) outer row teeth. Second outer row tooth from left (medial end of premaxillary) has been shed and is being replaced by inner replacement tooth.

Total vertebrae including Weberian apparatus and posterior terminal half-centrum 38 (37, one; 38, nine; 39, two). First and second hypurals not fused, supraneurals absent. One postcleithrum on each side; cleithra anteriorly articulate with each other in a specialized nonmovable joint; anterior three-fourths of coracoid bone closely applied to same bone on contralateral side.

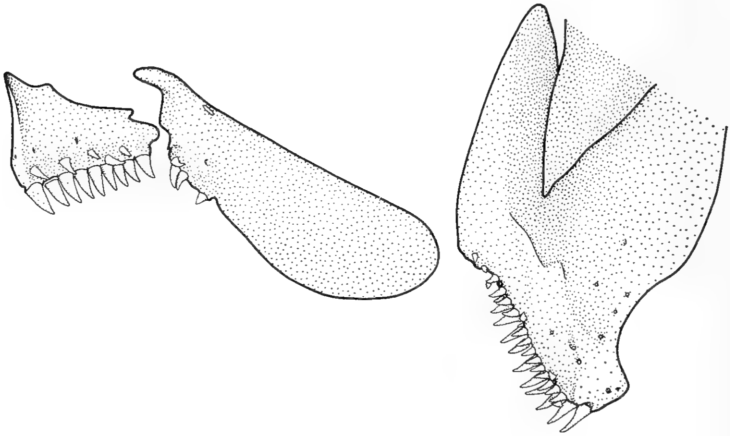

FIG. 4. *Ammocryptocharax elegans*, new species, USNM 210691, 34.8 mm SL, Brazil-Bolivian border region between Guajaro-Mirim and Mato Grosso, Guaporé River drainage, 1970. Internal view of premaxillary, maxillary, and dentary bones of right side, showing jaws in an extended position. Note there are only five replacement teeth present on premaxillary and one on maxillary. Only two small replacement teeth for the inner row of the dentary show in this jaw.

Color in alcohol: Body color pale yellowish brown, with a dark lateral stripe from tip of snout, across opercular region, along middle of body where it broadens and continues to caudal-fin base and the caudal fin. Stripe appears more faded in specimens from Guaporé River. Anterior end of stripe expanded over snout and onto maxillary and premaxillary areas, stripe darkest on maxillary, premaxillary, and area of nasal organs. Stripe becomes widest towards caudal-fin base, where it expands to form a dark blotch on caudal fin, reaching to posterior end of middle caudal-fin rays. Usually center of large dark blotch on proximal part of caudal fin pale or hyaline, especially in Guaporé River specimens. Below and dorsal to broad dark mid-lateral stripe occur 3 narrow horizontal, often interrupted, dark stripes; dorsalmost of these stripes extends from posterior end of head to an area ventral to mid-basal length of dorsal fin, or to posterior end of dorsal-fin base. Second of these dark stripes continues from posterior head termination beyond dorsal fin to intersect an imaginary vertical line above anterior anal-fin origin or extends to an area just posterior to adipose fin. Most ventral of 3 narrow dark stripes continues from posterior to eye to caudal-fin base. A narrow dorsal median stripe extends along back from nape to anterior dorsal-fin origin. This dorsal median stripe continues between dorsal-fin and adipose-fin bases and between adipose-fin and caudal-fin bases. Two and sometimes 3 narrow, often interrupted, horizontal dark stripes on sides below broad dark mid-lateral stripe; dorsalmost of these extends from just posterior to posterior termination of opercle to a vertical just dorsal to mid-length of anal-fin base or a vertical just posterior to posterior termination of anal-fin base. Middle of these 3 dark stripes interrupted, but extends from near posterior opercular termination to beyond anal fin where it continues as a series of spots to caudal-fin base. In Caño Muco specimens a third narrow dark stripe extends posteriorly from pectoral-fin base to pelvic-fin base. This third ventral dark stripe missing in specimens from Guaporé River.

About 8 more or less dark vertical bars on body; first begins at nape and ends ventrally at large dark mid-lateral stripe; large spot at pectoral-fin base may in life be continuous with ventral termination of first bar; next 2 dark bars occur between posterior border of gill cover and dorsal-fin origin, these extend a variable distance ventral to large lateral stripe; fourth and fifth vertical dark bars of variable occurrence, placed ventral to dorsal fin and may extend ventrally and then to meet similar bars on contralateral side [*i.e.*, completely around body (specimens from Guaporé River)]; sixth vertical dark bar begins at anal-fin origin and extends dorsally, ending at large mid-lateral stripe in Guaporé River specimens, extending onto back in specimens from Caño Muco; seventh vertical dark bar occurs between adipose fin and posterior end of anal-fin rays or anal-fin base; eighth dark bar broad, occurring just ventral to lateral stripe and anterior to caudal-fin base, being continuous with ventral part of caudal-fin blotch and itself more in nature of a blotch.

Vertical fins mostly hyaline except for dark color on caudal fin described above; 2 or 3 dark spots on anterior first and second rays of dorsal and anal fin, sometimes 4 on dorsal fin; distal half of caudal-fin lobes hyaline; dorsalmost and ventralmost principal caudal-fin rays with about 4 to 6 dark spots more or less evenly spaced along course of rays; adipose fin with a dark spot or stripe along dorsal border, sometimes with a dark spot on center part of fin.

Axillary base of pectoral fin with a dark blotch; anterior rays of this fin with 2 to 4 (usually 3) dark spots, remainder of pectoral fin hyaline. Pelvic fins with 2 dark spots on anterior fin ray and 1 dark spot on distal portion of second fin ray.

Iris of eye black; cheek, lower jaw, area of branchiostegal rays, and belly, pale brown or white.

Color in life: We recently received ten specimens of *A. elegans* from a tributary of the Yucao River, approximately 4.7 km west of Puerto Gaitán, Meta River system, Colombia, collected in January of 1973 and sent to us by Donald Taphorn, Department of Natural Sciences, University of Florida. At the time of capture some of these specimens were photographed in color. These photographs show a fish with the general dark pigment as described above, with the back

TABLE 2. Morphometrics of specimens from the Rio Amazonas basin.

	Rio Guaporé		Puerto Velho		Igarapé de Pereua		Guajaro-Mirim		Obidos	
	Range (n = 25)	$\bar{x}$	Range (n = 2)	$\bar{x}$	Range (n = 9)	$\bar{x}$	Range (n = 5)	$\bar{x}$	Range (n = 8)	$\bar{x}$
Standard length	28.5–39.8	34.3	45.0–51.0	48.0	23.5–42.5	27.7	24.0–30.0	26.8	19.5–50.5	38.1
Greatest depth	13.0–16.1	14.7	12.9–14.9	13.9	14.1–17.3	15.3	14.2–15.0	14.5	13.9–15.9	14.9
Snout to dorsal-fin origin	38.6–43.5	41.6	38.2–40.4	39.3	39.52–42.55	41.53	43.0–45.4	44.3	38.8–46.7	41.9
Snout to pelvic-fin origin	47.1–50.0	48.3	45.3–48.0	46.6	46.0–49.2	47.8	48.7–51.3	49.4	44.5–50.8	46.3
Snout to anal-fin origin	69.7–74.4	72.0	70.6–72.4	71.5	67.9–71.4	69.1	70.3–72.7	71.6	65.9–75.4	69.5
Caudal peduncle depth	7.0–8.7	7.8	7.3–7.8	7.5	7.1–8.5	8.0	7.3–8.3	7.7	7.2–8.4	8.0
Caudal peduncle length	19.1–22.1	20.7	21.6–21.6	21.6	20.7–23.5	21.9	20.0–21.0	20.6	17.9–25.2	22.3
Pectoral-fin length	15.7–18.6	17.2	13.9–15.3	14.6	14.1–21.3	19.2	18.0–20.4	19.6	12.5–27.2	17.4
Pelvic-fin length	14.9–16.8	15.5	13.5–14.6	14.05	13.6–17.0	15.6	16.0–17.1	16.5	13.5–19.0	16.0
Head length	23.4–26.4	25.3	21.8–23.1	22.5	23.8–27.5	25.8	26.3–28.8	27.7	22.6–28.2	24.8
Eye diameter	4.8–6.1	5.5	4.1–4.7	4.4	4.7–9.3	6.4	6.3–7.3	6.7	4.1–8.2	5.5

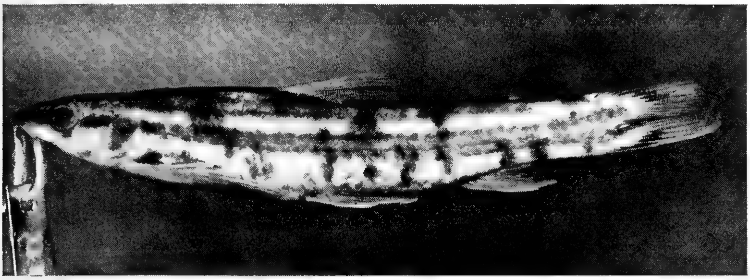

FIG. 5. *Ammocryptocharax vintoni* (Eigenmann), SU 21779, 55.0 mm SL, Guyana, Shrimp Creek, below Kaieteur Falls, Potaro River, Essequibo River basin, October 30, 1908.

above the elongate dark stripe a translucent brown color and the stripe itself as well as the sides below a green or bluish green. Jamie Thomerson and Graciella Cannella (pers. comm.) have seen the green bright "grassy" color in live specimens. In the photographs available, the green color appears to make the elongate dark stripe very dark green while the area ventral to it is a rather pale green or bluish green.

Variation: We have small samples from a wide range of localities in at least three countries, from the Orinoco drainage in Venezuela to the Guaporé River along the Brazilian and Bolivian border region and along the main course of the Amazon River into the State of Pará. Tables 1 and 2 show a few differences in morphometric character states in specimens from some of the different localities; however, the geographical distribution of our samples is very incomplete and, therefore, useful comparison of samples from adjacent drainage basins cannot be made. Some geographic variation in color pattern has been noted in the color description above.

Relationships: *A. elegans* is most closely related to *A. vintoni*. Both species are long, with slender, cylindrical body and a ventral mouth [compare Figs. 1 and 2 with Fig. 5 and with plate 38, figs. 1 and 2 in Eigenmann (1912)]. No other known species in the Characidiinae approaches these 2 in body shape and head shape. Both species have a similar color pattern with a well-developed mid-longitudinal stripe. The above characteristics are probably specialized for the Characidiinae and therefore are useful in relating these 2 species. The ventral mouth and elongate body may be adaptations shared by these 2 species for swift shallow water such as rocky riffles.

There is little information concerning the habitats of *A. elegans* and especially *A. vintoni*. *A. vintoni* was taken by Eigenmann from Shrimp Creek, a precipitous forest stream below Kaieteur Falls, Guyana, Eigenmann (1912:53, fig. 21). *A. elegans* was taken from "plant infested riffles" of the Caño Muco by Thomerson and party. Böhlke and party

TABLE 3. Morphometrics of *Ammocryptocharax vintoni.*

	Shrimp Creek, Guyana		Amatuk, Guyana
	Range (n = 13)	x̄	(n = 1)
Standard length	42.5–65.5	54.4	26.0
Greatest depth	16.6–19.5	18.0	17.3
Snout to dorsal-fin origin	43.5–47.2	45.4	46.2
Snout to pelvic-fin origin	50.0–54.2	52.3	50.7
Snout to anal-fin origin	75.4–78.5	76.3	74.0
Caudal peduncle depth	9.7–10.7	10.1	—
Caudal peduncle length	17.0–21.2	18.8	19.2
Pectoral-fin length	25.8–29.6	28.1	26.9
Pelvic-fin length	18.9–21.3	20.5	—
Head length	25.0–27.6	25.9	29.6
Eye diameter	5.4–6.5	5.9	7.3

took the fish in the Caño Emma, a stream with "strong to moderate" current, and water that was "clear to tea colored." It had a pebble and sand to mud substrate with algae and occasionally grass-like plants in water of a depth of up to about ½ m. There is no information available on the habitat of *A. elegans* from the Guaporé River or other localities listed above except for the igarapé Tarumazinho 45 km north of Manaus, Amazonas, where Graciella Cannella reported that the 1 specimen was taken in aquatic vegetation.

Apparently the habitats of these 2 species have not been much sampled in the past. *A. vintoni* has been taken only twice and from adjacent localities, while *A. elegans,* although widely distributed, has been collected only within the last few years. Neither of these fishes has been extensively observed in its natural habitat. Probably *A. elegans* is common in appropriate habitat all along the tropical eastern base of the Andes mountain range and along the Amazon river itself.

Although apparently closely related, *A. elegans* and *A. vintoni* differ in several easily discernable characters. Both species have basically similar color patterns but with some minor differences. The 2 dark narrow stripes dorsal to the large midside dark stripe appear narrow in *A. elegans* and broad in *A. vintoni,* at least in preserved specimens. *A. elegans* has 2 narrow longitudinal dark stripes on each side, ventral to the broad longitudinal stripe; these appear absent in *A. vintoni. A. elegans* has the leading rays of the fins with small but prominent black spots; these are completely lacking in *A. vintoni.*

Even more striking than the color pattern differences in these species is the difference in pectoral-fin morphology. Many species of *Characidium* have the anterior 2 or 3 pectoral-fin rays thickened. This is associated with the fact that many of the fishes in the Characidiinae spend part of their time sitting on the substrate supported by these fins (as well as the thickened ventral fin rays of the pelvic, anal, and caudal fins). *A. elegans* has the anterior 2 rays of the pectoral fin thickened, unbranched, and of about equal length. *A. vintoni* has the anterior 4 fin rays somewhat thickened and unbranched but they are not all of equal length. The anterior ray is shortest, about half the length of the fourth, while the second and third rays are of intermediate length, the third being longer than the second. Most species of the Characidiinae have three unbranched anterior pectoral-fin rays of graded length (the shorter rays occurring anteriorly). A few have four unbranched rays (for example *A. vintoni* and *Jobertina eleotrioides* Géry). Only *A. elegans* has 2 thickened rays and these are of about equal length; in this respect *A. elegans* appears specialized, differing from all known species of the Characidiinae. *A. elegans* has a total of 8 to 10, usually 9 pectoral-fin rays while *A. vintoni* has 12–13, usually 13. The relative length of the pectoral (and pelvic) fins is different in the 2 species, the fins being longer in *A. vintoni* than in *A. elegans* (compare in Tables 1–3).

There are other differences in the two species. All specimens of *A. elegans* have 12 scale rows around the caudal peduncle while 16 specimens of *A. vintoni* have 14. In adults, *A. vintoni* usually has about 19 to 20 tricuspid to conic teeth in the posterior (inner) dentary row, whereas *A. elegans* has 12 to 17 (usually 15) conic teeth in the anterior (outer) row and 15 to 21 (usually 17) conic teeth in the posterior (inner) row. There are 4 to 7 conic maxillary teeth in *A. elegans* and 8 to 10 tricuspid maxillary teeth in *A. vintoni*. *A. elegans* has 9 to 11 conic premaxillary teeth and *A. vintoni* has 13 to 15 tricuspid premaxillary teeth. The ectopterygoid of *A. vintoni* has 24 conic teeth in each of 2 rows along its length and a third greatly interrupted row of 8 to 10 conic teeth. In *A. elegans* the conic ectopterygoid teeth are highly variable with 4 to 22 in a single row. The mesopterygoid of *A. vintoni* anteriorly bears a patch of about 30 small conic teeth. These teeth are completely absent in *A. elegans*. Comparison of proportional measurements in percentages of standard length also shows important differences in the 2 species (see Tables 1–3, note especially the differences in the greatest body depth and caudal peduncle depth).

A. elegans often appears to have one more vertebra than *A. vintoni*. Twenty-one specimens of *A. elegans* had counts as follows: 37 (seven); 38 (eleven); 39 (four). *A. vintoni* had: 37 (thirteen) and 38 (one). The Weberian apparatus and the terminal half-centrum are included in these counts.

A. vintoni appears more primitive than *A. elegans* in having a larger number of teeth on all tooth-bearing bones as well as retaining mesopterygoid teeth. Furthermore, the mouth of *A. vintoni* is not as ventral as that of *A. elegans* and its body is not as elongate and slender.

Supraneurals are absent in *A. elegans,* while a few are present in *A. vintoni,* a more primitive situation. On the other hand, *A. vintoni* does have more elongate pectoral and pelvic fins, presumably a more advanced feature.

Etymology of species name: From the Latin word *elegans,* meaning special, choice, fine, select.

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RESUMEN

En varias colecciones de peces efectuadas en localidades de poca altitud relativa en la Cordillera de Los Andes, desde Bolivia hasta Colombia y Venezuela, y a lo largo del río Amazonas hasta Obidos, Pará, Brasil, se encontró una nueva especie de pez Characoidei, Characidiinae, que se designa aquí con el nombre de *Ammocryptocharax elegans.* Esta nueva especie tiene el cuerpo alargado, boca ventral y hocico cónico, presentando una apariencia similar a los "sand darters" de la América del Norte del género *Ammocrypta* Jordan. La neuva especie, que se sabe vive entre la vegetación de pequeños cursos de corriente rápida, está estrechamente relacionada con *Characidium vintoni* Eigenmann (1909) que se conoce sólo de los saltos en ríos pequeños por debajo de Kaiteur Falls, Guyana.

La nueva especie y *C. vintoni* se colocan en un nuevo género, *Ammocryptocharax,* el cual podría estar vinculado con *Klausewitzia* Géry (1965b). Este nuevo género se separa de los restantes conocidos entre los Characidiinae por la posesión de los caracteres siguientes: hueso maxilar con una fila única de dientes cónicos o tricúspides, que no exceden 10 en número, a lo largo de su borde anterior ventral;

dientes ectopterigoideos presentes; boca ventral; menos de 17 radios dorsales.

A. elegans y *A. vintoni* pueden distinguirse porque la primera especie presenta todos los dientes cónicos, mientras que la segunda tiene dientes tricúspides en los huesos premaxilar, maxilar y dentario. *A. vintoni* tiene dientes cónicos pequeños en el mesopterigoideo los cuales están ausentes en *A. elegans*. Los primeros dos radios pectorales anteriores de *A. elegans* son gruesos, no ramificados y más o menos del mismo largo. *A. vintoni* tiene los cuatro primeros radios pectorales anteriores algo engrosados y no ramificados, pero no son del mismo largo. El radio más anterior es el más corto, alrededor de la mitad del largo del cuarto, mientras que los otros dos radios restantes tienen una longitud intermedia.

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PROCEEDINGS
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REDESCRIPTION OF *EURYPYLUS PETROSUS* BRADY, 1869, AND A KEY TO THE GENERA OF SARSIELLIDAE (MYODOCOPINA: OSTRACODA)

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A single specimen collected from near the Cape Verde Islands was referred by G. S. Brady (1869:141) to a new genus *Eurypylus*, as *E. petrosus*. Because of having only one specimen and not wanting to risk its destruction by opening the shell, Brady did not illustrate the appendages, but only the shell. Later, Brady (1897:94) dissected the specimen and illustrated the mandible and caudal furca, stating, "I thought it well to sacrifice the shell for the sake of examining the contained animal, of which, unfortunately, I succeeded in obtaining fragments only."

Müller (1912:42) and Poulsen (1965:44) referred the species to the genus *Sarsiella* in the belief that the specimen described by Brady was a juvenile. As part of an effort, initiated by a Committee on Recent Ostracoda established at a symposium held in Naples, Italy, in 1963, to redescribe type-species of poorly known genera, we obtained the holotype of *E. petrosus* from the Hancock Museum and redescribe the available appendages herein.

We conclude that *Eurpyplus* is a valid genus and assign to it, in addition to *E. petrosus, Muelleriella setifera* Poulsen (1965:62) as *Eurypylus setifer* (Poulsen), and *Eusarsiella concentricostata* Hartmann (1974) as *Eurypylus concentricostatus* (Hartmann).

For completeness, the following key to the genera of Sarsiellidae includes a deliberate *nominum nudum*: *Junctichela* (Kornicker, in prep.).

KEY TO GENERA OF SARSIELLIDAE, FOR FEMALES

1.	Furca with only claw 1 united to lamella	2
	Furca with claws 1 and 2 united to lamella	5
	Furca with claws 1, 2, and 4 united to lamella	7
	Furca with claws 1, 2, and 3 united to lamella	*Junctichela*[a]
2.	Furca with 5 claws	3
	Furca with more than 5 claws	4
3.	First antenna with d-bristle on 8th joint	*Sarsiella*
	First antenna without d-bristle on 8th joint	*Adelta*
4.	Claw 3 longer and stouter than claw 4	*Parasarsiella*
	Claw 3 shorter and more slender than claw 4	*Spinacopia*, *Cymbicopia* (part)[b]
5.	First antenna with clawlike c-, f-, and g-bristles	*Anscottiella*
	First antenna with normal c-, f-, and g-bristles	6
6.	Endopodite of 2nd antenna with long ventral bristle	*Cymbicopia*
	Endopodite of 2nd antenna without long ventral bristle	*Eurypylus*
7.	First antenna with clawlike f- and g-bristles	*Ancohenia*[c]
	First antenna with normal f- and g-bristles	*Chelicopia*

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[a] *Junctichela,* a new genus in manuscript of senior author, includes *Sarsiella similis* Scott, 1905, *Sarsiella gracilis* Scott, 1905, as well as a new species.

[b] Furca of juveniles and adult males of *Cymbicopia,* but not *Spinacopia,* with claws 1 and 2 united to lamella.

[c] *Ancohenia* (Kornicker, 1976) is monotypic.

Eurypylus Brady, 1869

Type-Species: *Eurypylus petrosus* Brady, 1869.

Diagnosis of Genus: Carapace of female oval in lateral view, without incisur or rostrum but with small caudal process; surface punctate.

First antenna: Seventh and 8th joints without clawlike bristles.

Second antenna: Endopodite consisting of single joint with 1 or 2 small anterior bristles and either without ventral bristle or with 1 small ventral bristle.

Mandible: Without exopodite.

Furca: Claws 1 and 2 united to lamella and with blunt or pointed tips; remaining claws small, secondary, separated from lamella by suture, and with pointed tips.

Lateral eyes: Present on the 2 known species.

Eurypylus petrosus Brady, 1869
Figure 1

Eurypylus petrosus Brady, 1869:141, pl. 18: figs. 1, 2; 1897:94, pl. 16: figs. 25, 26.

Sarsiella petrosus (Brady).—Müller, 1912:42.—Poulsen, 1965:44.

Holotype: Unique specimen, number B75, Brady Collection, Hancock Museum, Newcastle-on-Tyne, Scotland.

Type-locality: Brady (1897:94) states that the specimen was collected off St. Vincent (Cape Verd); presumably this refers to São Vicenti, one of the Cape Verde Islands.

Material: A glass slide from the Hancock Museum containing labels with the following information: "*Eurypylus petrosus* Brady, type, St. Vincent, Cap. Verde, B75." This slide contains some appendages of the holotype: right 1st antenna, right 2nd antenna, both mandibles, one maxilla, proximal remnant of one 7th limb, both lamellae of furca, and one lateral eye. The whereabouts of the remaining limbs is unknown.

Description: The whereabouts of the carapace, if extant, is not known; therefore, Brady's original description (1869:141) translated by the junior author is given below and a tracing of his illustration is shown in Figure 1j, k.

> "Shell rounded in lateral view, greatest height three-fourths of the length at about the middle, posterior extremely rounded, upper margin slightly more convex than the lower; clavate in dorsal view, greatest breadth half the length at a little towards the anterior end, with the sides converging towards the rear, anterior rounded and weakly mucronate medially, posterior obtusely acuminate. Surface of the valves ornamented with coarse pits. Length 0.0008."

First antenna (Figure 1a): 2nd joint with 1 dorsal bristle; 3rd and 4th joints fused; each joint with 2 bristles, 1 ventral, 1 dorsal; 5th joint with long sensory bristle; 6th joint with short medial bristle. Seventh joint: a-bristle longer than bristle of 6th joint; b-bristle faint, about twice length of a-bristle; c-bristle about same length as sensory bristle of 5th joint. Eighth joint: d- and e-bristles long, bare, with blunt tips; f- and g-bristles long, slightly shorter than c-bristle. (Filaments not observed on bristles, but this could be due to condition of appendage.)

Second antenna: Protopodite bare; exopodite with 9 joints; joints 2–8 with natatory bristles; 9th joint with 2 bristles, 1 long, 1 short. Endopodite (Figure 1b) 1-jointed with 1 short, proximal, anterior bristle; ventral margin with small node.

Mandible (Figure 1c): Neither endite nor ventral spines or hairs observed on coxale, but this could be because of condition of limb.

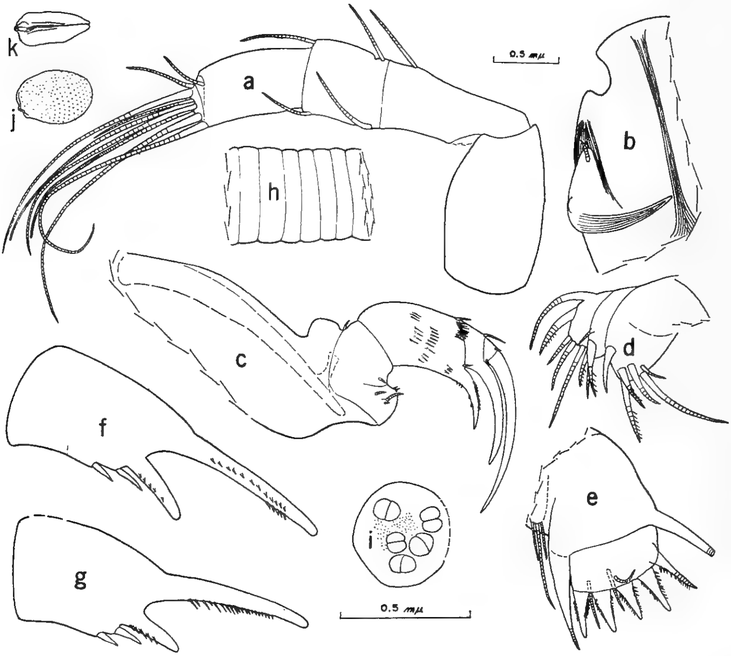

FIG. 1. *Eurypylus petrosus* Brady, Holotype: a, Right 1st antenna, medial view; b, Endopodite of right 2nd antenna, medial view; c, Left mandible, medial view; d, Endites I-III of maxilla, medial view; e, Exopodite and endopodite of maxilla, medial view; h, Fragment of 7th limb; f, g, Lateral view of right furcal lamella, and medial view of left furcal lamella; i, Lateral eye; j, k, Lateral and dorsal or ventral view of carapace, traced from Brady (1869, plate 8, figs. 1, 2), length of carapace given by Brady (page 141) 0.0008. (Same magnification in μm : a, c-g; b, h, i, j, k.)

Basale: Medial side near ventral margin with 4 small bristles; ventral margin with 2 short bristles; dorsal margin with 1 subterminal bristle. Endopodite: Main claw of 1st joint with minute teeth along both margins; medial surface of joint with spines, and with 1 minute bristle near main claw; dorsal margin of joint with small terminal bristle; 2nd joint with bare main claw and small terminal bristle on dorsal margin; 3rd joint with terminal claw and 2 minute bristles, one on each side of base of claw. Exopodite lacking.

Maxilla (Figure 1d, e): Endite I with 6 bristles; endite II with 4 bristles; endite III with 5 bristles; bristle on anterior margin of coxale not observed; exopodite with 3 bristles, 1 long, 2 short. Endopodite:

1st joint with alpha- and beta-bristles; 2nd joint with 2 short a-bristles, 1 small c-bristle, and usual 5 stout, pectinate, end bristles.

Fifth and sixth limbs: Not observed.

Seventh limb: Only proximal segment present on slide (Fig. 1h).

Furca (Fig. 1f, g): Each limb with 4 claws; claws 1 and 2 stout with rounded tips, with teeth along posterior margins, and not separated from lamella by suture; claws 3 and 4 small, secondary, separated from lamella by suture.

Lateral eye: Pigmented, with 5 divided ommatidia (Fig. 1i).

Medial eye and rod-shaped organ: Not observed.

Sex and maturity of holotype: The sex and stage of development of the holotype is unknown. The presence of a small fragment of 7th limb indicates that the specimen is probably a female, because for most species, males have, at most, vestigial 7th limbs. The absence on the slide of 5th limbs, which are well-developed even in early instars, suggests to us that the absence on the slide of the 6th and complete 7th limbs is the result of their having been lost rather than having been absent on the animal. The specimen could be a juvenile as already suggested by Müller (1912:42) and Poulsen (1965:44), but we must leave the maturity of the specimen open, until additional specimens are available for comparison. Even if the specimen is a juvenile, we believe that the appendages are sufficiently different from juveniles of other sarsiellids to warrant the retention of the genus.

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PROCEEDINGS
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OCCURRENCE OF *APANTHURA MAGNIFICA* MENZIES AND FRANKENBERG, 1966 (ISOPODA: ANTHURIDAE) FROM THE WEST COAST OF FLORIDA, WITH A KEY TO THE SPECIES OF *APANTHURA* STEBBING, 1900

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Bethnic samples from Dickerson Bay, Wakulla County, Florida, during February and May, 1975, contained many specimens of an anthurid isopod. The females conformed to the description of female *Apanthura magnifica* Menzies and Frankenberg, 1966, except that they had a setal comb on the distal article of the mandibular palp. Also, two forms of anthurid males were found: The first conformed to the male *A. magnifica* illustrated by Menzies and Frankenberg (1966) except for having chromatophores and a greater number of flagellar articles on the first antennae; the second form had elongate first antennae, but without setae, and lacked chromatophores and faceted eyes.

An examination of the female holotype *A. magnifica* (USNM 111073) demonstrated that the species does have a setal comb on the mandibular palp. No allotype was designated and the location of the male illustrated by Menzies and Frankenberg is not known. Therefore, in this paper, we redescribe a female *A. magnifica* to include the correct configuration of the mandibular palp, and describe immature and mature males from Florida. Also, we have extended the range of *A. magnifica* from Georgia to northwestern Florida, and have prepared a key to the species of *Apanthura* Stebbing, 1900.

ANTHURIDAE

Diagnosis: Isopods with tubular, elongate bodies, over 6 times as long as wide. Pleon with 6 or fewer pleonites and a telson. Uropods often arched over telson. Statocysts frequently present in telson. Mouthparts adapted for chewing. First pair of pereopods subchelate.

Genus *Apanthura* Stebbing, 1900

Type-species: *Apanthura sandalensis* Stebbing, 1900.

Diagnosis: Eyes usually present, absent in species from deep water. Pereonites not pitted. Pleon with sutures distinct. Telson not indurated, rather thin dorsally, smooth and concave. Antennae 1 (the upper and outer pair) with flagella of 1 joint, or obscurely 2–3 jointed; occasionally elongate and brushlike in males. Antennae 2 with flagella rudimentary. Mandible with third palpal joint shorter than or subequal to first, sometimes with a comb of setae, sometimes with only an apical tuft. Maxilliped 5-jointed. Pereopod 1 usually with tooth on palm near base, unguis typically long. Pereopods 2 and 3 with sixth joint somewhat ovate. Pereopods 4 through 7 with fifth joint underriding sixth. Pleopod 1 not indurated. Uropods not indurated, exopods folding over telson. Oostegites 4 pairs (Barnard, 1925).

Apanthura magnifica Menzies and Frankenberg, 1966

Diagnosis: Female (Fig. 1). Unpigmented, color pale pink to yellow. Eyes small, simple, black; separated dorsally by more than 5 eye lengths. Cephalon longer than wide; rostral projection as long as anterolateral margins. First antenna with peduncle of 4 articles and flagellum of 2 articles. Peduncle of antenna 2 with 4 articles visible dorsally; flagellum with 4 articles, the last 3 minute. Maxilliped 5-jointed. Mandibular palp consisting of 3 articles, second longest; article 3 with apical setal comb. Pereonite 1 about twice as long as cephalon, slightly longer than pereonites 2 or 3. Pereonites 2 and 3 subequal, slightly shorter than pereonites 4, 5 or 6. Pereonite 7 the shortest, about 0.8 times as long as pereonite 1. Pleon with 6 pleonites, about as long as pereonite 3. Pleonites 1, 2 and 3 distinctly separated dorsally, subequal in length. Pleonites 4 and 5 fused middorsally, fifth twice as long as fourth. Pleonite 6 with middorsal incision on posterior margin. Telson ovate. Uropod with endopod nearly twice as long as broad, not narrower than peduncle, smooth along inner margin and extending beyond distal end of telson. Exopod of uropod broadly ovate; apex notched. Pereopod 1 subchelate, with palmar tooth. Pereopods 4 through 7 with fifth joint underriding sixth; propodus and dactylus minutely toothed along interior margins.

Mature male (Fig. 2A, C, D): Chromatophores present. Eyes large, separated dorsally by less than one eye width, black, with facets. Cephalon slightly longer than wide, with rostral projection. Antenna 1 with peduncle of 4 articles and an elongate, multiarticulate, heavily

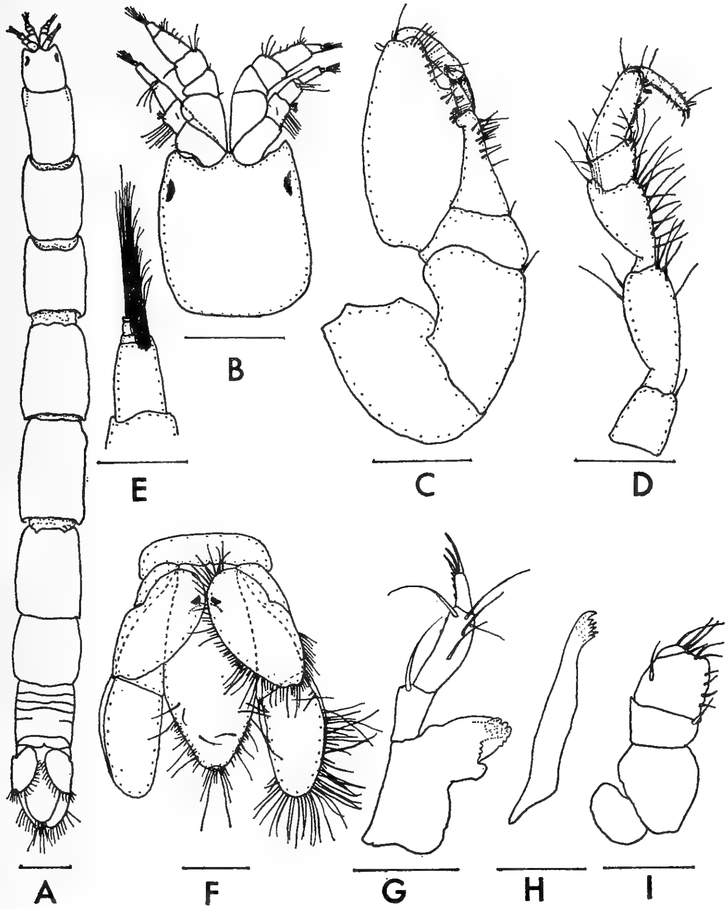

FIG. 1. Female *Apanthura magnifica* (l = 15.1 mm; w = 1.4 mm): A, Dorsal view; B, Cephalon and antennae I and II; C, Pereopod 1; D, Pereopod 7; E, Flagellum antenna II; F, Telson and uropods; G, Mandible with palp; H, Maxilla; I, Maxilliped. Scale = 1 mm in A; 0.5 mm in B, C, D, and F; 0.1 mm in E, G, H, and I.

setose flagellum extending beyond posterior end of second pereonite. Antenna 2 as in female. Pereonite 1 about 1.5 times as long as cephalon, longer than remaining pereonites. Pereonites 2, 4, 5 and 6 subequal in length, slightly longer than pereonite 3. Pereonite 7 shortest, about 0.6 times as long as pereonite 1. Pleon and telson

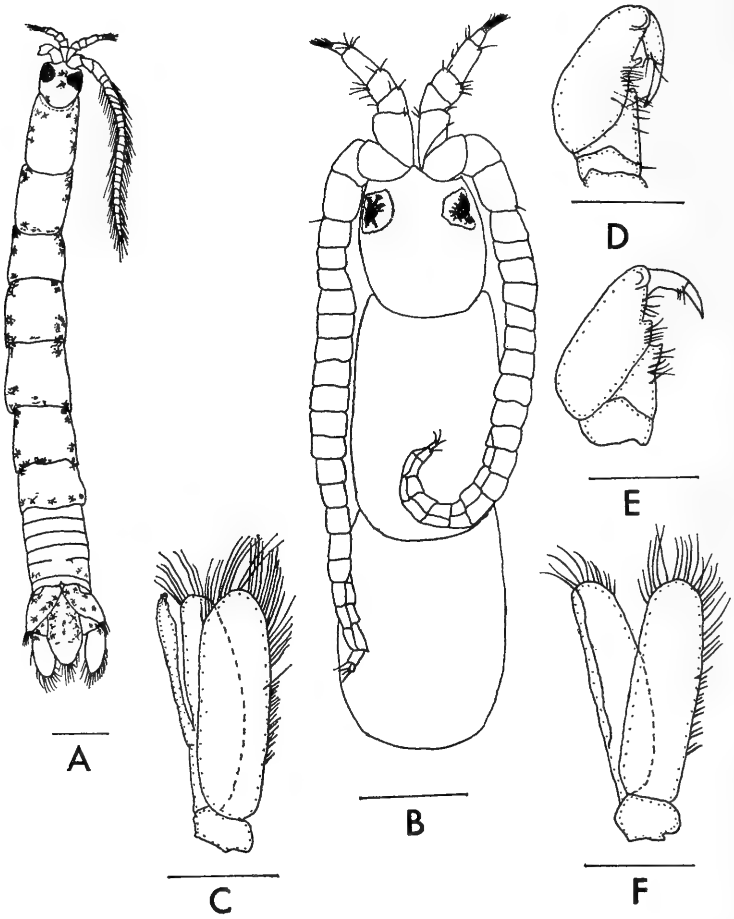

FIG. 2. Male *Apanthura magnifica*: A, Dorsal view, mature specimen (l = 10.8 mm; w = 1.1 mm); B, Cephalon and pereonites 1 and 2, immature specimen; C, Pleopod 2, mature; D, Distal articles of pereopod 1, mature; E, Distal articles of pereopod 1, immature; F, Pleopod 2, immature. Scale = 1 mm in A, 0.5 mm in B–F.

as in female. Appendix masculina slightly longer than endopod of pleopod 2. Pereopods as in female.

Four mature males were examined and all had chromatophores, faceted eyes, and a free appendix masculina. The number of flagellar articles in antenna 1 ranged from 23 to 27. Size ranged from 8.0 to 10.8 mm in length and 0.75 to 1.1 mm in width.

Immature male (Fig. 2B, E, F): Eleven immature males were examined. They lacked chromatophores and had non-faceted eyes. The flagellum of antenna 1 was multiarticulate, but generally had fewer articles (16 to 23) than mature males, and lacked setation. The appendix masculina was ensheathed within the endopod of pleopod 2. Size ranged from 8.7 to 13.0 mm in length and 0.8 to 1.2 mm in width.

Distribution: Off Georgia, 30°48′05″N, 80°00′W, type-locality; Tampa Bay, Florida; Egmont Key, Florida; Cedar Key, Florida; Dickerson Bay, Florida; Bald Point, Florida.

Material examined: Georgia, 154 m, 12 September 1963, holotype female, USNM 111073; Bald Point, Florida, low tide, 1 December 1955, 3 females, 1 immature male, USNM 208664; Cedar Key, Florida, 3.3 m, 19 January 1957, 1 mature male, USNM 215990; Cedar Key, Florida, 13 April 1957, 1 immature male, USNM 215990; west of Egmont Key, Florida, Gulf of Mexico, 4 m, 15 April 1970, 1 female, USNM 290578; Tampa Bay, Florida, October–December 1971, 1 mature male, 1 immature male, 27 females; Dickerson Bay, Florida, 2 to 5 m, 5 February 1975, 9 immature males, 19 females; Dickerson Bay, Florida, 2 to 5 m, 22 May 1975, 2 mature males, 1 immature male, 97 females.

Discussion

Several discrepancies were noted between our material and the original description of the species. First, examination of the holotype female revealed the presence of a setal comb on the mandibular palp which Menzies and Frankenberg stated and illustrated as absent. This absence was used by them as a character to disinguish *A. magnifica* from *Apanthura senegalensis* Barnard, 1925. This error could be due to the fact that the palp was viewed from the wrong side and the setal comb was mistaken for a single seta. Secondly, all mature males examined by us had chromatophores. Menzies and Frankenberg illustrated a mature male without any chromatophores. Possibly the individuals found at greater depths (17–154 m) by them are not pigmented, while those found at shallower depths (2–5 m) have chromatophores. Thirdly, Menzies and Frankenberg called the long brushlike antennae of the male, the second antennae. Barnard (1925) stated that: "The upper or first antennae are remarkable for the secondary modification displayed in the males of certain species" of anthurids. We agree with Barnard and opine that it is the first antennae of the male which are long and brushlike. The basal article of the first antenna fits into a groove in the basal segment of the second antenna. This grooved segment may be enlarged so that it appears that the second antenna is inserted above the first antenna (Fig. 2B). The peduncle and flagellum of antenna 2 are identical in both sexes of

A. magnifica. Lastly, Menzies and Frankenberg illustrated a mature male with many fewer flagellar articles in antenna 1 (10–13) than we have found (23–27), although the lengths of the antennae are similar, indicating that the Georgia males have larger, fewer articles than Florida males.

It appears that upon reaching sexual maturity, males develop chromatophores and faceted eyes, and add several flagellar articles to the first antennae, which also become heavily setose. We have also found two kinds of males among the types of *A. senegalensis.* One specimen had large, faceted eyes and a heavily setose flagellum of antenna 1 with 11 articles. Another specimen had smaller eyes and a non-setose flagellum of antenna 1 with 9 articles. We speculate that these changes come about through several molts and suggest that *Apanthura* may be protogynous, as is known to be the case in *Cyathura.* Barnard (1925) stated that perhaps two molts were necessary for the first antennae of anthurid males to develop this brushlike appearance, although the exact number has never been definitely determined.

We have compared the type of *A. magnifica* with the types of *Apanthura sandalensis* Stebbing, 1900, *A. senegalensis, Apanthura signata* Menzies and Glynn, 1968 and *Apanthura significa* Paul and Menzies, 1971 and have prepared an artificial key to all species in the genus. It is possible that two genera are represented here, since *Apanthura californiensis* Schultz, 1964 and *Apanthura inornata* Miller and Menzies, 1952 are illustrated showing the fourth and fifth pleonites free, while they are fused dorsally in *A. magnifica, A. significa* and *A. signata.* We could not conclusively ascertain the configuration of pleonite sutures in the old, preserved specimens of *A. sandalensis* and *A. senegalensis* and are not prepared at this time to separate the genus into two genera until fresh material of all species is examined.

Artificial Key to the Species of Apanthura Stebbing, 1900

1\. Without eyes 2
With eyes 3
2\. Third article of mandibular palp shorter than first .... *A. africana* Barnard, 1914
Third article of mandibular palp equal to first .... *A. coppingeri* Barnard, 1925
3\. Female without chromatophores 4
Female with chromatophores well-developed .... *A. signata* Menzies and Glynn, 1968
4\. Endopod of uropod nearly as broad as long; subcircular .... *A. xenocheir* Stebbing, 1910
Endopod of uropod nearly twice as long as broad 5
5\. Cephalon longer than first pereonite .... *A. significa* Paul and Menzies, 1971
Cephalon not longer than first pereonite 6

6. Cephalon subequal in length to first pereonite .... *A. senegalensis* Barnard, 1925
Cephalon shorter than pereonite 1 7
7. Uropods and telson with minutely serrate margins .... *A. californiensis* Schultz, 1964
Uropods and telson without serrate margins 8
8. Pereonite 7 as long as pleonites 1 to 6 combined (excluding telson) .... *A. magnifica* Menzies and Frankenberg, 1966
Pereonite 7 shorter than pleonites 1 to 6 combined 9
9. Pleotelson rounded distally and crenulate .... *A. sandalensis* Stebbing, 1900
Pleotelson truncate distally .... *A. inornata* Miller and Menzies, 1952

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PROCEEDINGS
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APHRASTOCHTHONIUS PACHYSETUS, A NEW CAVERNICOLOUS SPECIES FROM NEW MEXICO (PSEUDOSCORPIONIDA, CHTHONIIDAE)

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Among several collections of pseudoscorpions taken by W. C. Welbourn from caves in the Carlsbad Caverns area of Eddy County, New Mexico, one included a single specimen of a remarkable species of *Aphrastochthonius* Chamberlin. As this is the first representative of the genus to be discovered in the southwestern United States, it deserves description at this time.

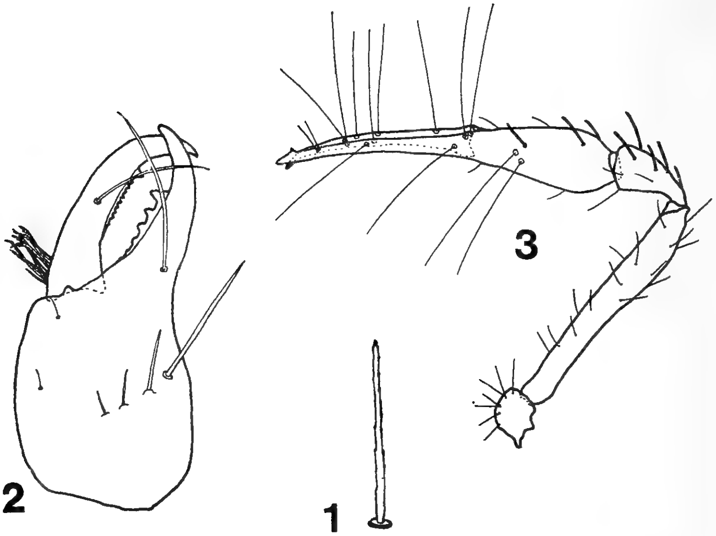
Aphrastochthonius pachysetus Muchmore, new species

Figures 1–3

Material: Holotype female (WM 4041.01001), found in Doc Brito Cave, 4.5 mi NE Whites City, Eddy County, New Mexico, on 25–V–1975, by W. C. Welbourn. The specimen is deposited in the Florida State Collection of Arthropods, Gainesville.

Diagnosis: A medium sized species of the genus with palpal femur 0.67 mm long; with 4 setae at posterior margin of carapace; with flat parallel-rayed coxal spines; and with setae of carapace, anterior tergites and some segments of palps and legs heavy, roughened and blunt-tipped.

Description of female: With the characters of the genus (see Muchmore, 1972, p. 433). Carapace longer than broad; anterior margin with about 6 small, spaced denticles near middle; no eyes present. Chaetotaxy of carapace m4m-4-4-2-4 = 20; except for the simple, anterolateral microsetae (m), all setae heavy, with roughened shafts and blunt at tips (Fig. 1). Coxal area typical; chaetotaxy 1+m-2-1-(2m):3m-3-1-CS:3-2-CS:2-4(5):2-4; maxilla with two microsetae (2m) on dorsolateral surface; each coxa I with 3 microsetae (3m) on prominent apical projection; about 6 flat, parallel-rayed coxal spines on coxa I and about



FIGS. 1–3. *Aphrastochthonius pachysetus*, new species: 1. Seta from carapace. 2. Lateral view of left chelicera (serrulae omitted). 3. Dorsal view of right palp.

8 similar spines on coxa II; intercoxal tubercle with 1 small seta. Abdomen typical. Tergal chaetotaxy 4:4:4:6:6:6:6:6:6:4:T2T:0; setae nearly as heavy as those on carapace, slightly roughened, and anterior ones with blunt tips. Sternal chaetotaxy 6:(4)6(4):(3)8(3):12:11:10:9:9:2T1T2:0:2; setae relatively heavy, but all acuminate.

Chelicera 0.75 as long as carapace; hand with 7 setae, *sb* large and spinelike (Fig. 2); movable finger with 9 teeth decreasing in size from tip to base; fixed finger with 1 very large and 10 progressively smaller teeth; spinneret a very slight elevation; flagellum of about 10 pinnate setae.

Palps typical (Fig. 3). Trochanter 1.15, femur 7.4, tibia 2.1, and chela 5.35 times as long as broad; hand 2.6 times as long as deep; movable finger 1.19 times as long as hand. Femur about 1.5 and chela about 2.0 times as long as carapace. Some setae at distal ends of femur and tibia heavy, scaly, and with blunt tips. Placement of trichobothria typical. Movable finger with 9 spaced, acute teeth; fixed finger with 16 similar teeth and 1 accessory denticle on external surface near distal end. Sensory pit on movable finger far proximal of last tooth.

Legs typical. Leg IV with entire femur 2.65 and tibia 5.5 times as long as deep. A few setae on various segments heavy, scaly and with blunt tips.

Male: Unknown.

Measurements (mm): Body length 1.50. Carapace length 0.43. Chelicera 0.325 by 0.155. Palpal trochanter 0.16 by 0.14; femur 0.665 by 0.09; tibia 0.23 by 0.11; chela 0.88 by 0.165; hand 0.415 by 0.16; movable finger 0.495 long. Leg IV: entire femur 0.48 by 0.18; tibia 0.33 by 0.06; metatarsus 0.155 by 0.05; telotarsus 0.385 by 0.04.

Etymology: The species is named *pachysetus* in recognition of the heavy, blunt, setae on the carapace, tergites, etc.

Remarks: This is the first representative of *Aphrastochthonius* to be found in the southwestern United States. Heretofore, the genus has been known from two cavernicolous species in Alabama (Chamberlin, 1962; Muchmore, 1968), three cavernicolous and one epigean species from Mexico (from southern Tamaulipas southward) and one cavernicolous species from Guatemala (Muchmore, 1972, 1973). Until now it has been easy to distinguish the U.S. forms from the Mexican ones by noting the number of setae at the posterior edge of the carapace and the morphology of the coxal spines (see couplet 1 in the key of Muchmore, 1972, p. 441). *A. pachysetus* is, however, intermediate between the two groups in respect to these characters, having 4 posterior carapacial setae like the Alabama species and short, parallel-rayed coxal spines like the Mexican forms. Therefore, a new key is required (see below).

The heavy, roughened, blunt-tipped setae on the carapace and elsewhere in *A. pachysetus* are unique in the family Chthoniidae. The purpose of such a modification is not evident.

The occurrence of a single seta on the intercoxal tubercle is probably teratologic, the normal number almost certainly being 2.

KEY TO THE KNOWN SPECIES OF APHRASTOCHTHONIUS
(based mainly upon females)

1. Setae on carapace distinctly heavy, with roughened shafts and blunt tips (New Mexico) .... *A. pachysetus*, new species
   Setae on carapace "normal," that is, only moderately heavy, with smooth shafts and tapered, sharp tips 2
2. Posterior margin of carapace with 4 setae; coxal spines elongate and bipinnate (eastern U.S.) 3
   Posterior margin of carapace with 2 setae; coxal spines short and parallel-rayed (Mexico and Guatemala) 4
3. Palpal femur greater than 0.75 mm in length, l/w ratio greater than 7.0; cheliceral hand with 6 setae .... *A. tenax* Chamberlin.
   Palpal femur less than 0.70 mm in length, l/w ratio less than 6.0; cheliceral hand with 5 setae .... *A. pecki* Muchmore
4. Carapace with single microseta on each side, "preocular" in position; maxilla with 2 or 3 microsetae dorsolaterally 5

Carapace with 3 microsetae on each side, one "preocular," others "postocular" in position; maxilla with 7 microsetae dorsolaterally (known only from tritonymph) .... A. *russelli* Muchmore

5. Palpal femur less than 0.5 mm in length l/w ratio less than 6.5 .... A. *parvus* Muchmore

Palpal femur greater than 0.6 mm in length, l/w ratio greater than 7.5 6

6. Very large for genus, palpal femur greater than 0.8 mm in length; tergal chaetotaxy 4:4:4:6:6:6:—; and with 7 setae on cheliceral hand .... A. *major* Muchmore

Smaller, palpal femur less than 0.7 mm in length; tergal chaetotaxy 4:4:4:4:6:6:—; and with 6 setae on cheliceral hand .... A. *verapazanus* Muchmore

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REMOVAL OF GELATINOUS COATING FROM THE SURFACE OF THE CARAPACE OF OSTRACODA IN PREPARATION FOR THEIR EXAMINATION WITH THE SCANNING ELECTRON MICROSCOPE

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The scanning electron microscope (SEM) permits the study in detail of morphological features of minute organisms previously only dimly visible when using the light microscope. It has proved extremely valuable for the study of the carapace of Ostracoda, minute Crustacea seldom exceeding 2 mm in length.

Some Crustacea, for example species in the ostracode family Sarsiellidae, are covered with a gelatinous substance of unknown chemical composition. When the specimen is dried during preparation for the SEM, the gelatinous coating forms an amorphous mass that masks the morphological details of the underlying carapace and produces an unsightly micrograph (Fig. 1a, c, e).

Banks and Williams (1972) described a procedure for removing wax, resins and exudates from the surface of insects prior to their taxonomic study. I tried a slight variation of the procedure recommended by Banks and Williams in an attempt to remove the gelatinous substance from the carapaces of sarsiellids. After soaking carapaces overnight in a strong solution of the surfactant Contrad 70,[1] a pellet of solid KOH was added to the solution, which was then

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[1] Manufactured by Harlco, 60th and Woodland Avenue, Philadelphia, Pennsylvania 19143, under license from Decon Laboratories Ltd., Ellen St. Portslade, Brighton, U.K.

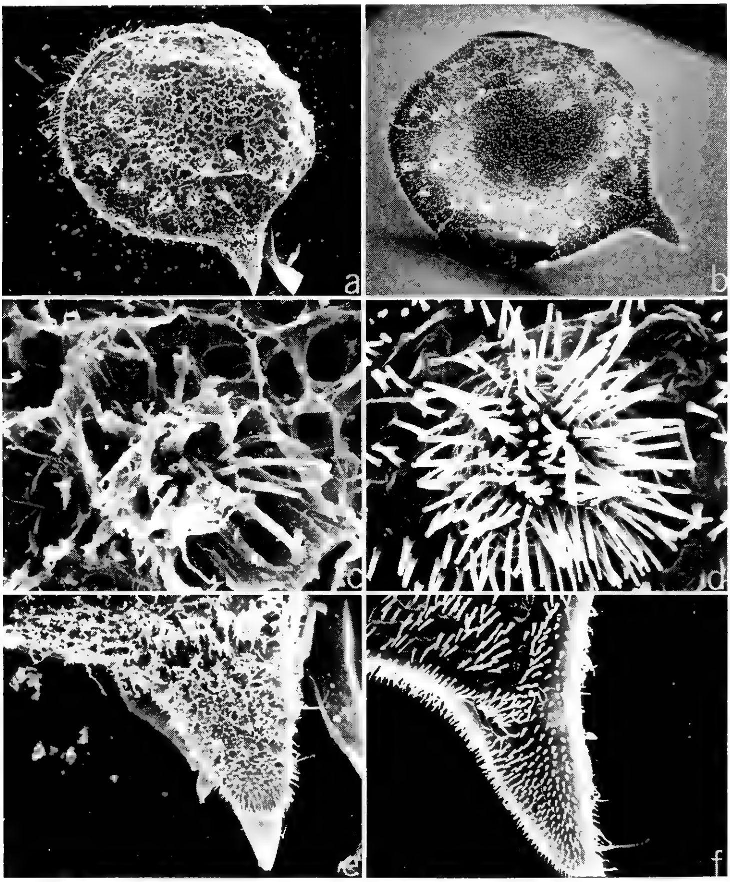

FIG. 1. *Sarsiella* sp.: a, c, e, Untreated left valve; b, d, f, Chemically prepared left valve.

boiled for 5 min. That this treatment successfully removed the gelatinous substance can be seen by comparing the SEM photographs (Fig. 1) of untreated (a, c, e) and treated (b, d, f) carapaces showing the same morphological features of two different specimens of the same species of *Sarsiella.*

The procedure for removing a gelatinous substance may be useful in the preparation of other groups of Ostracoda or Crustacea having a similar or chemically related coating.

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