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1.

The Sphingidae (Moths) of Kartabo, British Guiana, and Caripito, Venezuela¹

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[This contribution is the result of various expeditions of the Department of Tropical Research of the New York Zoological Society to British Guiana and to Venezuela, all under the direction of Dr. William Beebe. The Guiana expeditions were made during the years 1917, 1919, 1920, 1921 and 1924. The expeditions were arranged so that each month of the year is represented in the collections. The Venezuelan expedition, in 1942, during which field work was carried on from February 19 to September 2 was sponsored by grants from the Committee for Inter-American Artistic and Intellectual Relations and from four trustees of the Zoological Society, George C. Clark, Childs Frick, Laurance S. Rockefeller and Herbert L. Satterlee, and by invaluable assistance from the Standard Oil Companies of New Jersey and Venezuela.]

INTRODUCTION.

This is the first of a series of papers on the Lepidoptera collected at Kartabo, British Guiana, and Caripito, State of Monagas, Venezuela, by expeditions of the Department of Tropical Research of the New York Zoological Society.

A list of the species of any group of organisms from a definite but little-known locality has a certain value. This value is increased by any comparison or correlation with other places, or with corresponding lists of even distantly related classes or phyla. In this instance, the comparison is between the Sphingidae collected at two former stations of the Department of Tropical Research, Kartabo and Caripito, supplemented by reference to the Sphingidae collected by the Rev. Dr. A. M. Moss at Pará, Brazil.

The sphinx moth faunas treated in this paper are all confined to exceedingly limited areas. In Kartabo, British Guiana, the senior author and his staff worked for portions of eight years in a quarter square mile of jungle; in Caripito, Venezuela, our sphinx collecting was confined to an area of about one square mile during 28 weeks in 1942.

Dr. Moss, throughout a period of eight years, collected sphinx moths in and around the city of Belem or Pará, Brazil.

The geographical situations of these three places are well known, and it is sufficient to recall that they are separated from each other by two great rivers, the Orinoco and Amazon, as well as an over-all distance of about 1,300 miles; the distances from Caripito to Kartabo, and from Kartabo to Pará, being respectively one-third and two-thirds the total distance.

The total number of Sphingidae taken by Dr. Moss at Pará during his stay was 90 species. In Kartabo during the same length of time we took 53 and, curiously enough, an identical number throughout our seven months at Caripito. At the two localities we captured a total of 73 species. One hundred and twenty-six species of sphinx in the Clark collection at the Carnegie Museum are from the Guianas and eastern Venezuela and an additional 12 species are ascribed to this region by the literature.

It is interesting to compare these neotropical lists with the records of 38 species plus 15 subspecies of sphingids taken in Canada, 46 in New York City and vicinity, and 83 species from the whole of Argentina.

The world-wide law that in the tropics the preponderance of animal life is represented by an abundance of species and rarity of individuals, and in northern latitudes by the antithesis of these relations is well illustrated by notes on the 90 sphingids found at Pará. Dr. Moss notes 65 species or more than 72 per cent. as uncommon to very rare, and 25 species as common or abundant.

One more statistic will serve to point another distinction between Pará and the two more northerly places; we captured 14 species which have not been recorded from Pará, and Moss secured 30 which we failed to find at either Kartabo or Caripito. As regards subfamilies, there is an interesting correlation: Acherontiinae is represented by 16 Pará species, and 17 in our collections,

¹Contribution No. 704, Department of Tropical Research, New York Zoological Society.

in Ambulicinae the ratio is 6 to 7, in Philampelinae 9 to 7, and Choerocampinae 12 to 13. In these four subfamilies there is thus little distinction, but in the remaining fifth subfamily, Sesiinae, the balance is decidedly disturbed, the species count being 47 in Pará and 29 in Kartabo and Caripito. This unequal proportion is still very noticeable in the Sesiinae of Kartabo and of Caripito, the numbers being respectively 27 and 16. In this respect we have the species of this one subfamily amounting, in both Pará and Kartabo, to more than fifty per cent. of the entire count of sphingid forms.

We have sought in vain to interpret this in terms of definite factors. The principal similarity between Pará and Kartabo is their situation in the heart of a climax tropical rain forest without radical division into wet and dry seasons, whereas Caripito is close to the open llanos and exhibits very great extremes of both wetness and dryness. Whether this, directly or indirectly, contributes to the excessive disproportion of number of species of the subfamily Sesiinae can be solved only by continued, intensive investigation and observation.

The warmest thanks of the authors go to Mr. Walter R. Sweadner, Curator of the Department of Entomology of the Carnegie Museum, who identified the Venezuelan Sphingidae and listed the species in the Clark Collection captured in the Guianas and eastern Venezuela. The late Dr. William Schaus identified many of the British Guiana specimens and the junior author the remainder.

Sphingidae.

ACHERONTIINAE.

Herse cingulata (Fabricius).

Kartabo, common; Caripito, occasional.

Fourteen specimens were taken at Kartabo on the following dates: May 13 (2 specimens), May 15 (5), May 18, May 25, June 2, August 6, September 10, October 4 and one dateless specimen. Five specimens taken at Caripito as follows: May 19, June 3, June 14, June 17 and August 24. This species is found throughout the tropics and sub-tropics of North and South America and has even been reported as a straggler in Canada.

Cocytius antaeus medor (Cramer).

Kartabo, unique; Caripito, unique.

One specimen from Kartabo captured on November 29 and one from Caripito taken on April 8. This subspecies is distributed from Florida to south Brazil.

Cocytius beelzebuth (Boisduval).

Kartabo, not collected; Caripito, unique.

This species was reported from Caripito by Rene Lichy (*Boletín de la Sociedad Vene-*

zolana de Ciencias Naturales, Tomo VIII, No. 55, p. 225, Caracas, 1943). It was collected in July. Distributed from Nicaragua to south Brazil.

Cocytius cluentius (Cramer).

Kartabo, occasional; Caripito, unique.

Four specimens taken at Kartabo: June 6, July 12, August 8 and August 9. Six specimens taken at Caripito: May 13, May 17 (2), May 19, June 2 and July 24. Distributed from Mexico to southern Brazil and the West Indies.

Cocytius duponchel (Poey).

Kartabo, unique; Caripito, occasional.

One specimen was taken at Kartabo in May and three at Caripito as follows: May 16, June 14 and June 17. This species is widely distributed in the neotropics.

Cocytius lucifer Rothschild & Jordan.

Kartabo, not collected; Caripito, unique.

This species was reported from Caripito by P. Anduze (*Boletín de la Sociedad Venezolana de Ciencias Naturales*, Tomo IV, No. 32, p. 305, Caracas, 1938). It was collected in July. Widely distributed in the neotropics.

Amphimoea walkeri (Boisduval).

Kartabo, occasional; Caripito, common.

Four specimens taken at Kartabo as follows: May 22, May 30, August 15 and August 21. Eight specimens taken at Caripito as follows: April 9, May 13, May 19, June 3, July 1 and July 2 (3). This species is distributed from Nicaragua to south Brazil but has not been recorded from the West Indies.

Protoparce albiplaga (Walker).

Kartabo, not collected; Caripito, common.

Nine specimens taken at Caripito on the following dates: May 12, May 17, May 19 (2), June 10 (2), June 12, June 13 and June 16. Distributed from Mexico to southern Brazil but not in the West Indies.

Protoparce diffissa tropicalis

Rothschild & Jordan.

Kartabo, unique; Caripito, common.

One specimen from Kartabo with no date and thirteen taken at Caripito on the following dates: May 11 (2), May 16, May 19, May 25, June 2, June 5, June 10, June 17, July 9, July 12 and two specimens on July 16. This species is distributed from Colombia to Brazil.

Protoparce dilucida Edwards.

Kartabo, not collected; Caripito, unique.

One specimen taken at Caripito on May 12. This is an interesting record as it extends the range of the species to the north-eastern part of South America. Hitherto,

it has not been reported south of Honduras. This species has not been reported from Pará by Moss.

***Protoparce franciscæ* Clark.**

Kartabo, not collected; Caripito, abundant.

Twenty-seven specimens were taken at Caripito on the following dates: May 6, May 9, May 10 (3), May 11 (3), May 17 (6), May 19 (6), May 21 (2), May 22 (3), May 25 and May 27. This species was described from Venezuela and was not taken at Kartabo nor by Moss at Pará.

***Protoparce florestan* (Cramer).**

Kartabo, unique; Caripito, abundant.

One specimen taken in July at Kartabo, and 21 at Caripito as follows: March 11, May 7, May 12 (4), May 14 (3), May 17 (2), May 19 (2), May 21 (2), May 22 (2), May 23, May 26, June 1 and June 9. The range of this species is from southern Brazil to Mexico.

***Protoparce hannibal* (Cramer).**

Kartabo, unique; Caripito, not collected.

One specimen taken at Kartabo in 1920. The species is found from southern Brazil to Panama.

***Protoparce lichenea* (Burmeister).**

Kartabo, not collected; Caripito, occasional.

Four specimens captured at Caripito on the following dates: May 11, May 17 (2) and May 21. This species was not taken by Moss at Pará. It is distributed from northern Argentina to Mexico.

***Protoparce pellenia* (Herrich-Schäffer).**

Kartabo, not collected; Caripito, unique.

One specimen taken on May 17 at Caripito. Moss did not capture this species at Pará. Recorded in the literature from Colombia, Panama and Mexico.

***Protoparce rustica rustica* (Fabricius).**

Kartabo, common; Caripito, rare.

Seven specimens taken at Kartabo, and two at Caripito, one on June 2 and the other on July 9. Generally distributed in tropical and subtropical America.

***Protoparce sexta paphus* (Cramer).**

Kartabo, common; Caripito, unique.

Ten specimens taken at Kartabo, three of them in May and the remaining seven unlabelled. The single specimen from Caripito captured on June 23. This species is distributed from Costa Rica to Argentina.

AMBULICINAE.

***Protambulyx astygonus* (Boisduval).**

Kartabo, not collected; Caripito, occasional.

Three specimens taken at Caripito, one on each of the following dates: May 12, May 22 and July 3. Reported from Brazil. Moss failed to capture this species at Pará.

***Protambulyx euryalus* Rothschild & Jordan.**

Kartabo, unique; Caripito, not collected.

One specimen taken at Kartabo in January. This species was described from Peru and Venezuela. Not recorded by Moss.

***Protambulyx eurycles* (Herrich-Schäffer).**

Kartabo, not collected; Caripito, rare.

One specimen collected at Caripito on May 23 and another on June 3. Ranges from Colombia to south Brazil.

***Protambulyx goeldii* Rothschild & Jordan.**

Kartabo, not collected; Caripito, unique.

This species was reported from Caripito by P. Anduze (*Boletín de la Sociedad Venezolana de Ciencias Naturales*, Tomo IV, No. 32, p. 305, Caracas, 1938). It was collected in July. The species was described from Pará.

***Protambulyx strigilis* (Linnaeus).**

Kartabo, occasional; Caripito, abundant.

Six specimens collected at Kartabo on the following dates: May 19, June 8, June 10, November 10 and two with no date label. Twenty-two specimens taken at Caripito on the following dates: April 8, May 3, May 12 (2) May 14, May 15, May 16 (3), May 17, May 25 (2), June 10, June 13, June 15 (3), June 16, July 2, July 9, July 15 and July 16. Widely distributed in the American tropics.

***Amplipterus gannascus* (Stoll).**

Kartabo, not collected; Caripito, common.

Twelve specimens were collected at Caripito as follows: May 1, May 4, May 10, May 13, May 25, June 12, June 15, July 7, July 14 (2), August 2 and August 7. Distributed from Mexico to Argentina.

***Amplipterus palmeri* (Boisduval).**

Kartabo, not collected; Caripito, occasional.

Five specimens taken at Caripito as follows: May 21, May 22, May 24, July 15, and August 15. Widely distributed in South America.

SESIINAE.

***Pseudosphinx tetrio* (Linnaeus).**

Kartabo, occasional; Caripito, occasional.

Five specimens taken at Kartabo, but only two specimens have dates, the first July 14 and the other July 19. Three specimens taken at Caripito as follows: March 22, May 26 and June 13. Distributed from Mexico to Argentina.

Isognathus caricae (Linnaeus).

Kartabo, occasional; Caripito, rare.

Five specimens taken at Kartabo as follows: April 10, June 16 (2), July 14, and August 5. The two specimens taken at Caripito were taken on June 8 and July 14. Distributed from Venezuela to south Brazil.

Isognathus leachi (Swainson).

Kartabo, not collected; Caripito, rare.

Two specimens collected at Caripito, the first on May 22 and the second on July 16. Distributed from Surinam to south Brazil.

Isognathus menechus (Ménétriés).

Kartabo, rare; Caripito, not collected.

Two specimens taken at Kartabo, one on August 7 and the other on August 19. Distributed from Surinam to south Brazil.

Isognathus scyron (Cramer).

Kartabo, occasional; Caripito, occasional.

Four specimens taken at Kartabo as follows: May 10, May 24, May 29 and one with no date. The three specimens collected at Caripito captured as follows: May 16, May 22 and June 15. Distributed from Venezuela to Pará.

Isognathus swainsoni Felder.

Kartabo, rare; Caripito, common.

Two specimens taken at Kartabo, both on April 19. Eight specimens taken at Caripito as follows: April 15, May 5, May 14, May 22 (2), May 24, June 15 and August 2. Distributed from Surinam to southern Brazil.

Erinnyis alope (Drury).

Kartabo, occasional; Caripito, occasional.

Seven specimens taken at Kartabo as follows: March 14, May 19, June 10, June 16, June 22, September 11 and October 19. Seven specimens were taken at Caripito as follows: May 2, May 21, June 13, July 14 (3) and July 27. Found throughout tropical and subtropical America.

Erinnyis crameri (Schaus).

Kartabo, rare; Caripito, common.

Two specimens taken at Kartabo, one on May 5 and the other on May 15. Twelve specimens taken at Caripito as follows: June 3, June 10 (4), June 13 (4), June 17 (2) and June 21. Found throughout tropical and subtropical America.

Erinnyis ello (Linnaeus).

Kartabo, abundant; Caripito, abundant.

This species is the commonest sphingid in both Kartabo and Caripito. More than one hundred and fifty were taken at Kartabo and Caripito in May, June, July and August. This is a tropical and subtropical insect that wanders as far north as Canada.

Erinnyis obscura obscura (Fabricius).

Kartabo, occasional; Caripito, occasional.

Three specimens captured at Kartabo on June 16 and four at Caripito, one on June 12 and the remaining three on June 13. A tropical and subtropical species that occasionally is found as far north as Canada.

Erinnyis oenotrus (Cramer).

Kartabo, unique; Caripito, not collected.

One specimen collected at Kartabo on May 22. Distributed throughout the American tropics and subtropics.

Grammodia caicus (Cramer).

Kartabo, unique; Caripito, unique.

One specimen taken at Kartabo on September 29 and one at Caripito on May 5. Distributed from Florida to Argentina.

Pachylia ficus (Linnaeus).

Kartabo, occasional; Caripito, rare.

Four specimens taken at Kartabo as follows: November 22, December 18, January 5 and one specimen with no date. Two specimens were taken at Caripito, one on May 7 and the other on June 15. Ranges from Florida to Argentina.

Pachylia resumens Walker.

Kartabo, occasional; Caripito, not collected.

Three specimens were taken at Kartabo and the only one with a date label captured on July 5. Florida to Argentina.

Pachylia syces syces (Hübner).

Kartabo, not collected; Caripito, unique.

One specimen collected on May 25 at Caripito. Ranges from Mexico to Argentina. Other races are found in the West Indies and Cuba.

Leucorhampha ornatus (Rothschild).

Kartabo, unique; Caripito, not collected.

One specimen collected on May 13 at Kartabo. Found from Colombia to south Brazil.

Leucorhampha triptolemus (Cramer).

Kartabo, occasional; Caripito, unique.

Five specimens captured at Kartabo, three on July 16 and two on August 31. One specimen taken at Caripito on May 25. Found from Mexico to Brazil.

Hemeroplanes parce (Fabricius).

Kartabo, occasional; Caripito, not collected.

Three specimens taken at Kartabo as follows: May 17, May 28 and August 2. Distributed from Florida to Argentina.

Aleuron carinata (Walker).

Kartabo, rare; Caripito, not collected.

Two specimens captured at Kartabo, one on March 17 and the other on April 2. Dis-

tributed from Honduras to South Brazil. This species was not reported from Pará by Moss.

Aleuron chloroptera (Perty).

Kartabo, unique; Caripito, not collected.

One specimen taken in 1924 at Kartabo. Distributed from Nicaragua to Argentina.

Aleuron neglectum Rothschild & Jordan.

Kartabo, occasional; Caripito, not collected.

Five specimens taken at Kartabo, two on June 19 and three on September 23. Distributed from Mexico to south Brazil.

Enyo japix japix (Cramer).

Kartabo, rare; Caripito, not collected.

Two specimens taken, one on June 22 and the other on July 16. The range of the subspecies is from Mexico to the Amazon region.

Epistor gorgon (Cramer).

Kartabo, unique; Caripito, rare.

One specimen taken on May 15 at Kartabo and two specimens at Caripito, one on May 11 and the other on May 12. Distributed from Mexico to Argentina.

Epistor lugubris lugubris (Linnaeus).

Kartabo, occasional; Caripito, rare.

Seven specimens taken at Kartabo as follows: May 2, May 15, July 16 (3) and two without a date. Two specimens were taken at Caripito, one on April 27 and the other on May 26. Found from Argentina, throughout the tropics, and occasionally as far north as Massachusetts.

Epistor ocypete (Linnaeus).

Kartabo, rare; Caripito, unique.

Two specimens taken at Kartabo, one on May 10 and the other without a date. One specimen taken at Caripito on May 25. Distributed from Mexico to Argentina.

Pachygonia caliginosa (Boisduval).

Kartabo, rare; Caripito, not collected.

Two specimens taken at Kartabo, one without a date and the other captured July 7. Distributed throughout Central and South America. Not taken by Moss at Pará.

Perigonia lusca restituta (Walker).

Kartabo, rare; Caripito, not collected.

Two specimens taken at Kartabo, one on June 24 and the other without a date. Distributed from Mexico to the Amazons.

Sesia ceculus (Cramer).

Kartabo, common; Caripito, not collected.

Ten specimens taken at Kartabo as follows: January 14, January 16, July 5, July 16, July 19, August 5, August 15, October 22 and October 23 (2). Distributed from Mexico to south Brazil.

Sesia fadus (Cramer).

Kartabo, unique; Caripito, not collected.

One specimen without a date taken at Kartabo. Widely distributed throughout the neotropics and occasionally found in the nearctic region.

PHILAMPELINAE.

Pholus anchemolus (Cramer).

Kartabo, rare; Caripito, occasional.

Two specimens taken at Kartabo on May 25 and three at Caripito as follows: May 17, May 19 and June 1. Distributed from Mexico to Argentina.

Pholus capronnieri (Boisduval).

Kartabo, unique; Caripito, occasional.

One specimen taken at Kartabo without a date and three at Caripito as follows: May 19, May 22 and June 13. Reported in the literature from Ecuador, Peru, Venezuela, Surinam and the Amazon region.

Pholus eacus (Cramer).

Kartabo, unique; Caripito, not collected.

One specimen taken at Kartabo on August 9. Widely distributed in South America.

Pholus labruscae (Linnaeus).

Kartabo, common; Caripito, unique.

Sixteen specimens taken at Kartabo as follows: May 15, May 20 (3), May 25 (10), June 4 and September 29. One specimen taken at Caripito on June 3. Distributed everywhere in the American tropics and a straggler to Patagonia and Canada.

Pholus phorbis (Cramer).

Kartabo, unique; Caripito, unique.

One specimen taken on July 24 at Kartabo and one at Caripito on May 19. Distributed from Venezuela to Pará.

Pholus satellitia licaon (Cramer).

Kartabo, unique; Caripito, abundant.

One specimen taken at Kartabo in 1920 and 47 specimens taken at Caripito as follows: May 11 (2), May 12 (7), May 13 (8), May 14, May 16 (4), May 17 (4), May 19 (9), May 21 (2), May 22 (4), May 23, May 25 (2), May 26 (2) and June 10. Distributed from Mexico to north Brazil and Bolivia.

Pholus vitis vitis (Linnaeus).

Kartabo, occasional; Caripito, occasional.

Four specimens taken at Kartabo as follows: May 15, May 18, June 1 and one without a date. Five specimens taken at Caripito as follows: May 12, May 13 (2), May 16 and May 19. Widely distributed in the neotropics north to New England.

CHOEROCAMPINAE.

Xylophanes anubus (Cramer).

Kartabo, not collected; Caripito, unique.

One specimen collected at Caripito on June 19. Found from Mexico to Argentina.

Xylophanes ceratomioides (Grote & Robinson).

Kartabo, rare; Caripito, not collected.

Two specimens taken at Kartabo. Distributed from Mexico to south Brazil. This species was not taken by Moss at Pará.

Xylophanes chiron nechus (Cramer).

Kartabo, occasional; Caripito, occasional.

Three species taken at Kartabo as follows: March 2, April 30 and one with no date. Five species taken at Caripito as follows: May 19 (2), June 13, July 2 and July 14. Distributed from Mexico to Argentina.

Xylophanes elara (Druce).

Kartabo, unique; Caripito, not collected.

One specimen taken on July 21 at Kartabo. Distributed from Venezuela to Paraguay.

Xylophanes guianensis (Rothschild).

Kartabo, unique; Caripito, not collected.

One specimen taken at Kartabo on July 30. Reported from British Guiana and Ecuador.

Xylophanes mossi Clark.

Kartabo, unique; Caripito, not collected.

One specimen taken at Kartabo on May 7. The type came from Pará.

Xylophanes neoptolemus (Cramer).

Kartabo, occasional; Caripito, unique.

Six specimens taken at Kartabo with one specimen dated July 21. This species was taken by P. Anduze (*Boletín de la Sociedad Venezolana de Ciencias Naturales*, Tomo IV, No. 32, p. 305, Caracas, 1938) at Cari-

pito in July. Distributed from Mexico to Surinam. Not taken by Moss at Pará.

Xylophanes pistacina (Boisduval).

Kartabo, not collected; Caripito, rare.

Two specimens taken at Caripito, one on May 13 and the other on May 19. Distributed from Mexico to south Brazil. Not taken by Moss at Pará.

Xylophanes tersa (Linnaeus).

Kartabo, rare; Caripito, rare.

Two specimens taken at Kartabo that have no date labels and two at Caripito, the first taken on June 15 and the second on July 10. This insect is distributed from Canada to Argentina.

Xylophanes thyelia thyelia (Linnaeus).

Kartabo, not collected; Caripito, unique.

One specimen taken at Caripito on May 22. Distributed from Ecuador to south Brazil.

Xylophanes turbata (Edwards).

Kartabo, not collected; Caripito, rare.

Two specimens captured at Caripito, one on May 14 and the other on May 16. Reported in the literature as ranging from Mexico to Central America. This species was not taken by Moss at Pará.

Xylophanes tyndarus (Boisduval).

Kartabo, not collected; Caripito, rare.

Two specimens taken at Caripito, the first on May 16 and the second on June 13. Distributed from Mexico to Argentina. Not taken at Pará by Moss.

Celerio lineata (Fabricius).

Kartabo, not collected; Caripito, unique.

One specimen taken at Caripito on June 13. Distributed from Canada to Argentina. This species was not taken at Pará by Moss.

2.

Field Notes on the Lizards
of Kartabo, British Guiana, and Caripito, Venezuela.
Part 3. Teiidae, Amphisbaenidae and Scincidae.¹

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(Plates I-V, Text-figures 1-16).

[This contribution is a result of various expeditions of the Department of Tropical Research of the New York Zoological Society to British Guiana and to Venezuela, all made under the direction of Dr. William Beebe. The Guiana expeditions were made during the years 1909, 1916, 1917, 1919, 1920, 1921, 1922, 1924 and 1926, and the Venezuelan trips in 1908 and 1942. The latter was sponsored by grants from the Committee for Inter-American Artistic and Intellectual Relations and from four trustees of the Zoological Society, George C. Clark, Childs Frick, Laurance S. Rockefeller and Herbert L. Satterlee, and by invaluable assistance from the Standard Oil Companies of New Jersey and Venezuela.]

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INTRODUCTION.

This is a third paper on the lizards of Kartabo, British Guiana, and Caripito, Venezuela.² In the year 1909, and from 1916 to 1926, eight expeditions went out from this department to British Guiana, and in 1908 and again in 1942 field work was carried on in Venezuela.

Throughout the course of these expeditions many field notes, color plates and

photographs were made of tropical vertebrates, and the object of this present series of papers is to assemble and publish these notes and illustrative material. Any change or alteration of the original notes is placed between brackets. The chief value of these data is that they are concerned with living or recently killed specimens.

The observations in Guiana were made in one-quarter of a square mile of jungle at Kartabo, and those in Venezuela at or close to Caripito, which is only 528 kilometers northwest of Kartabo.

In addition to numerous technical papers in *Zoologica* and several popular volumes, there have been published the following general ecological summaries: *Zoologica*: (Kartabo) Vol. II, No. 7, 1919, pp. 205-227; Vol. VI, No. 1, 1925, pp. 1-193; (Caripito) Vol. XXVIII, No. 9, 1943, pp. 53-59. Also see "Tropical Wild Life in British Guiana" by Beebe, Hartley and Howes, published by the New York Zoological Society, 1917, pp. 1-504.

My hearty thanks go to Dr. Charles M. Bogert of the American Museum of Natural History and Dr. Karl P. Schmidt of the Chicago Natural History Museum for identifications and for bringing up to date my out-worn names of many years ago.

My original field numbers and other data have been appended to descriptions, breeding and other notes. These specimens are either in the collections of the Department of Tropical Research or in those of the American Museum of Natural History. Whenever the term total length is used, a perfect unregenerated tail is understood. Many of the figures in the plates are black and white reproductions of original color paintings, so only the pattern is preserved. The following plate figures are from

¹ Contribution No. 705, Department of Tropical Research, New York Zoological Society.

² Part 1, Gekkonidae, *Zoologica*, Vol. 29; pp. 145-160; Part 2, Iguanidae, Vol. 29, pp. 195-216.

paintings by Isabel Cooper, Figures 1, 3, 4, 5, 6, 7, 8, 12, 13, 14, 15 and 16. Figures 9, 10 and 11 are photographs by John Tee-Van. Text-figures 4, 5 and 6 are by Isabel Cooper; 1, 2, 8, 10 and 13 by Helen Tee-Van; 3, 7, 9, 11, 12, 15 and 16 by George Swanson.

FAMILY TEIIDAE.

Ecology of the Genera: Of the family Teiidae ten genera and twelve species were taken. Only one of the species was lacking at Kartabo while six were not captured during our relatively short stay at Caripito. No one of these genera is numerically dominant as is *Anolis* among the Iguanidae. In fact, all but two are monospecific as far as our collections go.

Ameiva is widely distributed over Central and South America in few species but many subspecific forms. A dozen species of *Bachia* are found over much of north and central South America. We found *B. cophias* at Kartabo, replaced by *B. heteropa* at Caripito. *Cnemidophorus* has differentiated into only three or four species, while *Iphisa* is monospecific and confined to northeastern South America. Two out of about eight species of *Kentropyx* were found at Kartabo, the genus occurring over northern and central South America, while *Neusticurus* with a similar distribution, contains six or seven species. Three species of *Leposoma* extend from Central America south to Brazil, one being found by us. The single species of *Tretioscincus* occurred both at Kartabo and at Caripito and one of the four species of *Tupinambis* which range over much of the continent.

Occurrence: In order of relative numbers as observed by us, we have: abundant, *Cnemidophorus*, *Ameiva*; common, *Kentropyx*, *Leposoma*, *Tupinambis*; occasional, *Bachia*, *Neusticurus*, *Tretioscincus*; rare, *Euspondylus*, *Iphisa*.

Size: From small to large; *Leposoma* (average adult 90 mm.), *Bachia* (123 mm.), *Iphisa* (127 mm.), *Tretioscincus* (130 mm.), *Euspondylus* (166 mm.), *Kentropyx* (200 mm.), *Neusticurus* (207 mm.), *Cnemidophorus* (225 mm.), *Ameiva* (377 mm.), *Tupinambis* (760 mm.).

Food: All the lizards of this family are carnivorous, the food ranging from minute insects in the case of *Bachia* and *Leposoma* to good-sized birds and mammals which are caught and devoured by *Tupinambis*. Tadpoles and small fish form the food of the swimming *Neusticurus*.

Sexual Dimorphism: This is strongly marked in only two genera, *Ameiva* and *Cnemidophorus*, the females being noticeably smaller than the males (85 and 75 per cent. respectively), and breeding males,

especially in *Cnemidophorus*, are decidedly more brilliant. Female patterns and colors are rather persistently juvenile.

Eggs: The number of eggs which we recorded is as follows: *Bachia* 1; *Cnemidophorus* 2; *Leposoma* 2; *Ameiva* 2 to 4; *Kentropyx* 4; *Tupinambis* 4 to 12.

Habitat: Unlike the family Iguanidae the members of the Teiidae are terrestrial, *Tupinambis* alone showing arboreal ability, while *Neusticurus* is dominantly aquatic. *Bachia* and *Leposoma* are nocturnal and sub-surface in haunts. The former is often found in the nests of *Atta* ants, while *Tupinambis* breeds in termite nests. *Ameiva* and *Cnemidophorus* live in open, sandy areas, while *Kentropyx* and *Tretioscincus* prefer the floor of the jungle.

Enemies: The more common types of danger to these ground lizards are snakes, hawks and kites, while among more unusual enemies are coati-mundis, weasels and attacks by army ants.

Escape Methods: The two most usual methods of avoiding death are swift flight to the openings of prepared burrows and, in extremis, the relinquishing of tails to the assault of beak and claw. In this family quick adaptive color change and resultant trust to escape by immobility is almost unknown, compared with its dominance in the Iguanidae.

Ameiva ameiva ameiva (Linnaeus, 1758).

(Plate I, Figs. 1, 2 and 3).

Names: *Ameiva*. Mato. Why-lo-reek; Why-mat-sah (Akawai Indian, "one who lives on the ground").

Range: Central and Northeastern South America.

General Account: *Ameivas* are abundant and wide-spread in all suitable localities. This is essentially a terrestrial jungle lizard, but whenever available it prefers ground among rather open undergrowth reached here and there by direct sunlight. It is also found in numbers in open clearings, both natural as caused by some great fallen tree, or artificially cleared by Indians.

More than terrestrial, *Ameiva* is fossorial, living in a deep burrow, to the entrance of which it always rushes when threatened by danger. It occasionally falls into our jungle pits, but if left more than a day or two will burrow out of sight and even drive a tunnel obliquely up to the surface. Not rarely we find it inhabiting old pits when we return the following year, in this case having provided itself with two escape tunnels leading to some upper outlet well hidden beneath jungle underbrush. *Ameivas* seem to breed throughout the year, and deposit from two to four eggs.

Progression in Search of Food: If we

stand perfectly still in the jungle any ameiva in the vicinity soon loses its momentary fear and continues its search for food. It may approach and actually creep over one's shoe with no hint of reaction to any human odor. Every movement is a quick, short, sudden rush or jerk, and the lizard sometimes pushes out of sight beneath loose, fallen leaves. A very common movement is to fling or scratch back the leaves, with first one, then the other fore foot, like a hen, also recalling the similar but ineffectual motions of *Cnemidophorus*. It touches every leaf with its tongue, snake-like, whether or not there is anything edible on it. When creeping over my shoe I have seen two such tongue touchings with no hint that the substance was not a leaf or bark instead of canvas or leather. In progressing, these lizards almost never lift the body clear off the ground, but slide over and around everything, pushing themselves along with all four feet. When motionless, perhaps curious or suspicious, the tip of the tail is vibrated, another compensatory movement for the nervous hand waving of *Cnemidophorus*.

The above note was made on April 20, 1924. On July 6, eighteen years later, I wrote the following at Caripito:

Watched a good-size ameiva (in the color pattern of about 350 mm.) feeding in the short grass of the laboratory compound. It was fifty feet away but the number 20 binoculars brought it within arm's length.

Its head constantly dipped and dipped in a succession of jerks, the tongue forking out each time, the head swinging from side to side, two or three dips to the right and the same to the left, the animal at the same time taking two creeping steps ahead. No wagging of the fore limbs, but constant digging, as a hen scratches, with first one leg, then the other, the head being pushed sometimes almost its length down into the roots of the short Bermuda grass-roots. When a bit of food was sensed, the whole back was strongly arched—the weight being sustained wholly by the hind feet. The forepart of the body thus swinging free enabled the fore legs and feet to work rapidly in turn, neither of them resting on the ground—a pose realistically like that of a restored dinosaur. It would almost seem as if the tongue conveyed knowledge by scent as well as touch, for it often played close to but not touching the object nearest it, and sight had nothing to do with unearthing a grub or cocoon hidden an inch or two beneath the dense sod.

Size: Twenty adult males with original, perfect tails average 401 mm. in total length, while the same number of females average 354 mm. The largest male measured

was 535 mm. and the largest female 465 mm.

Femoral Pores: The total average of femoral pores in 46 individuals shows no difference in males and females. The general average is 21 pores with extremes of 20.8 and 21.4. Age has nothing to do with the number in spite of the fact that of those I measured the largest male (535 mm.) had the smallest number, 18 and 19 pores, and the smallest male (132 mm.) possessed the largest number of pores, 24 on each leg.

Generalized Ontogenetic Sequence of Pattern and Color: In lizards with head and body of 50 mm. or less (total length ca. 150 mm.) the color above is greenish anteriorly and brownish elsewhere. Along the upper sides is a broad black band from eye to thigh, bordered usually by white above and below. The lower sides are vaguely marbled and mottled with paler colors. The ventral surfaces are dark brown except for cream or salmon color around vent and under thighs.

In specimens of 70 to 90 mm. body length (total ca. 175 to 300 mm.), brown often appears on the fore part of the head, the green being more or less restricted to the mid-back or rump. The black bands possess a single central line of pale dots, or these may show an increase in number and tend to a vertical arrangement into lines. The lower lateral mottling changes gradually to dots and enlarged spots, and also inclines to vertical bands. The ventral surfaces shift slowly to pale green and blue.

In ameivas of 125 to 165 mm. body length (total ca. 350 to 530 mm.), the whole anterior half of the lizard to mid-back is brownish or red-brown including head, fore body and fore legs, and freckled or blotched with black. The posterior half of the creature is generally green, with the tail occasionally blue. The lateral black band has disappeared, its place being taken by a green or brown background, crossed vertically by numerous bands of round, back-framed, yellow or blue spots. Pale greens and blues characterize the ventral surface.

No definite notes were made on sexual differences in pattern and coloration, except that the development of both characters was ontogenetically delayed in the females. Female specimens with the black band still intact were seen of much larger size than in any male. Conversely, the ventro-dorsal encroachment of blue and yellow, black-framed, lateral spots occur in much younger males than in females. Yet full-grown lizards of both sexes more than 500 mm. in total length, with head and body length of 165 mm., were recorded, which in pigment and pattern were indistinguishable. For example, a female in full breeding

condition with eggs three-fourths developed was in earliest juvenile pattern and color. The dorsal surface was chiefly brown, very faintly olive green on the head, the lateral black band showing only a row of minute pale dots and a lower border of the same color; the ventral surface pale buff, the only bright color being a tinge of turquoise on the anterior part of the thighs. Yet this lizard had a body length of 125 mm. and a total length of 397 mm.

As hints of pigmental variation of the above generalizations, I reproduce two from among many detailed descriptions of individual ameivas. Both are males, the first in the juvenile pattern with body of 75 mm. and the second fully adult, 140 mm. from snout to vent.

Specimen No. 182: Dorsally the head is yellow olive green, the mid-back between shoulders the same, merging posteriorly into golden brown on the rump. The tail is raw umber with a few black spots. Face pale cinnamon buff. The black lateral stripe extends down the tail as a series of black spots, which show faint vertical lines of pale buff spots. The sides are yellow behind the shoulders, cinnamon farther back with hints of blue spots. Ventrally the chin is white, throat gray and breast yellowish-pink. The belly greenish-yellow, the vent zinc orange, and this color on the under tail shades into greenish-gray. The fore legs are golden brown beneath, umber above; the thighs and hind legs zinc orange with pale blue spots in front.

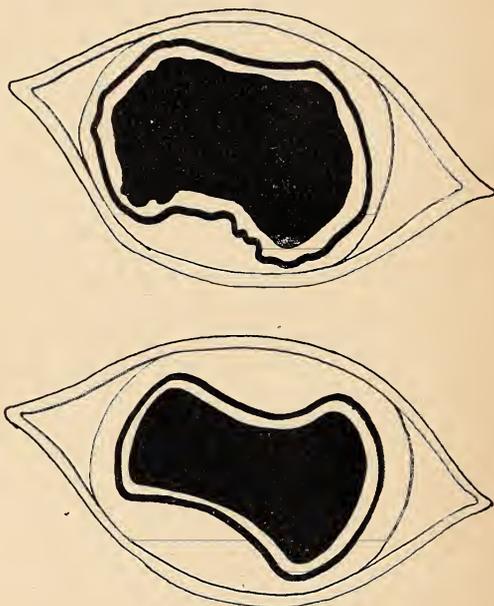
Specimen No. 184a: The head is dark raw umber, and the mid-back mahogany red merges into green on the lower back. Here the color changes to yellow green and into methyl green on the tail. The lateral band has become very indistinct, the original black persisting only as narrow frames around the vertical blue and yellow spots. The chin is white while the throat is dotted with dark spots. These are absent in this specimen from the head and neck. The breast is greenish-yellow shading to salmon and the belly is the same with a few blue spots along the upper edge. Vent apricot orange.

Tail Regeneration: As in many other species *Ameiva* sheds its tail very readily when an enemy attacks and seizes it. I once saw a lizard with three tails, and as many as four individuals with two. In two of the latter cases this was the result of a slight lateral injury from which a new tail had sprouted, this fact being deducible from the unchanged scalation and vertebration of one, presumably the original appendage.

In Specimen No. 180, 470 mm. over all, the head and body measured 145 mm. From the break, the original tail extended back

215 mm., while the additional tail was 125 mm. In Specimen No. 351, of 485 mm., a secondary tail only 7 mm. long had sprouted 55 mm. from the tip of the original one.

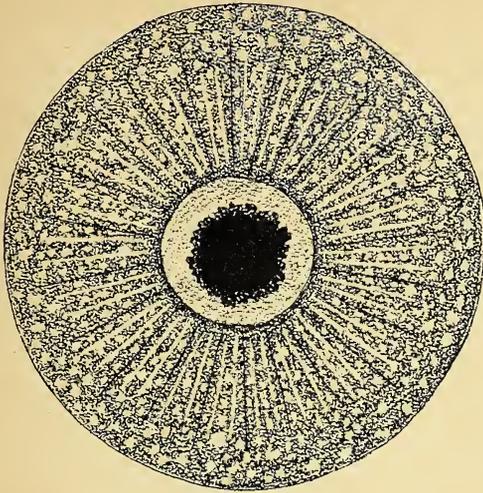
Iris and Pupil: A very distinctive character of ameivas of all ages and both sexes is the shape of the pupil, or perhaps more correctly, of the iris. The iris is golden, finely vermiculated with reddish and black flecks. In lizards of medium and large size there is a wide, conspicuous pupil frame of bright orange. What in most lizards would be a round pupil, in ameivas is deeply notched on the upper border and still more so on the lower rim, somewhat asymmetrically so that the general appearance of the figure is slightly oblique. The shape defies any exact name; it resembles a double, asymmetrical head of an ax as much as anything. Death causes no change in this shape. (Text-fig. 1).



TEXT-FIG. 1. *Ameiva ameiva*. Pupil outlines of two individuals, showing variation in shape. $\times 8$.

Fundus Oculi: Eyeground dark yellowish-gray covered with brilliant shining white dots, rather oblong in shape. The fundus is quite light toward the center owing to the many opaque nerve fibres. The optic disk is a rough circle with the pecten in the center but showing a broad band of the papilla around it. (Text-fig. 2).

The marsupium is conical, dark brown in color. The base where it runs down into the optic disk is a fine network of minute brownish-red veins. Also radiating from the disk alternately with the nerve fibres are brownish lines. These are about twice the



TEXT-FIG. 2. *Ameiva ameiva*. Fundus oculi.
× 15.

length of the opaque fibres and are quite pale where they run beside them, becoming darker beyond them.

The fundus oculi of *Cnemidophorus* and *Kentropyx* are indistinguishable from that of *Ameiva*.

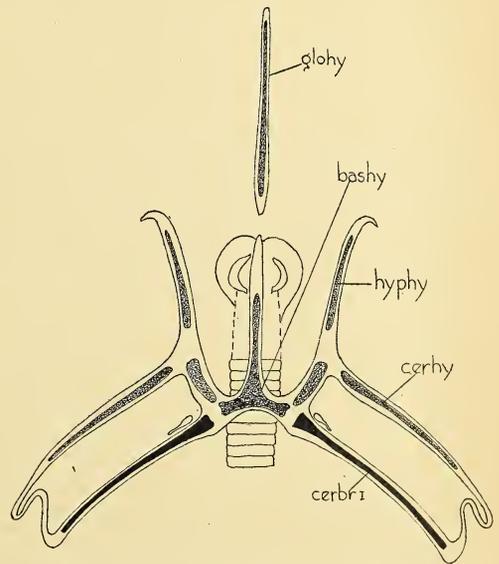
Hyoid: KOH. No. 2022, male, Kartabo, July 5, 1920. Text-fig. 3. The uro- or glossohyal is a long slender rod of dense cartilage, posteriorly branching into an inverted T-shape with short arms, each .7 mm. in length which represent the ankylosed basihyals. Anteriorly the median tongue element dies out in hyaline cartilage at a distance of 3.1 mm. and this in turn abruptly ceases after another .8 mm. There follows a very narrow hiatus, beyond which appears the continuation of the rod, a lingual process of dense cartilage which extends forward another 3.8 mm. The glottis appears just below the tip of the proximal portion of the glossohyal.

The proximal portion of the hyoid apparatus is attached firmly by cartilage to the slightly enlarged ends of the arms of the basihyals. First comes a short element, pointing obliquely forward, the hypohyal, 1.4 mm. in length, and extending beyond this a second element is directed almost straight forward to a distance of 4.2 mm. This I consider as still part of the hypohyal, making that element adaptively divided into two parts (like the similarly divided glossohyal). An identical although unseparated condition is shown in the hyoid of *Dracaena guianensis* as illustrated in Fig. 22, Plate 2, of Cope's "Crocodiles, Lizards and Snakes of North America."

At the junction of the proximal and distal elements of the hypohyal arises the posteriorly directed ceratohyal, 6.2 mm. in length.

From the junction of the basi- and hypohyals there projects backward, as a long rod, the ceratobranchial of the first branchial arch, 6.3 mm. long. These hyoid elements all have dense cores which fall short of the joints, and all are bound firmly together with hyaline cartilage. The tips of the long processes, one anterior and two posterior, terminate in rather short, curved hook-like ends. Alongside the very base of the ceratobranchial and exterior to it lies a small, narrow, free bit of cartilage with an enlarged, rounded head. Although this is quite buried in hyaline tissue and is only one millimeter in length, it may perhaps be the remains of the second ceratobranchial, an element which is much larger and in more typical position in the hyoid of *Cnemidophorus*.

The reticulated portion of the tongue begins about half way down the length of the glossohyal. At the posterior end of this latter element the tongue ceases and divides into two strong bands of muscle, which separate and pass over the curved and flattened basal element of the hypohyal and on down the channel between the ceratohyal and ceratobranchial, fitting comfortably between them. The anterior isolated lingual process lies embedded in the tissue of the tongue, ending behind exactly at the point of divergence. The glossohyal begins beneath the tongue, below the two bands of muscle which pass on either side and above it. A remarkable thing about the hyoid of this lizard is the complete union of the posterior ends of the ceratohyal and ceratobranchial, their tips being connected by a



TEXT-FIG. 3. *Ameiva ameiva*. Hyoid of adult.
× 4.3.

sinuous winding ribbon of cartilage, hardly softer than their own substance.

Food: The following list gives the detailed stomach contents of 25 Kartabo ameivas of assorted sizes, mostly more than 250 mm. in total length. (1) one three-inch orthopter full of eggs; (2) small caterpillar, grasshopper, spider, 40 *Hemetia* larvae; (3) woodroach, small snail; (4) two termites, two roaches, scorpion; (5) two beetles, ant, grasshopper; (6) two adult centipedes with 17-20 young; (7) grasshopper, dipterous larvae, small mantis, three mosquitoes; (8) two beetles, large grasshopper; (9) large grasshopper; (10) scorpion, millipede, earthworm, grasshopper, roach; (11) scorpion, two grasshoppers, spider; (12) scorpion, weevil, small quartz crystals; (13) caterpillar, spider, roach, orthopter, quartz crystals; (14) two dipterans (*Cyclorrapha*); (15) centipede, hemipteron, beetle; (16) eleven centipedes, ant cocoons, roach, ten black ants, quartz crystals; (17) cricket, snail; (18) large grasshopper, roaches, beetles, insect eggs; remains of two butterflies; (19) roach, beetle, insect eggs; (20) taken from stomach of a boa, contained roach, winged ant; (21) workers and soldiers of *Syntermes* sp., two centipedes, millipede, cricket, roach, two beetles; (22) three scarabs, spider, lizard egg; (23) beetles, three roaches; (24) five beetles, roach, snail; (25) spider, winged ant, was killing a 70 mm. sphingid caterpillar when shot.

In Caripito, Venezuela, day after day I watched from the laboratory as ameivas large and small leaped into the air after low-flying *Catopsilias* and *Uranias*. The small lizards often leaped clear of the ground. Out of a great many attempts I saw four which were not wholly failures. Twice the butterflies were nipped, and one of these times it fell to the ground but escaped. On two occasions two small ameivas caught the lepidopterans squarely and devoured every part. This was the case with captive lizards which, both with ameivas and plicas, ate as many butterflies as I provided and fought with each other over a single insect. Wings were invariably eaten unless they fell to the ground, when they were left.

The food record of *Ameiva* can be summarized by a list of the chief ingredients of diet, arranged in order of frequency of occurrence: Roaches (18), beetles (16), grasshoppers (14), centipedes (9), spiders (8), scorpions (7), snails (4), millipedes (4), termites (4), mantids (3), caterpillars (3), diptera (3), dipterous larvae (2), crickets (2), and once each of the following: butterflies, earthworms, earwigs, hemiptera and wasps.

Enemies: *Xenodon severus* and the com-

mon boa are the worst serpent enemies of ameivas at Kartabo. In one of the latter I found remains of three lizards, and three other snakes of the same species had fed on these unfortunate lizards. Two *Xenodon* which I dissected had eaten ameivas, and at Caripito two full-grown ameivas were taken from the stomach of an eight-foot *Drymarchon corais corais*. I saw two species of hawks in the act of unsuccessful attacks, one of which secured and carried off the entire tail.

Parasites: The large male ameivas seem especially susceptible to attacks by external parasites. Several species of large ticks often fasten on various parts of the body and even near the mouth and eyes. The armpits and thighs are occasionally filled with solid masses of bête-rouge. Small tape-worms and nematodes occur in the stomach and intestines in greater numbers than in any other lizard I have examined.

Breeding: Breeding seems to be distributed throughout the year. The following dates represent eggs or females with eggs about to be deposited: March (2 records), May (2), June (3), July (3) and October (2).

On July 2, 1919, I took a female of 230 mm. in a burrow a foot underground, with two eggs. One was broken in the capture, the other was leathery in texture, ivory white, fine-grained, oblong, weighing one gram and measuring 10.4 by 10.4 mm. A female of 397 mm. shot October 13, 1920, contained three eggs almost fully developed but without shell. On the same date a second female of 469 mm. would have deposited four eggs within a day or two.

Bachia cophias (Schneider, 1801).

Names: Worm Lizard. The Kartabo Indians had no name for this lizard and were in mortal terror of its supposed ability to sting fatally.

Range: Northeastern South America.

General Account: These were found occasionally at Kartabo, and intensive search would probably change its numerical status to Common. It is essentially fossorial or sub-surface, and in the dry season we found them under jungle débris, in decayed logs, and as deep as 30 cm. when digging jungle pits. In three instances they were taken from the nests of attas. After the rains began, several were found in early morning crawling over wet leaves, and on four occasions they fell into our pits.

The mode of progression of *Bachia cophias* is interesting. When it moves ahead quietly, of its own accord, it makes constant use of its small mittened feet, especially the front pair which work frantically and are of real use in pushing the lizard along in

a straight line. The hind feet also move continually but the slight downward curve of the mid-tail is so strong a lever that the hind limbs are often lifted slightly into the air where they continue to labor violently and futilely. On level ground the body is sometimes slightly raised above the surface, and for a few steps the lizard becomes a real quadruped. The motions are quite saurian and not ophidian, being short, quick jerks. The tongue constantly flickers in and out. (Text-fig. 4).

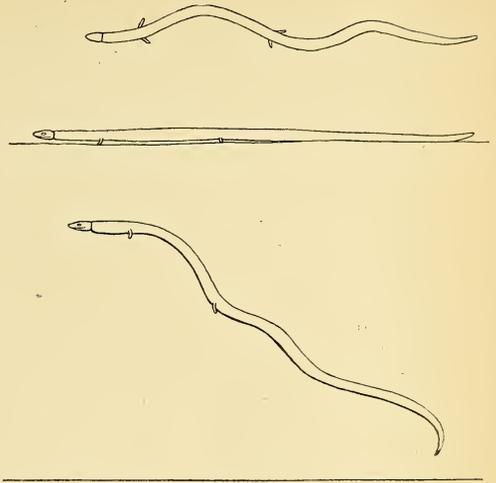
When touched or alarmed at the approach of a hand it often whirled the front half of its body about in a snake-like fashion and started off in a new direction, and in a wholly different method of progression. This was serpentine, the body moving in successive lateral waves, the legs dangling uselessly, moving in vain clear of the ground or occasionally rubbed into it. When thoroughly excited or in an extremity of alarm it leaped clear into the air by a sudden flexion of the posterior half of the tail, clearing at least three times its own length in height and advancing still more. The best leap, which I measured accurately, took it ten inches up and thirteen ahead. This action was so sudden and unexpected that it was startling enough to be a most efficient means of escape from an enemy. When the Indians saw this movement, it seemed to heighten their fear of the creature.

In water the lizard dived for a moment, then swam ashore with snake-like lateral undulations. Whenever it encountered bamboo leaves or loose débris of any kind, its first instinct was to creep or burrow beneath. Its sight seemed very poor in spite of its relatively good-sized eye, and two inches seemed the farthest distance of noticing anything in motion. When laid on a table for the first time it leaped over a four-inch partition into a pencil box and burrowed between the pencils. These observations were made on Specimen No. 3130, a male of 110 mm. taken July 10, 1919.

Measurements: Five specimens with uninjured tails show the following dimensional percentages:

		Total length	Head
3131:	Male	66.5 mm.	7.5%
2982:	Female	90	5.7
3130:	Male	110	5.5
2983:	Female	116.5	5.2
332a:	Female	135	4.5

In the three males, the head, body and limbs show relatively smaller percentages with increase in growth, while the tail increases. The two largest specimens are females and the weight of 1.25 grams in



TEXT-FIG. 4. *Bachia cophias*. Three methods of progression, undulation, walking and leaping. $\times .5$.

Specimen No. 332a includes an egg which was laid on the following day. (Text-fig. 5).

Color in Life: In general these diminutive lizards are dark red-brown above with four longitudinal lines and lateral mottling of light terra cotta, fading posteriorly to vinaceous pink. Below dull purplish-brown.

Eye: In all descriptions the eye is said to be minute, and in preserved specimens it appears very small. In life, however, it is surprisingly bright and conspicuous.

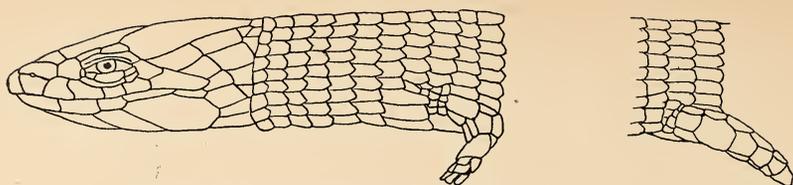
Food: In the stomach of No. 3130 was a small grub, many microlepidopteran scales and numerous fine particles of quartz. No. 3131 had eaten four ants and two sowbugs. A third *Bachia* had eaten two grubs and three termites.

Enemies: A perfect specimen, No. 604, measuring 150 mm. in total length, was taken from the stomach of a coati-mundi, *Nasua nasua*, shot in the jungle near Kartabo. The lizard in turn had made a meal on two small grubs and three termites.

Breeding: Specimen No. 332a, female, 135 mm. total length, taken in one of our

Body	Percentages of Length			Weight
	Tail	Legs		
42.2	50.3	3	.3 grams	
39.3	55	2.7	.8	
29.5	65	1.8	.6	
38.9	55.9	2.3	.8	
39.2	56.4	2.4	1.25	

jungle pits June 22, 1920, contained an egg about to be laid. It was in a median position in the body and so distended the skin that the hind legs were stretched clear of the ground and were quite useless even in slow



TEXT-FIG. 5. *Bachia cophias*. Side view of head and limbs. $\times 5$.

locomotion. The front legs pushed the body along while the posterior half of the lizard wriggled slowly. The egg was deposited on the following morning beneath a leaf. It was an elongated, parallel-sided oval, 4.1 by 11.5 mm. The shell was leathery with a calcareous roughened surface, showing slight, longitudinal striae. Faint transverse furrows divided the egg superficially into six segments.

Bachia heteropa (Lichtenstein, 1856).

Name: Fourteen-toed Worm Lizard.

Range: Venezuela.

General Account: At Caripito this was the only member we found of the genus *Bachia*. The most distinguishing character, aside from the color, was the number of degenerate toes. In *cophias* the number on fore and hind feet are three and one; in *heteropa* the corresponding numbers are four and three.

In life the two lizards were much alike in movement, habits and occurrence. The half dozen which we collected were taken while digging pits, or else fell into them after the rains, or were dug out of decayed logs. (Text-fig. 6).

Specimen No. 30012 was 165 mm. over all but, when taken in the hand, promptly lost half of its tail which expired after a period of frantic flicking about. Later, another section of ten segments parted company and although handicapped by its unbending,

stubby character, yet managed to roll around for a time. Progression by feet seemed somewhat more skilful than in the Kartabo species. A close superficial resemblance exists between this worm lizard and the young of a small species of burrowing snake, *Atractus trilineatus*. More than once in the dim light of the jungle we had to confirm the presence or absence of legs before we could be certain.

Color in Life: Chestnut brown above with a wide band down the back of dull cinnamon gray stippled with chestnut, fading into solid chestnut toward tail. A narrow stripe of chestnut down center of dorsal band. The band is edged on each side with a linear series of arrowheads of pale olive buff. Inner border of these marks edged with chestnut. The arrowheads get smaller and fade out entirely toward tail. Iris straw yellow.

Cnemidophorus lemniscatus lemniscatus

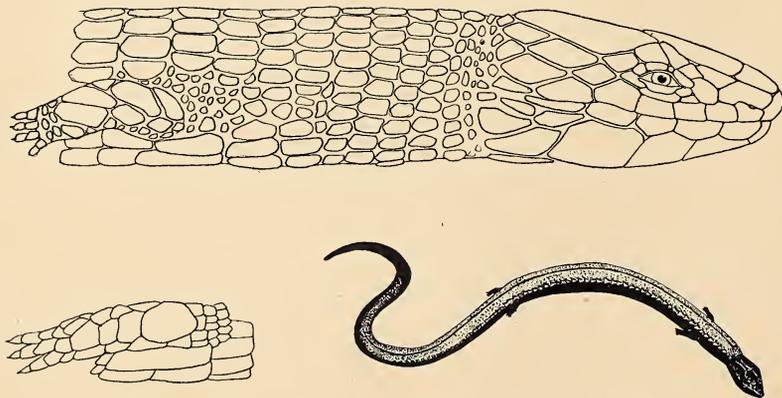
(Linnaeus, 1758).

(Plate II, Fig. 4)

Names: Striped Jungle Runner. Wyak-wyak (Akawai Indian, "One who lives on the ground").

Range: Northern South America, north into Central America and on some islands.

Field Characters: Brown and green lizards of medium size, the males larger and brighter. They can be identified as far as they can be seen by the eternal, nervous,



TEXT-FIG. 6. *Bachia heteropa*. Side view of head and limbs.

alternate, waving in midair of the fore legs.

General Account: This is the most common lizard at Kartabo, the young being more in evidence than those of any other species. It was even more abundant at Caripito, doubtless due to the open country and adjacency to the llanos. More were caught in Pit 13, which was dug at the edge of the llanos, than in all the jungle pits combined. The jungle runner is essentially terrestrial and lives in burrows which it excavates. It is by necessity a jungle lizard at Kartabo but only where the sunlight has access, especially clearings, trails and the shores of rivers. It climbs more frequently than *Ameiva* but only to low heights and for short periods.

Cnemidophorus is typical of those lizards whose whole life is controlled by sunlight. A cloud dims the sun and every one of the hundreds anywhere near seeks his hole or crevice. At the first hint of sunlight all come forth. I have seen one of these lizards creeping over the jungle leaves and could almost predict his course by the glints of sun which came through the foliage and lighted up the floor.

There is an interesting aural connection between these lizards and their relations the ameivas, and birds. Both birds and reptiles may be feeding quietly in a jungle clearing, the birds on insects and berries of the low undergrowth, the lizards scampering about or progressing by short, quick jerks, searching for food as they move. I may be sitting so quietly that I have avoided notice until some antbird or tanager spies me and sets up a piercing cry of alarm. I am not surprised to see every bird within sight or hearing take heed and fly off or at least perch quietly on the alert, but it is still more interesting to see the alarm understood by the lizards as well and every one rush headlong for his burrow. The reaction is as thorough and instantaneous as that between wild pheasants and mouse deer in the forests of the Himalayas.

More than other lizards *Cnemidophorus* in many ways reminds me of birds, especially in their nervous activity, their quick, short jerky movements and the way they have of looking quickly about. Then again, the larger individuals when running at full speed along a smooth, open stretch, often get up on their hind legs and sprint in a bird-like, bipedal position on their hind toes, the front legs and the tail held high off the ground.

The most characteristic thing about these lizards and the most inexplicable is the curious, nervous twitching or shaking of the fore legs. Very often they would escape observation were it not for this conspicuous

habit. First one, then the other fore leg is lifted, rapidly shaken or trembled and lowered to the ground again. This may occur when the lizard remains in one spot, or a shake may be given between each slow step. It has nothing to do with the alternate scratching or digging movements of *Ameiva*, and as far as I know, does not occur in any other genus of lizards.

In addition to feeding on the ground *Cnemidophorus* will now and then pursue an insect several feet up a low shrub. Not infrequently it will also leave the ground for another purpose. I have seen them a number of times flattened on the branch of some fallen tree, head, body and tail close to the bark, with all four legs lifted and spread out in mid-air. If we disregard the slender limbs, the general effect is of a short, green and brown snake asleep on the branch. The lizard is not asleep but it invariably chooses a spot in full sunlight and may lie there motionless for an hour at a time, or until the sun goes behind a cloud.

Fear, in these lizards, is developed in exact ratio to size. It is easy to creep up in full view of a small individual, to within three feet, but the larger the lizard the more distant the deadline which it sets for the approach of possible danger. Young lizards also recover from sudden fright sooner than their larger fellows. Seconds may mark the time of passing of suspicion in youngsters, while adults will remain motionless and on the alert for several minutes.

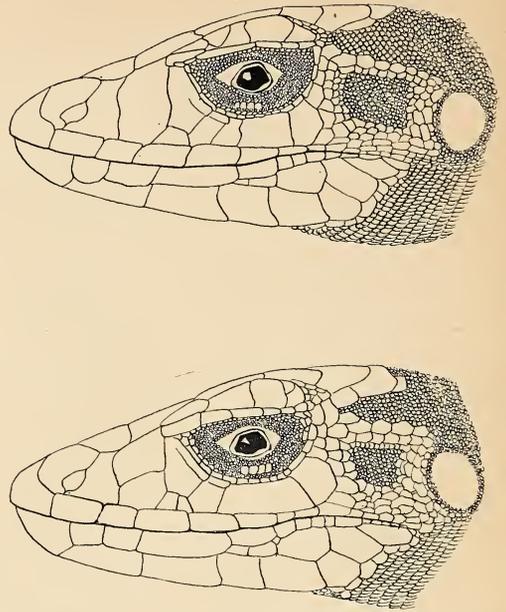
Detachment, loss and subsequent regeneration of the tail is as effective in *Cnemidophorus* as in other related lizards. Usually if shot, or if the creature is grasped awkwardly in the hand, the tail breaks off and if free, goes through a period of violent activity, wriggling about and snapping clear of the leaves, gradually weakening and, as far as appearances go, expiring. The curtailed owner, meanwhile, according to circumstances, either rushes to safety within its hole, or creeps quietly beneath a leaf or other protection. Again and again, when I had not seen the escape of the lizard I have grasped at the rustling disturbance to find only the nervous tail in my hand.

Three times I have seen in this species a peculiar semi-detached condition of the tail, with interesting effects lasting from several seconds to a full minute. When from a single dust shot or otherwise a lizard has been slightly wounded in the tail the motor control over that member is lost and although at my approach the lizard may wish to remain motionless, his tail has become a separate entity as regards activity, and wriggles about frantically, wholly regardless of the desires of its owner, sometimes actually knocking him over and tossing him

about. On two occasions with a violent twist the lizard managed to free himself from his unruly tail, and rushed off, probably more frightened than he had ever been. The tail continued to rustle and flop about, making a great racket among the dry leaves, and accomplishing its last duty, perhaps a more important one than it had ever fulfilled. On the third occasion the tail refused to desert its owner, or, more scientifically, the muscular attachment was too strong to be broken, and when last seen was giving a final wriggle, rather impeding the progress of the lizard as it fled down its hole.

An instance of a still slighter wound, but one sufficient to stir up reactions more appropriate to more serious conditions, is to be seen in Plate II, Fig. 4, where a diminutive new tail has sprouted from near the tip of the original tail of this female.

Size: As regards size, the females average about three-quarters as large as the males (measurements of 102 individuals, all with perfect tails, gave 73.5 per cent. The average of males were 260 mm. in total length; females 191 mm.) Different aspects of relative size were apparent when total lengths were compared of breeding versus non-breeding males and females. Breeding males are without exception the individuals of largest size, averaging 285 mm. as compared with 253 mm. of non-breeders. But non-breeding females averaged 202 mm., while females in full breeding condition showed an average of only 175 mm. total length. My breeding female *Cnemidophorus* at Kartabo were all taken in the long rainy season, May, June and July. If another brood of females of different age should come into breeding condition at the time of the short rainy season, this linear anomaly might be explained. (Text-fig. 7).



TEXT-FIG. 7. *Cnemidophorus lemniscatus*. Right and left side of the head of one individual, showing asymmetry of scalation. Spec. 30,284.

Weight: The weights of male lizards range from 2.2 grams for a youngster of 140 mm. (body length 43 mm.), to 19 grams for a breeding male of 290 mm. (body length 89 mm.). When a large number of males, all with perfect tails, are compared, their weights reveal several distinct nodes correlated with growth. A 150 mm. lizard weighed 2.4 grams; lizards from 205 to 230 mm. averaged 6.6 grams; those from 250 to 270 mm. averaged 12.1 grams, and the largest ones from 280 to 290 mm. showed an average weight of 17 grams. The curious

MEASUREMENTS, AS SHOWN BY PERCENTAGES OF TOTAL LENGTH.

Cat. No.	2972		2986		2956		2968	
Sex	Male, juv.		Male, br.		Male, br.		Female, br.	
Total Length	148		290		280		197	
Head	12.5	8.4%	27	9.3%	26	9.3%	18	9.1%
Snout to Vent	43	29%	89	30.7%	85	30.4%	67	34.9%
Tail	105	71%	201	69.3%	195	69.6%	128	65.1%
Eye Diameter	2	1.3%	3.5	1.2%	3.8	1.4%	2.9	1.5%
Fore Limb	17.5	11.8%	33	11.4%	33	11.8%	28	14.2%
Hind Limb	29	19.6%	63	61.5%	61.5	21.2%	52.5	26.6%

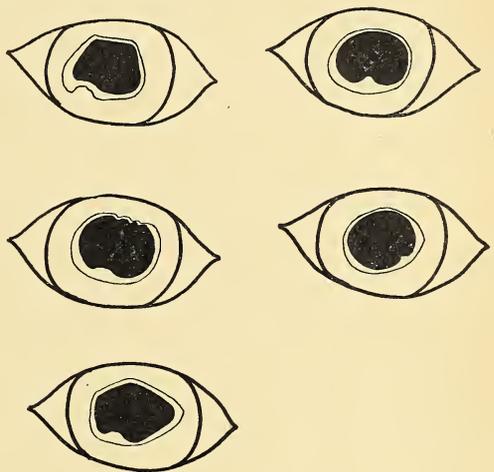
part of this was that there were almost no intermediates connecting the separate averages. In regard to the females, those in breeding condition (which as we have seen are less in size) far outweigh the larger non-breeding individuals. For example, twelve breeding females with an average length of 175 mm. averaged 8.4 grams, while an equal number of non-breeding females with an average of 213 mm. total length, weighed only 6.9 grams.

Color in Life: Any general description must disregard the maze of lesser details of variation which, when hundreds of individuals are examined, would require chapters of endless minutiae. In general the full-grown male *Cnemidophorus* have the top of the head cinnamon brown, the tip of nose and supraocular scales vivid green. The mid- and lower back are divided bilaterally by two longitudinal black bands, fading into cinnamon at the head and merging into the tail on each side. These bands are separated from each other by narrow lines of buff and divided down the center of the back by a broader but less distinct band which tends to divide into two lines on the mid-back. The tail is cinnamon brown with two chief black bands continuing some distance down it as a series of spots. A narrow edge of the ventral tail green is visible on each upper side. The face is emerald green shading into greenish-yellow with canary yellow spots on neck and behind the shoulders. The eyes are rimmed with bright yellow. Sides purplish-gray with bright greenish-yellow spots and single narrow line of greenish-yellow separating them from the black of the back. Chin, throat and breast pale vivid green. Lower surface grayish-white, turning into orange yellow at the sides just in front of the thighs. Vent maize yellow; limbs bright green in front, yellow beneath and neutral brown on top, the legs and thighs spotted with buff.

The head of the females is cinnamon brown, with the mid- and lower back divided by the black bands as in the male, but with five longitudinal bands on each side separated from each other by four narrow lines of buff. The three dorsal bands are black, the fourth and fifth lateral ones are golden brown and less distinct, as is the buff line separating them. Mid-back and upper tail as in male. Face is gray tinged with flesh color. The lower sides with two longitudinal stripes, golden brown behind shoulders. Chin and throat blue-gray, ventral surface maize yellow changing to greenish near the vent. Arms pale blue and greenish-gray beneath. Legs and thighs greenish-yellow thickly spotted with buff. Brownish below.

The coloration of young lizards is ac-

quired soon after hatching and remains unchanged in both sexes up to 80 to 130 mm. total length. The head and throat seal brown. The back with nine narrow, very distinct, longitudinal lines, creamy-white, separated by inter-spaces of black. The central dorsal light line, which is brownish, splits into two halfway down the back but posteriorly is lost at the tail base. The limbs are black dorsally, with numerous creamy-white dots and spots. There is an orange tinge on the sub-ocular and opercular region, absent in the very young. The under parts are clear green, becoming paler on the neck and chin, which are white in very young lizards. From the base of the hind leg a strong ivory white line extends back on the tail, with three fainter lines dorsally. (Text-fig. 8).



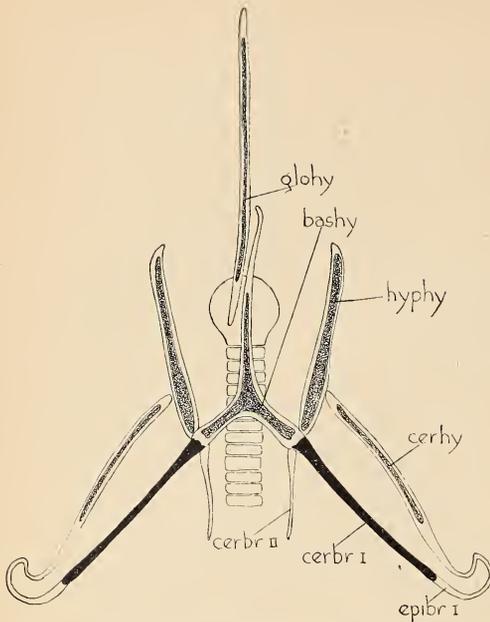
TEXT-FIG. 8. *Cnemidophorus lemniscatus*. Pupil outlines of the eyes of five individuals, showing variation in shape. $\times 4$.

The male *Cnemidophorus* of Caripito seemed generally to be much brighter and especially more blue than green. This may have been due to their occurrence in open country, in low and very open jungle, or actually in the llanos.

As in *Ameiva* the most significant ontogenetic pattern and color change in the present species is a gradual breaking down of the dull dorsal and especially lateral lines and bands into more or less brightly colored spots.

Femoral Pores: There is no appreciable difference in number of the femoral pores in male and female lizards, nor in age, the extremes being 21 and 20, and 27 and 25, on right and left legs respectively. Numerous counts show about one additional pore in breeding males and females over non-breeders regardless of size—scarcely a character of any significance.

Hyoid: KOH No. 2019, Kartabo, male,



TEXT-FIG. 9. *Cnemidophorus lemniscatus*.
Hyoid of adult. $\times 9$.

body length 65 mm., July 8, 1920. Text-fig. 9. The glossohyal extends forward as a slender rod to a distance of 3 mm. It diminishes in caliber anteriorly and half of its length is hyaline tissue, the cartilage core ceasing altogether. Anterior to this basal part is a detached segment, 4.5 mm. in length, with considerable clear tissue at both ends. With the tongue retracted as in the preserved KOH specimens, the two median ends of these glossohyal elements overlap almost half their length, but when the tongue is extended the termini lie end to end, forming a single glossohyal rod of 7.5 mm. This recalls a somewhat similar condition in the hyoid of *Ameiva*.

The proximal end of the tongue element separates into the basihyals, each arm being a single millimeter in length. From the tip of these basihyals we find three arches arising. Directed almost straight anteriorly is a long stout element, the hypohyal, 3 mm. long, with a dense cartilage core throughout. From the outer side of this hypohyal, a full fourth along its length arises, at right angles, the long, slender ceratohyal. Much of the posterior end is free from cartilage and loops about, probably a dim reminder of an epihyal.

From the end of each basihyal fork and continued in the same direction is the long, straight, slender, first ceratobranchial, 3 mm. long, unique in being of actual bone consistency. The distal tip is thread-like and hyaline, perhaps representing the epibranchial, and looping about, actually unites

with the corresponding filament of the ceratohyal, forming a closed visceral arch.

Returning again to the basihyal fork tip, we find a hyaline, tapering, posteriorly directed element, 1.5 mm. in length, representing all that is left of the second ceratobranchial.

Food: *Cnemidophorus* is wholly carnivorous and its food is found on the forest floor and open places, beneath leaves or at most a few inches up among low shrubs. Out of numerous stomach contents analyzed, the food of twenty-five individuals may be taken as representative.

Four young lizards: (1 to 4) 125 mm. or less in length, had eaten the following: 4 small orthoptera, 5 spiders of four species, 1 small grasshopper, 4 small beetles, 3 cricket nymphs, 2 green wire worms. Adult lizards: (5) 1 adult and 2 nymph grasshoppers, green caterpillar, brown spider, iridescent bee; (6) spider, geometrid caterpillar, grasshopper, 2 nymphs of same; (7) 2 wood roaches, grasshopper, orange wasp, robber fly, blue bee; (8) cricket, wire worm, 2 wasps, 3 caterpillars; (9) wood roach, 12 very small spiders and ants; (10) 3 spiders, dragonfly, small crab, grasshopper nymph, 13 ants, small bug; (11) caterpillar, 2 flies, beetle; (12) grasshopper, centipede; (13) 2 heteroptera, cicada; (14) beetle, roach, 2 wasps; (15) snail, 4 chalcids, grasshopper, bee, beetle; (16) ponerine ant, wasp, beetle, spider, caterpillar; (17) 2 hymenoptera, bug, spider, grasshopper; (18) caterpillar, beetle, mole-cricket; (19) long-legged fly; (20) 4 winged ants, 2 spiders, 2 grasshoppers; (21) beetle, 2 braconids; (22) roach, beetle, caterpillar, spider, centipede, flower bud; (23) 2 spiders, beetle, wasp, 6 ants; (24) 12 small beetles, chalcid; (25) Attention was called to a medium-sized *Cnemidophorus* because of its unusual weight. Its total length was 235 mm., yet its weight of 15.5 grams put it into the 285 mm. class of males. The secret of its weight was found to be the enormously distended stomach full of food, which equalled in brilliance of color its unusual quantity. There were three species of coccinellid beetles red, marked with yellow or white, a purple caterpillar, a small skipper butterfly with a gold patch on the wings and a small white moth, several spiders with red or yellow markings, wasps with red abdomens and head and thorax of shining gold, a brilliant yellow and black chalcid parasitic wasp and 3 green-winged grasshoppers.

A summary of the food record of *Cnemidophorus* is shown by a list of the chief ingredients of its diet, arranged in order of times of occurrence:

Beetles (18), grasshoppers (15), spiders (13), wasps (11), caterpillars (7), ants

(5), flies (5), roaches (4), crickets (3), heteroptera (3), bees (3), beetle larvae (2), centipedes (2), snails (2), and one each of the following, tail segments of *Cnemidophorus*, butterflies, moths, membracids, termites, dragonflies, mole crickets, crabs and flower bud.

Breeding: *Cnemidophorus* deposits two eggs at a time. Breeding seems to take place throughout the year, with greatest activity during or at the end of the rainy seasons as shown by the following records: January (1), March (1), May (2), June (5), July (3), August (3), September (1), October (1). Courting was especially noticeable in the months of May and September.

On January 13 I took a female containing two full-sized eggs placed in the oviduct side by side and measuring 7.5 by 16 mm. Ten other minute eggs were in the ovaries, one to two mm. in diameter, showing no signs of immediate development. On June 28 a female contained two half-developed eggs. A female on September 10 had two full-sized but as yet shell-less eggs, each about 10 by 15 mm., one lying in front of the other, distending her body. Two eggs in a female taken October 10 were about to be laid. They were 9 by 16 mm. and development had already begun.

At Caripito a female in captivity laid two eggs on May 21. They measured 8 by 15 mm. In the months preceding the rains, March and April, young lizards of this species were especially abundant.

Euspondylus sp?

General Account: Three specimens are recorded from Kartabo, but all have been lost. The data seem sufficiently definite to include the genus. Twenty-five years ago, in the field, my chief book of reference was Boulenger, and in my Journal I find these specimens named tentatively *Prionodactylus oshaughnessyi* as they were very close in appearance to the illustration in Plate XXI, Fig. 1, although they differed slightly in scalation. My notes were as follows:

Kalacoon, two specimens, one small, 1916. Black band to shoulder breaking up into eight large black ocelli along sides with white centers. Taken in thick jungle.

Specimen No. 198, Male, Kartabo, May 5, 1922. Caught near bamboos in laboratory clearing.

Dimensions: Total length 166.5 mm., head 13, tail 115.5, fore limb 17.5, hind limb 24 mm.

Color in Life: Head mummy brown, upper back umber, the outer and the two central dorsal keels very dark brown, forming four dark lines on the upper surface. A narrow, indistinct line of black from nostril to eye. Upper and lower labials spotted with black.

Upper surface of tail warm sepia. Band of dark buff from eye along back, bordered below by a narrow black line. Beneath this a broad band of red brown, in which are 8 to 10 black-bordered white-centered ocelli.

Below, pale grass green, changing to whitish on the snout. Under surface of tail light coral red, the edges of each scale lighter. Tail nearest the body grass green, each scale with a central black spot. Iris golden brown.

Iphisa elegans Gray, 1851.

(Plate II, Fig. 5).

Name: Red-bellied Skink.

Range: Northeastern South America.

General Account: At Kartabo I recorded three specimens, of which one is No. 21294 in the American Museum of Natural History. Specimen No. 553, female, February 5, 1921, Color Plate 309. Caught in jungle pit.

Measurements: Total length 158 mm., head 10, body 53, eye diameter 2.5, fore limb 7, hind limb 15 mm. Weight 2.8 grams.

Color in Life: Sepia above, which pales on edge of supraoculars, sides of head and body to form a narrow line of tawny olive. Ventral surface orange, deepening to grenadine on chin and orange vinaceous on tail. Iris black.

Specimen No. 638, male, March 22, 1922. Head 10 mm., body 50, tail 47 mm.:

Color in Life: Top of head, back and tail sepia, with narrow, latero-dorsal stripes of clay color. Sides of face, neck and body dusky brown, changing downwards to dark gray. Ventral scales drab gray, buffy on their edges. Chin and alternating ventral tail scales mouse gray.

Kentropyx calcaratus Spix, 1825.

(Plate II, Fig. 6).

Name: Striped Ground Lizard.

Range: Northern and western South America.

Field Characters: A medium-sized lizard of the jungle floor. Male purplish-brown in general, dull green on back spotted with black; female and young with three dorsal bright green lines, green on under side of head and fore body. In captivity this species is much more quiet than *Ameiva* and bites only on extreme provocation.

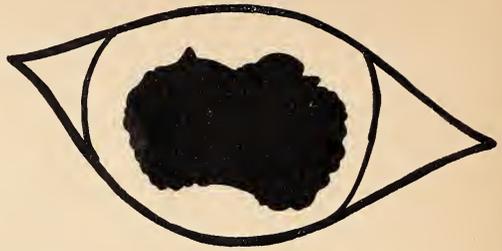
There is little difference in size between full-grown *Kentropyx*. The largest lizard I measured was a breeding female of 93 mm. head and body, and 303 mm. over all; the smallest was a female of head and body 37 mm., and 105 total length. The snout to vent, and the tail measurements varied slightly with growth, a decrease in the former from 35.2 to 30.6 per cent., and an increase of tail length from 64.8 to 69.4 per cent.

The weight of a young female of 130 mm. total length was 23 grams, and that of a 220 mm. female was 26 grams.

Specimen No. 255, adult male, Kartabo, 220 mm. length, December 18, 1920, Color Plate 279. Head dresden brown, lighter on neck, shading backward through greenish-yellow on anterior back to yellow bronze on rump. Eight or nine much broken transverse bands of black extending downward over sides from upper back. A narrow lateral line of brilliant orange yellow deepening to pure orange toward the tail. Below this a wide lateral band of rufous, occupying interspaces between black spots. Lower sides vinaceous fawn with thin scattering of minute black dots, and numerous large, round, greenish-white spots, arranged in eight or nine vertical rows extending down from the rufous band above. Ground color of limbs and tail russet, with black spots and irregular stippling. Sides of face dark tawny. All labials and sides of neck light purple gray, shading on chin and throat to pinkish-lavender. Ventral surface salmon color, darker on tail. New portion of renewed tail black. Iris flame scarlet. Pupil irregular in outline, somewhat hour-glass shaped, with many irregularities in the upper and lower pupil rim.

Specimen No. 203, young female, Kartabo, 105 mm. length, April 21, 1919. General color above black, striped narrowly with bright green. The green lines down the side of the back change to dull golden orange posteriorly. Front of head, sides and above dotted with golden brown on a green background. The latter color extends down the back of the neck and the mid-back changes to amber brown and dark chestnut on the tail. Lower chin and neck as far as angular fold, upper labials, sub-oculars and as far as tympanum and down the sides of the neck bright green changing into clear yellow-green. Upper surfaces of thighs and arms spotted with amber brown. Below, arms bronzy green, the rest of the ventral surfaces reddish-green. Pupil slightly irregular above and below, freckled orange-red.

Eye: In asymmetry the iris and consequently the pupil of *Kentropyx* are very close to *Ameiva* and approximate *Tupinambis*. (Text-fig. 10). No two are exactly alike. The adult male has a wide inner iris band of flame scarlet around the irregular inner border. The entire inner rim is irregular, lacking the even circular shape of the ordinary pupil. Above and below there are more or less deep nicks, usually an even concavity below, and an irregular outline above. At death the irregularities persist but to a less degree than in life. The iris in the young lizard is black, changing to orange in the female.



TEXT-FIG. 10. *Kentropyx calcaratus*—Pupil of eye showing irregularity of outline.

Breeding: Specimen No. 2704, taken April 18, 1924, and measuring 303 mm. in total length, contained four eggs almost ready to be laid. They were broad ovals, soft shelled, 9 by 17 mm.

Food: Three stomachs showed nothing but insects of various kinds, especially ants, termites and beetles.

Kentropyx intermedius (Gray, 1831).

Name: Striped Jungle Lizard.

Range: Northeastern South America.

General Account: In the field, the lizards collected from 1916 to 1924 were lumped as "*Kentropyx calcaratus*" and no distinction into two forms recognized. The one exception is Specimen Number 207, which was taken at Kartabo, October 1, 1917. It measured 160 mm. in length. In color it was pinkish-brown above with many broken bands of dark brown which became spots on the tail. A broad band of black extended from the eye down the sides of the body bounded by two pale lines. The head and neck were greenish on the sides, the sides of the body chestnut brown. Below, the head and neck were whitish, the body and tail pinkish-gray.

K. intermedius is far from rare, as sixteen specimens have been separated from the general collection of lizards of this genus taken at Kartabo. These are in the American Museum of Natural History and the Georgetown Museum.

Leposoma percarinatum (Müller, 1923).

(Plate III, Fig. 7).

Name: Dwarf Spiny Lizard.

Range: Northeastern South America.

Occurrence: This is a common species both at Kartabo and Caripito, on or under leaves in the jungle, chiefly nocturnal. It escapes by a sudden burst of speed or by hiding under the leaves.

General Account: This is a small (maximum length ca. 100 mm.) active, spiny-scaled lizard of the jungle floor. It is chestnut brown above with broad black lateral band.

These little lizards are seen occasionally

creeping over the leaves in the jungle but usually they are nocturnal. This is shown by the fact that out of 23 taken at Caripito, 14 had fallen at night into our pits. Apparently they travel less widely after the rains begin, as we took fewer then. Once, in mid-March, I found four close together under bark.

Their usual gait is lizard-like, but when alarmed they progress by short quick jerks, stopping now and then to examine any object of suspicion. In a pit these lizards would dash across the circular meter of floor so fast that the eye lost them completely except at start and finish. I have seen no animal which can equal this burst of speed. Among a tangle of moss and leaves when only somewhat alarmed, they writhe and wriggle their way, quite without help from their limbs.

Measurements: From a young female of 52 mm. total length to a breeding female of 80 mm., the relative length of the head plus body increases from 36 per cent. to 42.5 per cent. of the total length. The tail under the same circumstances shortens from 64 to 57.5 per cent. The fore limb averages 12.5 per cent. of the total length, and the hind limb 17.5 per cent. The weight of *Leposoma* varies from .85 of a gram in an 80 mm. lizard to one gram in a specimen of 92 mm.

Color in Life: Specimen No. 2965, female, length 52 mm., March 11, 1924, Color Plate 766. Dorsal surface entirely covered with chestnut brown, beginning above the tympanum, narrowing above shoulders, widening on mid-back and gradually disappearing on the tail. This dorsal brown is bordered below with light vinaceous buff in the form of a strong but narrow stripe, strongest on the forward half of the body. Top of head clove brown, pinkish at snout. Beginning back of tympanum, the sides are covered with a broad band of brownish-black, extending from the dorsal band to a broken edge on the lower sides or upper abdomen. Sides of neck mottled with brown. Labials pinkish-gray with large irregular black blotches which increase in number posteriorly, and merge below the tympanum into the lateral band. Limbs above brown with scattered spots of pale sandy. Tail brown, any renewed portion being black. Chin and neck dull flesh color with purplish tinge. Remainder of ventral surface deep olive buff, reddish under shoulders and yellow at vent. Iris very dark brown with a wide pupil rim of orange rufous, sometimes heightened to scarlet.

In Specimen No. 512, breeding female of 92 mm., taken June 19, 1919, there are six black bands which radiate downward from the eye and nostril regions, crossing both

lips on to chin shields. Aside from this regimenting of the labial blotches, the pattern and color are as in No. 2965.

A breeding female taken at Caripito, No. 30268, April 1, 1942, showed an orange band from eye back to mid-body, and below it was amber.

Food: The following were the stomach contents of four individual Kartabo lizards: (1) 4 small craneflies; (2) 16 springtails, homopteran nymph; (3) five termites; (4) two termites, four ants and a small caterpillar. A Caripito specimen had eaten a spider, roach and beetle.

Enemies: I found one medium-sized *Leposoma* lying dead at the edge of the jungle, showing no cause that I could discover. I caught a second under bamboos trying in vain to escape from army ants, two of which were clinging to its body and would soon have killed it.

Breeding: Specimen No. 512, Kartabo, June 19, 1919, 92 mm. in length, contained two eggs, lying alongside one another, ready to be laid. They were broad ovals, 4.5 by 8 mm., the shell deeply and irregularly corrugated longitudinally.

An egg found in a vivarium containing four *Leposoma* females was 3.8 by 8.5 mm. oblong with blunt, equal ends, and numerous longitudinal striae.

On March 6, 1922, at Kartabo, four eggs were found in groups of two, ten feet apart in leaves and other forest debris close to a fallen tree. The two sets differed somewhat in size and this was found to correspond with the development, those about to hatch being 7.5 by 9.8 mm. The shell was leathery, fairly soft, ivory white and covered with very fine striae as in the above eggs.

Of the set of smaller size, 6.5 by 8.5 mm., a contained embryo was 25 mm. long, pigmentation just beginning on the scales, head and snout very short and obtuse, limbs translucent so that bones and blood vessels were visible. On the tip of the tail was a curious persistent transparent extension of tissue resembling a fin of sorts.

On March 7 one of the first set of eggs hatched. The lizard was 40 mm. over all, the tail 23, and in general pattern and coloration identical with full-grown *Leposoma*.

At Caripito a lizard, No. 30072, was taken on April 28 in a pit and on the way to the laboratory deposited two eggs in a vial. The female measured 86 mm. over all; the eggs were 3.5 by 6.5 mm. Their unusually small size may indicate that eggs may gain in diameter by water absorption after deposition.

Neusticurus rudis Boulenger, 1900.

Name: Brown Water Lizard.

Range: Northeastern South America.

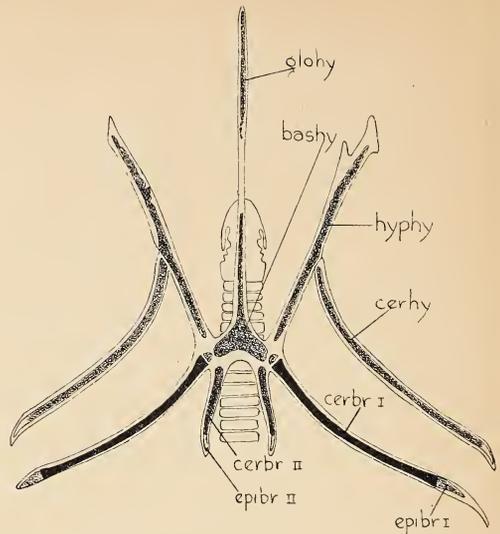
Occurrence: A rare lizard, of which I have notes on only five specimens at Kartabo and none at Caripito. It lives in holes in the banks of jungle streams and rivers and is a swimming lizard.

Measurements: Specimen No. 2638 with perfect tail, female, March 9, 1924, showed the following dimensions and percentages in total length. Total length 180 mm., head 15.5 (8.6 per cent.), head and body 60 (33.3), tail 120 (66.7), fore limb 23.5 (13) and hind limb 30.5 mm. (17 per cent.). The lizard weighed 4.5 grams. The largest lizard taken was No. 75, a female, with a total length of 235 mm.

Color in Life: Anterior head and face cold gray. Upper parts reddish-brown with wide, dark lateral band. The dorsal red is blotched with black and the lateral band spotted with whitish, sometimes so profusely that their color obscures the ground color. White below except for the tail which is brown like the upper surface. The tail is flattened and the lines of dorsal heavily keeled scales give it the appearance of a diminutive crocodile. Three supraborbital and a single suborbital spot bright mustard yellow.

Eye: The asymmetry of the iris puts this species in the same category with *Ameiva*, *Kentropyx* and *Tupinambis*. The background of the iris is black, densely freckled with brilliant apricot orange and with a thin line of the same color around the inner rim. In small specimens the iris color may be apricot buff. The pupular edge is circular except for the upper-anterior portion, beginning at the zenith and extending forward for about 80 degrees. In this area a large curved projection, brilliant apricot orange in color, cuts deeply into the pupil circle and there are several toothed irregularities on each side. In one individual there were three small nicks in the lower portion of the pupil profile.

Hyoid: Coll. No. 75, Kartabo, female, KOH 2036, total length 235 mm., July 11, 1920. Text-fig. 11. The glossohyal consists of a very long, slender rod of cartilage. Just posterior to the glottis the spongy core vanishes and the hyaline rod becomes very attenuated but does not break as it does in *Ameiva* and *Cnemidophorus*. Anteriorly it increases in diameter and density again, ending half-way to the tip of the tongue. Posteriorly the urohyal bifurcates into the basihyals which form two, thick, short, truncated branches. The blunt tips of these form the point of attachment for three arches. Anteriorly the hypohyals extend obliquely outward, forming almost straight rods. The hyaline cartilage case widens in the distal half and a short distance from the tip of the left hypohyal there arises, on



TEXT-FIG. 11. *Neusticurus rudis*. Hyoid of adult. $\times 4$.

the inner side, a well-marked branch of unknown nomenclatural derivation. This is absent in the right hypohyal. The tip ends in an oblique, broad shoe. One-third of the distance from the base, a small, lateral, outwardly pointing process forms the point of attachment for the long, posteriorly and outwardly curving ceratohyal. The hyaline envelope of these elements widens somewhat distally and the rods sweep backward for a long distance, paralleling and gradually approaching the ceratobranchials. The end is free and possesses a very short curved tip.

The second attached element, at the bifurcated ends of the basihyals, is the elongated ceratobranchials of the first branchial arch. These are the most distinctly and strongly ossified elements of the entire hyoid structure, and each lies in paralleled proximity to the ceratohyals. The body core ceases abruptly near the extremity and gives place to an elongated phalanx-like bit of dense cartilage, and this in turn to a final curved claw of hyaline tissue. This latter may represent a vestigial epibranchial. Between the distal end of the basihyals and the proximal end of the ceratobranchials lies an isolated cartilage cap, perhaps all that is left of a hypobranchial.

The third element arising from the basihyals is the ceratobranchials of the second branchial arch, two short, straight, backward-pointing cartilaginous rods which end in a segment of hyaline cartilage.

Measurements: Total length of glossohyal 10 mm., basihyal 1.5, hypohyal 7.1, ceratohyal 8.2, first ceratobranchial 8, second ceratobranchial 2.8 mm.

Food: Two stomachs were examined. One contained a small unidentifiable poeciliid fish and the remains of 2 tadpoles. The other had many small fish scales, a water beetle and the chewed remains of at least three tadpoles.

Enemies: My only record is an indirect one. *Neusticurus* Number 78 was picked up on the ground near the laboratory, freshly killed, still bleeding, with the left hind foot and the tail bitten off. It may probably have been dropped by a hawk but this is only a guess.

***Tretioscincus bifasciatus* (Dumeril, 1851).**

Names: Blue-tailed Skink. Lucia (Venezuelan name).

Range: Northeastern South America.

General Account: Rather uncommon. Captured or saw only five or six at Kartabo and the same number at Caripito. This lizard is terrestrial and lives usually in fairly open jungle under leaves and fallen logs. Occasionally comes into the laboratory.

Measurements and Color in Life: Specimen No. 30,110, Caripito, May 18, 1942, Color Plate 1577. Total length (renewed tail) 115 mm., head and body 50, tail 65 mm. Body above in general black, with two lines of creamy white, and tail brilliant cobalt blue. The two upper white lines extend around the tip of the snout where they are reddish-buff, changing gradually posteriorly to cream and finally to white, and at the tail merging into the bright blue. The center of the head above is rufous changing on the back into black and persisting on the tail as a median band of black dying out half-way down the tail. The sides of the head and body are black. This bounded below by a second pair of bluish-white lines, beginning on the upper labials, and widening into a strong white band from the ear to over the shoulder and from here below the lateral black, becoming an interrupted line of short white dashes to the thigh. From the lateral narrow white line to the mid-abdomen, the scales are first black with narrow edges of bluish-white, and from this first line downward there is less and fainter black and more blue. Below, chin and throat immaculate bronzy white, chest and abdomen bluish-white. Iris black.

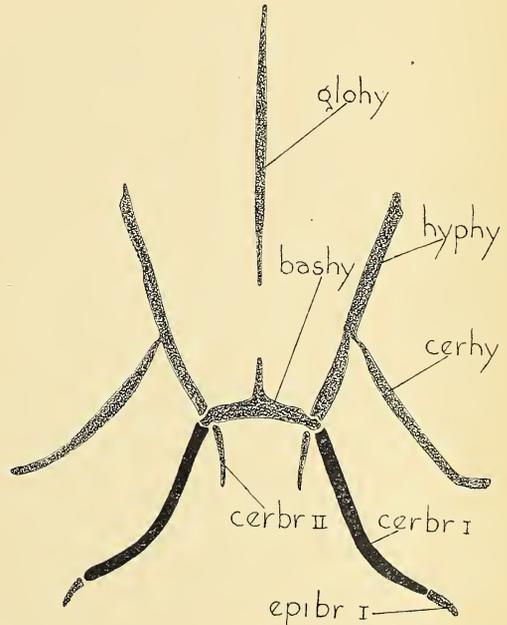
The terminal 35 mm. of the tail is regenerated growth. The last original segment contains a circular count of 25 scales. The first regenerated segment has 29 scales.

Another specimen, No. 30,127, has 45 mm. of new tail. The junction as to size is perfect, but the last original segment shows a circumference count of 12 scales, while the first renewed segment touching it has 24 perfect scales. The dorsal black line stops at the break but the pale ventral areas are

reproduced as in the original appendage. This specimen has a total length of 140 mm. and weighed 6 grams.

Another specimen, No. 30,127, taken June 2, 1942, at Caripito, has the two uppermost dorsal lines bright gold instead of creamy white. The same is true of Specimen No. 729, Kartabo, Color Plate 531.

Hyoid: Spec. 30,127, KOH 2,508, Caripito, June 2, 1942, total length 140 mm. Text-fig. 12. All the hyoid elements except the first ceratobranchials have a loose, granular appearance, with indistinct annulations. The outlines are fairly definite but the caliber varies slightly. The glossohyal is very slender and long, 6.5 mm. over all, with a wide hiatus close to the base. Proximally it joins the basihyals with almost no enlargement. The latter show the merest suggestion of an arch, being in general appearance a heavy, almost straight transverse bar, 1.7 mm. in length, very slightly and shallowly concave below.



TEXT-FIG. 12. *Tretioscincus bifasciatus*. Hyoid of adult. $\times 5.5$.

From the outer end of the basihyals arise, at a 45 degree angle, slender, straight rods, 4 mm. long, the hypohyals, of equal diameter throughout, and with the tips dying out in loosely knit points. Two-fifths from the base of the hypohyals the ceratohyals take their origin at a right angle, the juncture being by a thread-like osseous extension. These have a decided outward curve, and the granular tips show no definite hint of epihyals.

From the ends of the basihyals the first ceratobranchials arise, at a slightly greater than right angle with the hypohals. These elements are 4.75 mm. in length, bent in an outward direction, and of real bony appearance, homogeneous and with firm outlines. Their base occupies the entire truncate extremity of the basihyals, and these bases show a substantial collar, and a definite bony cap. Short first epibranchials are visible. From the postero-external surface of the hypohyals arises a tiny needle of bone, one millimeter in length, all that remains of the second ceratobranchials.

Tupinambis nigropunctatus Spix, 1825.

(Plate III, Fig. 8; Plate IV,

Figs. 9, 10 and 11).

Names: Tegu. Salempenta (British Guiana Creole), Ah-lee-cah-bah (Akawai Indian).

Range: Northern and Central South America.

General Account: Common, by which I mean that when searched for, a tegu can usually be found, both at Kartabo and Caripito. It is terrestrial but with sufficient climbing ability occasionally to obtain food and to nest well above the ground.

The tegu is a large, heavily-built lizard, with considerable pattern and color variation. In general it is black above, spotted and blotched on head and body and broadly banded on tail with bright yellow. Head, body and limbs below straw yellow. The young are banded from nape to tail tip.

Measurements: The tegu is second in size only to the iguana and is much heavier in body than that lizard. The average length of a dozen full-grown males, all with perfect tails, is 757 mm., the largest being 780 mm. Females of the same relative size average 768.3, the largest being in full breeding condition 835 mm., or something over 32 inches over all. Adult males weigh on an average 665 grams, and females 683.4, the heaviest being the large breeding female weighing 910 grams or almost exactly two pounds.

Femoral pores vary in the males from 10 to 12, averaging 11 on each leg, and the females possess from 10 to 13 pores with an exact average of 12.

An adult male shows very slight change in relative measurements compared with a newly hatched tegu or even a late embryo. The percentages of various parts into total length are as follows: Adult male and late embryo, total lengths 730 and 176 mm., eye diameters 1.23 and 2 per cent., snouts to vents 35 and 37.5, tails 65 and 62.5, fore legs 13 and 15, hind legs 25 and 28.4 per cent. We observe only a slight relative in-

crease in size of eye, and length of body and limbs in the embryo.

Color in Life: Late embryo, female, Specimen No. 2784, length 180 mm., April 17, 1924, Color Plates 702, 1110, Photograph 677. In general the color was pinkish-flesh, with all the dark cross bands of the new hatched tegu in very pale gray. The only pattern peculiar to this early stage is an interrupted lateral band of black extending from the eye along shoulder and thigh back to the tail. Another pattern of unusual prominence was four longitudinal series of white dashes down the back from nape to three-fourths the length of the tail.

Newly hatched male, No. 2942, June 12, 1924, length 247 mm., Color Plate 762. Pattern in general: head spotted and blotched; body, limbs and tail crossed with many wide bands of black. Using Ridgway's Color Key, the colors in detail are as follows: Above isabella color on head, honey yellow on anterior back shading to isabella again on lower back, olive on proximal and colonial buff on distal half of tail. Fore limbs deep colonial buff, hind limbs isabella; all toes grayish-olive. Head scales with large patches of very dark brown with dull brown mottlings toward snout. The back has 12 transverse black bands beginning at nape, very irregular, some split on one side. These extend down over sides, narrowing and ending at edge of ventral surface. There are also widely scattered fine spots of empire yellow, which take a vague arrangement of lines down the sides of the dorsal region. The tail has 15 cross bands, the first six narrow, the others gradually widening, the interspaces also widening slightly. The tail bands extend around the entire tail. The limbs are irregularly banded with black, the posterior surface being very dark brown speckled with dark honey yellow. Sides of face in front of eye mottled with light brownish-olive. Broad band of black from and up over tympanum, which is dark gray with a pinkish tinge. Sides of face, back of eye and lower labials with irregular scattered patches of black. Chin ivory yellow, other ventral surfaces barium yellow with scattered, square-edged patches of black. Pupil rim pale gold, very much broken at tip and bottom with large, rough-edged points, with crescent patches of very dark brown each side. Rest of iris dull greenish-white with gray stippling.

Newly hatched female, No. 2943, length 243 mm., June 12, 1924, Color Plate 762. As typical of individual variation in this species, this specimen, which was sister to No. 2942, differed from it in having fewer black spots on the face and none at all on top of the head in front of the orbits. The dorsal bands much more broken. Limb

bandings reduced on anterior surfaces to a few blotches of dark brownish-gray. The whole lizard has a generally greener tone, the snout region being dull citrine, ground color of the body olive, and the tail char-
treuse yellow.

One-third grown male, No. 711, length 295 mm., August 15, 1922. Above black. Edges of head scales, irregular banding on back (broken on neck), fine spots on limbs, tail bandings all light olive green. Upper eyelid, streak under eye, two rows of small dorsal spots and two dorso-lateral rows straw yellow. Side of face mottled olive green, with dark streaks toward tympanum. Lower labials yellow with four strong black spots and another above. Sides of body with mottled bands of empire yellow which become more solid and lemon chrome and finally olive green on tail. Tail deep slate green. Below amber yellow heavily spotted on throat and under arms with black, and with heavy black banding on lower sides of body, thighs and tail. Iris generally dull gray with scattered points of pale gold which are concentrated along the irregular pupil rim.

Male breeding, No. 2961, length 730 mm., June 16, 1924. Black above. Head scales edged with yellowish-green. Sides of snout mottled with olive and dark gray. A dark line backward over tympanum. Ten very faint cross bands on body, faintest on lower back, composed of small, scale markings which become thicker and change to buff on lower sides. Fifteen bands on tail, nine proximal and very faint, six distal widening and changing to dull buffy yellow. Scales on upper limbs deep colonial buff, with black spots which increase and merge with the black posterior region, which is faintly dotted with reed yellow. All toes buffy olive darkened with black scale edgings. Ventral surfaces, picric yellow on throat, lemon yellow on body with scattered black spots. Ventral sides of body touched with lime green. Iris as in young.

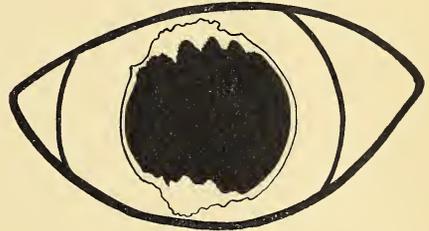
Adult female, No. 3518, length 765 mm., June 22, 1924. Much as in No. 2961, except that the dorsal bands have wholly disappeared, being merely a generally symmetrical scattering of tawny olive spots scattered on the back and the sides of the body into cabalistic markings and forming indistinct bands on the outer sides of some of the ventral scales. Tail bands are indistinct and broken and turned pinkish-buff posteriorly. Ventral coloring much duller, all surfaces straw yellow. A few bluish-gray blotches on chin. Ten bands are barely discernible on the distal half of the tail, but all the proximal area is covered with irregular fine spots of olive.

Adult male, No. 1820, length 745 mm.,

July 28, 1920, Color Plate 147. In this fully adult lizard the numerous black bands on body, limbs and tail characterizing the young, have completely disappeared.

Head black with irregular mottlings of dresden brown. Lower labials and chin shields ivory yellow, faintly mottled with pale blue. Body black with irregular spots of bright cadmium yellow, deepening to water green beneath the tail. Legs and feet black above with numerous spots of honey yellow, deepening to light brownish-olive on toes. Tail with dull patterning of black and dark olive green.

Eye: Details of several irides will be found under color descriptions. Text-fig. 13. The following is typical of an adult tegu. Adult male, length 745 mm., July 28, 1920, Color Plates 147 and 1175. Iris empire yellow and gold, flecked with orange, with jagged, toothed edges at top and bottom of pupil. A narrow irregular rim of gold at sides of pupil, the remainder dark greenish-brown flecked with black. Pupil slightly flattened vertically and irregularly denticulated at top and bottom. This asymmetry is apparent in the newly hatched lizard and there is some variation, but the top and bottom sharp teeth characterize this species.



TEXT-FIG. 13. *Tupinambis nigropunctatus*. Pupil of eye showing irregularity of outline.

Food: The tegu is an omnivorous feeder in the widest possible meaning of that term. No phylum of animals is refused, whether the organisms are small or large, living or long dead. A large number of plants, leaves and berries are taken. I saw them feeding many times on plants which I had thought poisonous. Both in Kartabo and Caripito we found that unguarded hens' eggs, chicks and full-grown domestic fowl are taken at night. In a letter written to me by Mr. Edgar Beckett in 1919 he says, "I know very little about the details of the regular diet of salempentas, but fowls' and lizards' eggs and chickens are favorites. My nephew wounded a plover and as it was only slightly hurt, he tethered it with a string under the house. In a short time he found a large salempenta on the end of the string, having swallowed the bird. The blacks and coolies

have a deep belief that these lizards often disinter shallow buried human bodies and feed upon them. It is quite possible."

A dozen stomach contents will give a cross section of the food of the tegu around the laboratory in the jungle at Kartabo and Caripito. (1) Five large cokeyao berries, young *Cnemidophorus* lizard 175 mm. in length, two small spiders, large tarantula-hawk wasp; (2) Long-horned grasshopper, crab, several dead leaves, six yellow-fleshed fruits; (3) Hair, bones and skin of spiny rat, large beetle; (4) Beetle, roach, three centipedes; (5) Mass of chewed-up insects, leaves, hunting wasp, bones and feathers of tinamou from the laboratory garbage dump; (6) Large red berries, several winged queens of *Cryptoceros atratus*; (7) Skull of jungle mouse, large cone-headed grasshopper; (8) Large *Passalus* beetle, medium-sized *Ameiva*, three seeds; (9) Centipede, grasshopper, small snake; (10) Mass of egg yolk, *Leptodactylus* frog; (11) 18 yellow fruits; (12) Three worker *Nasutitermes ephratae*. (This tegu had just hatched in a termite nest and these insects were eaten before I captured him.)

Breeding: Direct or indirect evidence of six separate nestings of tegus in the nests of termites were found at Kartabo and Caripito. These varied from two feet above the ground to as high as twelve. Five were three to four feet up in low growths. Details of one nesting will be found under the heading General Habits.

On June 16, 1919, our Indian hunter brought in a big termites' nest with six tegu eggs buried near the center. We had to hack and saw the nest material away. In places it was so hard that it seemed like excavating fossils from their bed of rock. The Indian has found as many as 12 eggs in one nest. The eggs were oblong, round ended, the entire shell concealed by a thin, smooth layer of the termite building tissue. Beneath this there was a yellow stain and where the termite material came away clean the white leathery shell was exposed. The whole gave the appearance of a half-scraped nut. The eggs were laid irregularly, some end up, some sideways. Several were touching, others isolated. The weights of three, free from encompassing material, averaged 34.2 to 35.2 grams. In size they measured 36 by 48.5, 36 by 49 and 34.5 by 51.8 mm. The embryos were only slightly developed.

Specimen No. 711, length 835 mm., August 21, 1922, had six enlarged, subequal but shell-less eggs in each of the two ovaries. All would very evidently have matured at the same time. On April 20, 1924, I flushed two mating tegus, which separated at once and tore away at full speed through the jungle. Breeding lizards were found

in April (3 records), May, June (2), and August (2).

General Habits: On April 16, 1924, a nest of four tegu eggs was located in a large termite nest in a bamboo clump about one hundred yards west of the laboratory at Kartabo. The four eggs were visible not more than two inches beneath the surface of the nest. The least touch made the surface swarm with the insects, which were *Nasutitermes ephratae* (Holmg.). Nymphs and adults of the large red and black assassin bugs crawled over the nest feeding on the owners.

The discovery of the tegu eggs was wholly accidental, due to a sudden, severe storm the night before, which so thrashed the bamboo stems about that even near the base the movement was sufficient to split apart a portion of the nest and to expose the eggs. No white shell was visible, only the dark brown nest tissue spread over the vaguely oval forms.

I took one of the eggs but did not disturb the others. A fine mesh wire was then fastened over the whole nest, encircling the stems of the bamboos around which the nest was built. The egg which I took contained a very large embryo with a total length of 180 mm., and only a very small attached yolk sac. The lizard was very lively, opened and shut its mouth and tried to walk about. It was pinkish-flesh color with the dark markings fairly indicated but very faintly. (No. 2784, Color Plates 702 and 1110).

Several times since this April 16th I visited the nest and found the cavity we had made completely filled and resealed by the indefatigable insects. I had estimated that ten more days would have seen the embryo normally hatched and out of its shell, so I naturally expected a corresponding early hatching of the remaining eggs. I found that my estimate was far out. Week after week passed with no indication of emergence. The unnatural drought of this particular March and April lasted until May 11, when the rains began with an equally unusual amount and duration. The rains lasted with but little intermission until June 12, when I visited the nest again. I found that one of the large bamboo stems had broken off and fallen a little from its old position, wrenching the wire open at the point of juncture around the stem, resulting in a good-sized opening more than large enough for a newly emerged tegu to escape to the outside world. Near the bottom, however, I discovered a newly hatched tegu in person, and by closing up one opening and making another I secured it. It attempted to bite but I found that it had little strength, not nearly as much as the jaws of

a *Thecadactylus* or *Polychrus*. It had made its escape when the nest was still uninjured, not through the side way, where three inches would have reached the surface, but through a tunnel straight downward to the base of the nest. This means of egress was fourteen inches in total length and the tunnel was perfectly straight and through some exceedingly hard layers. It was so well-marked and permanent that I was able to preserve a section of it. Digging in I came upon the shrivelled egg-shell, still soft and damp. When I later distended this with cotton to almost normal size its surface was seen to be covered with a number of small round holes which I thought at first had been made by the teeth of the young lizard. Closer examination showed evidences of external gnawing, so it was probable that the holes were gnawed by the termites after the emergence of the lizard. Near the empty shell was another egg, perfect and very heavy, which I took. If this had hatched, the lizard would have been so near the tunnel already made that it would have had little or no excavation to do on its own account. So close together were the eggs that the first tegu to make his way out doubtless does the major part of the work for the rest.

At my desk in the laboratory I noticed that a few drops of yolk were escaping from one end of the whole egg, and found a small hole made doubtless by my tool when I was digging it free. I began to enlarge this and had it half an inch across, when I felt a terrific commotion within the shell and without any warning the enclosed tegu shot out like a catapult from the *opposite* end of the egg, scrambled across my knees and back on the table again where it stood looking around and feeling about with its tongue as if it had had two weeks instead of two seconds experience of life. There was almost no liquid left in the shell and the navel of the tegu was quite dry and hardly at all protuberant. The little lizard eluded my first effort at capture and rushed down behind my desk and behind an upright beam where three of us captured it with difficulty. It tried constantly to bite but could not make any impression on my skin. Its claws, however, were sharp and powerful and when put in a glass dish it struck the sides again and again with its nose and claws. It is probable that these lizards make their way through the tough termites' nest by clawing and by pushing with the head rather than by any use of teeth and jaws.

This egg, five minutes before hatching, weighed 33.3 grams and measured 34 by 52 mm. It was wholly covered with the dark brown deposit of termite building mate-

rial. The shell was soft and leathery and wherever freed of debris was creamy white, with deep, sharply marked, irregular, longitudinal reticulations. The opening through which the lizard escaped was a symmetrical hemispherical slit occupying almost the terminal third of the egg, 20 mm. in width and about the same in height. As there was no sign of an egg-tooth the fracture was probably the result of direct pressure against a normally weakened area. The head was directly against the point of fracture, hence enabling the tegu to keep up its straight away dash, without turning, from the instant of breaking through.

The astonishing viability of newly hatched organisms was plainly shown by the tegu which I found already hatched in the nest. I placed it in 50 per cent. alcohol and after a short period of thrashing about, it sank and remained quiescent for an hour and a half, when I removed it for study. Its eyes soon opened, it began to breathe naturally, and presently it was as strong and as active as ever, quite unaffected by its prolonged immersion. Not until I added the fumes of chloroform did the lizard expire for good. This was a male, No. 2942, length 247 mm., Color Plate 762.

Within a half hour after hatching, tegu number two (No. 2943, length 243 mm., Color Plate 702) began to shed its skin, although when it emerged its colors were bright and clear and there was no trace of the coming sloughing. The shed embryonic skin was as strong and perfect as that of any subsequent ecdysis. The tongue was a decided pink in color and was frequently extruded as in the adults. In a shallow glass dish the newly hatched lizards made no attempt to climb, although an elevation of two inches would have taken them over the edge. They strived only to force their way downward or straight ahead. This is rather significant in connection with the fossorial habits of the adults. There was a considerable difference in coloration in the two young tegus and the pattern also was unlike (See under Coloration).

***Amphisbaena alba* Linnaeus, 1758.**

(Plate V, Figs. 12 and 13).

Names: White Burrowing Lizard; Double-ender Snake, Blind-eyed Snake, Cushie-ant Snake (Guiana Creole Names); Poong, Arrawhy-oo (Akawai Indian name).

Range: Tropical South America.

General Account: These lizards are not uncommon both at Kartabo and Caripito, but are seldom seen except during heavy rains or when uncovered by digging. They live beneath forest debris or down one or two feet in the ground, and also in the nests of attas and other ants.

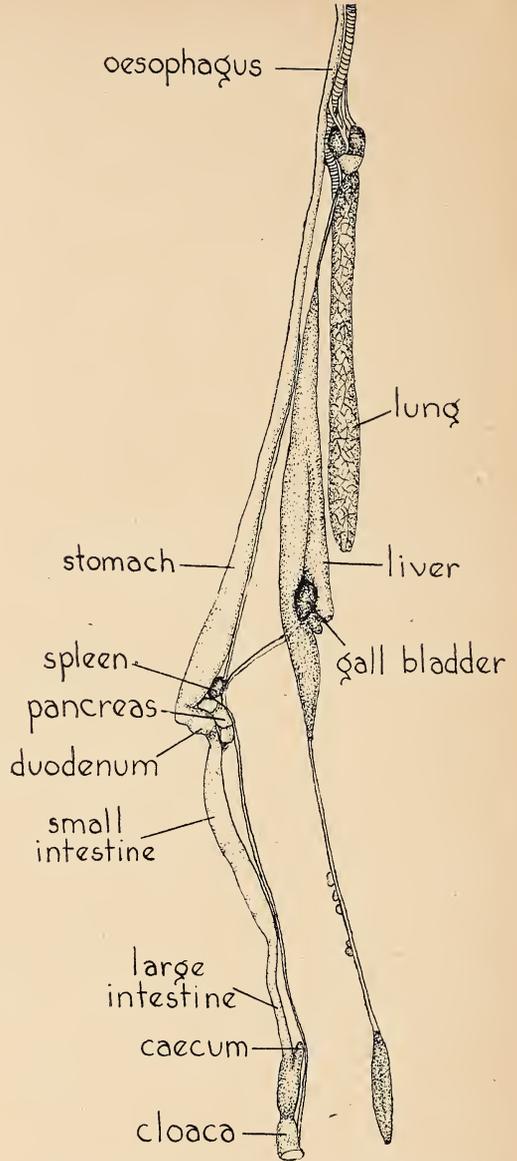
They are legless, snake- or worm-like lizards, growing to two feet in length, thick bodied, cylindrical, with minute eyes, equal ended, and are dark brown above, shading to creamy white beneath.

Specimen 346 was caught while crossing a jungle trail in the rain. Its reactions, strength and other characteristics are similar to those of *A. fuliginosa*, except that its mode of progression is in a straight line and not curved or bent. On a smooth board its rate is rather slow, but on earth, moving from an open space toward shade, it made three successive meters in 23, 16 and 13 seconds respectively.

When progressing steadily, the slightest touch anywhere on the body causes an instant reaction, comparable to a steel spring. The head and the head-like tail are raised at the same angle and to the same height, the body at this moment being stretched out straight. With not a fraction of a second's delay the final position between the two extremes is attained and held motionless. This is slightly bowed with the two ends raised, the body in striking position and after the confusing double flexion has been completed it is very difficult to tell which is head and which tail, and the same must apply to any enemy not familiar with the anatomy of the creature. The shape, contour and pigmentation of the head, and even a small dark spot simulating the eye characterize the tail.

When progressing, three waves of undulation of about twenty segments each, are plainly visible. The tail, however, takes no part in this function, and remains steady, being dragged motionless along, awaiting its important part the moment the body is touched, or the lizard alarmed. After the curved, frozen position of alarm, the first motion discernible is in the tail which is slowly lowered and appears to feel about, exactly as does the head in serpents.

Specimen No. 30,185 was taken at Caripito June 13, 1942, in Pit Thirteen. I find the following notes: Tried now and then, when handled, to twist and bite. Was exceedingly powerful especially in pushing ahead, lifting up the copper wire on its cage, supporting itself on the posterior fifth of its body, and even wedging partly through half-inch soldered wire mesh, until ten bricks were piled on top. It escaped three times and travelled in an absolutely straight line down the long corridor of the laboratory to the darkroom. The successive waves consisted of twenty segments each alternating with twenty quiescent segments. In sun after being handled and photographed, it steadily attempted to escape, occasionally lifting the tail alone and progressing backward with as great facility as ahead. In the



TEXT-FIG. 14. *Amphisbaena alba*. Gross anatomy.

pit at time of capture it began boring into the side, so swiftly that I just saved it by getting hold of the tail. It took all my strength gradually to drag it out. Even in hard clay its hard skull and powerful muscles allowed it to drill steadily by sheer force.

Measurements: Specimen No. 346, male, Kartabo, June 13, 1920. Measurements—actual and in percentage of total length, as follows: Total length 480 mm., snout to vent 441 mm. (92 per cent.), tail 39 (8), body depth 12.5 (2.6), body width 18 (3.75), body annuli 220, tail annuli 21, mid-body segments circumference 73, dorsal segments

31, ventral segments 42, preanal pores 8, weight 83.9 grams.

A female of 540 mm. total length showed the same relative figures as to body, tail, segments and annuli, but possessed ten instead of eight preanal pores, and weighed 143.2 grams.

Color in Life: Specimen No. 346 had the snout back to the eyes and the chin shields pale pink. Above dark brownish-yellow shading to old ivory below, the tail mottled with dead white. Eye showing pink beneath its scale.

Gross Anatomy: Coll. No. 346, Kartabo, June 6, 1920. Text-fig. 14. The oesophagus is extremely elongate, opening into a long stomach which is constricted at the pylorus. The duodenum is slightly enlarged as it leaves the stomach, then constricted into an hour-glass shape, giving the entire organ the appearance of a tiny gizzard with a large proventriculus. The pancreas is small and short. The bean-shaped spleen is placed above and just touching the pancreas. The small intestine is not looped though somewhat twisted, and there is a small caecum at the beginning of the rectum. A constriction occurs between the rectum and the cloaca, the latter organ being enlarged. There is one lung.

The liver is extremely long, running to a fine point at both ends, connected to the heart by the post-caval vein which is very large. The liver is single lobed, but running from the gall bladder anteriorly is a shallow crease or groove in the tissue of the organ which gradually dies out. This probably represents the only separation into right and left lobes. The gall bladder is large and oval. Measurements: total length 480 mm., weight 83.9 grams, liver 1.8 grams, lung 151 mm., small intestine 118, large intestine 22, duodenum 8.5, spleen 6, cloaca 18 mm.

Food: A thirteen-inch specimen had eaten a mole cricket, grasshopper and three termites.

***Amphisbaena fuliginosa* Linnaeus, 1758.**

(Plate V, Figs. 14 and 15).

Names: Black-and-white Worm-lizard; Two-headed Snake, Cushie-ant Snake (Guiana Creole names); Poong, Arra-why-oo (Kawai Indian).

Range: Tropical South America.

General Account: This is a common species, both at Kartabo and Caripito, more frequently seen in daylight above ground than *A. alba*. At night or in heavy rains it may be met crawling about the forest floor or open trails. More often it is dug up in sub-soil depths of six inches to two feet, and is also found in ant nests. It is a burrowing, legless lizard, dark brown or black

above, pale below, both colors encroaching more or less on opposite areas in narrow, shorter or longer circumferential lines.

This specialized lizard is exceedingly powerful for its size, twisting with great force when held in the hand, and if held loosely revolving rapidly attempting to bite. It can seize and bite through several thicknesses of paper. One which seized the side of my thumb drew blood at once and the jaws had to be pried open with forceps. The tail is stronger than the head and when looped over a support the animal can hang suspended by the tail for some time, feeling about in mid-air with its head for support.

Like *A. alba* it progresses by successive annular undulations, worm-like, keeping, however, a permanent bend in the body which increases its leverage so it can make faster speed. When touched or suddenly alarmed, the movement changes to a lateral serpentine progression for a few seconds. It feels constantly about with its tongue.

Measurements: As extremes taken by us, Specimen No. 30194 was 180 mm. and No. 935 was 412 mm. over all. In all sizes the ratio of tail to head and body is 13.5 per cent. The relative weight ratio to length is almost the same at all ages. A specimen of 180 mm. in total length weighed 9.6 grams, 300 mm. weighed 16 grams, 355 mm. weighed 20 and a 401 mm. specimen weighed 24 grams.

Color in Life: The pattern and coloring of this species are wholly unlike those of *A. alba*. The latter is dark above the pale beneath, but dorso-ventral transition is even and gradual. In *fuliginosa* the boundary of pigmentation is controlled by the annuli and the segments, and there is presented a bewildering variety of patterns, always, however, dominately darker above and lighter below. In the majority of individuals the head is immaculate, with an irregular dorsal patch around the eyes in about 40 per cent. Brief descriptions of several lizards both from Kartabo and Caripito, together with the illustrations, show these variations.

Color Descriptions Showing Variation: Specimen No. 3268, Kartabo, length 220 mm. Head and first two annuli white except for wide interorbital band of pink. Black above with scattered pink, no long lines, almost all flecks. Below pink with many cross lines of black, mostly single but many of these crossing mid-line.

Specimen No. 2941, Kartabo, length 225 mm. Dominately black above, white below. Head, chin, throat and two annuli white except for an irregular black patch on mid-snout, between eyes and on right side above, behind eye. Black above with numerous flecks, single, double and triple short linear

intrusions of dorsal black, but almost never across.

Specimen No. 3254, Kartabo, length 230 mm. Head, above and below, and four annuli salmon. Above black with short dashes and flecks very abundant. Below salmon pink, with sparse scatterings of single linear intrusions, six across mid-line in isolated places.

Specimen No. 237, Kartabo, length 320 mm. (before tail was broken). Head pink back to first annulus above, third below; the dorsal mark a small central triangle on middle of second and third annuli. Above black, broken by occasional cross lines and many shorter ones of pink. Below same, with colors reversed, pink crossed by black. A decidedly black amphisbaenan, lined and cross-lined with pink.

Specimen No. 935, Kartabo, length 412 mm. (before tail was broken off). Head, including first annulus, chin and throat white. Above dominantly brown with many irregular lines and flecks of ivory white, many extending clear across. Below same, with colors reversed, many extending across.

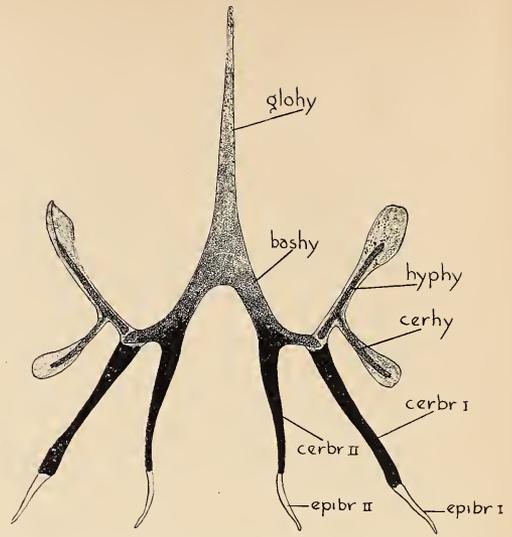
Specimen No. 30,194, Caripito, length 180 mm. Head back to fourth annulus, chin and throat immaculate. Above blackish-brown, with many flecks and short lines. Below white, unspotted. Dorsal black visible as short lateral lines here and there, crossing mid-ventral only four times under tail.

Specimen No. 30,269, Caripito, length 280 mm. Above dark brown with many annular lines of white. Head to third annulus white, with irregular blotch between eyes. Below scattering of single or rarely triple pigment ends of dorsal brown, crossing in mid-line only on twelve annuli under tail.

Specimen No. 30,153, Caripito, length 286 mm. (when alive before breaking off of tail). Above black with few scattered flecks of ivory yellow. Head and first two annuli with large irregular blotch on top of head from mid-snout to back of eye. Below chin and throat white. Black encroaching in many single, double and triple annular streaks, leaving narrow interspaces of yellowish. In only three places extending across mid-ventral lines. Pores right 3, left 4.

Eye: The small and deep sunken eye is merely a dim spot of pink with a faint central dark speck of a pupil.

Hyoid: Text-fig. 15. The glossohyal is long and tapering, about 4 mm. in length, ending anteriorly in a blunt point while posteriorly it widens gradually and merges into the basihyal arch. These are stout, branched elements, and each limb expands behind into an outwardly directed, flat-bottomed shoe. From the tops spring the hypohyals at about 50 degrees in a forward direction. The osseous part of this element



TEXT-FIG. 15. *Amphisbaena fuliginosa*. Hyoid of adult. $\times 7.5$.

is a straight rod, but it is surrounded by translucent cartilage-like tissue which expands distally into a wide fin extending well beyond the tip of the hypohyal core. This terminal expansion of the left hypohyal differs considerably in shape from its opposite fellow. Posteriorly and about one-quarter out from the origin of the hypohyal arises, at right angles, the short ceratohyal, of the same shape and three-fourths as long as the hypohyal. This too is surrounded, except at its base, by a wide fin. The hypo- and ceratohyal cores are united, but the former is distinct from the shoe tip of the basihyal. From this latter juncture the first ceratobranchials extend obliquely backward for about 3 mm., rather stout rods, ending in long, slender first epibranchials. From the inner portion of the basihyal shoes and continuing the limbs of the arch, the second ceratobranchials take their origin, more slender than but equally long as the first ceratobranchials, and also bearing well developed second epibranchials.

Food: The contents of four stomachs were as follows: (1) Mole cricket, grasshopper nymph, 6 ants; (2) 2 beetles, cricket nymph, 2 termites, many small bits of quartz; (3) 10 ants, 11 termites, roach, many transparent bits of quartz; (4) 15 termites, wire-worm, 2 rootlets.

Mabuya mabouya mabouya (Lacépède 1788).

(Plate V, Fig. 16).

Name: Brown-lined Skink.

Range: Mexico and the Lesser Antilles south to Boliva and Brazil.

General Account: These skinks are occasionally seen or captured but they are so

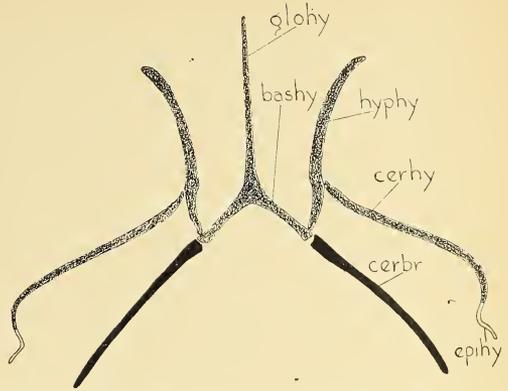
protectively colored that they are probably more common than observations would indicate. They are terrestrial inhabitants of the jungle floor. Characteristically their scales are smooth and flat. Above they are olive with a bronze sheen and a broad, dark brown lateral band extends from snout to tail, bordered below with pink. The under parts vary from sea green to sulphur yellow.

Measurements: In size these skinks range from the 91 mm. total length of a new-born individual to a female of 265 mm. over all. The weights of the same two lizards were 1.2 and 21.5 grams. Dimensions in percentages of total length (tails perfect) of a day-old male and its female parent are as follows: Total lengths 91 and 245 mm., head lengths 9.1 and 8.8 per cent., snouts to vents 45 and 42, tails 55 and 58, fore limbs 13.7 and 10.6, and hind limbs 19.8 and 14.5 per cent. This comparison shows a slight relative reduction in head and body length in the adult, and a greater reduction in lengths of fore and hind limbs (3.1 and 5.3 per cent.).

Color in Life: Specimen No. 223, male, length 150 mm., July 24, 1920, Color Plate 179. Head at snout deep colonial buff with over-sheen of citron green, deepening posteriorly through pale mustard yellow and old gold with over-sheen of tawny, to light yellowish umber, and finally on the tail to dark olive with over-sheen of olive green. Wide lateral band, from just in front of the eye backward, sooty black with narrow, broken inferior stripe of cream color. Side of face pale orange yellow. Upper labials shell pink with over-sheen of deep seafoam green. Lower labials chartreuse yellow, fading to pale sea green on throat. Ventral surface pale sea green deepening to dull blue-green. Iris dark brown.

A second lizard, No. 1923, male, had the under parts sulphur yellow.

Hyoid: Spec. 953, KOH 2509, Kartabo, September 9, 1922. Text-fig. 16. As in *Tretioscincus* all the hyoidean elements of this species, except the ceratobranchials, are of loose, granular structure. The slender glossohyal narrows throughout its length, and is 5.25 mm. long. It forms an exact triangular figure with the basihyals, the three elements being of equal diameter at their point of origin. Each arm of the basi-



TEXT-FIG. 16. *Mabuya m. mabouya*. Hyoid of adult. $\times 4.5$.

hyals is 2 mm. long. From the anterior side of the tip of the basihyals spring the hypo-hyals, extending forward almost parallel to the glossohyal, with a slight angle part way, and 5.6 mm. over all. At this angle there may be a hint of the former division of these elements into two bones, but this is only suggested. From a slight node two-fifths from the base the ceratohyals arise, curving back and down, and ending in distinct epihyals. The first and only pair of ceratobranchials spring directly from the truncate ends of the basihyals and continue their direction. No epibranchials are visible.

Food: No. 223 had eaten 2 hemipterons, 5 winged ants, 3 termites and a beetle.

Breeding: Skinks in breeding condition were taken in July and August. Female No. 2862 was captured on August 22, 1920. She was very stout as if she had eaten an enormous meal. Placed in a vivarium, seven days later she gave birth to four young lizards, averaging 93 mm. in length. Their coloration was less brilliant but otherwise much like the pattern and color of the adult. Two days after birth the quartet was scrambling all over the ground, constantly disturbing a pair of *Phylllobates* and another of *Dendrobates* in the cage.

The only specimen of this lizard taken at Caripito was captured in the laboratory. The head and body were 85 mm., with only 10 mm. left of the original tail. Its colors were brighter than those of any Kartabo specimens.

EXPLANATION OF THE PLATES.

PLATE I.

- Fig. 1. *Ameiva ameiva*, adult male in final pattern, specimen 577. $\times .4$. Head and anterior half of body red-brown dotted with black, paler below; posterior half of body and tail bright green; belly pale blue.
- Fig. 2. *Ameiva ameiva*, dorsal view of full-grown specimens, one with double tail.
- Fig. 3. Head of *Ameiva*, showing irregular iris, $\times 2$. Top of head green, face pale lilac, pupil with broad orange ring.

PLATE II.

- Fig. 4. *Cnemidophorus lemniscatus*, adult male and female, lengths 285 and 160 mm. $\times .3$. Male with green head, limbs and under tail, yellow lateral spots; back brown and black. Female brown and black, showing a small extra tail.
- Fig. 5. *Iphisa elegans*, adult, specimen 553. $\times 4.5$. Brown above, salmon red below.
- Fig. 6. *Kentropyx calcaratus*, head of adult, showing irregular iris. $\times 4$. Sepia brown above, lilac below, iris scarlet.

PLATE III.

- Fig. 7. *Leposoma percarinatum*, adult, specimen 2965. $\times 4.5$. Sepia brown above with black bands, iris scarlet.
- Fig. 8. *Tupinambis nigropunctatus*, adult head, showing irregular iris. Nat. size. Anterior head brown, posterior spotted with yellow, neck wholly yellow.

PLATE IV.

- Fig. 9. Tegu's eggs in termite nest.
- Fig. 10. Tegu's eggs chopped out of termite nest. $\times .8$.
- Fig. 11. Full-grown embryo tegu in shell, and a tegu just hatched. $\times .7$.

PLATE V.

- Fig. 12. *Amphisbaena alba*, head of adult. Nat. size.
- Fig. 13. *Amphisbaena alba* in defensive position. Creamy white.
- Fig. 14. *Amphisbaena fuliginosa*, head of adult. $\times 2$.
- Fig. 15. *Amphisbaena fuliginosa*, dorsal view, and head of a second individual, showing asymmetry of pattern. $\times .3$. Black and white.
- Fig. 16. *Mabuya m. mabouya*, head of adult. Nat. size. Bronze above, lateral bands black with alternating bands of pink.

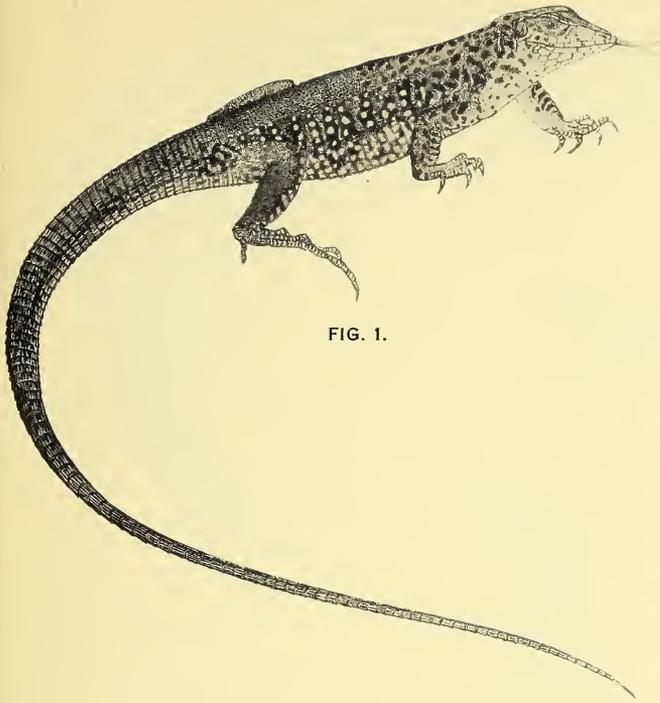


FIG. 1.

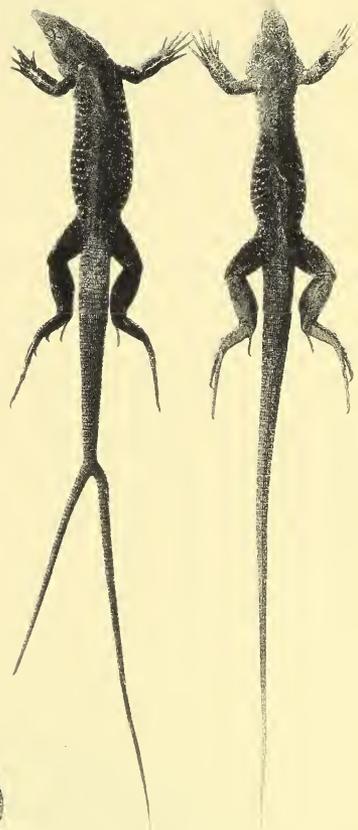


FIG. 2.

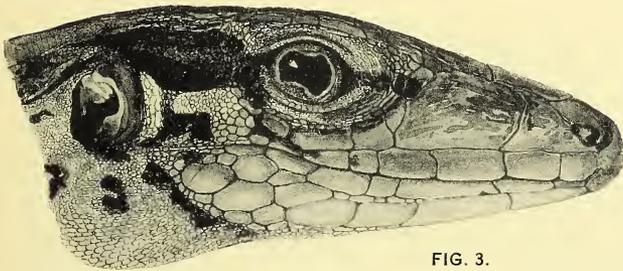


FIG. 3.

FIELD NOTES ON THE LIZARDS OF KARTABO, BRITISH GUIANA, AND CARIPITO, VENEZUELA.
PART #. TEIIDAE, AMPHISBAENIDAE AND SCINCIDAE.

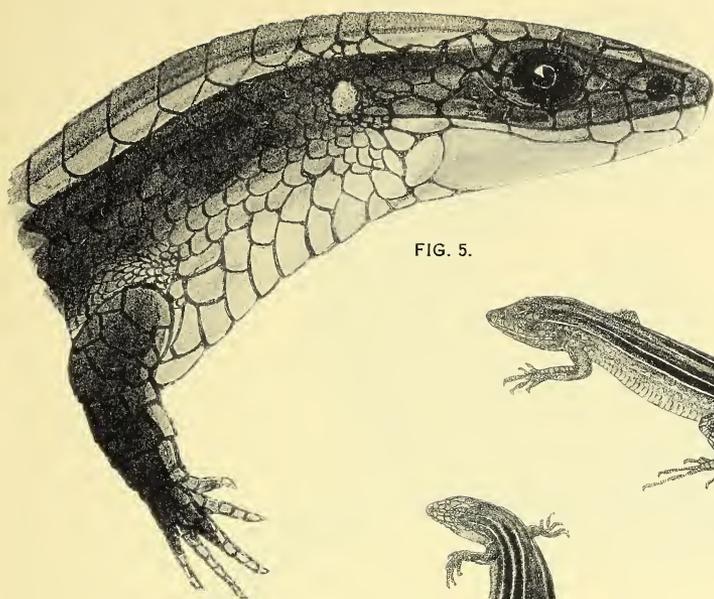


FIG. 5.

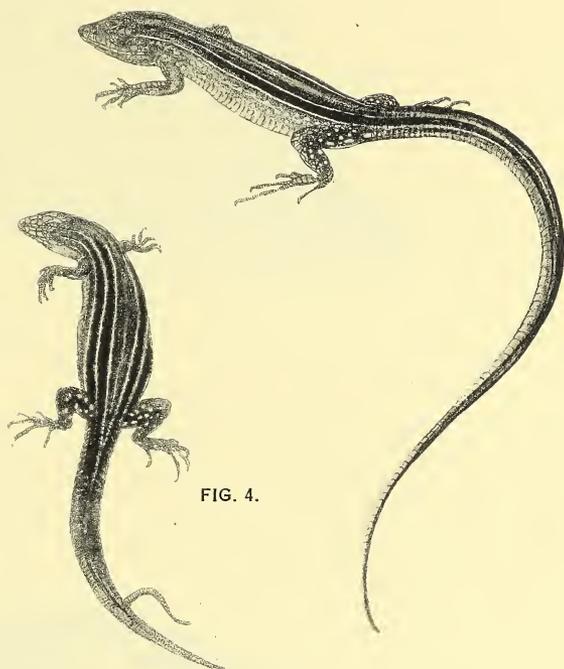


FIG. 4.

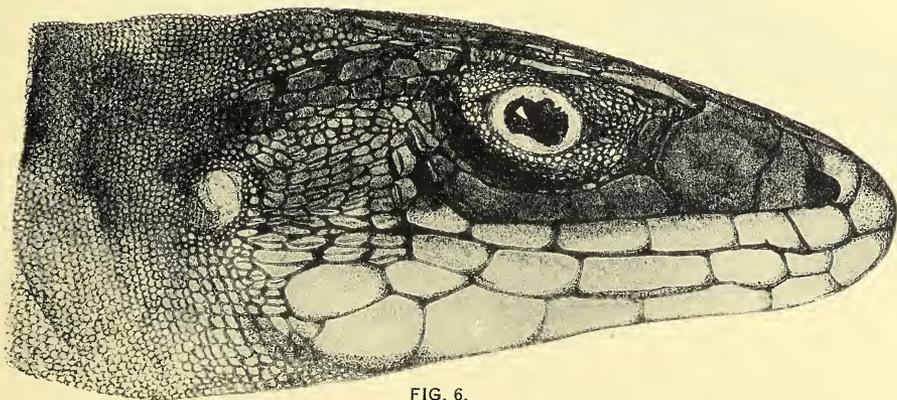


FIG. 6.

FIELD NOTES ON THE LIZARDS OF KARTABO, BRITISH GUIANA, AND CARIPITO, VENEZUELA.
PART #. TEIIDAE, AMPHISBAENIDAE AND SCINCIDAE.

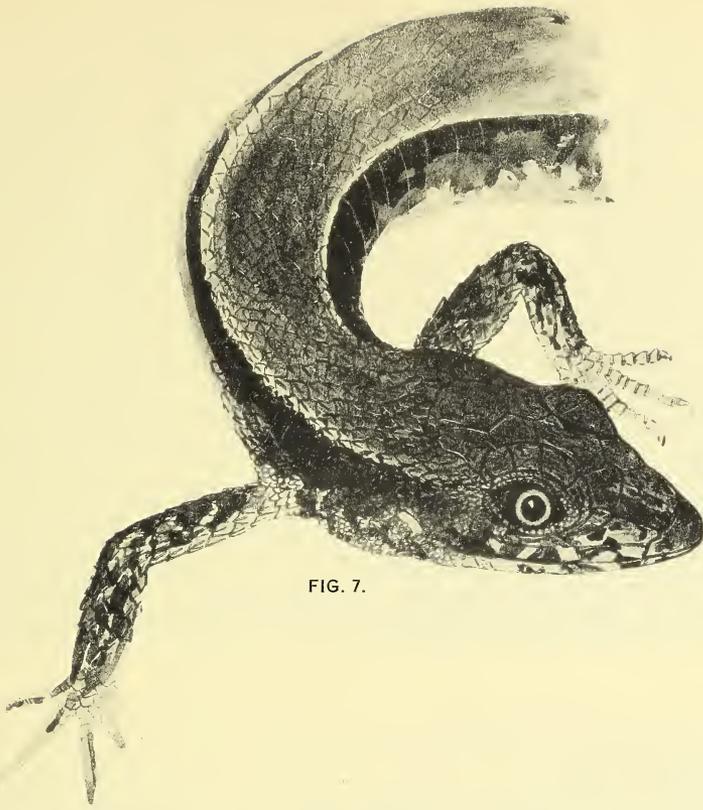


FIG. 7.

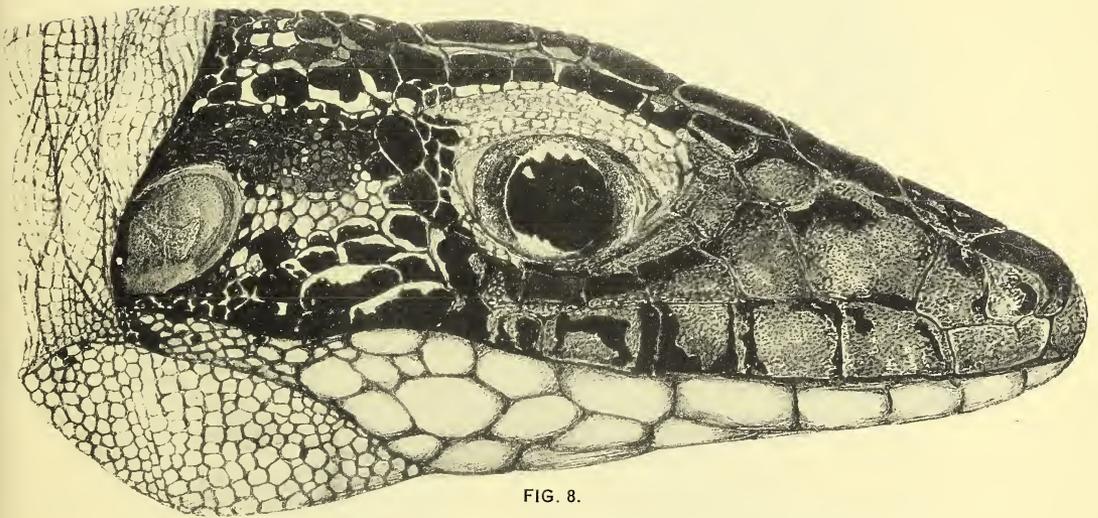


FIG. 8.

FIELD NOTES ON THE LIZARDS OF KARTABO, BRITISH GUIANA, AND CARIPITO, VENEZUELA.
PART #. TEIIDAE, AMPHISBAENIDAE AND SCINCIDAE.



FIG. 9.



FIG. 10.



FIG. 11.

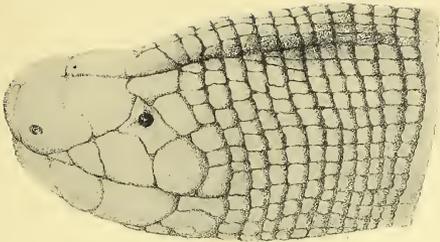


FIG. 12.

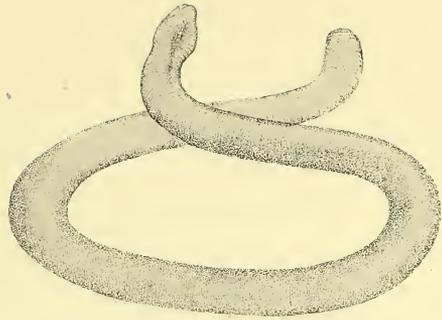


FIG. 13.

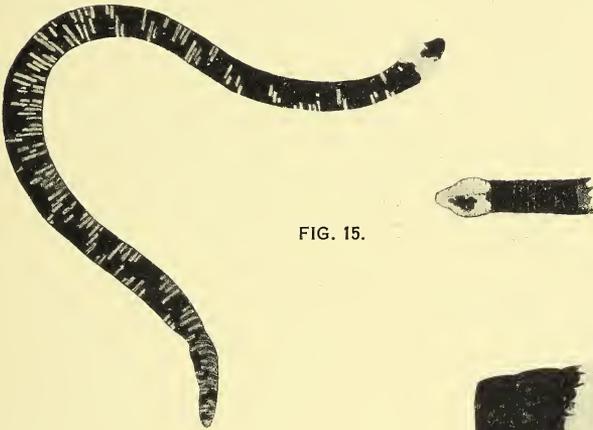


FIG. 15.



FIG. 14.



FIG. 16.

FIELD NOTES ON THE LIZARDS OF KARTABO, BRITISH GUIANA, AND CARIPITO, VENEZUELA.
PART #. TEIIDAE, AMPHISBAENIDAE AND SCINCIDAE.

3.

Spiders of the Family Salticidae from British Guiana and Venezuela.¹

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New York Zoological Society.*

(Text-figures 1-5).

[This contribution is a result of various expeditions of the Department of Tropical Research of the New York Zoological Society to British Guiana and to Venezuela, all made under the direction of Dr. William Beebe. The Guiana expeditions were made during the years 1917, 1919, 1920, 1921, 1922 and 1924. The Venezuelan trip, in 1942, was sponsored by grants from the Committee for Inter-American Artistic and Intellectual Relations and from four trustees of the Zoological Society, George C. Clark, Childs Frick, Laurance S. Rockefeller and Herbert L. Satterlee, and by invaluable assistance from the Standard Oil Companies of New Jersey and Venezuela.]

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INTRODUCTION.

This is the second of a series of papers on the salticid spiders collected at Kartabo, Bartica District, British Guiana, and Caripito, State of Monagas, Venezuela, by expeditions of the Department of Tropical Research of the New York Zoological Society under the direction of Dr. William Beebe. For maps and ecological data, refer to Beebe, 1925 and 1943; for general remarks on field notes, measurements and definitions of growth stages (immature="imm.", and juvenile="juv."), see Crane, 1943.

All types are deposited in the collections of the Department of Tropical Research, New York Zoological Society, Bronx Park, New York 60, N. Y.

The carefully executed drawings are the work of George Swanson.

My thanks go to Dr. W. J. Gertsch and Dr. E. B. Bryant for their helpful suggestions and for furnishing comparison material.

¹ Contribution No. 706, Department of Tropical Research, New York Zoological Society.

FAMILY SALTICIDAE.

Subfamily Thiodininae.

Psecas sumptuosus (Perty, 1833).

References: *Psecas sumptuosus* Petrunkevitch, 1911, p. 697 (References and synonymy to date). Mello-Leitao, 1941, p. 177 (Record only, British Guiana).

Color in Life (from painting): Female, probably immature: cephalothorax bright scarlet with a broad, closed oval ring of iridescent blue scales passing behind anterior eyes, through dorsals and curving behind posterior eyes across anterior part of thoracic region. Abdomen bright scarlet with four bands of iridescent blue scales, about equally spaced and equally broad, including a basal and a distal; the bands are narrower than intervening red portion. Tip of spinnerets scarlet. Anterior legs covered with long, violet-brown hairs, with patches of iridescent blue scales as follows: at distal end of femur, base of tibia and base of metatarsus. Second, third and fourth legs pale straw color; clypeus covered with iridescent blue scales, and a narrow border of them around cephalothorax.

Color in Alcohol: After two years in alcohol, the scarlet has vanished completely, and many scales are lost, the remaining ones being chiefly greenish and gold with no hint of blue; the general effect is much as in Peckham's description (1894, p. 98) of a much larger, 11.5 mm. preserved female.

Comparison with the males illustrated by Perty (pl. xxxix) and Koch (1846, fig. 1224), shows that there is no red on the cephalothorax, which is instead blue with dark markings, while the abdomen, instead of being red with blue bands as in our female, appears as definitely blue with red bands; this, however, may be a difference in delineation only. To Simon (1901, p. 468) the scales appeared green, not blue.

A juvenile male has the cephalothorax, abdomen and first legs brown, with iridescence barely commencing development; three posterior legs and underparts pale.

Measurements in mm.: Female, probably immature, total length 5.3; juvenile male, 4.2.

Range: Known from Brazil, the Guianas, the West Indies and Trinidad; the present is the first record from Venezuela.

Material: 2 specimens from Caripito, State of Monagas, Venezuela: 1942, May 15-30, 1 juv. ♂ (Cat. No. 42466); 1 imm. ♀, June (Cat. No. 42467; Col. Pl. No. 1545).

***Scopocira carinata* sp. nov.**

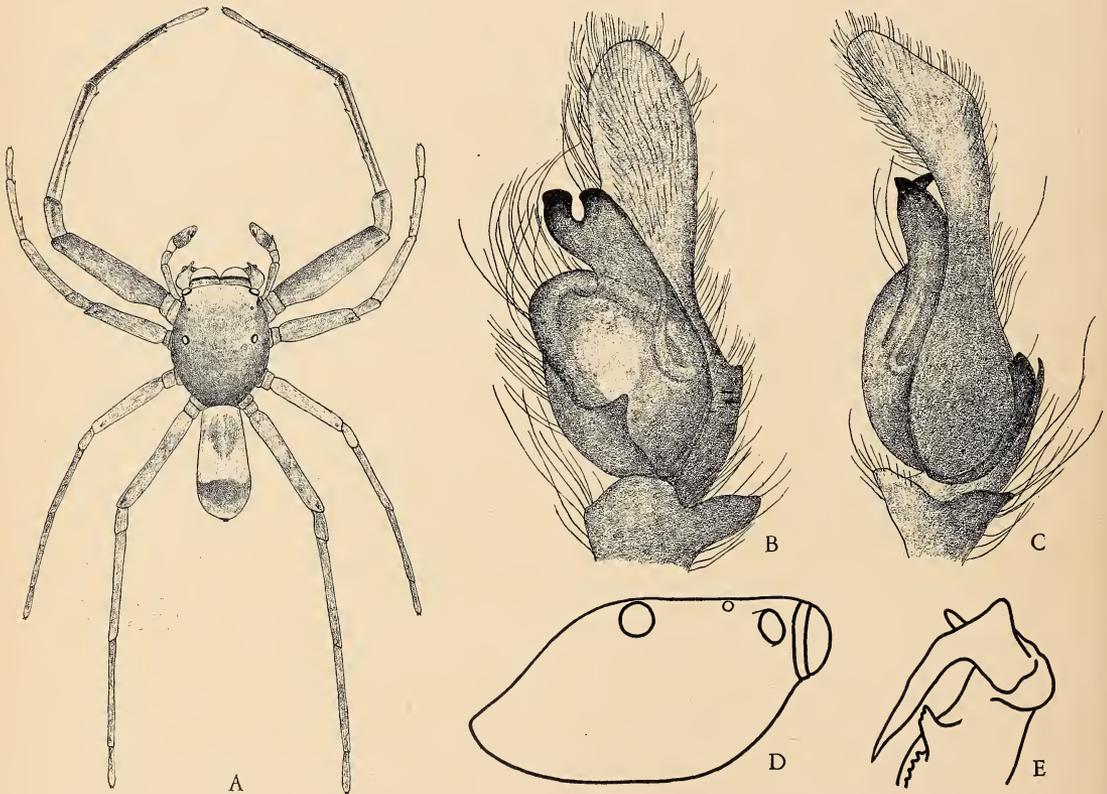
Text-fig. 1.

Color in Alcohol: (Male holotype, after 27 years; apparently about to moult): Cephalothorax brown, except for paler ocular quadrangle; abdomen, underparts and all appendages pale; traces of black pigment in two indistinct bands on abdomen, above and below, and in longitudinal anterior and posterior stripes on all segments of at least first two and fourth legs. No scales or hairs remaining on body except for a few pale hairs around anterior eyes and on the very narrow clypeus; they are not nearly numerous or regular enough to give a "bearded" appearance.

Structure and Affinities: Typical of the genus, except for details of spinulation, as follows: The first tibia is armed with 4 spines, as in the previously known species, but the second spines (next to basal pair)

are elevated and very minute; also, the members of the first and second pairs are not opposite, nor is the first pair isolated from the remainder. Rest of spines as follows: first and second metatarsi: 2 pairs; second tibia: 3, postero-ventral, unpaired; third and fourth metatarsi, 1 pair, distal, slender, minute; all femora: 1 unpaired, distal, dorsal.

The proposed new species is related to *S. vivida* (Peckham, 1900, p. 226), and is very close to *S. histrio* Simon, 1900 (p. 368), with which it may prove to be synonymous. It differs from the description and figure (1901, p. 442, fig. 499) of the latter as follows (exclusive of color pattern): the tip of the large tooth on inferior margin of chelicera has three distinct teeth as in *denticelis* Simon, 1900 (1901, p. 442, fig. 498); at the apex of the inferior margin is a distinct small tooth on a large elevation (cf. *S. panamena* Chamberlin & Ivie, 1936, pl. viii, fig. 60); details and spinulation of the palpal tibia are apparently different. In our specimen a long crest, truncate distally, arises from the outer posterior side of the base of the tarsus, paralleling the longer of the two tibial spines, which is slender, simple and nearly straight. The embolus is divided at the tip, as in *histrio* and *vivida*,



TEXT-FIG. 1. *Scopocira carinata* sp. nov., ♂ holotype. A, dorsal view; B, left palpus, ventral view; C, same, ectal view; D, cephalothorax, lateral view; E, chelicera, ventral view.

but the branches do not diverge as in *vivida*; details not figured in *histrion*.

Measurements in mm.: Total length 3.5; cephalothorax 1.8; abdomen 1.7; width of cephalothorax 1.43. Tibia-patella: I, 2.7; III, 1.3; IV, 1.9.

Range: Known only from Kartabo, Barica District, British Guiana.

Material: ♂ holotype, Kartabo, 1917, Sept. (Cat. No. 1750). Named *carinata* in reference to the characteristic crest on the palpal tarsus.

***Thiodina pallida* (Koch, 1846).**

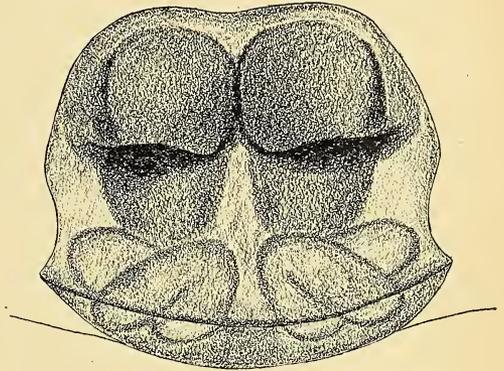
Text-fig. 2.

References: *Thiodina pallida*, Petrunkevitch, 1911, p. 712. (Synonymy to date.)

Color in Life: Adult females: Cephalothorax bluish-white to pale olive gray, except for ocular quadrangle which is russet, and two patches of rufous orange and white hairs between and behind posterior eyes (one on each side); small and posterior eyes each set in a large naked black spot with a few adjacent hairs of rufous and white; antero-median eyes, clear russet, changing to black, surrounded by white hairs. Abdomen pale maize yellow to white, covered with short hairs of same color, with a median dorsal pair of olive-buff or grayish-olive bands, and a pair of lateral stripes of grayish-white or pinkish: there is an irregular scattering of black dots on the dorsal surface and sides, very variable in arrangement, even on the two sides of the same female. Underparts pale olive gray to white, without dark spots or speckles. Legs and palpi bluish-white with a scattering of hairs of the same color. Young females: These differ from the adults as follows: the general color is translucent bluish-green with 5 or 7 reddish-brown or blackish spots on ocular quadrangle (in addition to the four regular black ocular spots, although they usually merge with these); the spots are arranged as follows: two as crescents behind anterior median eyes (these alone are sometimes indistinct or absent); two immediately behind small eyes, two between and slightly behind posterior eyes, and one in middle of quadrangle. Abdomen with the spots usually more distinct than in adult and confined to single rows on posterior half of the dark dorsal stripes. Legs translucent greenish-white.

Color in Alcohol: Females: the reddish-brown in both young and old remains only where hairs are present on cephalothorax, otherwise it is either faded or, in the young, persists as jet black spots; there is often a great deal of granular white showing beneath integument of cephalothorax. Except for the two pairs of darker stripes, the abdomen above and below presents a surface also covered with dead-white granules in all

but the very young. Males: Our single nearly adult male (5.8 mm.) agrees in color in every detail with the description of Chamberlin & Ivie's holotype of *T. pseustes* except that the carapace is reddish-brown, not scarlet; the sternum is pale, not orange; there is a *puerpera*-like band of white hairs below dorsal eyes; there are no streaks below posterior eyes nor on posterior declivity; basal two-thirds of first two femora pale (probably immature); the third and fourth coxae are pale, not dusky reddish-brown. In addition, our specimen has the posterior half of the cephalothorax narrowly bordered laterally with black, and the white stripes of the dorsal abdomen each contain a single row in posterior half of fine black dots. The juvenile male is exactly like the juvenile females in coloration, pale all over, except for 5 dark patches on ocular quadrangle, and faint abdominal stripes. Koch's plate (1846, fig. 1229) shows an intermediate color with the pigment on the legs partially developed.



TEXT-FIG. 2. *Thiodina pallida*, epigynum.

Structure: Typical of the genus. The 17 specimens in the collection, of which unfortunately only two are males, permit an unusual amount of comparison for a tropical species, showing the great amount of variation. The teeth on the chelicerae in particular are exceedingly variable, irrespective of sex and to a certain extent of size, although of course they tend to be fewer in the very young. Frequently different counts occur on the two sides of the same spider. On the ventral margin the range is from 1 minute tooth (found even in some large females) through a definitely fissidentate form to 3 moderate-sized well-separated teeth; Simon (1901, p. 455), records 3. On the superior margin the range is from 2 to 5, usually 3 or 4 (Simon records 4), the median ones often enlarged.

Spines: As will be seen, variation is considerable here too, and is found even on two sides of one specimen; in general spines are best developed in males, as may be seen

by the presence of spines in this sex only on the 1st and 2nd patellae, and the 2-2 arrangement of 1st tibial spines in male only; also, the median dorsal spines on all femora are usually strong in the males, but scarcely more than stiff hairs in females. Sporadic development of spines, especially on posterior legs, is typical of the young, and hence their numbers must be used more cautiously than usual in identification: the facies and color pattern are far more reliable. The posterior tibial spines of the first leg are very small, especially the distal, and irregularly placed, even in the larger male, while the posterior distal spine is always lacking in the female. The spines on all four legs are as follows: I—femur, 5 or 6 (3 or 4 distal); patella, 1 anterior (male only); tibia, male 2-2, female 2-1, in distal third; 2-2 bulbous hairs near base; metatarsus 2-2. II—femur 5 or 6 (3 or 4 distal); patella, rarely 1 anterior (found in young male only), usually 0, both sexes; tibia, male 2-2, plus 2 antero-lateral and 1 ventral (latter sometimes missing), female 1-1 or 1-0, in distal half plus 1 or 2 antero-lateral; no bulbous hairs; metatarsus 2-2. III—femur 6 to 8 (3 to 5 distal); patella 1-1; tibia, 1 proximo-dorsal (male only); lateral, male 3-3, female 2-3 or fewer; ventral, male 2-2, female 1-2 or 0-2; metatarsus, lateral 2-2, distant whorl 4, and, in male only, proximo-ventral 1-1. IV—femur 3 to 5 (2 to 3 distal); patella 1-1; tibia, proximo-dorsal 1 (male only); lateral, male 3-3, female and yg. male 2-3; ventral 1-2; metatarsus, lateral 3-3 or 2-3; proximo-ventral 1-1 or none; distal whorl 4.

Palp: Typical of the genus. Agrees perfectly with the figure of Chamberlin & Ivie, *T. pseustes*, 1936, pl. viii, figs. 61-62.

Measurements in mm.: Larger male 5.8; smaller male 5.2; largest female 10.1; smallest female 4.03.

Cocoon: The largest female was taken on a maize yellow cocoon, spun against the rib of a leaf on the under side; one thick band of webbing crossed the nest and was fastened to the leaf edges, drawing them slightly together; an entrance at each end of the cocoon.

Remarks: Through the kindness of Dr. Gertsch, some unrecorded specimens of *Thiodina* from the collections of the American Museum of Natural History were compared with the present Venezuelan and Guiana material. They included specimens from Panama and Paraguay, in addition to the well-known *puerpera* from Mexico and the United States. A complete survey of the material is impossible, but the following points may be brought out, indicating that the South American forms are distinct from those in North America, yet in several characters intermediate between the two

northern species: *Male*: The cephalothorax markings of *pallida* include a white central spot, as in *sylvana*, a white bar beneath the dorsal eyes as in *puerpera*; streaks on posterior surface apparently lacking; a unique black marginal band of varying width around posterior half of cephalothorax. *Female*: no trace of black terminal spot on underside of abdomen (this is always present in adult *sylvana*, sometimes in *puerpera*); epigynum distinct. *Both sexes*: spines on second tibia, although variable as usual, about mid-way in number between those of *sylvana* and *puerpera*. Although the Venezuelan and Guiana specimens are otherwise exceedingly similar to those of Paraguay, they differ in the twisting of the tubules of the epigyna, which will perhaps prove to be of subspecific importance. It is interesting that in this genus the male palps are apparently useless for specific identification. The Panamanian material, save for one young male resembling the South American form with the addition of faint oblique posterior streaks on the cephalothorax (as in *sylvana* and *puerpera*), closely resembles *sylvana*; here again, however, the epigyna appear to be distinct. Chamberlin & Ivie's (1936) unique male holotype of *Thiodina pseustes* from Panama appears, from the description of the markings, to be identical with or close to *sylvana*, rather than to the South American form.

Habitat: In half a dozen cases where collecting records were made, the specimens were shaken from low bushes in the shade near the edge of low jungle.

Range: Known from all northern South American countries from Peru to Brazil, except Ecuador. The present are the first records from Venezuela and British Guiana.

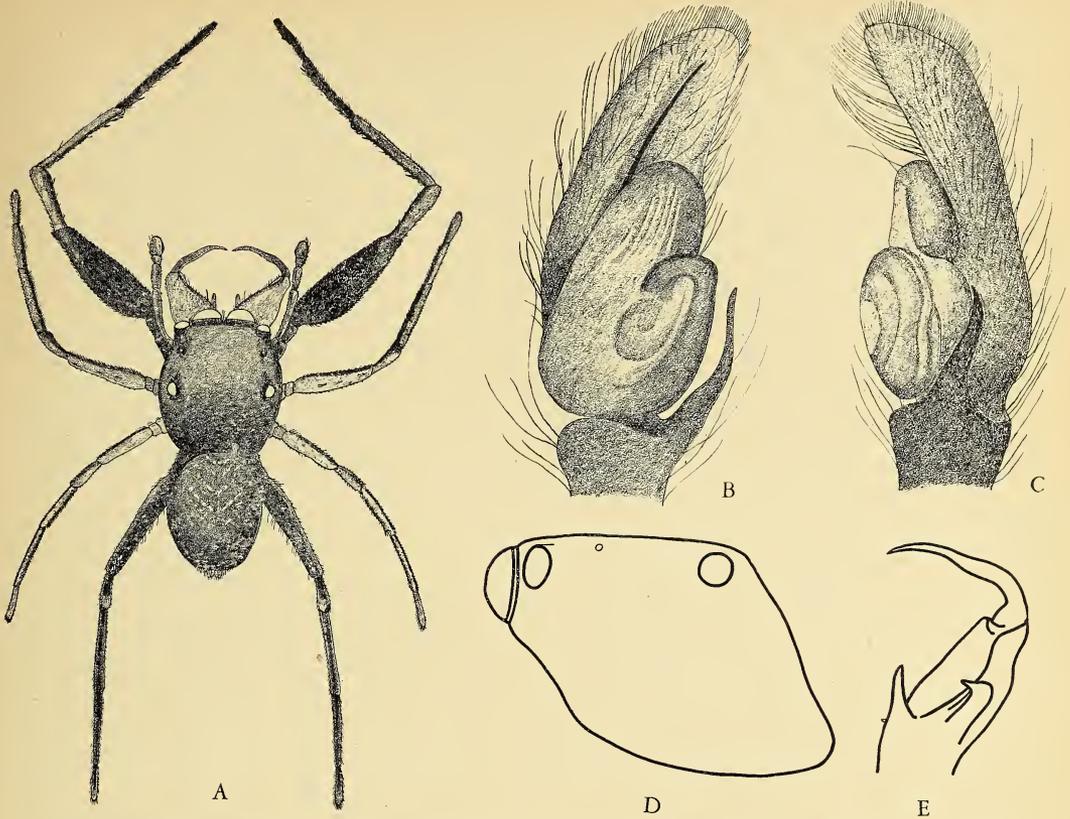
Material: The 17 specimens were distributed as follows: Kartabo, Bartica District, British Guiana: 1917: Sept., 1 juv. ♀ (Cat. No. 1717), 1 imm. ♀ (No. 1741). 1920: 1 juv. ♀ (No. 2030); Nov. 1-6, 1 imm. ♀ (No. 201493); 1 ♀ (No. 201639). 1921: 1 ♀ (No. 21313). 1924: Mar. 29, 1 ♀ (24328); Date?, 1 ♀, breeding, (24859). Caripito, State of Monagas, Venezuela: 1942: Mar. 17-25, 4 juv. and imm. ♀ (No. 4264); Apr. 1-15, 1 ♂ (No. 42468); Apr. 6-30, 1 juv. ♂ (No. 42469); May 24, 1 juv. ♀ (No. 42274); June 15-30, 1 imm. ♀ (No. 42270); Aug. 16-31, 1 imm. ♀ (No. 42271).

Subfamily Zygoballinae.

Zygoballus gracilipes sp. nov.

Text-fig. 3.

Color in Alcohol (after 20 years): Holotype male (unique specimen); Cephalothorax, palp, mouthparts and sternum reddish-brown. Abdomen, above and below, dark brown with fine, faint paler chevrons above and pale concentric streaks below.



TEXT-FIG. 3. *Zygoballus gracilipes* sp. nov., ♂ holotype. **A**, dorsal view; **B**, left palpus, ventral view; **C**, same, ectal view; **D**, cephalothorax, lateral view; **E**, chelicera, ventral view.

First leg: coxa, femur, trochanter, metatarsus and tarsus dark reddish-brown; patella and tibia light brown with a black line along anterior side of each segment. Second and third legs entirely pale horny, with anterior black line on all segments except coxa, trochanter and third tarsus, and posterior black line on tibia and metatarsus of third. Fourth legs: coxa, trochanter and femur dark brown, the latter with a light dorsal stripe and a few white scales; patella dark anteriorly, mostly light posteriorly; tibia, metatarsus and tarsus dark brown except for narrow pale stripes anteriorly and posteriorly and pale tip of tarsus.

Structure and Affinities: With the characteristics of the genus. This proposed new species is exceedingly close to *Z. rufipes* Peckham, 1885, from Texas, Mexico and Guatemala, from which it differs as follows: The first tibia is 8 to 9, not 5 to 6 times as long as wide; the labium is considerably wider; the posterior part of the cephalothorax is not indented as in Cambridge's figure (1900, pl. 27, fig. 167), although this may, of course, be merely a difference of preservation; in coloration the metatarsus and tarsus of the first legs are dark, not light, and details of coloration in the fourth

legs (which differ in Cambridge's, p. 289, and Peckham's, 1909, p. 582, respective accounts of *rufipes*); the present specimen lacks white and iridescent scales except for a few on the fourth femora; this, however, is almost certainly due not to their absence but to their loss.

Cambridge (1900, p. 289, and pl. 27, fig. 16a) remarks that there is no visible spine at apex of palpal bulb in *rufipes*, but that this possibly is not a constant character. No spine was visible at first in our specimen, but gentle pressure of the bulb brought into view a very slender embolus, to lie in the usual furrow.

It is interesting to note that in passing from south to north in the series of related species *gracilipes* from South America, *rufipes* from Central America and Mexico, and *bettini* from the United States as far north as Maine, the legs, especially the first tibia, are progressively shorter and thicker.

Measurements in mm.: Male holotype: total length 3.59; cephalothorax 1.71; abdomen 1.88.

Range: Known only from Kartabo, Barica District, British Guiana.

Material: One ♂, the holotype, Kartabo, 1924 (Cat. No. 241046).

Subfamily Dendryphantinae.

Lurio solennis (Koch, 1846).

Text-figs. 4 A-G.

References: *Hyllus solennis* Koch, 1846, p. 163, pl. cccclix, fig. 1217.

Lurio solennis, Simon, 1901, pp. 619, 626, 631, figs. 733, 734.

Color in Life: Female: Cephalothorax integument dark brown with narrow white marginal band, extending completely around clypeus. Ocular quadrangle covered with iridescent green scales; white scales behind anterior eyes, in a narrow line outside of small and posterior eyes, and in a narrow band across cephalothorax behind posterior eyes. Abdomen, integument wood brown with a broad median stripe and two pairs of vertical bands of lighter brown; 4 or 5 small anterior dorsal white spots, a curving basal marginal stripe, and three pairs of large white lateral spots; iridescent green scales covering all lighter brown areas. First pair of legs dark reddish-brown, remaining legs lighter brown. A few whitish scales on all femora, on first three patellae and on 2nd and 3rd tibiae. Underparts of cephalothorax dark reddish-brown, abdomen wood brown with paler longitudinal markings. The abdominal dorsal markings show with various degrees of clarity, depending on the swelling of the abdomen.

Color in Alcohol: Male: Brownish-black. No trace of the iridescence described by Koch and Simon remaining on cephalothorax and only faintly traceable on abdomen in two narrow dorsal stripes. A narrow marginal white band around cephalothorax, including the very narrow clypeus. Patches of white scales between small and posterior eyes, behind the latter and in a faint median patch between them. A white marginal band around abdomen distinct, as described by Koch and Simon. Blue scales described by Koch on legs white in preservative, present on femora of palp and all legs, and on patella, tibia and metatarsus of first three pairs, being numerous only on first pair.

Female, somewhat faded, especially in regard to iridescence, but otherwise as in life.

Measurements: Largest male, 6.9 mm., largest female 9.7 mm. Remaining specimens not much smaller.

Remarks: In structure our specimens check with Simon's description and figures in every detail, save that in each of our four males the distal tooth on the superior margin of the chelicera is well separated from the smaller basal tooth, instead of being contiguous (cf. Text-fig. 4D, present paper, with Simon's Fig. 733). It is somewhat variable, however, in position. The large

tooth of the inferior border is decidedly variable in amount of curvature.

Range: Known previously from Colombia to Brazil. The present series were all taken at Kartabo, Bartica District, British Guiana.

Material: A total of nine specimens was taken, as follows: 1917: Sept., 1 ♂ (Cat. No. 1712). 1920: 2 ♂ (No. 2034); 3 ♀ (No. 201482). 1924: Mar. 20, 1 ♀ (No. 24199); April, 1 ♀ (No. 241047); May 22, 1 ♂ (No. 241048).

Parnaeus cyanidens (Koch, 1846).

Text-figs. 4H-M.

References: *Phidippus cyanidens* Koch, 1846, p. 156, pl. cccclviii, fig. 1211.

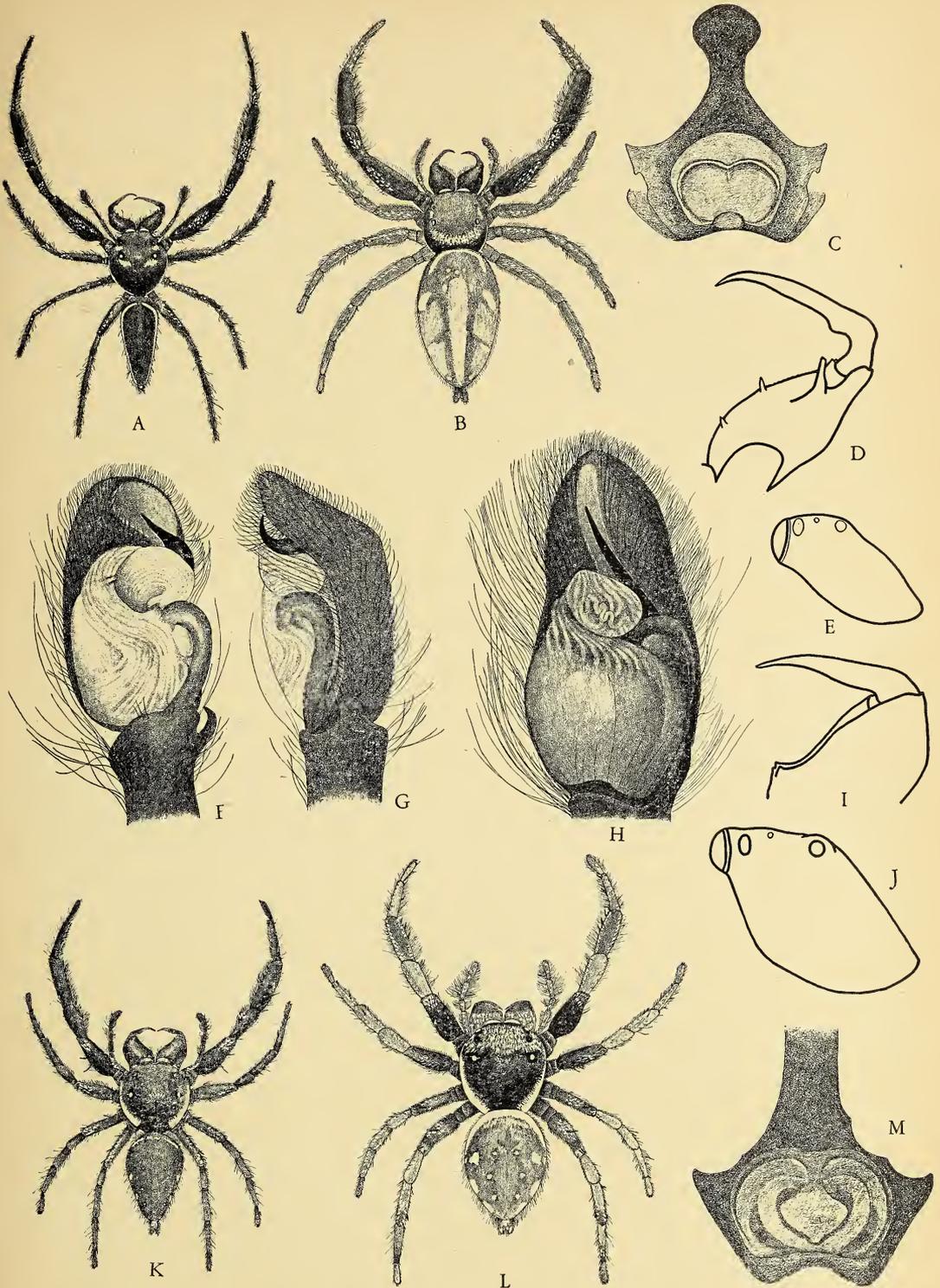
Parnaeus cyanidens, Peckham, 1896, p. 38, pl. iii, fig. 2; id., 1900, p. 301; F. Cambridge, 1901, p. 288, pl. xxvii, figs. 12, 13.

Dendryphantus cyanidens, Simon, 1901, p. 618, fig. 746.

Color in Life: Two males and a female, from British Guiana and Venezuela. Ocular quadrangle and abdomen brilliant iridescent green; abdomen with four pairs of white spots set in a pair of black stripes; a basal white band and lateral white spots or bands set in an iridescent stripe. Chelicerae iridescent green, gold, blue, or reddish; integument and legs black and brown, except, in female, for orange-cinnamon anterior part of cephalothorax; a broad white marginal band around posterior half of cephalothorax; a median white spot between posterior eyes; white scales present on femora and palps, and, in female, on cephalothorax and chelicerae. Long black hairs on legs. Patella and tibia of palp with green iridescence in one male. All eyes black, the antero-medians rimmed narrowly below with white. Underparts black anteriorly; abdomen black or brown, faintly striped. Female differs from male in less brilliant and widespread iridescence, in cinnamon-orange anterior part of cephalothorax and in white scales on cephalothorax and chelicerae.

Measurements in mm.: Largest male, 7.5; smallest male (immature), 6.53; largest female, 8.9; smallest female (immature), 6.5.

Remarks: Our series agrees perfectly with the Peckhams' (1896, p. 38) description and figures, including the variation of the iridescence. The following minor differences and additional detail may be remarked; the white interocular spot and the iridescence on the male cephalothorax is apt to be missing in the preserved specimen; white scales are conspicuous in the cephalic region and on the chelicerae of the female; in our series there are no more than two white spots on the sides of the abdomen, instead of two or three bands; in the females, however, three bands are developed; the fourth pair of dorsal abdominal spots is usually



TEXT-FIG. 4. **A**, *Lurio solennis*, dorsal view, ♂; **B**, same, ♀; **C**, same, epigynum; **D**, same, ♂, chelicera, ventral view; **E**, same, cephalothorax, lateral view; **F**, same, ♂, left palpus, ventral view; **G**, same, ectal view; **H**, *Parnaeus cyanidens*, ♂, left palpus, ventral view; **I**, same, chelicera, ventral view; **J**, same, cephalothorax, lateral view; **K**, same, dorsal view, ♂; **L**, same, ♀; **M**, epigynum.

very faint; there is a patch of white hairs at the tip of the abdomen; in both sexes there are white scales on the basal segments of all femora. Striation pattern in palp variable.

Development: The young female has white scales on the thoracic part of the cephalothorax, as well as anteriorly. The pigment is feebly developed, and iridescence is practically lacking. The young male has almost full pigment, but scarcely any iridescence, and the palp is just commencing to be differentiated.

Parasite: A small mite was attached to the right posterior metatarsus of a full grown Guiana male.

Range: Previously known from Brazil and Guatemala. The present specimens give two additional nodes at Kartabo, Bartica District, British Guiana, and Caripito, State of Monagas, Venezuela.

Local Distribution: On bushes, roadside and low jungle (two males, Guiana and Venezuela).

Material: A total of nine specimens was taken as follows: *Kartabo*: 1920: Oct. 4, 1 ♂ (Cat. No. 2021); Nov. 11, 1 imm. ♀ (No. 201640). 1922: 1 ♂, 1 imm. ♂ (No. 22487). 1924: March 15, 1 ♀ (No. 24168); March 16, 1 imm. ♂ (No. 24169); April, 1 ♂, 1 imm. ♀ (No. 241049). *Caripito*: April 18, 1 ♂ (No. 42208).

***Parnaeus smaragdus* sp. nov.**

Text.-fig. 5.

Color in Life: In general: black, with white spots and iridescent green patches in and near ocular quadrangle, a narrow white marginal line around posterior half of cephalothorax; iridescent green bands on abdomen; and pinkish-white scales and gold iridescence on legs.

In detail: Adult male paratype: Integument of cephalothorax black with narrow marginal band of white scales extending posteriorly from slightly behind vertical from median eyes; a large patch of white scales on each side between small and posterior eyes; a pair of smaller patches behind posterior eyes; a tiny median patch in posterior part of ocular quadrangle. Patches of dark green iridescent scales on ocular quadrangle near eyes. A few long hairs in quadrangle region. Anterior half of abdomen benzo brown, posterior half with four transverse bands, the first and third iridescent golden green, the second and fourth blackish-brown; entire abdomen surrounded laterally with a band of green iridescence. Under parts black, abdomen brown anteriorly, black posteriorly, with lateral iridescence extending on to the ventral margins. Mandibles dark brown, without iridescence. Palp and legs dark brown with seashell pink

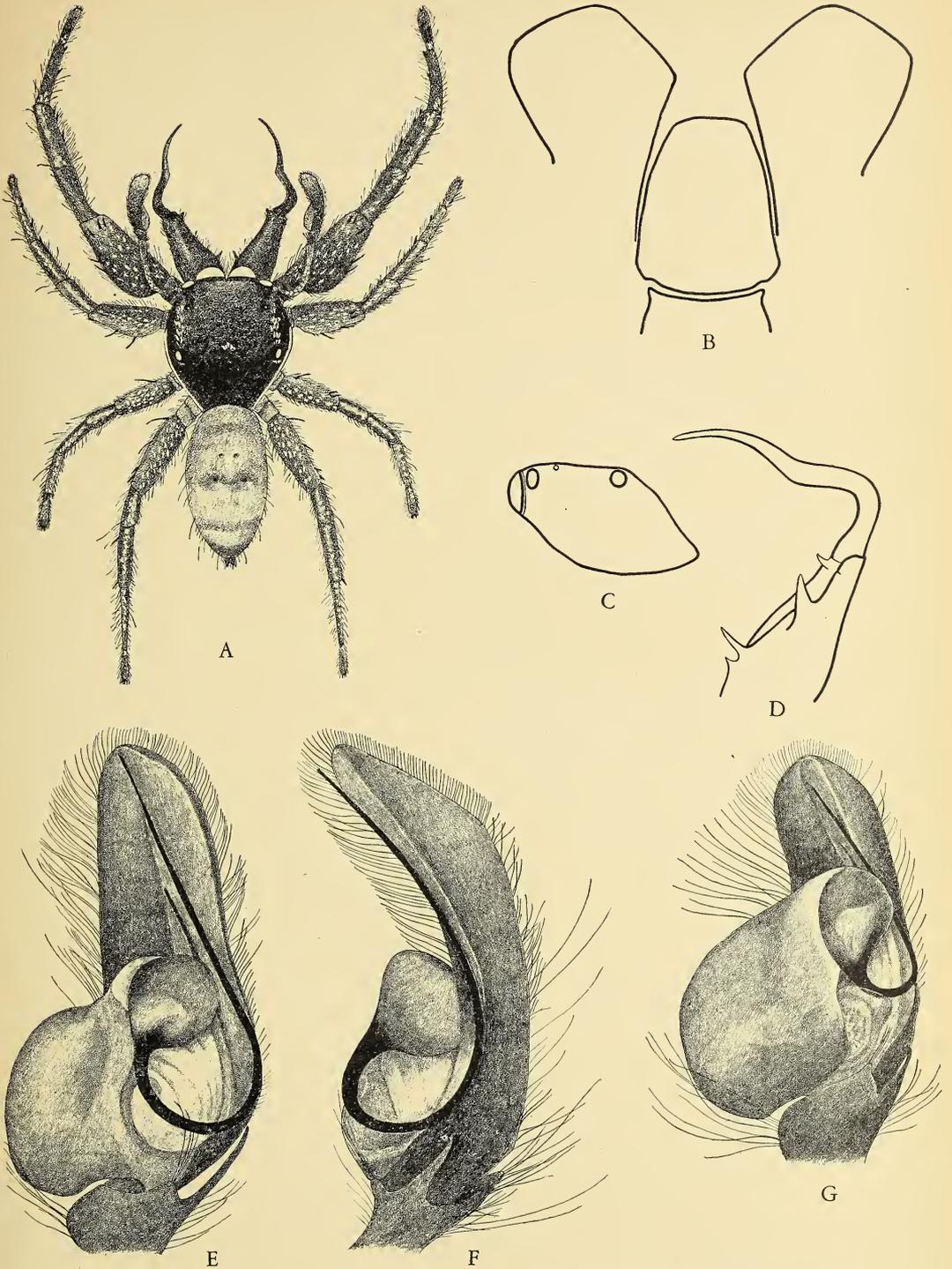
iridescent scales on femora and irregular golden iridescent markings.

Immature male paratype: Like adult, but iridescence just developing; it is absent on cephalothorax, as are all white patches except those between small and posterior eyes; on abdomen are two median iridescent green spots, and the lateral band is silvery green; pinkish scales on femora few in number, gold iridescence lacking.

Color in Alcohol: Iridescence practically gone, femoral scales white; abdominal band white in young, absent or nearly absent in adults. The holotype, studied only in preservative, apparently had golden green iridescence in bands on anterior part of abdomen as well as posterior.

Structure: Cephalothorax typical of the genus, broad in middle, narrowing posteriorly; cephalic portion high, but with ocular quadrangle perfectly flat; sides bulging moderately in front of posterior eyes; thoracic slope steep, commencing close behind eyes. Ocular quadrangle, viewed from above, occupying more than half of cephalothorax; anterior eyes strongly recurved, close together; median eyes more than twice nearer first than third row; posterior eyes on dark tubercles, about as large as anterior lateral eyes. Quadrangle decidedly wider behind than in front; clypeus exceedingly narrow, about a tenth diameter of anterior median eyes. Mandibles long, porrect and divergent; teeth widely separated; one long, strong and pointed, directed slightly distally (fangward), at middle of inferior margin; two, close together, the distal much the longer, near base of superior margin; superior apical angle with a strong, spine-like cusp; fang long and strongly sinuous. Maxilla distally convex, prolonged into a moderate lobe on upper outer side; anterior margin of sternum slightly narrower than labium. Abdomen with two pairs of dorsal pits, the more posterior, at mid-abdomen, being the deeper. Legs 1-4-2-3. First leg considerably enlarged, especially the femur. Insertion of ventral spines on first tibia very variable, but those of inner row always confined at least to distal two-thirds. A weak fringe of hair on first tibia. Tibia of palp not quite half as long as patella; tibial spine long, slender, tapering, not curving downward at tip; bulb with large lateral lobe; embolus long and curving, arising from basal end of distal bulb, not from its external, distal side (as in *P. cuspidatus*), nor from its tip (as in *Phidippus*, *Metaphidippus*, etc.); a small, slim separate spine, arising from the external side of the median, tubuled mass of the bulb, is visible beside the embolus in basal part of its groove.

Measurements in mm.: Male holotype, total length 5.8; cephalothorax 2.7; ab-



TEXT-FIG. 5. *Farnaesus smaragdus* sp. nov. **A**, ♂ holotype, dorsal view; **B**, same, labium; **C**, same, cephalothorax, lateral view; **D**, same, chelicera, ventral view; **E**, same, left palpus, ventral view; **F**, same, ectal view; **G**, immature ♂ paratype, left palpus, ventral view.

domen 3.21. Male paratype, total length 5.91. Male paratype, immature, total length 6.0.

Development: The largest specimen is definitely immature, the cephalothorax and abdomen being both relatively slightly narrower, iridescence little developed, pigment weak and the tarsus of the palp with its embolus shorter. (Text-fig. 5G).

Affinities: The proposed new species is closely related to *Parnaeus cuspidatus* Cambridge, 1900, from the descriptions and figures of which it differs as follows: the details of the palp are different, including the non-apical origin and great development of the embolus, the presence of the secondary spine arising beneath the bulb, and the relative straightness of the tibial spine; there are white patches as described above on the cephalothorax; and the markings on the abdomen appear to be different.

Simon (1901, Supplément Général, p. 1055) suggested that Cambridge's *P. cuspidatus* and *P. fimbriatus* should be placed in the genus *Lurio*. If the position of the dorsal eyes is retained as an important generic character, however, this shift would be incorrect, since the ocular quadrangle, both in Cambridge's two species and in the present one, far from being parallel-sided as in *Lurio*, is wider posteriorly than even in *Parnaeus cyanidens*, or in most *Phidippus*. It seems more likely that when this character, plus the form of the palp and chelicerae, as well as the flatness of the ocular quadrangle at least in *smaragdus*, are considered, the erection of a new genus will be desirable. In the present scarcity of material and questionable taxonomic values of characters throughout the group, however, it does not seem feasible to take this step at the present time.

Range: Known from Kartabo, Bartica District, British Guiana, and Caripito, State of Monagas, Venezuela.

Local Distribution: Holotype shaken from bushes in low jungle; one paratype, immature, from mucka-mucka plants at low tide on river bank.

Parasites: No. 24103 had attached to it two scarlet mites, small and larger, one on each hind leg.

Material: A total of three specimens was taken as follows: *Kartabo:* 1924: March 3, 1 ♂ paratype (Cat. No. 24103); April 3, 1 ♂ paratype (No. 24348). *Caripito:* 1942: March 29 to April 15, 1 ♂ holotype (No. 42472).

Named *smaragdus* in reference to the iridescent green markings.

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4.

Note on the Eared Pheasants (*Crossoptilon*) with the Description of a New Subspecies.

JEAN DELACOUR.

(Text-figure 1).

In the course of detailed studies necessary for the preparation of a new work on the pheasants that Dr. William Beebe and I hope to publish shortly after the end of the war, I have recently examined the eared pheasants (*Crossoptilon*).

Although a great deal remains to be learned of the distribution and variation of these birds, we nevertheless now possess useful information which was not available twenty-seven years ago when Dr. Beebe's "Monograph of the Pheasants" was published, and we can form a better understanding of the whole group. It appears to consist of three distinct species. Two of them are very closely related and highly specialized, while the third one is different and more primitive.

The blue eared pheasant (*C. auritum*) shows the highest degree of evolution in its tail, which is normally composed of twenty-four rectrices, of which the two central pairs have very long, disintegrated and widely separated webs almost to the tip. It is found in Kansu and the neighboring parts of Kokonor and perhaps of northwestern Szechuan. "Interior of China" has so far been given as its type locality, which I now propose to restrict to Si-gu, Kansu, where Berezowski collected specimens.

The brown eared pheasant (*C. manchuricum*) inhabits northern Shansi and northwestern Chihli; it is a little less specialized, having only 22 rectrices, the central pair of which is also much disintegrated, but there is a small solid patch at its tip. I restrict its type locality to the mountains beyond San-yu, Chihli, (after A. David), to replace "vicinity of Peking."

There is no geographical variation in these two species, and they have completely isolated ranges on high mountains. In both the ear-tufts consist of long and disintegrated feathers, and they project conspicuously above the nape. The tail is much compressed and usually held upwards, the central rectrices well above the others. They can be considered as forming one super-

species, being identical in shape, voice and behavior.

The third species, *C. crossoptilon*, is larger; the ear-tufts are short and hardly show above the head, if at all. The rectrices number 20, exceptionally 22, and are almost normal in structure, the terminal half having no long disintegrated webs. The tail is much flatter, less compressed, and held downwards. It certainly represents a less specialized, more primitive type.

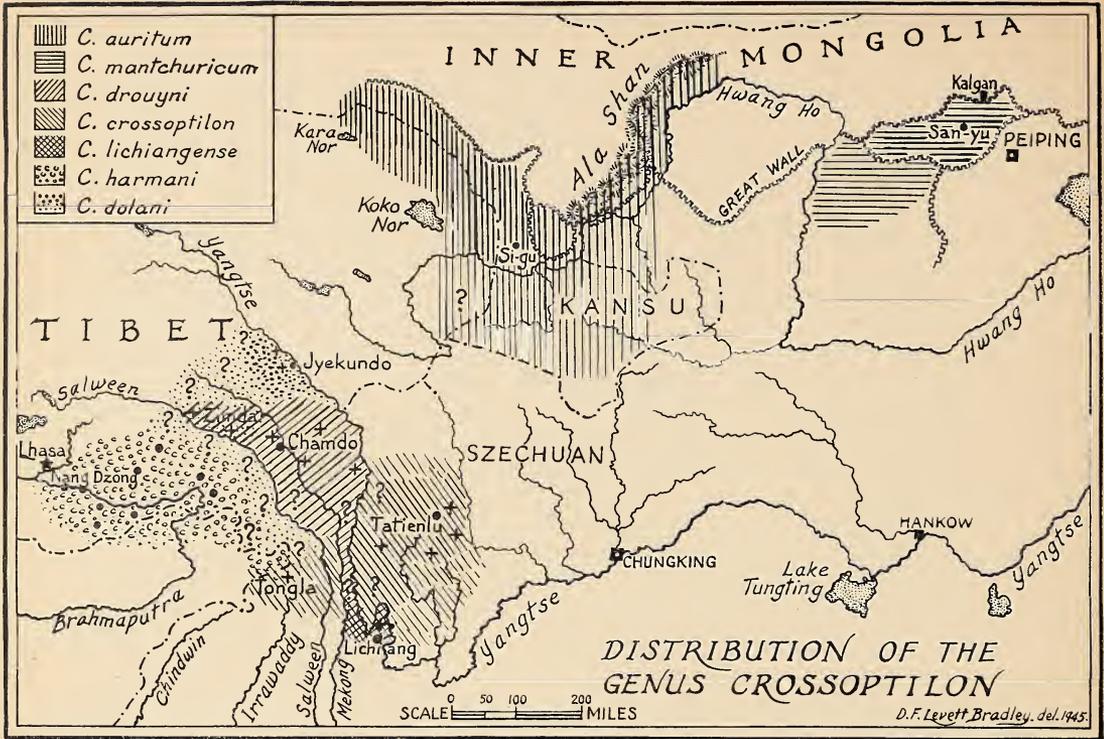
In life, the aspect of *C. crossoptilon* is strikingly different from that of the other two species, as are its voice and actions.

The distribution of the species *crossoptilon* is still incompletely recorded. Unlike *C. manchuricum* and *C. auritum*, the present species varies greatly in color throughout its range, which consists of the high mountains of central and southwestern Szechuan, northwestern Yunnan, eastern Tibet and southern Kokonor. In the southwest, according to Ludlow (*Ibis*, 1944, pp. 377-379) it reaches Long. 91° 33' E. in the Tsangpo Valley, and it does not occur south of the main Himalayan axis.

The species varies in color from almost pure white, with black cap and tail-tip, to a dark blue-gray.

The western Szechuan form (*C. c. crossoptilon*) is white with dark brownish-gray wings and more or less gray wash on the mantle. The tail is mostly black, with some brownish-gray on the basal half, green and purple reflections near the tip. The type locality of *C. c. crossoptilon* Hodgson (*Journ. As. Soc. Bengal*, 7, 1838, p. 864) has remained vague, as no locality was given with the description. I propose to restrict it to Ta-tien-lu, western Szechuan, where many specimens, all agreeing with the type, have been collected.

The form from eastern Tibet (*C. c. drouyni*) has an almost pure white body, a variable but always considerable amount of white or gray in the tail, and very little gray in its wing, restricted generally to the inner webs of the primaries. It meets and



TEXT-FIG. 1. Distribution of *Crossoptilon*.

intergrades with a pale gray form (possibly *C. c. dolani*?) in the Upper Salween region. In his book "Salween," R. Kaulback reports that he found in 1936 "large pheasants, pure white apart from pink rings around the eyes, and a gray patch on the top of the head" near Idashi, north of Zimda (near 95° 30' E. Long., 31° 20' N. Lat.) and farther west and north, between Kyierothang and Deje (94° 40' E. 31° 40' N.) "both kinds all white and pale grey with black tips to wings and tails, in mixed flocks with between them half-bred of every shade." A little to the south, near Sating (94° 40', 31° 20'), in light juniper forest, he came across about fifty white eared pheasants and blood pheasants feeding together by the side of the path, and further west, north of Pengar Gompa (94° 10', 31° 20') he saw "thirty more big pheasants mostly of the blue variety with some half bred."

As no specimens were collected, it is impossible to know if the "pale grey" birds seen by Kaulback are *dolani* or some other still undiscovered race. It seems improbable that it could be *harmani*, which is very dark indeed.

There has been a great deal of confusion as to the name to be applied to the whitest race, as *C. drouyni* was described by Verreaux (*Nouv. Archives du Muséum*, 4, Paris, 1868) from a bird sent by M. Dabry, French Consul at Hankow; the bird is recorded as

coming from "Tibet, in the part called Mou-Pin." This last named must have been an error, as the country usually known as Mupin is that around Ta-tien-lu where *C. c. crossoptilon* is commonly found, and the series collected there shows very little variation. Therefore, the type locality of *C. drouyni* ought to be fixed, and I propose to restrict it to the Sok Pass, Tibet, near which several specimens were collected (including the type of *leucurum*) by Thorold and Bower between Chamdo and the Sok Pass, and by Prince Henri d'Orleans, west of the Pass.

Individuals from this region vary, some having the basal part of the tail white as well as the shafts of the primaries as in Seebohm's male type of *C. leucurum*; the majority of them, however, are identical with the type of *C. drouyni* and agree with the plates in the *Nouvelles Archives du Muséum* and in Elliot's Monograph. They have dark shafts to the primaries, the inner webs of which are more or less mottled with brownish-gray; there is sometimes a very slight gray wash on the mantle and rump, and the basal part of the rectrices is gray, with more or less white on the outer pairs. Verreaux's name *drouyni* (1868) antedates Seebohm's *leucurum* (1892) and must be used for this subspecies.

In 1935, a very distinct pale gray form, *C. c. dolani* was discovered by the Dolan ex-

pedition in southern Kokonor, at Jyekundo (96° 45', 33') and at some distance to the north on the Yangtze River. It has been described and studied by R. M. de Schauensee and E. Schäfer (*Proc. Acad. Nat. Sci. Philadelphia*, 89, 1938, p. 339—Ibid, 90, 1939, p. 190). It is a very pale edition of *harmani*, with the feathers of the upper parts very rough to the touch, instead of smooth and rather silky as in the other subspecies.

C. c. harmani shows a superficial resemblance in color to *C. auritum*, but this is purely coincidental, as the two birds differ sharply in the shape and proportions of the tail and ear-tufts, and they are widely separated geographically. Even in color *harmani* differs from *auritum* in its white belly, in a broader white band on the nape and a white stripe down the fore-neck, in its darker, browner neck and upper back, its much lighter lower back and rump, and in the absence of white in the tail. It is identical with *C. c. crossoptilon* in the structure of tail and ear-tufts as well as in its general build. It inhabits the southwestern part of the range of the species, on the northern slopes of the Himalaya from 91° 33' in the west in the Tsangpo Valley to Pome, Gyale and Pankar west of Gyamda Dzong (93° 30' E, 30° 15' N).

Beebe has observed and recorded eared pheasants from northeastern Yunnan, and good series have since been collected on the Lichiang Range by Forrest and by Rock. These series are fairly uniform, whether the birds were collected in the spring or in the autumn; wear affects only the white parts of the plumage, which become ochraceous yellow by stain long after the moult. These Lichiang birds have paler wings than *C. c. crossoptilon*, but they are not as white as *C. c. drouyni*. I propose for them the name of:

Crossoptilon crossoptilon lichiangense
subsp. nov.

Differs from *C. c. crossoptilon*, which it most resembles, in having the wings lighter gray. The outer webs of the primaries are light gray; secondaries and tertiaries pale gray in their exposed part, as are the wing-coverts. The four outer pairs of rectrices in most cases have a distinct whitish-gray outer border, which is usually lacking in *C. c. crossoptilon*, and more gray on the basal half of all the tail feathers; gray wash of the mantle averaging weaker. Adult males are lighter than females and young specimens, as in all other forms. "Iris pale golden yellow; cere grey; bill fleshy pink, yellowish towards the base; legs and feet scarlet, claws horn-brown; skin around the eyes deep rich crimson."

Type 5, No. 543127, American Museum of Natural History, New York, coll. by C. For-

rest, eastern flank of the Lichiang Range, N.W. Yunnan, alt. 14,000 feet, October 10, 1922. Wing, 327; tail, 520; tarsus, 95; culmen (from nostril), 36 mm. Eight specimens examined; one has 21 rectrices.

There are no doubt many intermediates between the different races still to be recorded, and in many areas unstable populations exist. Of the forms known and examined, *crossoptilon*, *lichiangense*, *dolani* and *harmani* show little individual variation, but *drouyni* (= *leucurum*) appears rather unstable as to the amount of white on the rectrices and of the dark tinge on the primaries and their shafts.

Ghigi has made an interesting survey of the genetic characters of the eared pheasants in studying and experimenting with hybrids (*L'Oiseau*, 1934, pp. 10-23). It appears that on the one hand the long ear-tufts of *auritum* and *mantchuricum* are dominant, while on the other hand the flat, almost normal tail of *crossoptilon* is likewise dominant.

In hybrids between *auritum* and *mantchuricum* the blue color and clear white tail patches of the former are plainly dominant; the central rectrices are intermediate in structure.

Brown eared pheasants were first introduced into France in 1864, they were soon bred in great numbers first by Melle de Bellonet in 1866, and in 1868 and 1869 (*Bull. Soc. Accl.*, Paris, 1870, p. 170) several hundred were reared. Ever since, they have been well established in Europe and later in America.

The first blue eared pheasants to arrive alive in Europe from China were sent to my collection at Clères in 1929 by A. Hampe, whom I had commissioned to this effect. The following years some were also introduced into the United States. They were soon propagated. Both species are now common in captivity, a happy state of things since these large pheasants are threatened with an early extinction in their North China home, owing to persecution and to the destruction of the forests and brush in which they live.

A few white eared pheasants were sent from Ta-tien-lu to London in 1891. One pair laid eggs at the Berlin Zoo, but the species was never bred; only a hybrid with the brown was reared at Antwerp, and it now figures in the Tring collection. It has been studied by Ghigi.

In 1936 several pairs of the Szechuan race (*C. c. crossoptilon*) were received in California by Mr. W. Leland Smith, who succeeded in rearing several in 1938 and the following years. There is now a fair number of these fine birds in the United States.

Lt. Col. F. M. Bailey brought a pair of *C. c. harmani* to England a few years ago, but they died without having bred.

5.

Trypanosomes from North American Amphibians, with a Description of *Trypanosoma grylli* Nigrelli (1944) from *Acris gryllus* (Le Conte).

ROSS F. NIGRELLI.

New York Zoological Society.

(Plate I; Text-figures 1-4).

INTRODUCTION.

The North American continent is the natural habitat of many species of amphibians, yet relatively few have been examined for their blood parasites. Table I lists the species that have been examined for trypanosomes.

The extreme polymorphism demonstrated by many of these trypanosomes makes them very difficult to classify on a morphological basis alone. Until cross-infection experiments are made to prove them otherwise, the species described by various investigators must remain valid.

The present contribution deals with trypanosomes found in certain urodeles and anurans from different parts of the eastern and southern United States, together with a more complete description of *Trypanosoma grylli* Nigrelli (1944) from cricket frogs caught in Georgia.

MATERIAL AND METHODS.

Table I also includes those species examined by the writer. These amphibians were collected from Connecticut, New York, New Jersey, Pennsylvania, North Carolina, Georgia, Florida, Michigan and Mississippi.

Blood smears were taken as the amphibians were received in the laboratory and stained immediately with Wright's and Giemsa's blood stains. Splenic smears also were made to determine whether or not intracellular leishmanian bodies were present.

Efforts at cultivating trypanosomes (*T. diemyctyli*) from *Triturus viridescens* were unsuccessful, although it was found possible to isolate the trypanosomes under sterile conditions. Further experiments are under way along this line and attempts will also be made to inoculate laboratory-raised amphibians with *Triturus*-infected blood to establish the specificity of this trypanosome.

Trypanosoma grylli Nigrelli, 1944.

(Text-figure 1 A-J).

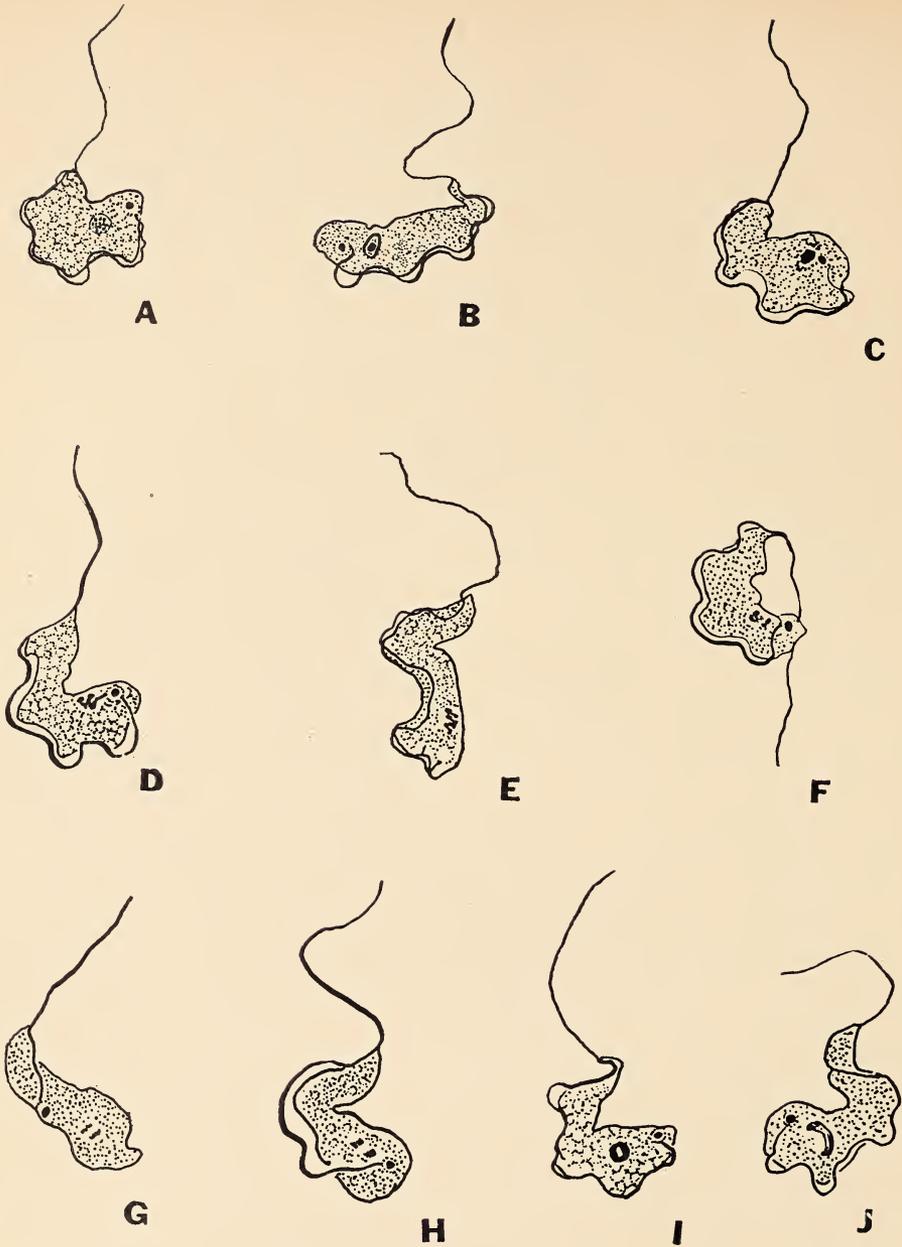
A short preliminary description of this

flagellate was given by the writer in 1944. Twenty-four frogs collected from Georgia were found to be 100% infected and in all cases the infection was relatively heavy. Unlike most of the trypanosomes of amphibians, *T. grylli* is a monomorphic species in which the posterior end is round, while the rest of the body is variable in shape. Fifty trypanosomes were measured, showing a variation from 15.77 to 19.92 μ in length (average 17.43) and from 4.15 to 6.64 μ in width (average 5.31). The parabasal body is well developed, surrounded by a clear area. It is posterior in position, with the nucleus lying nearby. The blepharoplast, from which the intracellular axoneme arises, is present. This fibril passes anteriorly as the border of the undulating membrane and terminates in a well developed flagellum. The length of the flagellum may be as long or slightly longer than the length of the body of the parasite. The periplast is weakly developed, which may account for the amoeboid-like movements and the shape taken by this trypanosome. The cytoplasm is highly vacuolated and no internal myonemes were seen. In the vegetative nucleus a well developed karyosome with a peripheral ring of chromatin material is present. As may be noted from an examination of the figures of *T. grylli*, many of the nuclei are in various phases of mitosis.

TRYPANOSOMES FROM HYLIDAE.

(Text-figure 2 B-F).

Both the incidence and intensity of trypanosome infection in various species of Hylidae examined were very low. Three flagellates were found in smears from two *Hyla andersoni* (Figs. D-F). The presence of a crithidia-like form (Fig. E) and differences in the position of the parabasal body indicates that the infection is a recent one. The parasites measure 10-18 μ in length and 2-3 μ in width. The undulating membrane is fairly well developed with the terminating flagellum being shorter than the length of the body.



TEXT-FIG. 1. A-J. *Trypanosoma grylli* Nigrelli (1944) from *Acris gryllus*. Note the relationship of the nucleus with parabasal body, the highly metabolic body and nuclei in various stages of mitosis. $\times 1200$.

The trypanosome (Fig. B) found in *Hyla versicolor* is long and slender in form, with the parabasal body a short distance from the posterior end. The nucleus is centrally located and the cytoplasm granular in appearance. The undulating membrane is weakly developed and the free flagellum comparatively short. The parasite measures about 35μ in length and about 2.3μ in width.

The flagellate (Fig. C) from *Hyla crucifer* shows certain similarities to *T. grylli*, especially in appearance and in the location of the parabasal body. However, the length and width of this parasite is greater than any of the trypanosomes found in the cricket frog, measuring 27.2 by 10.8μ .

The trypanosomes from these tree frogs are not named because of insufficient material for comparative study. They resem-



TEXT-FIG. 2. A. *Trypanosoma* sp. from *Rana pipiens*. B & C. *Trypanosoma* spp. from *Hyla versicolor* and *H. crucifer*, respectively. D-F. *Trypanosoma* sp. from *Hyla andersoni*. Note position of parabasal body and development of undulating membrane. Fig. E shows a crithidia form, indicating that the infection in this host is a recent one. $\times 1200$.

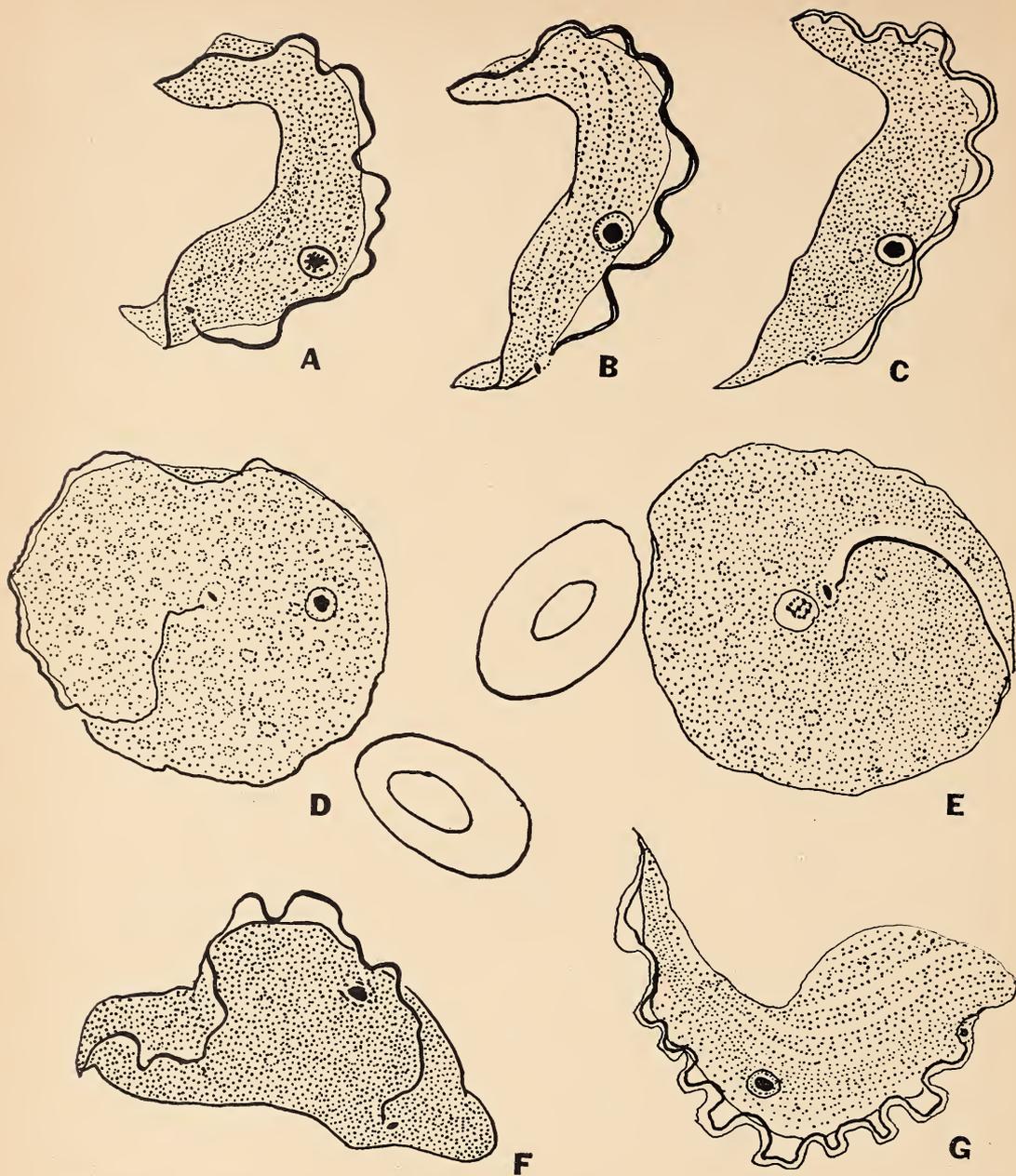
ble somewhat the small elongate forms of *T. rotatorium* that have been reported from tadpoles from various parts of the world. Insofar as is known, Brandt (1936) was the first to report a species of trypanosomes from a species of North American Hylidae. He referred to the flagellates found in *Hyla crucifer* from North Carolina as *Trypanosoma rotatorium*.

TRYPANOSOME FROM *Rana pipiens*.

(Text-figure 2 A).

Trypanosomes recovered from smears taken from eight pickerel frogs measure 68-72 by 6-9 μ and resemble to a certain

extent the long slender form of *T. diemyctyli* found in the newt (compare with Plate I; see also Nigrelli, 1929). The position of the nucleus and parabasal, the clear zone at the posterior tip of the body, the degree of development of the undulating membrane and the flagellum, and size of the body are characteristics which resemble those present in *T. diemyctyli*. Lack of sufficient material for a more detailed study makes it difficult to name this form. However, it is different from *T. rotatorium* and *T. inopinatum* Ed. & Et. Sargent (1904) reported from *Rana pipiens* by several investigators (see Kudo, 1922; Fantham, Porter & Richardson, 1942).



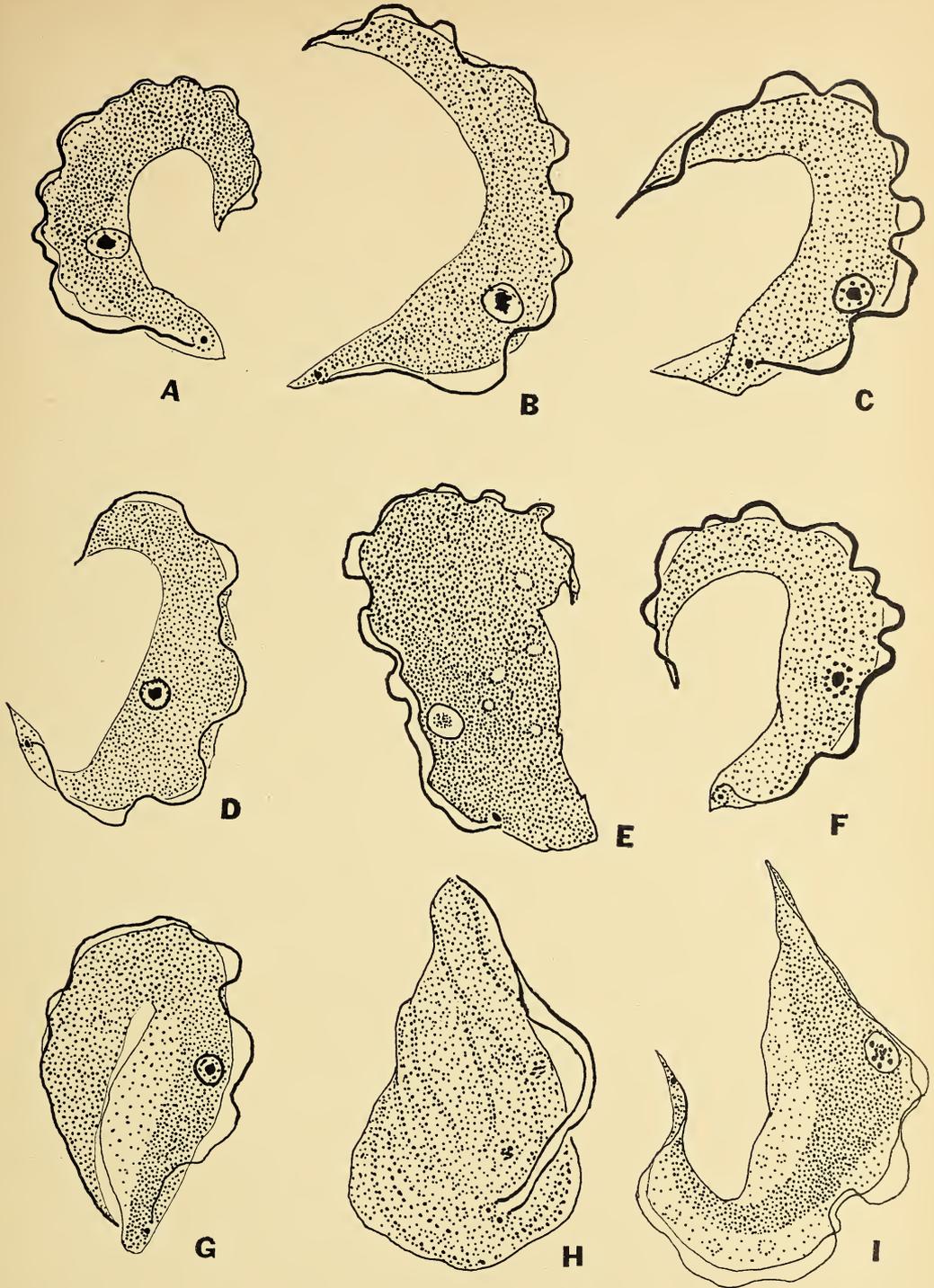
TEXT-FIG. 3. *Trypanosoma rotatorium* (Mayer) from *Rana clamitans*. Note the highly polymorphic nature of this trypanosome. Figs. A-C; F & G. Typical forms. Figs. D and E rounded dividing forms. Note the juxtaposition of nucleus and parabasal in the flagellate in Fig. E. $\times 1200$.

Trypanosoma rotatorium (Mayer).

(Text-figures 3, 4).

Typical polymorphic forms of *Trypanosoma rotatorium* were found in *Rana clamitans* and *Rana catesbeiana* from various localities in Connecticut, New York, New Jersey and Pennsylvania. This flagellate has been reported from all the localities in

which these hosts occur. In the present case, the trypanosomes from adult *R. clamitans* (Text-figure 3 A-G) are of two general types designated here as elongated forms and round forms, the former measuring $51-80 \times 10-25 \mu$ and the latter $48-50 \times 45 \mu$. The trypanosomes from *R. catesbeiana* (Text-figure 4 A-I) were also variable in form but no round individuals were encountered.



TEXT-FIG. 4. *Trypanosoma rotatorium* (Mayer) from *Rana catesbeiana*. Figs. E, H, I show dividing individuals. $\times 1200$.

They measure $51-85 \times 12-19 \mu$. No free flagella were noted and stages in binary fission were seen frequently.

Several *Rana catesbeiana* were caught that had leeches (*Macrobdella?*) on them. Stained smears of the partly digested blood

TABLE I. North American Amphibians Examined for Trypanosomes.

AMPHIBIA	TRYPANOSOME	AUTHOR	YEAR
<i>Acris gryllus</i> (Le Conte)	<i>T. grylli</i>	Nigrelli	1944
<i>Ambystoma maculatus</i> (Shaw)	Negative	Nigrelli	Present paper
<i>Ambystoma opacum</i> (Gravenhorst)	Negative	Nigrelli	Present paper
<i>Ambystoma tigrinum</i> (Green)	Negative	Nigrelli	Present paper
<i>Ambystoma tigrinum</i> (Green)	Negative	Roudabush & Coatney	1937
<i>Bufo americanus</i> Holbrook	<i>T. lavalia</i>	Fantham, Porter & Richardson	1942
<i>Bufo americanus</i> Holbrook	<i>T. gaumontis</i>	Fantham, Porter & Richardson	1942
<i>Bufo americanus</i> Holbrook	<i>T. montrealis</i>	Fantham, Porter & Richardson	1942
<i>Bufo fowleri</i> (Hinckley)	<i>T. rotatorium</i>	Brandt	1936
<i>Bufo woodhousii</i> Girard	Negative	Roudabush & Coatney	1937
<i>Cryptobranchus alleganiensis</i> (Daudin)	<i>T. cryptobranchi</i>	Roudabush & Coatney	1937
<i>Desmognathus fuscus</i> (Rafinesque)	Negative	Nigrelli	Present paper
<i>Desmognathus fuscus</i> (Rafinesque)	Negative	Hegner	1921
<i>Hyla andersoni</i> Baird	<i>Trypanosoma</i> sp.	Nigrelli	Present paper
<i>Hyla cinera</i> (Schneider)	Negative	Nigrelli	Present paper
<i>Hyla crucifer</i> Wied	<i>T. rotatorium</i>	Brandt	1936
<i>Hyla crucifer</i> Wied	<i>Trypanosoma</i> sp.	Nigrelli	Present paper
<i>Hyla femoralis</i> Latreille	Negative	Nigrelli	Present paper
<i>Hyla squirella</i> Latreille	Negative	Nigrelli	Present paper
<i>Hyla versicolor</i> (Le Conte)	<i>Trypanosoma</i> sp.	Nigrelli	Present paper
<i>Necturus maculosus</i> (Rafinesque)	<i>Trypanosoma</i> sp.	Hegner	1921
<i>Necturus maculosus</i> (Rafinesque)	<i>Trypanosoma</i> sp.	Roudabush & Coatney	1937
<i>Necturus maculosus</i> (Rafinesque)	<i>Trypanosoma</i> sp.	Nigrelli	Present paper
<i>Plethodon cinereus</i> (Green)	<i>Trypanosoma</i> sp.	Hegner	1921
<i>Plethodon glutinosus</i> (Green)	<i>Trypanosoma</i> sp.	Hegner	1921
<i>Pseudacris brimleyi</i> (Brandt & Walker)	<i>T. rotatorium</i>	Brandt	1936
<i>Pseudotriton rubra</i> (Latreille)	Negative	Nigrelli	Present paper
<i>Rana catesbeiana</i> Shaw	<i>T. rotatorium</i>	Brandt	1936
<i>Rana catesbeiana</i> Shaw	<i>T. rotatorium</i>	Fantham, et al	1942
<i>Rana catesbeiana</i> Shaw	<i>T. rotatorium</i>	Nigrelli	Present paper
<i>Rana catesbeiana</i> Shaw	<i>T. inopinatum</i>	Fantham, et al	1942
<i>Rana catesbeiana</i> Shaw	<i>Trypanosoma</i> sp.	Hegner	1920 ¹
<i>Rana clamitans</i> Latreille	<i>T. clamatae</i>	Stebbins	1907
<i>Rana clamitans</i> Latreille	<i>T. parvum</i>	Kudo	1922
<i>Rana clamitans</i> Latreille	<i>T. rotatorium</i>	Kudo	1922
<i>Rana clamitans</i> Latreille	<i>T. rotatorium</i>	Fantham, et al	1942
<i>Rana clamitans</i> Latreille	<i>T. rotatorium</i>	Nigrelli	Present paper
<i>Rana clamitans</i> Latreille	<i>Trypanosoma</i> sp. ²	Stebbins	1907
<i>Rana clamitans</i> Latreille	<i>Trypanosoma</i> sp.	Hegner	1920
<i>Rana palustris</i> Le Conte	Negative	Nigrelli	Present paper
<i>Rana pipiens</i> Schreber	<i>T. rotatorium</i>	Kudo	1922
<i>Rana pipiens</i> Schreber	<i>T. rotatorium</i>	Packchianian	1934
<i>Rana pipiens</i> Schreber	<i>T. rotatorium</i>	Fantham, et al	1942
<i>Rana pipiens</i> Schreber	<i>T. inopinatum</i>	Fantham, et al	1942
<i>Rana pipiens</i> Schreber	<i>Trypanosoma</i> sp.	Nigrelli	Present paper
<i>Rana sphenoccephala</i> (Cope)	<i>T. rotatorium</i>	Brandt	1936
<i>Rana sylvatica</i> Le Conte	Negative	Fantham, et al	1942
<i>Rana sylvatica</i> Le Conte	Negative	Nigrelli	Present paper
<i>Rana virgatipes</i> Cope	Negative	Nigrelli	Present paper
<i>Scaphiopus holbrookii</i> (Harlan)	Negative	Brandt	1936
<i>Spelerpes (Eurycea) bislineatus</i> (Green)	Negative	Hegner	1921
<i>Triturus viridescens</i> (Rafinesque)	<i>T. diemyctyli</i>	Tobey	1906
<i>Triturus viridescens</i> (Rafinesque)	<i>T. diemyctyli</i>	Hegner	1921
<i>Triturus viridescens</i> (Rafinesque)	<i>T. diemyctyli</i>	Nigrelli	1929
<i>Triturus viridescens</i> (Rafinesque)	<i>T. diemyctyli</i>	Nigrelli	Present paper

¹ See Calkins (1933).² Larger of two forms found, probably *T. rotatorium*.

taken from the gut of the leeches showed the presence of many leptomonad and crithidia bodies in various stages of longitudinal fission, much like those reported by

the writer (1929) for the metacyclic forms of *T. diemyctyli*. The cytoplasm of the parasites from the leeches contained red staining granules (volutin?) not unlike those that

TABLE II. Comparative Measurements of Trypanosomes from North American Amphibians

TRYPANOSOME	AVERAGE (microns)	WIDTH	LENGTH	FLAGELLUM
1. <i>T. rotatorium</i> (Mayer, 1843) Fantham, et al (1942) Nigrelli (present paper) From adult <i>R. clamitans</i> Elongate forms Round forms From adult <i>R. catesbeiana</i>	47.4-72.6 51-80 48-50 51-85	3.0-26.7 10-25 43-45 12-19	..... 67.7×17.2 44×49 67.7×12.8	Very short None or very short None or very short None or very short
2. <i>T. inopinatum</i> Sergent & Sergent (1904) Original Measurements Kudo (1939) Slender forms Larger Forms Fantham, et al (1942)	16.5-21 12-20 30-35	1.5-2.2 ..... ..... .....	..... ..... ..... .....	1-6 1.5-2.5
3. <i>T. diemyctyli</i> Tobey (1906) Hegner (1921) Nigrelli (1929) Broad forms Slender forms	38.1-75.3 63.5-79.4 38-57	1.9-4.4 5.2-9.0 1.9-4.5	56×2.89 71×8.2 53×3.8	..... Very long
4. <i>T. clamatae</i> Stebbins (1907) Slender forms Larger forms	21 27.56-47	2.5-2.8 16.78-28.51	..... .....	12-13 5.96-14.79
5. <i>T. parvum</i> Kudo (1922)	11-14	1.2-1.9	.....	5-15
6. <i>T. cryptobranchi</i> Roudabush & Coatney (1936)	46.8-77.4	1.8-5.84	60.87×3.51	31.61
7. <i>T. lavalia</i> Fantham, Porter, & Richardson (1942)	31.1-35.5	3.9-4.4	.....	1.5-2.6
8. <i>T. gaumontis</i> Fantham, Porter & Richardson (1942) Group I Group II	15-15.8 19.7-20.7	1.3-1.85 1.5-1.85	..... .....	None None
9. <i>T. montrealis</i> Fantham, Porter & Richardson (1942)	45-68	1.8-6	44-45	3-5.5
10. <i>T. grylli</i> Nigrelli (1944)	15.77-19.92	4.5-6.6	17.4×5.4	ca. 17

are known to occur in similar stages of other species. The presence of metacyclic forms in the gut of leeches is good evidence that these annelids are the true intermediate hosts of *T. rotatorium*, and presumably the trypanosomes of some of the other Amphibia.

***Trypanosoma diemyctyli* Tobey**
from *Triturus viridescens*.
(Plate I; Figures 1-4).

Details concerning the morphology and life-history of *T. diemyctyli* Tobey (1909) were reported by the writer in 1929. This is a dimorphic species, involving long and broad forms, the former measuring 46-65 × 2.5-5.0 μ and the latter varying from 63-5-79 × 8.2 μ . The life cycle of *T. diemyctyli* was demonstrated experimentally. A leech is the transmitting agent. In the newt,

reproduction takes place by binary fission while free in the blood stream, and in large mononuclear leucocytes where leishmanian bodies are produced. A similar cycle was demonstrated by Carini (1912) for *T. leptodactyli*, a form occurring in the South American amphibian, *Leptodactylus ocellatus*. Reproduction by formation of leishmanian bodies that are intracellular parasites is characteristic of *Trypanosoma cruzi*, the causative agent of South American human trypanosomiasis (Chaga's disease). However, in Chaga's disease, the trypanosomes do not multiply in the blood stream. Reproduction is limited to the intracellular stage.

DISCUSSION.

Table II lists and compares the various species of trypanosomes reported from North American amphibians. Whether or

not they can all be relegated to one or more species cannot be answered at this time. It is certain that size and form alone are not good diagnostic characters to establish a species. The size of the host may have some influence on these factors.

Culturing the trypanosomes may throw some light on specificity. Characteristics such as shape and size of the colonies, the time it takes the colonies to develop, cyclic forms that may occur and nutritional requirements, would in all probability indicate species differences. Amphibian trypanosomes have been cultivated by several investigators, and Nöller (1913) obtained a good growth in sealed preparations of infected frog's blood mixed with an equal quantity of bouillon. He was able to follow the development of the large trypanosomes typical of *T. rotatorium* from *Rana esculenta* into the smaller, slender flagellates (cristidia) which result from repeated binary fission. Ponselle (1923) showed that the development of these large trypanosomes is dependent upon the reaction of the medium. He found that a mixture of broth (pH 6.3) and one-tenth its volume of defibrinated rabbit's blood yielded good cultures of *T. rotatorium* but would not support the growth of *T. inopinatum*, a second species found in *Rana esculenta*. However, the latter flagellate was grown in a mixture of equal parts of distilled water and defibrinated rabbit's blood, a mixture which, in turn, would not support the growth of *T. rotatorium*. Galliard (1926) was able to keep *T. inopinatum* alive for two years in sealed tubes of this medium. Packchianian (1934) cultured *T. rotatorium* from *Rana pipiens* on N.N.N. medium. He reported that the organisms formed colonies only after several months of cultivation, but once they began, they colonized readily thereafter. The colonies reached a size of about 8 mm. Varga & Bacsich (1938) obtained weak cultures on Zeisler's substrate but were able to find many dividing forms of *T. rotatorium*.

Cross-infection experiments and serological tests may also give some evidence as to the validity of the described species of trypanosomes. Nöller (1913) showed that infections in adult frogs (*R. esculenta*) may be superimposed by a second one by inoculation of infected blood from tadpoles of this host species, or by injection of large doses of cultured trypanosomes. Further, infection of *Rana temporaria* with cultured *T. rotatorium* was also accomplished. Under similar conditions the tree frog, *Hyla arborea*, was successfully infected, suggesting that *T. hylae* of França (1908) naturally found in this amphibian may be identical with *T. rotatorium*. Transmission ex-

periments with toads (*Bombinator igneus*) were negative. This would indicate a natural immunity and a certain degree of host specificity.

The presence of more than one species of the same type of parasite in the same host is not uncommon. Thus, at least three species were found to occur in the *R. esculenta* (European green frog): *T. inopinatum* Sargent & Sargent (1904), *T. neueu-lemairi* Brumpt (1923) and *T. rotatorium* (Mayer). As is shown above, *T. inopinatum* and *T. rotatorium* appear to be distinct species since their culture requirements are different. In this country *T. clamatae* Stebbins (1907), *T. parvum* Kudo (1922) and *T. rotatorium* of various investigators were reported from *Rana clamitans*. *T. parvum* and *T. clamatae* are probably the same and these, in turn, may be young stages of *T. rotatorium*. More recently, Fantham, Porter & Richardson (1942) found *T. inopinatum* in addition to *T. rotatorium* in *R. catesbeiana*. Here again, *T. inopinatum* may be a cyclic form of *T. rotatorium*. Only by cultivation on the differential test media of Ponselle can this assumption be proved or disproved. For *Bufo americanus* they describe three new species: *T. lavalia*, *T. gaumontis* and *T. montrealis*. The three occur in toads from different regions of Canada. However, they do not state whether or not a mixed infection of two or more species was encountered. The distinction between these species is vague, being separated mainly on differences in size.

It is perhaps through serological reactions that specificity of these amphibian trypanosomes may be determined. That this is a possibility has been demonstrated by several investigators for trypanosomes of warm blooded animals. It is known that some animals have sera with trypanolytic properties. Thus, human serum destroys all the pathogenic trypanosomes of mammals with the exception of those found in man (see Culbertson, 1941). The same results have been determined for other animals, and may also be true for the Amphibia. It is an established fact that anatomically related Amphibia show, in some instances, great divergence when tested serologically. Boyden & Noble (1933) have demonstrated by serological reactions that "Within the Salinetia, *Rana catesbeiana* and *Rana clamitans* are very close together, while *Rana pipiens* is not very close to either. *Hyla septentrionalis* is remote from all the species of *Rana*." On the same basis, relationships between certain of the Caudata were determined. *Triturus* and *Cryptobranchus* are not related. No mention was made of the serological affinities of the Bufonidae. There seems to be some correlation between these serological reactions and the species of try-

panosomes harbored by the various amphibian hosts. It has always been felt among certain investigators, as indicated above, that the trypanosomes occurring in *R. catesbeiana* and *R. clamitans* are *T. rotatorium*. There is some doubt about the validity of *T. rotatorium* and *T. inopinatum* reported by several investigators (see Table I) from *Rana pipiens*. The flagellate reported by the writer from this species seems to be different from the highly polymorphic *T. rotatorium*.

Trypanosoma diemyctyli, *T. cryptobranchi*, *T. grylli* and the species described by Fantham, et al., from *Bufo americanus*, appear to be good species, and the correlation between the serological reactions of some of the hosts involved and their haemoflagellates is very striking. *T. diemyctyli* has always been considered a distinct species. *T. cryptobranchi* is a comparatively new species, but there seems to be no doubt about its validity. *T. grylli* is unlike any of the previously described trypanosomes from amphibians. Those found in *Bufo americanus* are probably valid, but it is the writer's opinion that the three species described from this host could be reduced to a single type. The trypanosomes recovered from various species of *Hyla* have not been designated because of insufficient material. Brandt (1936) categorically considered all the trypanosomes he found in the amphibians he investigated as *T. rotatorium*. Those present in *R. catesbeiana* and *R. sphenoccephala* probably are but those in *Bufo fowleri*, *Pseudacris brimleyi* and *Hyla crucifer* may not be. All this material should be re-investigated to determine species differences, if any.

In any event the authenticity of the various species of trypanosomes in North American amphibians can only be established, in view of their highly polymorphic nature, by serological tests and by cultivation of the organisms found in the different host species. A simple experiment, which would add much to our knowledge of these trypanosomes, would be to test for the trypanolytic action of sera from various amphibians on cultured strains of a known species.

SUMMARY.

1. Nineteen species of Caudata and Salientia were examined for trypanosomes.

2. Infections were found in the following species: *Acris gryllus*, *Hyla andersoni*, *Hyla crucifer*, *Hyla versicolor*, *Rana catesbeiana*, *Rana clamitans*, *Rana pipiens* and *Triturus viridescens*.

3. The species found in *Acris gryllus* is considered new and designated as *Trypanosoma grylli* Nigrelli, 1944. A detailed description is given in this paper.

4. The species found in *R. catesbeiana* and *R. clamitans* is considered as *T. rotatorium* (Mayer); that found in *Triturus viridescens* as *T. diemyctyli* Tobey. The trypanosomes found in various species of *Hyla* and in *R. pipiens* were not named because of insufficient material to make a proper diagnosis.

5. A list of North American amphibians examined for trypanosomes by various investigators is given.

6. A table of measurements of the several species of trypanosomes reported is included in this study.

7. The apparent correlation between the serological reaction of the various hosts and the species of trypanosome harbored is discussed.

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EXPLANATION OF THE PLATE.

PLATE I.

Figs. 1-5. *Trypanosoma diemyctyli* from blood of *Triturus viridescens*. $\times 3200$.



FIG. 1.

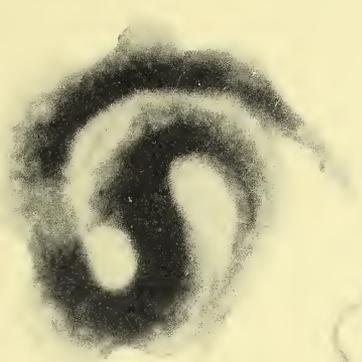


FIG. 2.

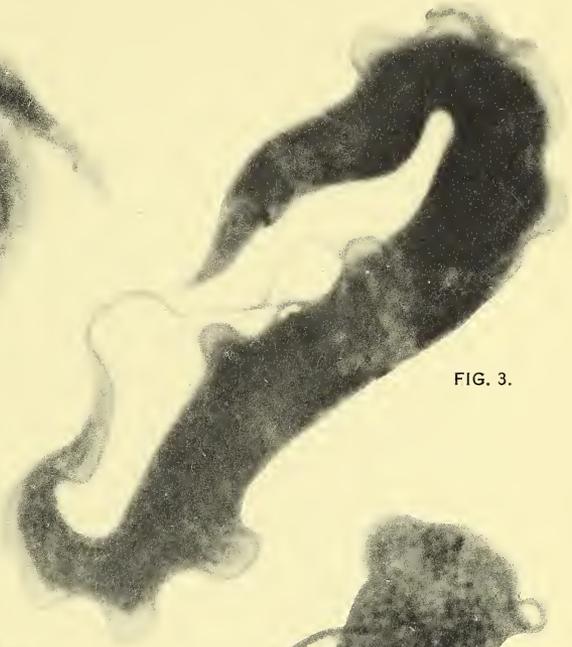


FIG. 3.

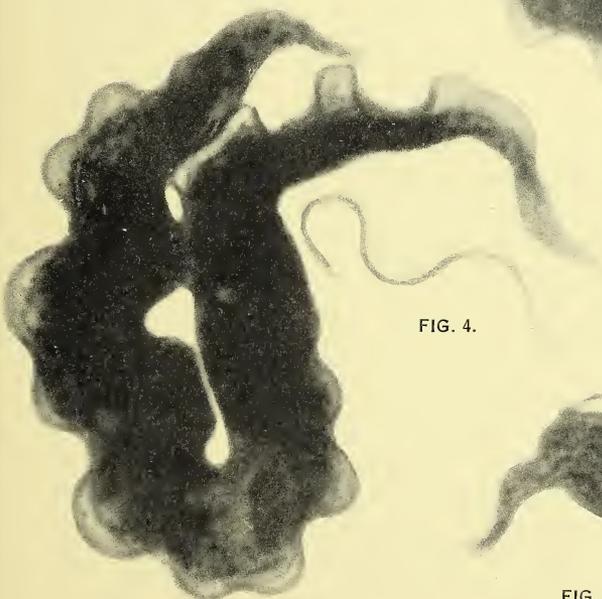


FIG. 4.



FIG. 5.

TRYPANOSOMES FROM NORTH AMERICAN AMPHIBIANS, WITH A DESCRIPTION OF TRYPANOSOMA GRYLLI NIGRELLI (1944) FROM ACRIS GRYPHUS (LE CONTE).



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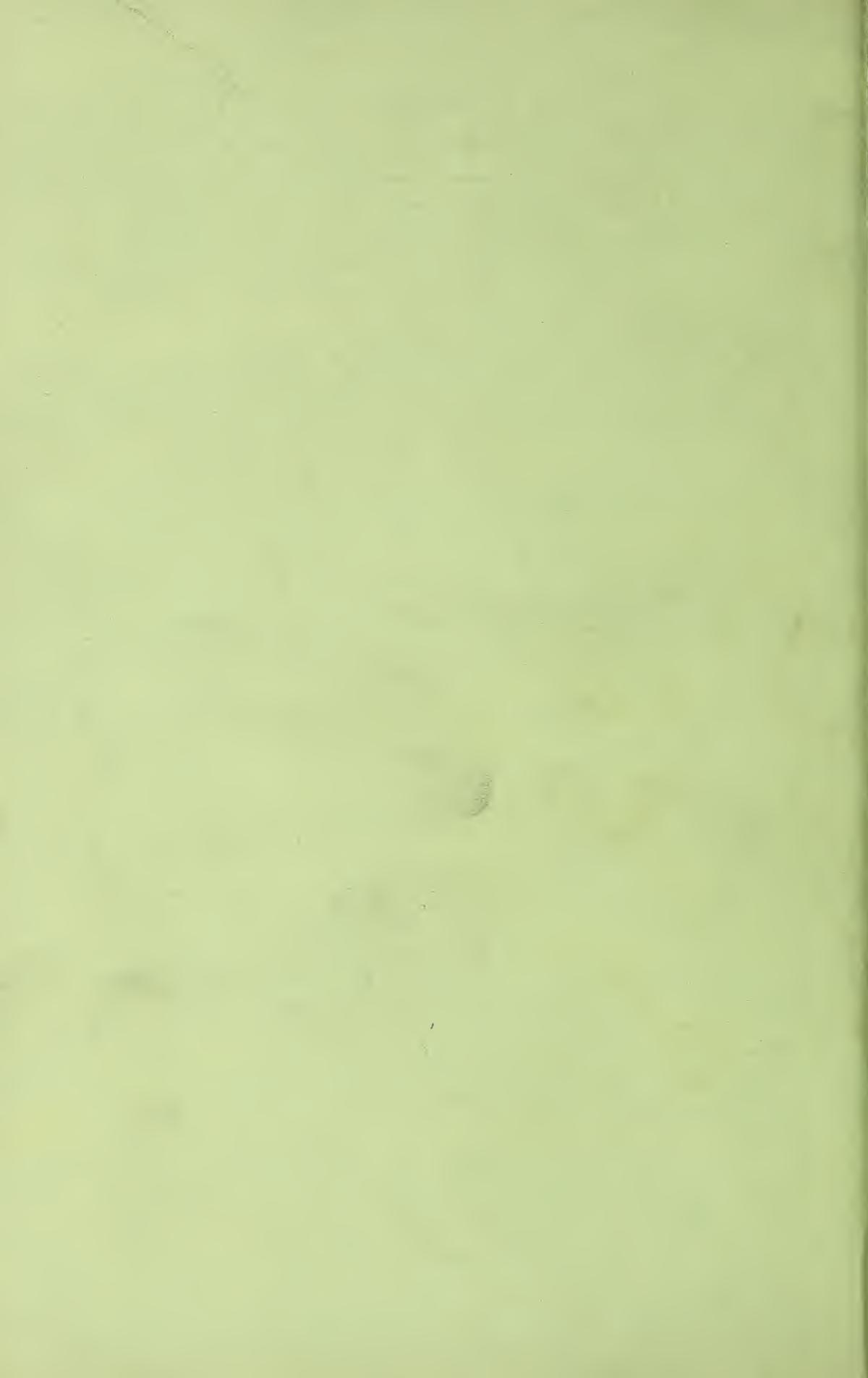
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6.

Sexual Dimorphism in the Skeletal Elements of the Gonopodial Suspensoria in Xiphophorin Fishes.¹

MYRON GORDON & PAUL BENZER.

New York Aquarium.

(Plate I; Text-figures 1-11).

This survey of the sex-modified hemal and interhemal spines that make up the gonopodial suspensorium in xiphophorin fishes was made to serve several purposes. These skeletal elements were found anew by Howell Rivero and Hubbs (1936) to be of importance in the classification of viviparous cyprinodonts in general; therefore, it is hoped that definitive descriptions of these bones in each of the seven xiphophorin species might reveal relationships in this small but difficult taxonomic group not previously appreciated. Recent work by Turner (1942) and by Cohen (1942), reported by Gordon, Cohen and Nigrelli (1943), has also shown that these structures in immature fishes are extremely sensitive to synthetic sex hormones; thus it is necessary for future endocrine studies to define the normal and final stages in untreated males of each species for comparative purposes. Finally, the standard types of the gonopodial suspensorium elements are required for possible genetic analysis of species and generic differences, for in this group hybridization, under laboratory conditions, is the rule rather than the exception. Heretofore no comprehensive study of these elements has been made of the seven xiphophorins now known, although Langer (1913) has shown these structures beautifully in two of them: *Xiphophorus hellerii* and *Platypoecilus maculatus*.

MATERIAL AND METHODS.

Fully developed males of three species of *Xiphophorus* and four species of *Platypoecilus* were studied. The original stocks of the seven xiphophorin species were collected in 1939 and 1940 by two New York Aquarium expeditions. The stocks have been

¹ This work has been aided, in part, by grants from the Alma Fuller Fund. The authors acknowledge the kindness of The American Museum of Natural History for the use of their laboratory facilities. We thank Doctors C. M. Breder, Jr., W. K. Gregory, C. L. Hubbs and Mr. J. T. Nichols for reading the manuscript and for their suggestions.

maintained at the New York Zoological Society's laboratories. Many of the stocks are in their seventh generation.

The specific sites from which the living material has been collected are given on page 58, together with the number of each species used and the standard size limits in millimeters.

Further details of the distribution of these species and the ecological conditions of their various habitats are given by Gordon (1940, 1943).

Whole fish were fixed in 95% alcohol, cleared in 2% potassium hydroxide to which a 3% solution of hydrogen peroxide was added. They were stained in Alizarine Red S and mounted and studied in glycerine. The technique followed was Benzer's (1940) modification of the method of Schultz (1897). This treatment made the muscles transparent, with all the tissues intact, while the bones are specifically stained.

The areas of the gonopodial suspensorium were photographed. Enlargements were made on 8" x 10" semi-matte paper. The critical elements were outlined with waterproof ink, then the prints were bleached in potassium ferro-cyanide solution. Final tracings were made from these drawings.

GENERAL DESCRIPTION OF THE GONOPODIAL SUSPENSORIUM IN THE XIPHOPHORINI

The gonopodial suspensorium consists of the masculinized hemal spines (gonapophyses) and the masculinized interhemal spines (gonactinosts) that are associated with the anal fin (gonopodium). Between the points of articulation of the gonactinosts and the bases of the rays of the gonopodium, there are two series of tiny pterygial elements. These provide the pivotal elements upon which the gonopodium is enabled to swing in all directions.

The Gonapophyses (the masculinized hemal spines).

The most anterior hemal spines, usually

Species	Size		Habitat of Original Stock
	No.	in mm.	
<i>Platypoecilus couchianus</i>	18	21-26	Spring pool at St. Catarina, Nuevo Leon
<i>Platypoecilus xiphidium</i>	25	20-33	Spring pool at Cruz, Tamaulipas
<i>Platypoecilus variatus</i>	21	18-34	El Nilo, Rio Tambaon, San Luis Potosi
<i>Platypoecilus maculatus</i>	13	20-25	Plaza de Agua, Rio Jamapa, Veracruz
<i>Xiphophorus pygmaeus</i>	16	18-23	Rio Axtla at Axtla, San Luis Potosi
<i>Xiphophorus montezumae</i>	14	26-43	Arroyo Palitla, Tamazunchale, San Luis Potosi
<i>Xiphophorus hellerii</i>	12	32-45	Arroyo Zacatispan, San Bartolo, Oaxaca.

three in number, are modified into gonapophyses. Unlike normal spines they are directed forward rather than backward. Some gonapophyses are as straight as unmodified hemal spines while others are slightly bowed, deeply arched or sigmoid. Some gonapophyses are no broader than hemal spines while others are at least twice as broad, indicative of greater strength and larger surface for the insertion of gonopodial muscles. The first gonapophysis is the shortest. The most posterior gonapophysis (usually the third) is the longest, being as long as, or longer than, its adjacent unmodified hemal spine. The second gonapophysis is intermediate in length. All gonapophyses have concave posterior contours.

The first gonapophysis arises from the thirteenth vertebra and its tip is directed just anterior to the end of the seventh actinost. The tip of the second gonapophysis lies just posterior to the eighth actinost. The distal tips of the ninth and tenth actinosts are encompassed by the terminal points of the second and third gonapophyses.

The first gonapophysis usually bears the last rib, but ribs may be borne, particularly in some species of *Xiphophorus*, on the second and on the third gonapophysis.

The Ligastyle (bone in the suspensory ligament).

A spinous ligament connects the ventral surface of the centrum of the tenth vertebra with the distal portion of the fused gonactinosts 2, 3 and 4. The spine which lies embedded within the ligament has been shown by various workers to be the modified first hemal spine originating on the twelfth vertebra. In ontogeny it breaks away from its hemal arch, becoming much thinner; it is forced anteriorly a distance of two vertebrae. Being a thin, spinous bone within a ligament, the term "ligastyle" is suggested for it.

The Gonactinosts (the masculinized actinosts).

The actinosts or interhemal spines are nine in number. They are variously modified in the gonopodial suspensorium complex. The first, and most anterior gonactinost is

free, small and rod-like; it is directed more anteriorly than dorsally.

The second, third and fourth gonactinosts are variously fused to form the gonactinost complex proper. The second and third gonactinosts may be fused suturely at their bases. The third and fourth are always fused at their bases. The posterior surface of the fourth gonactinost is concave. This concavity serves as a grooved area in which the fifth gonactinost is moved in a directed path. The fifth element is not fused to any other; it is shaped like a bow and its middle convex portion slips within the concave trough of the preceding gonactinost complex. Only the ends of the fifth element are visible from the lateral aspect.

The sixth, seventh, eighth and ninth actinosts form a series of simple, slightly curved rods which are evenly spaced; they become smaller and weaker progressively towards the posterior. They do not appear to be greatly modified.

The fusion of some gonactinosts, the increased strength of some and the weakening of others, is reflected, in some measure, to the conditions found in the rays of the gonopodium. In the latter, rays 3, 4 and 5 are tremendously strengthened while the others are generally smaller and weaker than their unmodified counterparts as seen in the anal fins of females.

GENERIC DISTINCTIONS.

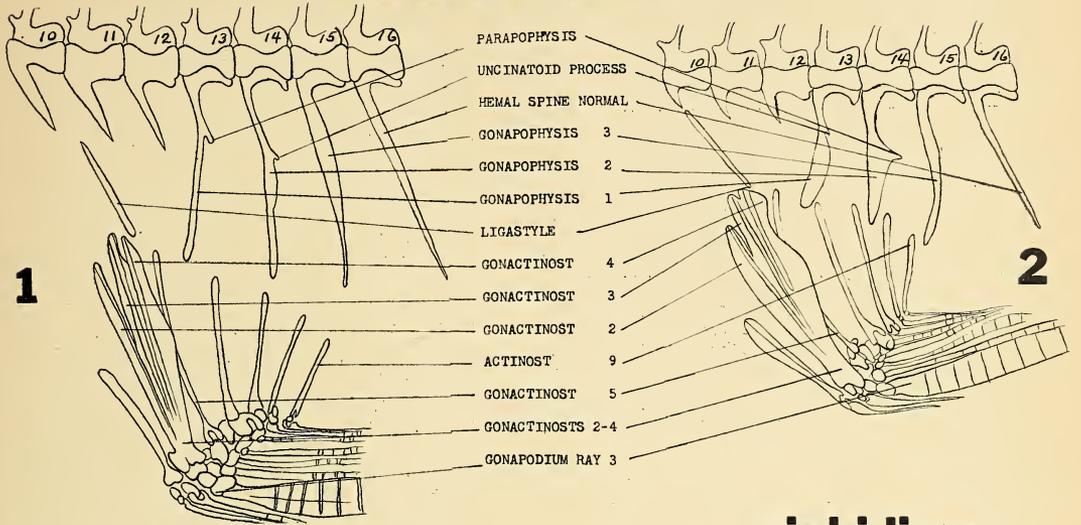
Several general differences in the configuration of the element of the gonopodial suspensoria exist between the members of the genus *Xiphophorus* and those of *Platypoecilus*, see Table II.

Extent of Fusion of the Gonactinosts.

Fusion of the gonactinosts may take place at their bases, at their tips, at their bases and tips leaving the mid-section separate, or the elements may fuse for their entire length.

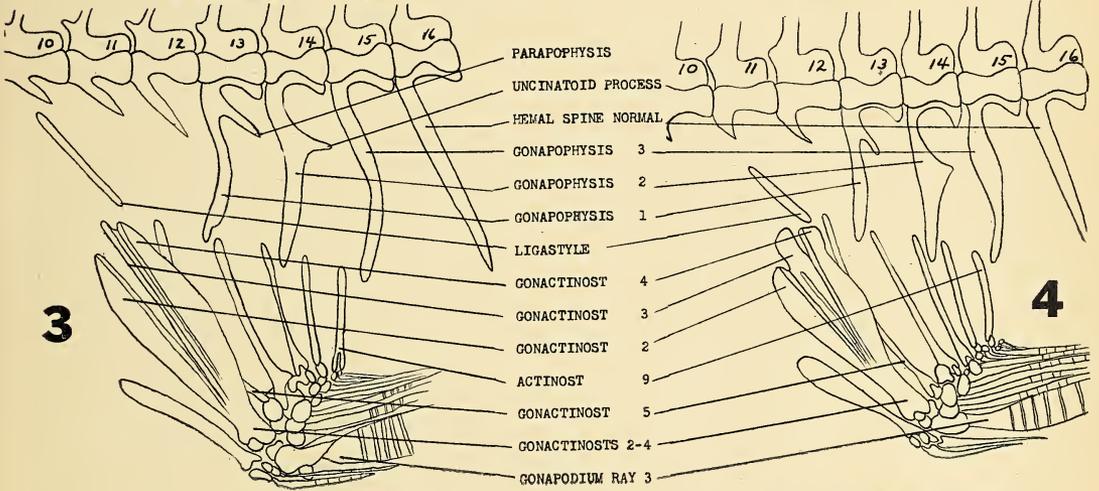
While there is general fusion of some of the gonactinosts 2, 3 and 4 in all xiphophorins, fusion is much more extensive in the swordtails than in the platyfishes. For example, the tips and bases of rays 3 and 4 are rarely fused in *Platypoecilus* species; they are rarely separate in *Xiphophorus*.

PLATYPOECILUS



maculatus

xiphidium



variatus

couchianus

TEXT-FIGS. 1-4. Comparative morphology of the gonopodial suspensoria of the four species of *Platypoecilus*.

The Rib-Gonapophysis Relationships.

In all species of *Platypoecilus*, the first gonapophysis bears the last pair of ribs. In the swordtails no such uniformity exists. In *Xiphophorus pygmaeus* the rib gonapophysis relationship is the same as in the platyfishes; that is, the first gonapophysis carries the last pair of ribs. In *X. montezumae* the second gonapophysis bears the last pairs of ribs, while in *X. hellerii* the third gonapophysis presents the last pair of ribs.

SPECIFIC DISTINCTIONS IN *Platypoecilus*.

The Second Gonapophyses.

The differences in the elements of the gonopodial suspensoria of the platyfishes may be expressed quantitatively, see Tables I, II. The gonapophyses are small, the largest measuring only 3 mm., and their extensions, the parapophyses of the first and the uncinatoid processes of the second gonapophyses, are smaller still. Nevertheless an

TABLE I. Analysis of the Second Gonapophyses in *Platyopocilus* Males.

Each number represents in millimeters the measurements of the gonapophyses and their processes of three specimens, averaged.

The second set of values: a, b, c, d, represents the average measurements of A, B, C, D, in proportional parts of A.

<i>Species of Platyopocilus</i>	Length of gonapophyses	Length of uncini	Spread of uncini tips	Width of gonapophyses	
	A	B	C	D	
<i>maculatus</i>	2.53	0.97	1.00	0.53	
<i>variatus</i>	1.93	0.97	1.33	0.40	
<i>xiphidium</i>	2.56	1.13	0.73	0.72	
<i>couchianus</i>	2.07	0.97	1.13	0.40	
	a $\frac{A}{A}$	b $\frac{B}{A}$	c $\frac{C}{A}$	d $\frac{D}{A}$	$\frac{c}{d}$
<i>maculatus</i>	1.00	0.38	0.39	0.21	1.9
<i>variatus</i>	1.00	0.50	0.53	0.21	2.5
<i>xiphidium</i>	1.00	0.45	0.28	0.28	1.0
<i>couchianus</i>	1.00	0.47	0.55	0.19	2.9

attempt was made to record their proportions accurately.

The uncinus of the second gonapophyses is least developed in *P. maculatus* (0.38) and is increasingly stronger in *P. xiphidium* (0.45), *P. couchianus* (0.47) and *P. variatus* (0.50). For these values the lengths of the second gonapophysis served as a standard. It was measured from the mid-point of the centrum to its ventral tip. The extent of the posterior projection of the uncinus was obtained by measuring the distance between the anterior margin or keel of the second gonapophysis and the most posterior limit of the uncinus.

While on the whole the lengths of the uncini are much alike in the four species, they differ in the manner in which they spread away from the keel of the gonapophyses. For example, in *P. xiphidium* the uncini point directly toward the posterior while in the others they flare out at various angles. This degree of spread of the terminal points of the uncini has been measured by comparing the spread with the length of the gonapophysis; it was least in *P. xiphidium* (0.28), increasing in *P. maculatus* (0.39), *P. variatus* (0.53), *P. couchianus* (0.55).

Anterior views of disarticulated vertebrae with their second gonapophyses indicate that there are considerable species differences in the widths (possibly also denoting degrees of strength) of the modified hemal spines. When the measure of their widths is divided into the measure of their lengths, the following values were obtained: *P. couchianus* has the least width (0.19); it is greater in *P. maculatus* (0.21) and *P. variatus* (0.21), greatest in *P. xiphidium* (0.28). It will be noticed that this relationship is just the opposite of the width of

spine relationship. It may be that the area available for muscle attachments is about the same in all species but in *P. xiphidium* the attachment areas are mainly represented by the wide hemal spines whereas in *P. couchianus* these areas are furnished by the widely flaring uncini.

The First Gonapophyses.

If the length and the width of the first gonapophyses be compared, it becomes evident that *P. xiphidium* has the widest spine and *P. variatus* the narrowest. If these two measurements are related to the degree of spread of the parapophyses' terminal points, another feature of difference becomes evident: *P. variatus* has the greatest spread while *P. xiphidium* has the least.

SPECIFIC DISTINCTIONS IN *Xiphophorus.*

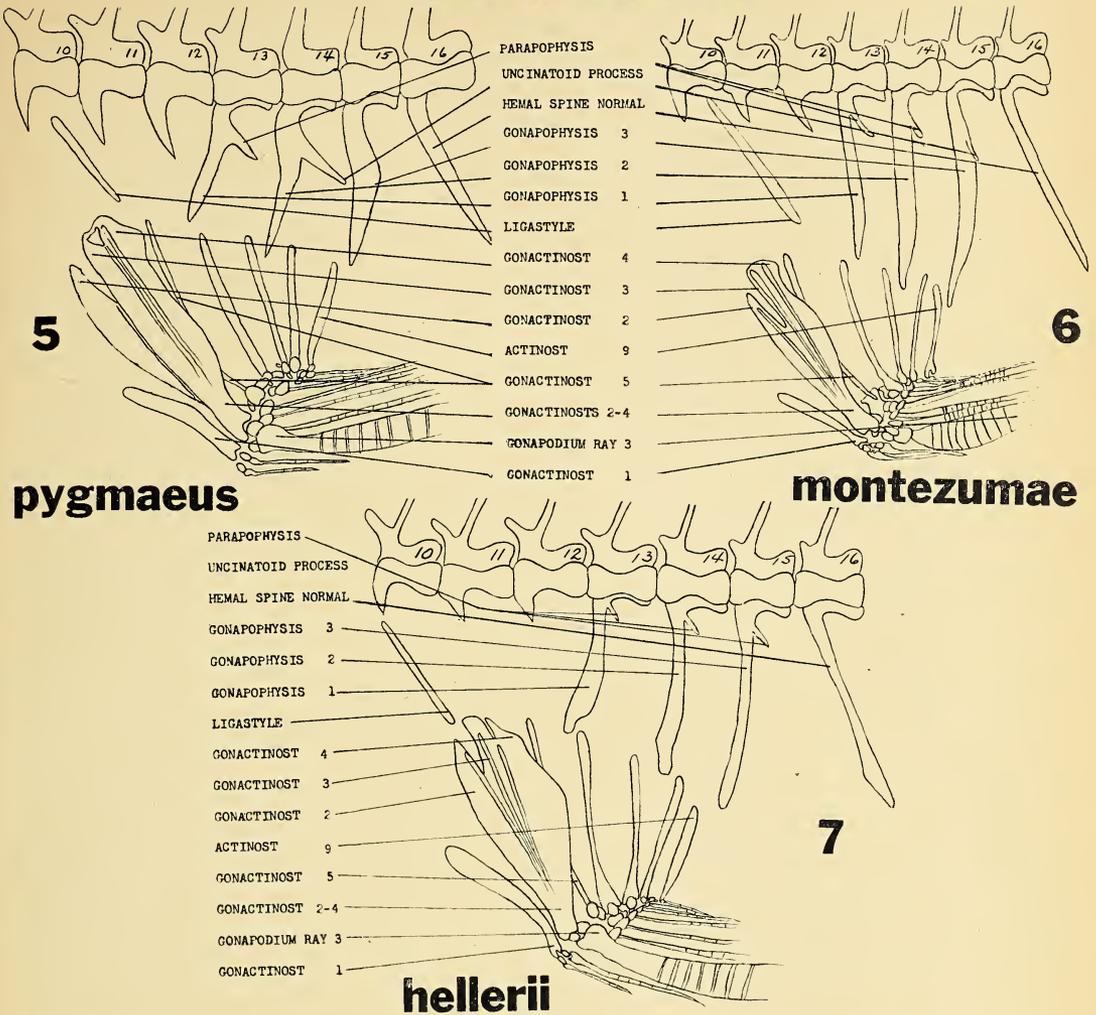
As stated under "The Rib-gonapophysis Relationships," *X. pygmaeus*' first gonapophysis bears a rib. *X. montezumae*'s first and second gonapophyses bear ribs. And *X. hellerii* has ribs coming off the first, second and third gonapophyses. See Table II.

The parapophyses of the first gonapophysis are long in *X. pygmaeus*; they are extremely short in *X. montezumae* and *X. hellerii*.

The uncini of the second gonapophysis are long in *X. pygmaeus* and their counterparts, the parapophyses of the second modified hemal spines are quite short in *X. montezumae* and *X. hellerii*.

The third gonapophysis of *X. pygmaeus* bears neither parapophyses nor uncini; that of *X. montezumae* bears tiny uncini, while that of *X. hellerii* bears small parapophyses which support a pair of ribs.

XIPHOPHORUS



TEXT-FIGS. 5-7. Comparative morphology of the gonopodial suspensoria of the three species of *Xiphophorus*.

ANOMALIES IN THE ELEMENTS OF THE GONAPODIUM SUSPENSORIA.

P. maculatus.

In three out of eleven specimens studied in great detail, the second gonapophyses bore only single uncini instead of normal pairs. In these instances the unpaired uncinus arose from nearer the mid-region of the gonapophysis than the lateral section.

P. xiphidium.

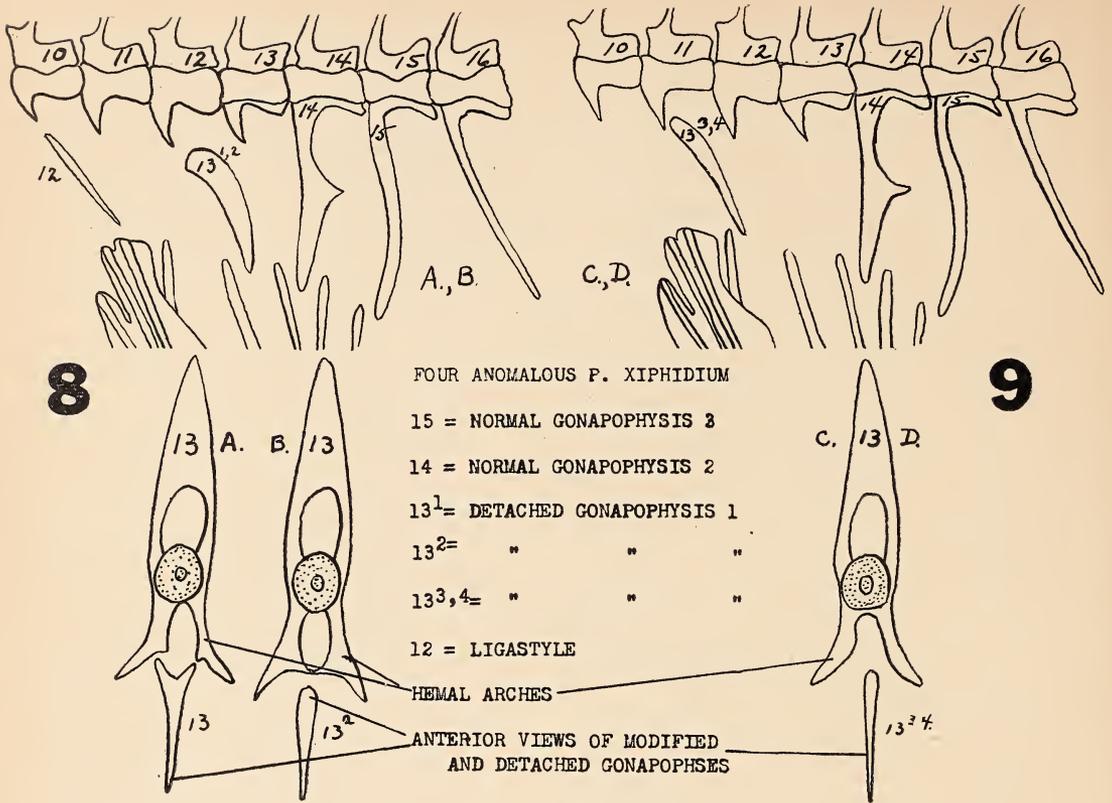
In two out of eighteen specimens the ligastyles were missing. In the same specimens the first gonapophyses were detached from their hemal arches at the thirteenth vertebrae; they were found further forward below the eleventh abdominal vertebrae. This

may represent an instance of substitution, the gonapophyses taking the place of the wanting ligastyles.

In two other specimens the first gonapophyses were also detached and located a distance of two vertebrae forward of their normal position. The ligastyles of these fish were atrophied and they too were forward of their normal position, being found below the ninth instead of the tenth vertebrae.

P. couchianus.

In eight out of eleven specimens the uncini of the second gonapophyses were unequally developed. In these non-symmetrical gonapophyses one of the pair of uncini was normal while the other was variously shortened and scalloped along the posterior edges.



TEXT-FIGS. 8-9. *Platypoecilus xiphidium*. The anomalous elements in the gonopodial suspensorium.

In three specimens the right uncini were the shorter; in five the left ones were smaller. Owing to the fact that eight out of eleven specimens were unsymmetrical with reference to the second gonapophysis it may be more properly said that the symmetrical condition is the anomalous one.

X. hellerii.

In six out of ten specimens the anterior facet of the tip of the fourth hemal spine is slightly flattened and broadened; this may be indicative of a partial transformation of a normal hemal spine to a gonapophysis.

DISCUSSION.

Historical Review of the Gonopodium and its Suspensorium.

The various elements of the gonopodial suspensorium were first described briefly in *Gambusia* by Ryder (1885) during a period of popular interest in the subject of viviparity in our native fishes. Garman in his extensive study, "The Cyprinodonts" (1895), figured the gonapophyses of seventeen species, remarking: "A peculiar modification of several of the vertebrae is to be

noticed on males of some species in which the anal fin is modified and carried forward; an inferior process from the centra of two or more of the vertebrae over the hinder portion of the body cavity is sent down to furnish support for the base of the transformed fin." In *Xiphophorus*, Garman said that there were four or five modified inferior processes which he called "stays." Later Phillippi (1909) called these "stays" *gonapophyses*, a term which has since been used in referring to the modified hemal spines in cyprinodonts.

Garman referred to the "subvertebral processes" characteristics in distinguishing *Xiphophorus* from *Mollienisia* and *Poecilia*. Phillippi studied the relationships of *Glaridichthys* (now = *Phalloptychus*) *januarius* to *Glaridichthys* (now = *Cnesterodon*) *decemmaculatus*. In his studies he referred not only to gonopodial suspensorium characters but to those of the modified anal fin to which he gave the name of *gonopodium*. The taxonomic value of the male's anal fin had been known previously. Heckel (1848) illustrated his newly described *Xiphophorus hellerii* showing its modified anal fin; the generic name, *Xiphophorus*, was coined with refer-

TABLE II. Evaluation of the Xiphophorin Gonopodial Suspensoria.

	1st Gonapophysis	2nd Gonapophysis	3rd Gonapophysis	Gonactinosts 2-3-4
<i>P. maculatus</i>	Hardly modified Width normal Parapoph. small Bears last RIB	Hardly modified Width normal Uncinus tiniest	Hardly modified Straight No uncinus	2-3 never fused at tips 3-4 never fused at tips 4 no "collar"
<i>P. variatus</i>	Greatly modified Thin, bowed Parapoph. longest Bears last RIB	Greatly modified Width nor., bowed Uncinus longest	Slightly modified Bowed No uncinus	2-3 never fused at tips 3-4 never fused at tips 4 no "collar"
<i>P. xiphidium</i>	Modified Width greatest Parapoph. tiniest Bears last RIB	Modified Width greatest Uncinus long	Slightly modified Bowed No uncinus	2-3 never fused at tips 3-4 never fused at tips 4 "collar" small
<i>P. couchianus</i>	Greatly modified Wider Parapoph. long Bears last RIB	Greatly modified Narrowest Uncinus long	Slightly modified Bowed No uncinus	2-3 never fused at tips 3-4 never fused at tips 1 "collar" small
<i>X. pygmaeus</i>	Greatly modified Tip far forward Parapoph. great Bears last RIB	Greatly modified Tip far forward Uncinus greatest	Modified Broadest No uncinus	2-3 never fused at tips 3-4 usually fused at tips 1 "collar" pronounced
<i>X. montezumae</i>	Hardly modified Tip down Parapoph. small Bears a RIB	Hardly modified Tip down Parapoph. small Bears last RIB	Hardly modified Longest, bowed Uncinus tiny	2-3 never fused at tips 3-4 usually fused at tips 4 "collar" small
<i>X. hellerii</i>	Hardly modified Tip forward, broad Parapoph. small Bears a RIB	Hardly modified Tip broadened Parapoph. small Bears a RIB	Hardly modified Tip blunt Parapoph. small Bears last RIB	2-3 never fused at tips 3-4 usually fused at tips 1 "collar" small

ence to this fin. Poey (1854) figured and described the modified anal fin of *Girardinus metallicus*. Further historical details concerning gonopodia are given by Howell Rivero and Rivas (1944). The work of Langer (1913) will be referred to in some detail.

Kuntz (1913) figured and described the gonopodium and its suspensorium in *Gambusia affinis*. His work was extended by Collier (1936) who stressed the mechanism of gonopodial action in courtship behavior.

The Ligastyle.

The origin of the ligastyle has been worked out in great detail by Turner (1942). He showed that in the course of development in the female *Gambusia affinis*, the first hemal arch stemming from the thirteenth vertebra dissolves and its hemal spine is forced forward a distance equal to the lengths of two vertebrae.

Garman (1895) first noticed the relationship of an anterior subvertebral element of the suspensorium to the air bladder, saying that the "stays" divide the posterior portion of the air bladder into separate chambers. Phillipi (1909) called attention to Garman's observations and added that he no-

ticed a "skeletalstab" in *G. januarius* male which was detached from the skeleton proper and located in the notch of the air bladder just posterior to the forked section. Langer (1913) definitely related the "skeletalstab" to one of the hemapophyses, or hemal spines, in incompletely developed male *Xiphophorus* and *Platypoecilus*. These were figured. He explained that the tiny bony elements separate from the subvertebral region of the centra by the thinning of the bony structures and become embedded in ligaments. Langer figured the long ligastyle of *Petalsomus* (= *Alfaro*) *cultratum*, indicating that it is hardly modified from the normal hemal spine. He agreed with Phillipi that *Gulapinnus* does not have a typical ligastyle and adds the following species as lacking one: *Anableps anableps*, *Poecilia heteristia* and possibly *Poecilia vivipara*. However, in *Poecilia amazonica* he found instead of the usual ligastyle four irregular ossicles (*Knochenstuechen*) within the ligament.

An interesting parallelism concerning the history of the ligastyle in *Gambusia* was found in some anomalous specimens of *Platypoecilus xiphidium*. In two adult males no ligastyles were found. Their places were taken by detached hemal spines stemming

from the thirteenth vertebrae. They too had been moved forward a distance equal to the lengths of two vertebrae.

In two other *P. xiphidium* adult males, the ligastyles were found but they were atrophied. Here, too, their places were taken by the detached hemal spines of the thirteenth vertebrae. The detached hemal spines were hardly modified in some while in others they approached the slim stilus contours of typical ligastyles. When the detached spines were dissected and placed back to their presumed point of origin beneath the thirteenth vertebrae they fitted fairly well into the remaining parts of the hemal arches, Figs. 8, 9. In the specimens lacking their normal ligastyles, the detached hemal spines did not restore completely the normal arrangement when applied to the vertebrae of their origin, Figs. 8, 9.

Sexual Dimorphism Expressed in Hemal Spines.

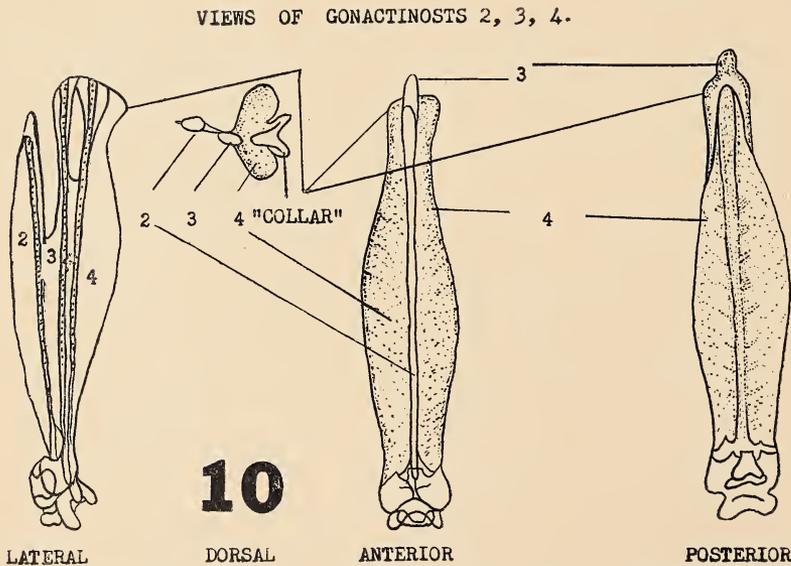
Sexual dimorphism expressed in hemal spines in fishes other than viviparous cyprinodonts has been reported by Ford (1937). He says that in *Labrus mixtus* there is a marked difference in the relative size of the circular hemal canal of the first caudal vertebra, this being larger in the male than in the female. He also illustrates the sexual difference in the condition of the hemal arch of the first caudal vertebra in *Labrus bergylta*, calling attention to the fact that in the male there are two canals but in the female one only. His figures also show another type of dimorphism which he does not mention; namely, the hemal spine is forked

ventrally in the male, but lanceolate in the female. The forked nature of the male's hemal spine has been seen in some cyprinodonts, too; in *Molliensia* for example, according to the figure in Hollister (1940); and Scott (1944) shows a somewhat similar structure in *Lebistes*. Undoubtedly there are many instances of sexual dimorphism expressed in hemal spines which have not yet been recorded, both in cyprinodonts and in other groups.

Effects of Sex Hormones.

Experiments designed to analyze the effects of sex hormones in gonopodium development were performed before studies were made of their effects upon suspensorial elements. For the work upon the gonopodium, Grobstein (1940, 1942) has a complete report on normal and treated *Platy-poecilus maculatus*, except for the brief statement of Grumbach (1935) which is based on his extensive but unpublished work on the regeneration of the anal fins without the use of hormones (1935b) and the unpublished thesis of Tasker (1934). Now, the work of Cummings (1943) on *Molliensia* should also be added.

Turner (1941, 1942) described the normal morphogenesis of the gonopodium and its suspensorium in *Gambusia* and was the first to report in detail the effects of androgens upon the development of the latter in females. This was followed closely by the studies of Cohen (1942) whose unpublished results were reported, in part, by Gordon, Cohen and Nigrelli (1943); these studies indicated that the gonopodium, its suspensor-



TEXT-FIG. 10. *Xiphophorus montezumae*. An example of the typical fusion of the gonactinosts 2, 3 and 4, developed in males only.

ial elements and modification of the caudal fin in *P. maculatus*, may be induced in females by the synthetic steroid pregnenolone. Scott (1944) reported hormonal effects on the *Lebistes* suspensorium.

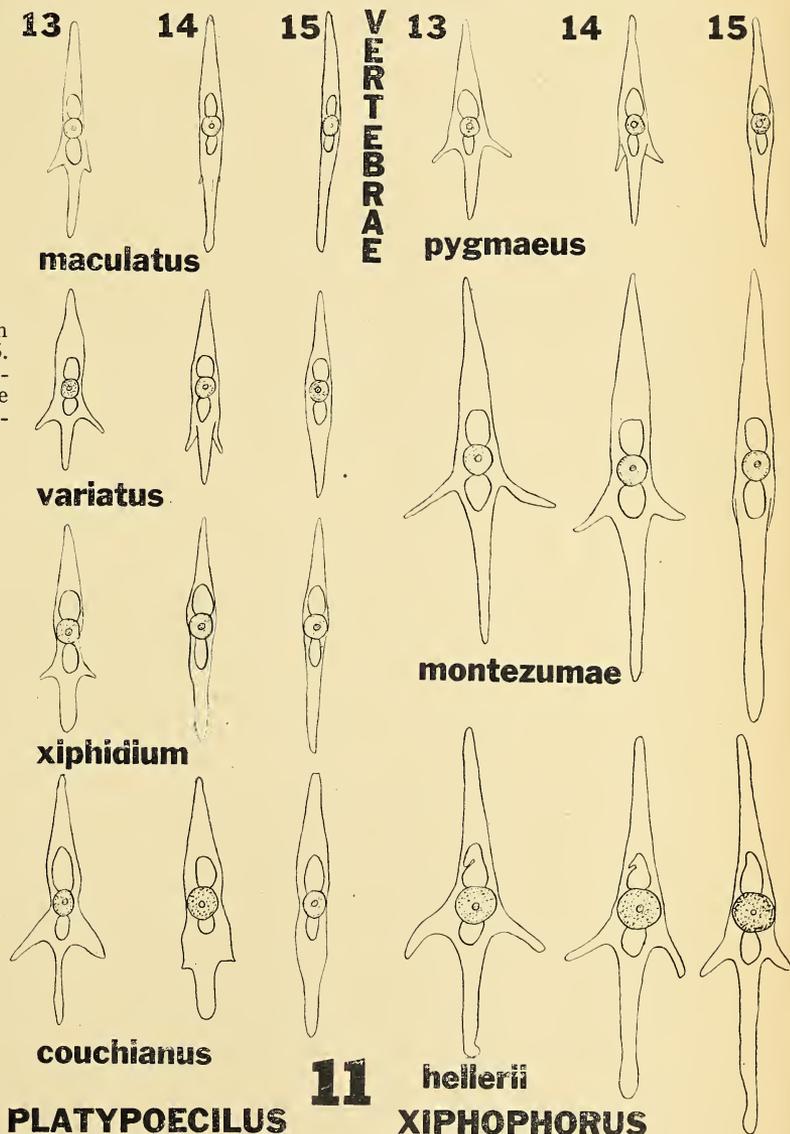
Thus it may be seen that the number of references to the effects of sex hormones upon skeletal elements recently reviewed by Gardner and Pfeiffer (1943) may be extended considerably, as far as fishes are concerned.

The Bearing of Gonopodial and Suspensorial Characters upon Taxonomy.

After the work of Garman, Phillipi and Langer up to 1914, interest in the elements of the gonopodial suspensorium for taxonomic purposes was revived by Howell

Rivero and Hubbs (1936) in their redescrptions of *Furcipennis huberi* (Fowler) and *Alfaro cultratus* (Regan). Hollister (1940) worked out a key to the cyprinodonts of Bermuda utilizing the characters of the gonopodial suspensorium. A somewhat similar study was made by Howell Rivero and Rivas (1944) for some of the cyprinodonts of Cuba. These workers reviewed the extensive use of gonopodial characters alone in taxonomy by Regan (1913) and Hubbs (1924) and earlier systematists.

In 1913 both Regan and Langer, working independently, pointed out that species of *Xiphophorus* and *Platypoecilus* were more closely related than had previously been suspected. Regan relied upon the characters of the gonopodia whereas Langer referred to



TEXT-FIG. 11. Xiphorhynchus Vertebrae: 13, 14, and 15. Anterior views of disarticulated vertebrae to show the first, second and third gonapophyses.

TABLE III. Regional Analysis of the Xiphophorin Vertebral Column in Males.

Species	No.	Pre-caudals	Caudals						Grand Total	
		Ribs only	Ribs only	Ribs and gonapoph.	Gonapoph. only	Hemal spine	Total	Average	Totals	Average
<i>P. maculatus</i>	8	11	1	1	2	11	15	14.9	26	25.9
	1	11	1	1	2	10	14		25	
<i>P. variatus</i>	10	11	1	1	2	12	16	16.3	27	27.3
	4	11	1	1	2	13	17		28	
	1	12	1	1	2	12	16		28	
<i>P. xiphidium</i>	13	11	1	1	2	12	16	15.7	27	26.6
	3	11	1	1	2	11	15		26	
	2	11	?	1	2	12	15		26	
	2	10	?	1"	2	12	15		25	
<i>P. couchianus</i>	9	11	1	1	2	12	16	16.2	27	27.2
	2	11	1	1	2	13	17		28	
<i>X. pygmaeus</i>	11	11	1	1	2	12	16	15.9	27	26.9
	1	11	1	1	2	11	15		26	
<i>X. montezumae</i>	10	11	1	2	1	13	17	17.0	28	28.0
<i>X. hellerii</i>	5	11	1	3	1	12	17	16.9	28	27.9
	5	11	1	3	0	13	17		28	
	1	11	1	3	1	11	16		27	
	(Cordova)	2	11	1	2	1	13	17		28

'=Gonapophysis detached, located below the 11th precaudal.

"=Gonapophysis detached, located below the 9th precaudal.

gonopodial and suspensorial features. Regan in associating *Xiphophorus* with *Platy-poecilus*, separated them off as a distinct group from other poeciliids. (This group later became the tribe *Xiphophorini*, Hubbs, 1924b). Langer's conclusion was more radical than Regan's. He suggested that members of the *Xiphophorus-Platy-poecilus* group be placed under a single genus.

Undoubtedly both Regan and Langer were influenced in making their decisions concerning the closeness of *Xiphophorus* to *Platy-poecilus* by the knowledge that *X. hellerii* (= *strigatus*) and *P. maculatus* were capable of hybridization and that many of their hybrids were fertile. Both men referred to the journals devoted to aquarium fish-culture: *Blätter für Aquarien und Terrarienkunde* and *Wochenschrift für Aquarien und Terrarienkunde*. These periodicals contained many stories concerning the rearing, breeding and hybridization of the platyfishes and swordtails during the years 1909 to 1913. A historical statement on this phase of the problem may be found in a paper by Gordon (1931).

The Major Vertebral Regions.

The vertebral column of fishes has been variously divided and subdivided by divers authors depending upon the complexity of the elements and the requirements of the analysis. The one major division all analysts use is the separation of the precaudal ver-

tebrae from the caudals. A generalized definition of a typical precaudal or caudal is unsatisfactory since vertebral details vary from one major group to another. A definition based upon the presence or absence of ribs is unsuitable. In some species like *Gadus*, according to Thompson (1917), and the anchovy, *Anchoa compressa*, according to Chapman (1944), the bearing of ribs stops at the last precaudal. Many species have this arrangement. Many do not: *Salmo*, according to Parker and Haswell (1897) has ribs on its first six caudal vertebrae and *Sardinops caerulea* has ribs on its first ten caudals, according to Phillips (1942). On the other hand, many of the posterior abdominals (precaudals) of *Xiphias*, for example, do not bear ribs, according to Gregory and Conrad (1937). Raven (1939) points out that the ribs in *Diodon* and *Masturus* are entirely lost and Dr. C. M. Breder, Jr., tells us that ribs are wanting in all species of the Molidae, Diodontidae and Tetradontidae.

Viviparous cyprinodonts have rib-bearing caudal vertebrae: *Flexipennis* has four and *Alfaro* has six such caudals according to Howell Rivero and Hubbs (1936). Thus rib-bearing vertebrae are not necessarily caudal or precaudal.

In view of these details the presence or absence of ribs in xiphophorin species cannot be used to determine the type of vertebra in question, for *X. hellerii* has a pair of

TABLE IV.

From Langer (1913)	Page 254	Page 263
Name	Zahl der regulären Hámápopophysen zu den Überganshamápopophysen, zu den Gonápopophysen ohne Rippe, zu denen mit Rippe, zu den Kumpfwirbeln nur mit Hámalkanal, zu den typischen Rumpfwirbeln des ♂	(Erste Zahl=Wirbel ohne Rippen, zweite Zahl=Wirbel mit Rippen, D=Differenz) ♂
<i>Platypoecilus maculatus</i>	(2 mal) 10:0:3:1:0:12=26 (1 mal) 11:0:3:1:0:14=29	D.3 14:15=29 13:13=26 13:15=28
<i>Xiphophorus strigatus</i>	x ¹ 13:0:0:3: 12=28 14:0:0:2:0:12=28 x (vor x ¹) 14:0:0:3:?:11=28 x (vor x ¹) 15:0:0:3:0:10=28 x (vor x ¹) 13:0:1:2:?:12=28 x (vor x ¹) 14:0:1:2:?:13=30 x (vor x ¹) 15:0:1:2:?:12=30	D.2 13:15=28 14:14=28 15:13=28 15:15=30 18:11=29 16:13=29 16:14=30

x¹=unerwachsenes Männchen (from another table on page 230-231).

ribs on each of its three gonapophysis-bearing vertebrae; *X. montezumae* has two pairs of ribs and the others have but one pair at comparable points. However, Langer (1913) has used this criterion in his analysis, Table IV.

Ford (1937), in illustrating a typical abdominal and caudal vertebra in *Anguilla* and *Conger*, shows that the precaudal, like that of *Gadus*, has widely open parapophyses, while the anterior caudal not only has a closed hemal arch, but that arch is extended into a produced hemal spine. Jordan (1905) says that a vertebra having hemal as well as neural spines is known as a caudal vertebra. Such a definition does not hold for some members of the Order Heterosomata. For those groups in which, like the Gadidae, the differences between the caudals and precaudals are sharp, there is a further complication of asymmetry. Ford points out that not infrequently it will be found that between the typical abdominal vertebrae and the typical anterior caudals there is a transitional form of vertebra which on the one side exhibits the characters of an abdominal vertebra and on the other side the characters of a caudal vertebra.

For our purposes the presence of a closed hemal arch plus its produced hemal spine will serve to determine the first caudal vertebra. On this basis, since the first hemal spine (the first gonapophysis in adult male Xiphophorini), develops from the ventral surface of the thirteenth vertebra, the thirteenth becomes the first caudal.

However, Turner's demonstration, through morphogenesis, that the ligastyle is in reality a modified and detached hemal spine, introduces an important factor in attempts to determine the point of separation of the

true caudal and precaudal vertebrae in viviparous cyprinodonts.

In *Gambusia affinis*, which has one more anterior vertebra than the xiphophorins, Turner has shown that the thirteenth vertebrae of juveniles and a few adult females bear closed hemal arches and spines while the same vertebrae of adult males and most adult females bear open hemal arches and no spines: in most adults, the fourteenth vertebrae bear closed hemal arches and spines. Obviously the conditions expressed earlier should determine the designation of the true caudal and precaudal for *Gambusia affinis*; the true point of division comes between the thirteenth and fourteenth. This illustrates another type of transitional vertebrae previously discussed.

In *P. maculatus* and *X. hellerii* Langer had previously shown that in young males, the "skeletstab" lies just in front of the presumptive first gonapophyses. These spinous bones do not appear, according to his figures, to be different in shape nor in size from the next hemal spines. In later stages, they become modified into typical ligastyles and are found more forward. Additional examples of transitional vertebrae may be seen in the anomalous specimens of *P. xiphidium*, previously described in detail, in which the ligastyles were either missing or atrophied and their positions were taken by detached hemal spines of the caudal vertebrae next in series. It seems, therefore, that the ligastyles in *Platypoecilus* and *Xiphophorus* have the *Gambusia affinis* type of morphogenesis, except for this detail: the xiphophorin ligastyles develop from the twelfth vertebra.

Thus on the basis of the above discussion, we have decided, perhaps arbitrarily, to call

the twelfth vertebra of xiphophorins the first true caudal, and every one anterior to it, precaudal. The first gonapophysis-bearing vertebra, the thirteenth, is the second caudal vertebra.

Vertebral Counts and Source of Specimens.

Langer listed the total number of vertebrae in detail of *P. maculatus* and *X. hellerii*. Since Langer's data do not agree with ours, Table III, it is desirable to reprint his as he presented them for purposes of discussion, Table IV.

He reports four gonapophyses in *P. maculatus* and two or three in *X. hellerii*. We find three gonapophyses constantly in the former and three or four in the latter. Garman (1895) reported that *X. hellerii* had four or five "stays," one of which may have been an incompletely developed ligastyle.

We agree that, in *Platypoecius maculatus*, the first gonapophysis is the only one that bears a pair of ribs. We disagree on the number of rib-bearing gonapophyses in *Xiphophorus*: Langer records that four specimens out of seven have only two rib-bearing gonapophyses; we find that all the specimens from the Rio Papaloapan have three gonapophyses-bearing ribs. However, we indicate that two of our *X. hellerii* from Cordova (Rio Blanco) have the arrangement reported by Langer.

We believe that one of the reasons, probably the most important, for our disagreement lies in the dissimilar sources of the materials. We are aware that small but consistent differences may be found in geographically isolated populations of the same species or subspecies. We were careful to present the natural source of our specimens. Langer states in his introduction that his specimens came, for the most part, from aquarium-fish dealers, mentioning among others, probably the largest and most famous one in his day and place, Frau Bertha Kuhnt, Conradshöhe bei Tegel-Berlin.

In his history of the platyfish and swordtails under domestication, Gordon (1931, 1937) pointed out that the platyfish were first imported into Germany in 1907, to be followed by the swordtails in 1909. During 1910 and thereafter up to the first World War, many reports of hybridization of these species appeared yearly in the aquarium journals. One of the hybrids between *P. maculatus* and *X. hellerii* had been backcrossed so often to the swordtail that Regan (1911) took it to be a new species, describing it as *Xiphophorus rachovii* Regan, only to recall the name after realizing its hybrid origin in the aquarium. Thus it is definitely possible that Langer worked with *P. maculatus* containing some *X. hellerii* genes and *X. hellerii* containing some *P.*

maculatus genes. Preliminary study of our own genetically known hybrid material indicates a breakdown in the usually consistent patterns of the vertebral columns in pure species.

Another possibility to account for our lack of agreement in total vertebral counts and other details may be that Langer's specimens came from localities in Mexico other than those recorded by us. We indicated that the *X. hellerii* from the Rio Blanco (to be sure only two specimens were available) differed from those of the Rio Papaloapan. Many isolated geographical populations differ in their genetic constitution, sufficiently so that they may be recognized according to the preliminary report of Gordon (1943) on the xiphophorins.

Finally, six of the seven specimens of the swordtail studied by Langer were immature. The one adult he analyzed agrees with our material.

We fail to understand the lack of correlation between the total vertebral counts in Langer's two tables, in view of the circumstances that the number of specimens listed in each table is the same, Table IV.

Analysis of Vertebral Column.

An analysis of the regional differentiation of the vertebral column in the seven xiphophorin fishes reveals that the precaudal section is essentially uniform in all. With the exception of one *P. variatus* and two anomalous specimens of *P. xiphidium*, all the rest of the 82 Xiphophorini studied have eleven precaudal vertebrae and the ligastyles are located beneath the tenth ones.

Differentiation of the xiphophorin vertebral column takes place in the caudal region. Here differences involve (1) the number of caudal vertebrae, (2) the number of anterior caudal vertebrae with ribs and gonapophyses, (3) the number of anterior caudal vertebrae with gonapophyses alone, and (4) the presence and nature of the apophyseal projections from the vertebrae or gonapophyses. It is significant that all types of variations appear in the caudal vertebrae. It is just these vertebrae which are particularly susceptible to variation in numbers in response to changes in temperatures and possibly other environmental agents during the developmental stages of fishes. Hubbs (1922, 1942a) pointed out that in *Notropis atherenoides*, *N. hudsonius* and *N. blennioides*, the number of caudal, not the precaudal, vertebrae are affected by change in temperature during their development stages; the higher the temperatures during that critical period, the fewer caudal vertebrae developed. The same effect has been found in the herring by Ford (1933). Gabriel (1944), too, has demonstrated that the total verte-

bral counts in *Fundulus* reflect a similar response to temperature levels during the embryonic stages. His more important demonstration was showing proof that there are genetic factors present which play a dominant part in controlling the number of vertebrae. Some sib-ships, he reported, are temperature-labile and some are not. In other words there are some groups possessing hereditary factors which find expression regardless of, or in response to, high or low temperatures.

We know that *P. maculatus* and *X. hellerii* live together in portions of the Rio Papaloapan and in our laboratory under similar temperature conditions; yet platyfish have 15 caudal vertebrae while the swordtails have 17. This reflects part of the sum total of genetic differences between these species. These details also suggest that the platyfish has a more rapid rate of development. This seems to be borne out by data published by Bellamy (1924) who stated that the average interval between broods for *P. maculatus* is 31 days; for *X. hellerii*, 39 days. The meaning of "interval between broods" probably needs some explanation. For some time many of us thought that the interval between broods represented the full time of gestation. However, Hopper (1943) has found that in *P. maculatus* fertilization of the eggs takes place not immediately after the birth of the previous brood, but about seven days after. Thus the gestation period in platyfish is about 24 instead of 31 days. Unfortunately similar kinds of data are not available for the swordtail, but it is likely, in view of its longer "interval between broods," that its gestation period is longer than that of platyfish.

To allow for any possible future need for correction, the following is put on the record: Bellamy's data were obtained from cultivated fishes. The wild stocks used in our laboratory originated, as indicated under "Material and Methods," in Plaza de Agua, Rio Jamapa, Veracruz, for the platyfish; and headwaters of the Arroyo Zacatispan (tributary of the Rio Papaloapan), Oaxaca, for the swordtails. There is no appreciable difference in the dorsal fin-ray count for platyfish populations of the Rio Jamapa and the Rio Papaloapan systems, although the two populations may be told apart on the basis of the distributions of their gene frequencies, genes that control their color patterns, Gordon (1943).

The habitat of *P. variatus*, *X. pygmaeus* and *X. montezumae* is the Rio Panuco system. In one of its tributaries, the Rio Axtla, just at the village of Axtla, San Luis Potosi, the three species may be found in the same cross-section of the stream. Other conditions of their special ecology are different:

X. pygmaeus are found in pure colonies, numbering in hundreds, only along the cut-in slope where the water is deep and runs in a strong current; *P. variatus* and *X. montezumae* are found in the slip-off section of the stream, in shallow, slow waters, often in pools alongside the banks. If the field notes of the collections are studied closely, a further breakdown of the ecological condition of *P. variatus* and *X. montezumae* becomes evident, for the greater numbers of *P. variatus* are to be found downstream, while *X. montezumae* outnumber the platyfish upstream. This distinction in population composition of the two species may be seen in localities of the same stream only two or three miles apart. At the time the collections were made there was no appreciable difference in the temperatures at these various localities. The vertebral number in the caudal region is genetically set: 17 for *X. montezumae*, about 16.3 for *P. variatus* and about 15.9 for *X. pygmaeus*. The specific localities of the stocks used is given elsewhere, while they are all found in waters of about the same temperature. It is likely that on a basis of yearly average temperatures, *X. pygmaeus* is subject to the lowest temperatures, while *P. variatus* is subject to the highest.

Going back for a moment to the general problem of variation in vertebral counts in response to changes in temperatures and other agents during the developmental stages of fish, we find that this reaction has, as yet, not been correlated with the finding of Hyman (1921) that during the development process in the teleost *Fundulus*, a secondary region of high physiological activity (metabolic gradient) arises at the posterior end and persists for some time.

An interesting problem suggest itself—of studying at just what developmental period the number of vertebrae may be affected by temperature changes. From the available information, it would seem that the developmental stages during somite formation might be the critical ones.

The Degrees of Specialization.

Howell Rivero and Hubbs (1936) have made a preliminary evaluation of the degrees of specialization in three tribes of cyprinodont fishes: Alfarini (*Furcivensis* and *Alfaro*), Poeciliini (perhaps referring to *Lebistes* and *Mollienisia*) and Xiphophorini (*Xiphophorus*). They state that the gonopodial suspensoria of the Alfarini are strikingly unlike those of the Poeciliini, being much less specialized; they are, however, very similar to that of the *Xiphophorus*. This resemblance they believe indicates a primitive origin for the Alfarini and *Xiphophorus* but does not definitely indicate any very

close relationship between the Alfarini and the Xiphophorini.

In estimating the degrees of specialization in the gonopodial suspensorium, Table II and the following criteria may be used:

1. The degree of masculinization of each of the three hemal spines of the first three anterior caudal vertebrae.

2. The degree of masculinization of the interhemals, 1, 2, 3, 4 and 5.

3. The presence of ribs on the first three anterior caudal vertebrae.

If minimal changes seen in male's hemal spines over the homologous structures in juveniles or in unmodified females indicate primitiveness, then *X. hellerii*, *X. montezumae* and *P. maculatus* are the most primitive.

Concerning the interhemals, if much fusion of 2, 3 and 4 is a measure of specialization, then all the *Xiphophorus* are more highly developed; if the dorsal tip of the fourth gonactinost when modified into a "collar" indicates complexity of structures, then *P. maculatus* and *P. variatus* are the more primitive forms.

If the presence of a pair of ribs on each of the first three anterior caudal vertebrae is an indication of primitiveness, then *X. hellerii* is most primitive, with three pairs, *X. montezumae* second with two, and the rest the most specialized with but one rib.

It would be shortsighted to base any new revision upon characters of any one limited group of morphological units, and no attempt is made in this paper to change the present arrangement of species which might be based upon the many details described. One could easily make out a case in support of Regan's conclusions or those of Langer. We prefer to postpone our final decision until all the many known facts concerning the group are evaluated. In the final analysis the important matter is not to decide whether these fishes represent one or two genera but rather to gain detailed information concerning the constitution of each member of the group.

SUMMARY.

(See also Table II).

The sex-modified hemal and interhemal spines that make up the gonopodial suspensorium are analyzed for the seven species of xiphophorin fishes. The hemal spines of the first three, anterior, caudal vertebrae are masculinized into gonapophyses and directed forward rather than backward. They are of various shapes and in most instances more massive than ordinary hemal spines. The second gonapophyses are the most specialized.

In relation to the serial number of the vertebrae, the first caudal is usually the twelfth. In all but *Xiphophorus hellerii* which has a pair of ribs on its 13th, 14th and 15th vertebrae and *Xiphophorus montezumae* which has a pair of ribs on its 13th and 14th vertebrae, all the rest have one pair of ribs on their 13th vertebrae only. *Xiphophorus pygmaeus* is the only sword-tail that has greatly extended parapophyses on its first gonapophysis and greatly extended uncinatoid processes on its second.

The masculinized actinosts or pterygiophores, 1, 2, 3, 4 and 5 (out of the nine), are called gonactinosts. Gonactinosts 2, 3 and 4 are variously fused. Gonactinosts 3 and 4 are rarely fused at their tips in the species of *Platypoecilus*; they are rarely separate in *Xiphophorus*.

On the basis of measurements of the gonapophyses in the four species of *Platypoecilus* with respect to length of spine, width of spine, length of uncinatoid processes and the degree of spread of the uncini, it is possible to identify the characteristic features in *P. maculatus*, *P. variatus*, *P. xiphidium* and *couchianus*.

The origin of a spinous bone within a ligament connecting the ventral surface of vertebra 10 and the compound gonactinosts is discussed and the structure named, *ligastyle*.

Discussions cover the degrees of specialization within the group in relation to other cyprinodont fishes, the bearing of gonopodial and suspensorial characters upon taxonomy.

The paper contains an analysis of the regional differentiation of the vertebral column in xiphophorin fishes and this is related to the genetic constitution of the species and to the special ecology of the fishes in their natural waters.

Descriptions of anomalous specimens are presented together with descriptions of sexual dimorphism in hemal spines in fishes other than cyprinodonts.

Figures illustrate the gonopodial suspensoria of each of the seven xiphophorins, showing the relationship of the gonapophyses to the gonactinosts and to the gonopodia. The gonapophyses are presented in lateral and anterior views.

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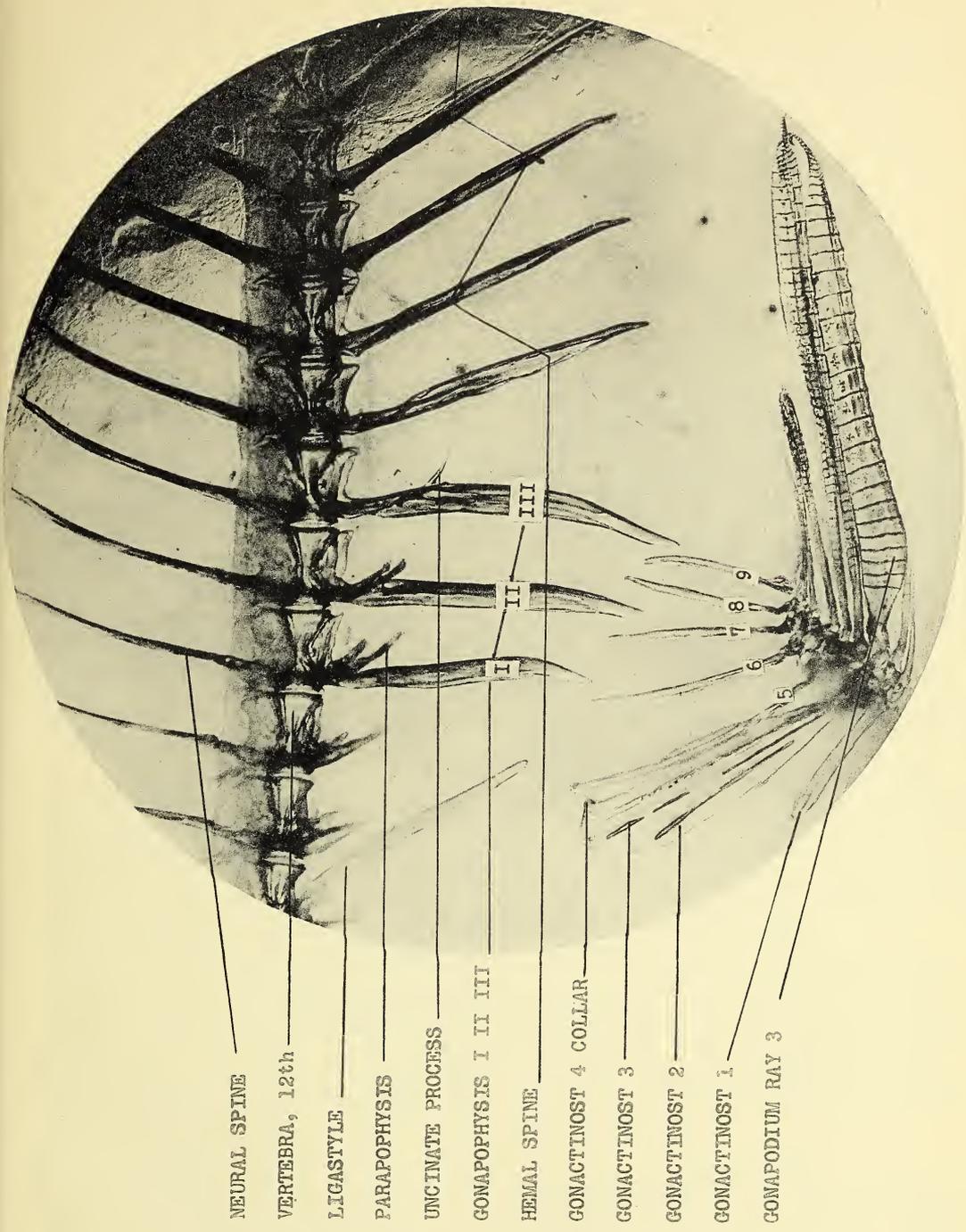
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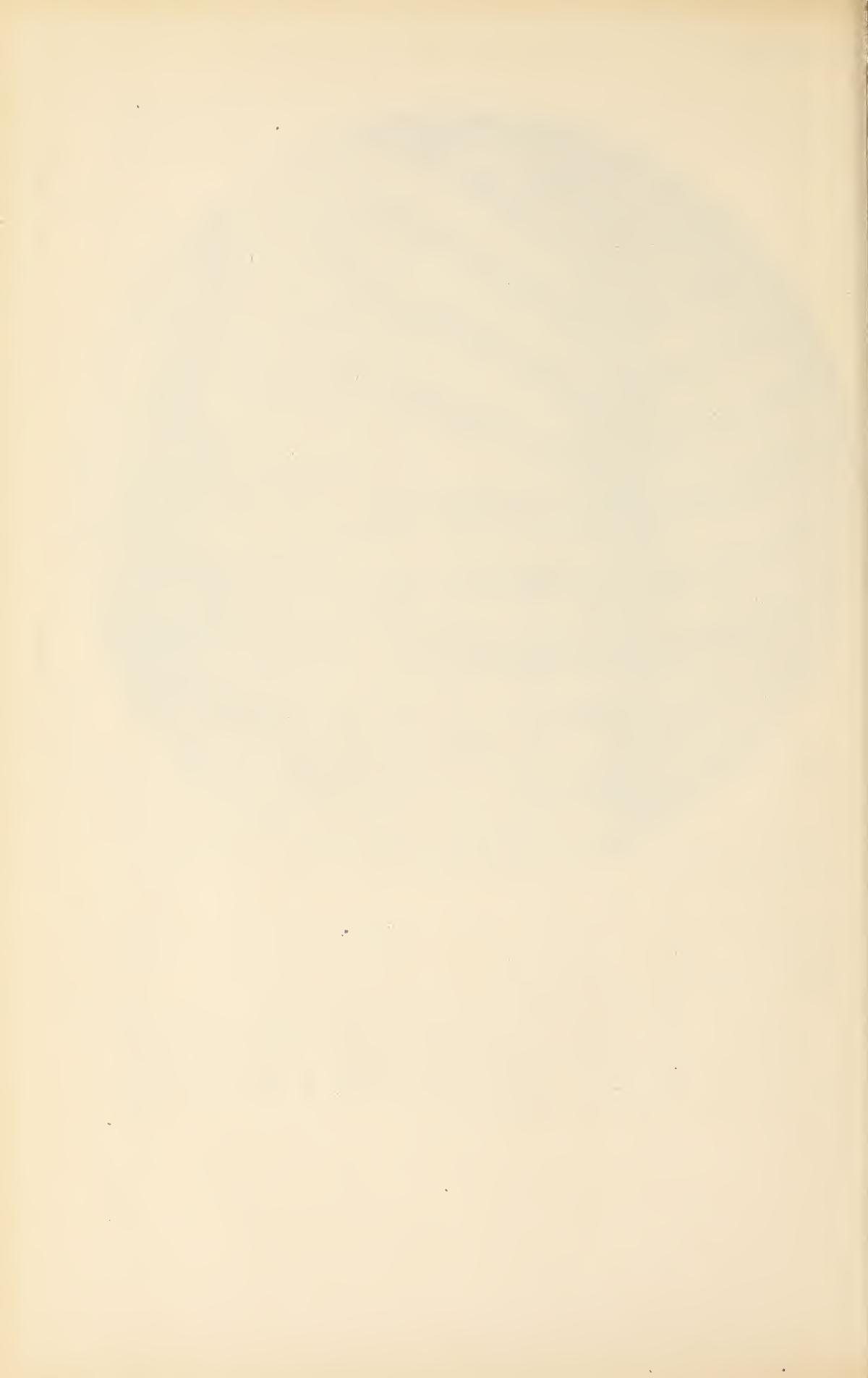
EXPLANATION OF THE PLATE.

Plate I.

The Gonopodium and Its Suspensorium of *Xiphophorus montezumae*.



SEXUAL DIMORPHISM IN THE SKELETAL ELEMENTS OF THE GONOPODIAL SUSPENSORIA IN XIPHOPHORIN FISHES



7.

The Saturnioidea (Moths) of Kartabo, British Guiana,
and Caripito, Venezuela.¹

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(Plate I; Text-figures 1-2.)

[This contribution is a result of various expeditions of the Department of Tropical Research of the New York Zoological Society to British Guiana and to Venezuela, all under the direction of Dr. William Beebe. The Guiana expeditions were made during the years 1909, 1916, 1917, 1919, 1920, 1921, 1922, 1924 and 1926. The expeditions were arranged so that each month of the year is represented in the collections. The Venezuelan expedition, in 1942, during which field work was carried on from February 19 to September 2, was sponsored by grants from the Committee for Inter-American Artistic and Intellectual Relations and from four trustees of the Zoological Society, George C. Clark, Childs Frick, Laurance S. Rockefeller and Herbert L. Satterlee, and by invaluable assistance from the Standard Oil Companies of New Jersey and Venezuela.]

INTRODUCTION.

This is the second of a series of papers on the Lepidoptera collected at Kartabo, British Guiana, and Caripito, Venezuela, by expeditions of the Department of Tropical Research of the New York Zoological Society.

A total of fifty-six species of Saturnioidea was captured at Kartabo and Caripito. Thirteen of the thirty-five species taken at Kartabo have not previously been reported from British Guiana and twenty-two of the twenty-nine species from Caripito are new to Venezuela. Only eight of the species collected were taken at both localities although Kartabo and Caripito are approximately only four hundred miles apart and are both within the range of many of the species. While the Kartabo collection is the result of a greater amount of time in the field, this was compensated at Caripito by excellent light collecting conditions.

The most significant ecological difference between Kartabo and Caripito seems to be the nature of the rainfall. Caripito is characterized by having one intensely dry season, so dry, indeed, that the jungle reminds one of a temperate autumn with its falling and

crackling leaves; and a very rainy wet season which renders most of the parched jungle impassable because of ankle to knee-deep residual water. Almost the only uninundated areas are the ridges. Kartabo, on the other hand, while having a greater average rainfall, 100 inches compared with Caripito's 80 inches, has the precipitation broken into four seasons in such a manner that sufficient rain falls in the dry periods to keep the jungle flora fresh, while it is moderate enough in the wet seasons so that the jungle does not flood. The alternate parched and flooded condition of the Caripitan jungle must certainly have a profound effect on those insects which spend part of their life cycle on or beneath the ground, or whose food plants may suffer from insufficient moisture.

For maps and a detailed account of the ecology of Kartabo and Caripito, see Beebe, *Studies of a Tropical Jungle; One Quarter of a Square Mile of Jungle at Kartabo, British Guiana. Zoologica*, Vol. VI, pp. 1-193 (1925) and *Physical Factors in the Ecology of Caripito, Venezuela. Zoologica*, Vol. XXVIII, pp. 53-59, (1943).

My thanks go to Dr. William Beebe who offered many valuable and helpful suggestions during the writing of this paper and who corrected the manuscript, and to Mr. William Comstock of the American Museum of Natural History for his many favors.

All types are in the collection of the Department of Tropical Research unless otherwise stated.

OXYTENIDAE.

No representatives of this family were taken at Caripito. This locality, however, is within the range of the five species listed below which were captured at Kartabo, and one of them, *Oxytenis modestia*, has been reported from Trinidad, only a little over one hundred miles away.

Asthenidia geometraria (Felder).

Two specimens were taken at Kartabo on December 12.

¹ Contribution No. 707. Department of Tropical Research, New York Zoological Society.

Asthenidia lactucina (Cramer).

One specimen captured at Kartabo on October 12.

Asthenidia stricturaria (Hübner).

Two specimens collected at Kartabo on July 18 and December 8.

Oxytenis angulata (Cramer).

One male taken at Kartabo on June 6.

Oxytenis modestia (Cramer).

One captured on June 26 (No. 22318) and other specimen on June 29. These specimens were captured at Kartabo in different areas.

SATURNIDAE.

(Saturnidae and Hemileucidae of Bouvier).

Only ten species of Saturnidae were collected at Caripito whereas twenty-two were captured at Kartabo. Three species were common to both localities.

Rothschildia aurota (Cramer), subspecies?

One specimen taken at Caripito on July 1. This specimen closely resembles a specimen I have seen from Ecuador, and both specimens run to *Rothschildia aurota andensis* Rothschild in Bouvier's key (*Étude des Saturnioïdes Normaux. Famille des Saturniés. Mém. Mus. Nation. Hist. Nat., N.S., tome 3, pp. 288-289, 1936*). It seems unlikely at the Caripitan individual should be *andensis*, since the latter is a sub-tropical form described from southeastern Peru. Furthermore, the Caripitan specimen differs in being a somewhat lighter chestnut-brown and having the bluish line which runs through the lilac area waved instead of straight. I have not seen a specimen resembling *Rothschildia aurota venezuelensis* Bouvier which as described from Merida, Venezuela. I include from the key that the specimen from Caripito differs in having the hyaline spots larger and touching the median band.

Rothschildia betis betis (Walker).

Four specimens captured at Caripito on the following dates: May 21, June 5, July 21, and August 10. This species was not taken at Kartabo and is the first record for Venezuela.

Rothschildia erycina erycina (Shaw).

One specimen captured in 1920 at Kartabo where it would be expected to occur though had not as yet been reported. It was not taken at Caripito but probably occurs there since it has been reported from Trinidad.

Rothschildia lebeaui lebeaui (Guérin-Ménéville).

This species was taken occasionally at Kartabo. Three specimens were taken in 1920, two of them on December 1 and one

on December 8, and two specimens in May of 1924 (24209). This species was not collected at Caripito.

Automeris abas abas (Cramer).

Five specimens taken at Kartabo, two on June 12, two on June 29 and one on September 5. This species ranges from Brazil to Honduras but was not taken at Caripito.

Automeris cinctistriga (Felder).

Two specimens captured at Caripito, one on March 3 and the other on March 7, and one at Kartabo on September 27. This is a new distribution record for both British Guiana and Venezuela as the species has been reported only from Colombia north to Mexico.

Automeris cypria vala (Kirby).

A common species at Kartabo which probably flies all year. Nine specimens captured on the following dates: January 12, March 3, May 1, June 12, June 15, July 1, July 11, August 2 and September 12. This is a new record for British Guiana as it has only been reported from Surinam.

Automeris egeus egeus (Cramer).

Three specimens (24256) captured at Kartabo in May. It has been recorded from Trinidad so probably will be found in Venezuela.

Automeris illustris illustris (Walker).

One individual taken at Kartabo. This species is common throughout Brazil and has been reported from Surinam. This is the first record as far north as British Guiana.

Automeris irmina (Cramer).

Six specimens taken at Kartabo as follows: one specimen on January 4, February 10, May 15, December 7, and two on December 8. This form is distributed from Panama to the Amazons and Ecuador.

Automeris junonia (Walker).

Collected at Caripito on May 1, May 4 and July 28. A new record for Venezuela as well as extending the range of the species across northern South America. Formerly, it was thought to occur only from Colombia north to Mexico.

Automeris liberia liberia (Cramer).

Collected at Caripito on May 22 and August 25 and at Kartabo on March 11 and August 21. This is a common species widely distributed in South America.

Automeris nausica (Cramer).

One specimen taken at Caripito on May 14. This species occurs from Mexico to Bolivia and the Guianas.

Automeris pallens Conte.

specimen taken at Kartabo on June 4
 another on December 1. Judging by the
 sure, the range of this species is re-
 corded to British Guiana.

Automeris pictus Conte.

specimen with no date forms a new
 record for British Guiana.

Automeris pyrromelas Walker.

Two specimens taken at Kartabo on De-
 cember 11. Although this species occurs from
 Bolivia to Brazil, this is the
 first record from British Guiana.

Automeris surinamensis Kirby.

Two specimens taken at Kartabo on January 1 and
 May 4 (No. 127). It has been recorded
 from the Guianas previously.

Hylesia canitia (Cramer).

Two specimens taken at Kartabo on the
 following dates: February 1, May 29, June
 20, July 19 and July 24. The species
 known from Venezuela and the Guianas.

Hylesia indurata Dyar.

Two specimens captured at Kartabo on
 the following dates: May 29, June 2, June 26,
 July 19. The original type material came
 from the Guianas.

Hylesia mystica Dyar.

One specimen at Kartabo in May (24249).
 This species was described from material
 found in Trinidad and the Guianas.

Hylesia ochrifex Dyar.

One specimen at Kartabo in May. This is
 a new record for British Guiana, as the spe-
 cies has been reported only from Peru.

Hylesia praeda Dognin.

One specimen on March 14 and another
 at Kartabo. The species occurs in
 Guiana, Ecuador, Guianas and Brazil.

Hylesia sp.?

Kartabo specimen very badly rubbed
 and indeterminate.

Hylesia sp.?

Two specimens from Caripito, apparently
 the same species, badly rubbed and undeter-
 mined.

Lonomia achelous (Cramer).

One specimen taken at Caripito on May 2.
 This is a valuable new record for Venezuela,
 previously it has only been reported from
 Ecuador and Bolivia.

Dirphia eumedide (Cramer).

Two specimens taken at Kartabo, one on
 May 10 and another later in the year. It

has been found from Panama to Ecuador
 and Surinam, but this is the first record
 from British Guiana.

Dirphia radiata Dognin.

One specimen taken in May at Kartabo.
 This species has been reported only from
 French Guiana, so this is another new re-
 cord for British Guiana.

Dirphia speciosa (Cramer).

One specimen collected at Caripito on
 April 14, and two specimens at Kartabo, the
 first in May and the second on June 26. This
 species is distributed from Costa Rica to
 Bolivia and the Guianas. This is the first
 time it has been reported from Venezuela.

Dirphia tarquinia (Cramer).

An individual taken on June 15 at Kartabo.
 This species occurs from the Amazon region
 to Venezuela, but this is the first actual re-
 cord from British Guiana.

Molippa simillima Jones.

Two males captured at Caripito on March
 20 and April 10 and a female on June 16.
 This species occurs from Mexico to the Gui-
 anas.

SYSSPHINGIDAE.

Nineteen species of Syssphingidae were
 collected at Caripito and seven at Kartabo.
 Of these, only two species were taken at
 Kartabo that were not found at Caripito. I
 am not able to give an explanation of why
 so few were collected at Kartabo nor why,
 with the exception of two species, *Rhescyntis*
armida and *Syssphinx molina*, all the speci-
 mens collected at Caripito were males.

Machaerosema hippodamia hippodamia

(Cramer).

Four specimens collected at Caripito on
 April 9, May 3, May 4 and May 13, and at
 Kartabo one specimen taken on August 31.
 This species has been reported from British
 Guiana to Argentina. The Caripitan cap-
 tures represent a new record for Venezuela
 as well as extending the range of the species
 to northern South America.

Rhescyntis armida (Cramer).

This is a very common species at Caripito
 in May and June. Six males captured on
 the following dates: April 3, May 2, June 1,
 June 7 and June 15. Six females, two of
 them much smaller than the rest of the
 series (form *erythrinae* Fabricius), cap-
 tured on the following dates: May 2, May
 19, June 2 (2 specimens), June 7 and June 8.
 One specimen was taken at Kartabo. This
 species ranges from Mexico to south Brazil
 but has not heretofore been recorded from
 Venezuela or British Guiana.

Rhescyntis beebei, new species.

(Pl. I, Fig. 1).

The wing shape is similar to *Rhescyntis armida* (Cramer) with the produced apex and somewhat sinuous outer margin. The wing length (measured from the base of the wing to the apex) is 69 mm.

The head is dark reddish-brown with light brownish-yellow bipectinate antennae. The thorax is mostly light reddish-brown with the femurs of a similar color; the tibiae are dark reddish-brown and the tarsi bright orange-yellow with the terminal spurs surrounded by dark reddish-brown hair.

The basal two-thirds of the forewing below the cubital stem are composed of light brown hair, and above this of gray scales irrorated with brown flecks. The transverse anterior line is brown and runs from the radial stem to the inner margin. It is almost straight to a point a little below the cell, then curved proximally at about 120°. The discal bar is the same color. The transverse postmedian band is of a contrasting deep, rich brown with no line separating the band from the gray and light brown proximal area as in *R. armida* and allies. The distal margin of the band is very strongly produced at the apex of the wing and is also produced into round lobes at cells M_3 and Cu_1 . The proximal and distal margins of the band converge below vein Cu_1 , making the band narrow at the inner margin. An interrupted line follows the distal margin of a blackish-brown color flecked with bluish-white scales. At the apex of the wing the line becomes brown and runs through the base of two purplish-vinaceous figures. There is no white scaling between the line and the transverse postmedian band at any point. A broad rufous line rises from the band a little below vein M_1 and curves evenly to the apex of the wing. There is a brownish-black spot 7 mm. before the apex of the wing and two streaks of whitish scales which run along cells R_5 and R_6 to the apex of the wing.

The hindwing is tailed as in the males of *Rhescyntis armida*, except that the tails are more prominent. The basal two-thirds of the hindwing are composed of light brown hair similar to the inner margin of the forewing. The discal bar is brown and is continued below the discocellulars to the postmedian band which is concolorous with the postmedian band of the forewing. The proximal margin of the band is almost straight from the inner margin to vein R_5 , where it bends distally to the costal margin. No line is present on the proximal border of the band, but a fine dark brown line encloses the distal border. A narrow light brown band follows and is confined distally by an irregular blue-black line flecked with bluish-white scales. The terminal band is the same color as the

corresponding band in the forewing, but with no markings.

The underside of the basal two-thirds of the forewing is gray. The transverse anterior line is absent, but the brown discal bar is present. The transverse postmedian band is reddish-brown proximally but grades into a grayish-brown, irrorated with blackish-brown specks, and terminated by a blackish-brown line of varying width. From the inner margin to vein Cu_2 , between the transverse postmedian band and the subterminal line, a narrow brownish-white band is present that is not evident on the upperside of the wing. The underside of the hindwing is almost the same as the upperside, but differs in two respects. First, the narrow band proximal to the subterminal line is absent except from the inner margin to a point mid-way between veins Cu_1 and Cu_2 . Here, the band is only slightly lighter than the postmedian band, but the scaling of the subterminal line is much broader and darker than in the rest of its course on the wing. Secondly, a purplish-vinaceous half-moon rests on the subterminal line in cell R_5 with its round side in the terminal band. The terminal band is light brown from the costal margin to vein M_1 , while from M_2 to the inner margin is reddish-brown.

The most distinctive feature of the male genitalia is a projection on the cephalad part of the aedeagus shaped like a "Y".

This species is named in honor of Dr. William Beebe, Director of the Department of Tropical Research.

Material: One ♂ holotype taken at Caripito, Venezuela, on May 19 (Cat. No. 42486).

Rhescyntis mossi Jordan.

One individual taken at Kartabo on June 30. This is the first record for British Guiana. It has not been reported before outside of the Amazon region.

Dysdaemonia boreas (Cramer).

Another common species at Caripito, appearing soon after the rains commence. Although this species is found from Mexico to Argentina, this is the first record for Venezuela. Eleven specimens were captured as follows: May 2, May 12, May 13, May 16, May 20, May 21 and four specimens on May 25.

Dysdaemonia tamerlan Maassen.

One specimen captured at Caripito on May 13. Reported from Colombia, Guianas and Brazil but not previously recorded from Venezuela.

Citheronia laocoon lobesis Rothschild.

A very common species at Caripito. Twelve specimens taken on the following dates: April 30, May 11, May 13 (3), May 14, May 16 (2), May 17 (2), June 1 and

August 21. This subspecies was described from Costa Rica and has previously been reported from Venezuela.

***Citheronia mexicana aroa* Schaus.**

Four specimens were captured at Caripito, one on each of the following dates: May 19, May 20, May 22 and June 1. This species is found from Arizona to south Brazil with this particular subspecies described from Venezuela and reported from Honduras.

***Citheronia phoronea phoronea* (Cramer).**

One female taken at Kartabo in 1920. The species has been reported from the Guianas and Brazil and I have seen two specimens from Panama in the collection of the American Museum of Natural History.

***Citheronia phoronea minutus*, new subspecies.**

(Pl. I, Fig. 2).

The wing shape is similar to *Citheronia phoronea phoronea*, but the moth is much smaller. The seven specimens range from 40 mm. to 44 mm. wing length, with an average of 42 mm., whereas the wing length of the nomenclatural type ranges from 50 mm. to 53 mm.

The purple drab and the yellow color in the forewings are lighter than in *C. p. phoronea*. In the hindwing the discal cell and cells R_1 and R_5 , to a point a little beyond the middle of the wing, are light creamy yellow. A patch of light yellow of variable size extends along the inner margin of the hindwing. The remainder of the wing is purple drab except for a lunulate subterminal line. The yellow markings of the hindwing are bright creamy yellow rather than light orange-yellow as in *C. p. phoronea* in which the yellow tones spread over more of the wing; the lunulate subterminal line is sharp in *minutus* whereas in *phoronea* the yellow color diffuses towards the base, particularly in the region of the median veins. The underside of the hindwing is bright creamy yellow with the veins heavily marked with purple drab.

The material used for comparison was borrowed from the American Museum of Natural History and consisted of specimens from Santa Catharina, Brazil, and two specimens from Panama. Some differences seem to exist between the Panamanian and Brazilian specimens—mostly, in that the ground color of the forewing of the Panama specimens is brown drab, but the characters given above appear to be confined to *minutus*. The small size, the large contrasting dark area of the hindwing, and the heavily marked veins on the underside of the hindwing distinguish *minutus*.

Material: A total of 7 specimens taken as follows: Caripito, Venezuela: June 1, 1 ♂ holotype (Cat. No. 42473); June 1, 4 ♂ paratypes (Cat. Nos. 42473, 42476, 42477,

42478); May 17, 1 ♂ paratype (Cat. No. 42479); May 21, 1 ♂ paratype (Cat. No. 42475). All of the above specimens were collected at light.

Paratypes Nos. 42474 and 42479 are in the collection of the American Museum of Natural History. Paratype No. 42476 is at the Museo de Ciencias Naturales, Caracas

***Eacles magnifica approximans* Bouvier.**

Four males were captured at Caripito on May 11, May 22, May 23 and May 25. This subspecies was described from Guyana, Venezuela.

***Eacles penelope penelope* (Cramer).**

One female without a date label taken at Kartabo. Five males captured at Caripito, one on April 19 and the remaining four specimens on May 13. The subspecies is reported only from the Guianas so this represents a new record for Venezuela.

***Eacles tyrannus* Draudt.**

One specimen caught on May 14 at Caripito. This rare species has only been reported previously from western Colombia, so this capture represents a new Venezuelan record.

***Syssphinx anthonilis anthonilis* (Herrich-Shäffer).**

A common species about the lights at Caripito in July. Thirteen specimens captured as follows: July 11 (2), July 12 (6), July 14 (3) and one specimen each on July 15 and July 16. This is the first record from Venezuela. It has been reported from Brazil with a race, *analis* (Rothschild), in Peru and southern Colombia.

***Syssphinx arpi* (Schaus).**

One specimen taken at Kartabo in 1920 and one May 13 at Caripito. This species has been reported only from Brazil, so it is new to both British Guiana and Venezuela.

***Syssphinx carisma* Schaus.**

One specimen captured at Caripito on June 3. A new distribution record for Venezuela as it has not been mentioned in the literature as occurring outside of British Guiana.

***Syssphinx comstocki*, new species.**

(Pl. I, Fig. 4; Text-figs. 1A, B).

The wing length of the specimens ranges from 32 to 37 mm. with an average length of 34 mm. The wing shape is similar to *Syssphinx flavosignata* and allies.

This species has the same general appearance as *Syssphinx flavosignata* with which it is confused in collections. Forewing with basal area creamy yellow bordered by a narrow purplish anterior band which is concave basally and distally blends into a yellowish-orange median band. The median band ter-

minates at a dark brown line which commences at the costal margin just anterior of the apex of the wing and is arched in the direction of the base of the wing to a point approximately three-fourths out the inner margin. The median band is marked with brown striae and contains as many as three silvery white spots outside the lower corner of the discal cell. The silvery spot in cell Cu_1 is never absent, the spot in cell M_3 is rarely absent and the spot on the lower discocellular vein is frequently absent. The grayed purple terminal band is bound by the dark post-median line and the margins of the wing, and encompasses a creamy yellow pattern commencing at vein M_3 and continuing to the inner margin.

The discal region of the hindwing is yellowish-brown; the costal region and three-fourths out the inner margin are darker and of a brownish-sepia color. A brownish-sepia postmedian line of variable distinctness separates the medial area from the distal area of the wing.

The purplish color on the underside of the wings is usually more intense than in *Syssphinx f. flavosignata* (Walker) in which the purple is mixed with brown. The veins of *flavosignata* are also more heavily marked and darker.

The ground color of the abdomen is light brown. Dorsally, the conjunctivae are filled with purplish-brown hairs, but dorso-laterally, they cover the whole of the metameres caudad of the fifth metamere. Ventrolaterally, there is a light brown streak along the length of the abdomen with the ventral surface entirely purplish-brown. In *flavosignata* the dark hairs of the abdomen are confined to the conjunctivae or one-half of the metamere except ventrally. In other words, the dorsal half of the abdomen appears banded in *flavosignata* while in *comstocki* the dorso-lateral brown hairs form a longitudinal line which contrasts so with the mid-dorsal area as to give the latter the effect of a light orange-brown streak.

The male genitalia possess the best characters for separating the species from *flavosignata*. In the following table the most salient genitalic differences between the two species are listed.

Syssphinx flavosignata.

Clasper with the ventro-posterior process stubby, broad and hooked in a dorsal direction along the posterior margin of the clasper.

Harpe² with the spatulate-like end laterally pointed.

The two lobes on the dorso-posterior part of the uncus not pronounced and with only a shallow depression between them.

Median ridge of the uncus divided linearly into two symmetrical parts and armed with setae-like spines.

The two processes at the anal end of the aedeagus with one of the processes much shorter than the other.

Syssphinx comstocki

Clasper with the ventro-posterior process acuminate and broadly curved toward the inner face of the clasper.

Harpe acuminate with the end usually curved.

The two lobes large and very pronounced with a deep depression between them.

The ridge undivided and armed with large tooth-like spines.

One anal process thin and almost as long as the broad process.

Syssphinx flavosignata was described from Rio de Janeiro and is distributed from southern Brazil to northeastern Venezuela. *Syssphinx comstocki* is found from northeastern Venezuela to Central America. The close relationship between *flavosignata* and *comstocki* is emphasized by the tendency of the harpe in specimens of *comstocki* captured at Caripito to broaden at the end with the point more on the side than in specimens from Panama. Other characters of the genitalia, however, are identical with specimens from Panama.

This species is named in honor of William Comstock, Research Associate of the Department of Entomology at the American Museum of Natural History.

Material: A total of four specimens taken as follows: Caripito, Venezuela, May 16, 1 holotype ♂ (Cat. No. 42482); May 14 1 ♂ paratype (Cat. No. 42483); May 19, 2 ♂ paratypes (Cat. Nos. 42484 and 42485). In addition, five specimens from Panama at the American Museum of Natural History which I designate as paratypes. Another specimen from Aroa, Venezuela, is apparently the same species. (Text-figs. 1 and 2).

Syssphinx flavosignata caripitoensis, new subspecies.

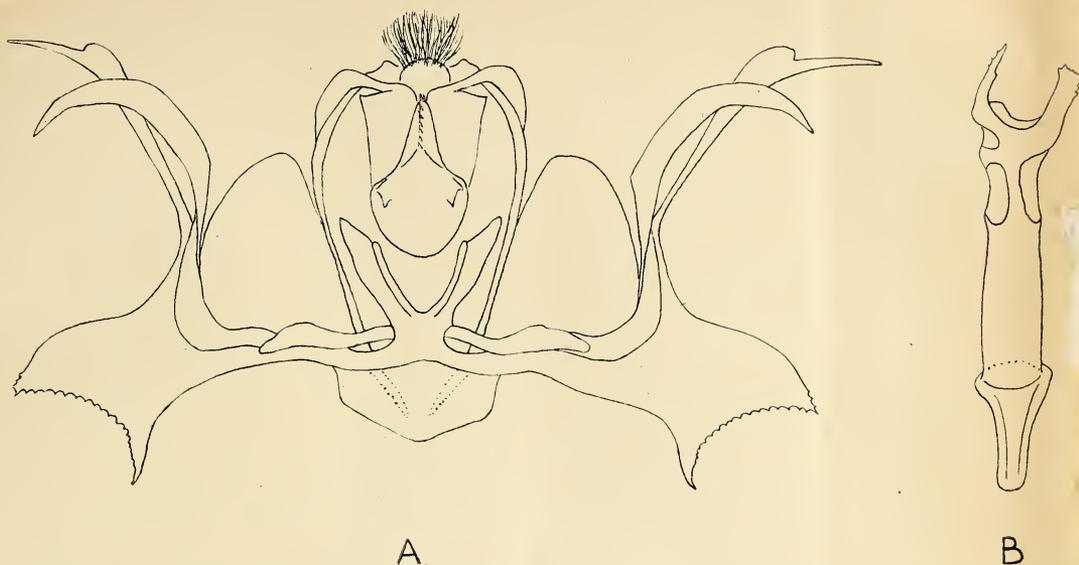
(Pl. I, Fig. 4; Text-figs. 2C, D).

The wing shape is similar to *S. f. flavosignata*, but the wings are reduced in size. Both specimens of *S. f. caripitoensis* have a wing length of 31 mm. rather than the 38 to 41 mm. of the nomenclatural type.

The head and ventral part of the thorax are light yellowish-orange. The legs are light purple with variable amounts of yellowish-orange. The anterior part of the prothorax and the patagia are light purple.

The appearance of the wings is similar to *flavosignata*. The median band of the fore

² Of McDonough: On the Nomenclature of the Male Genitalia in Lepidoptera. *Canad. Ent.*, Vol. XLIII, p. 188, 1911.



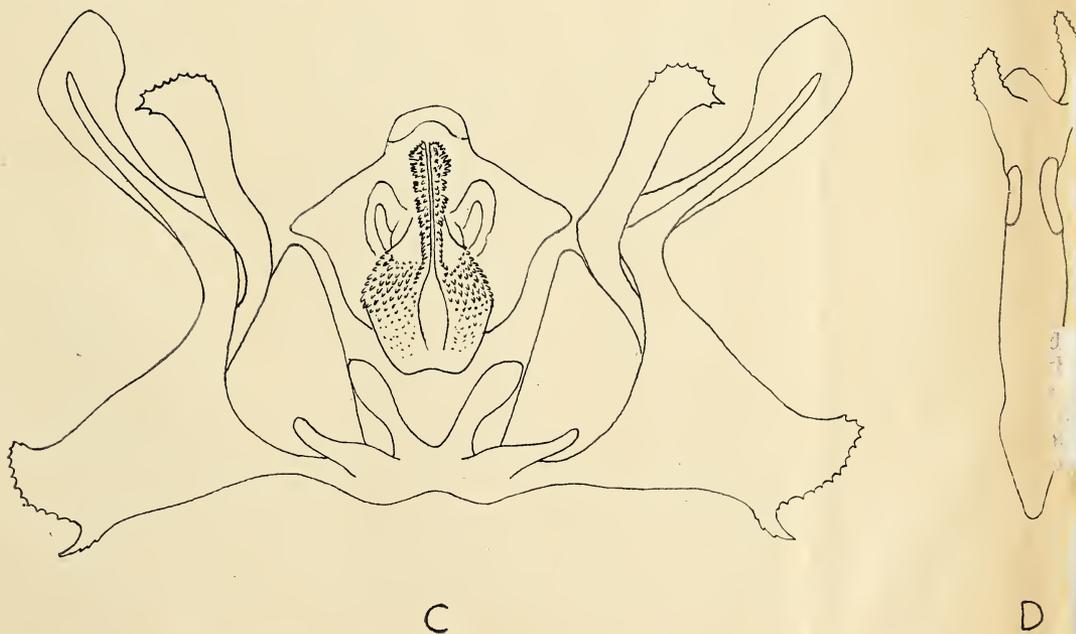
TEXT-FIG. 1. **A**, *Syssphinx comstocki*. Paratype: Cat. No. 42485. Caudal view of the ♂ genital organs with the claspers spread and aedeagus omitted. The uncus has been bent downward. **B**, aedeagus.

wing is orange-yellow flecked with purplish-brown scales. There are two silver spots near the discal cell in cells Cu_1 and M_3 . The terminal band is grayed lavender and encloses an almost immaculate light yellow band extending from vein M_3 to the inner margin.

The basal and median areas of the hind

wing are light orange-yellow with a fuscous streak in the anal fold. The terminal band is light cream and is separated from the rest of the wing by an indistinct brown line.

The abdomen is light yellowish-orange with light fuscus in the conjunctivae. The genitalia are similar to *flavosignata*.



TEXT-FIG. 2. **C**, *Syssphinx flavosignata caripitoensis*. Paratype: Cat. No. 42481. **D**, aedeagus.

This subspecies is easily separated from *flavosignata* by its smaller size and much lighter color. The basal and median areas of the hind wing in particular are so light that they do not contrast with the outer portion of the wing as in *flavosignata* in which these portions of the wing stand out from one another very strongly. Furthermore, the purple colors of *caripitoensis* are very light, a grayish-lilac rather than the brownish-lilac usually present in *flavosignata*. Lastly, in the fore wing vein A_2 is not clothed with purple scales in the yellow basal area as is usually the case in *flavosignata*.

Material: A total of two specimens taken as follows: Caripito, Venezuela: May 19, 1 ♂ holotype (Cat. No. 42480); May 14, 1 ♂ paratype (Cat. No. 42481).

***Syssphinx klagesi* (Rothschild).**

One specimen taken at Caripito on May 10. Another new record for Venezuela. It has been reported from British Guiana and Surinam.

***Syssphinx lilacina photophila* (Rothschild).**

Two specimens captured at Kartabo, one on April 1 and the other on June 20. The species has been found in the Guianas, Amazonas and Peru.

***Syssphinx molina molina* (Cramer).**

A common syssphingid at Caripito. A total of eleven specimens captured as follows: males—May 5, May 14 (2), May 16, May 25, June 14, August 21; females—May 19 (2), May 23 and July 3. This species has been found at Trinidad but has not before been reported from Venezuela. It has been captured in the Guianas, Brazil and Argentina. The subspecies *simulatilis* (Grote and Robinson) is found from Mexico to Colombia.

***Syssphinx subochreatea* Schaus.**

One specimen taken at Caripito on May 10 and another on May 14. Reported only from Colombia. Another new record from Venezuela.

EXPLANATION OF THE PLATE.

PLATE I.

- Fig. 1. *Rhescyntis beebei*. Holotype: Cat. No. 42486.
 Fig. 2. *Citheronia phoronea minutus*. Holotype: Cat. No. 42473.
 Fig. 3. *Syssphinx flavosignata caripitoensis*. Holotype: Cat. No. 42480.
 Fig. 4. *Syssphinx comstocki*. Holotype: Cat. No. 42482.



FIG. 1.



FIG. 2.



FIG. 3.



FIG. 4.

THE SATURNIOIDEA (MOTHS) OF KARTABO, BRITISH GUIANA,
AND CARIPITO, VENEZUELA.

8.

Vertebrate Fauna of a Tropical Dry Season Mud-hole.¹

WILLIAM BEEBE.

Director, Department of Tropical Research, New York Zoological Society.

(Plates I & II).

[This is a contribution from the Forty-third or Venezuelan Expedition of the Department of Tropical Research of the New York Zoological Society made under the direction of Dr. William Beebe. The expedition was sponsored by grants from the Committee for Inter-American Artistic and Intellectual Relations and from four trustees of the Zoological Society, George C. Clark, Childs Frick, Laurance S. Rockefeller and Herbert Satterlee, and by invaluable assistance from the Standard Oil Companies of New Jersey and Venezuela.]

GENERAL ACCOUNT.

The collection and observation of fishes were not among our chief objects of research activity during the seven months, from February to September, 1942, which we spent in the field at Caripito, in northeastern Venezuela. But the concentration and viability of many species in an all but dried up mud-hole in the bottom of a ditch, were so unexpected that I attempted to obtain every species of vertebrate which had been thus terrestrially marooned and was still alive in this most unprepossessing spot. A week or ten days more of rainless weather would have resulted in the extermination of every organism, and would have started them well on the way to fossilization.

As I have stated in a former paper,² Caripito has a very pronounced dry season, one which brings extreme suffering to many forms of wild life. The example of the mud-hole, together with a few observations on changes of pattern and color, are the reasons for this paper.

I have to thank Dr. Leonard P. Schultz for his identifications of two-thirds of the species of fish and for his descriptions of two new species found among them.³

Ten kilometers south of Caripito on the highway which leads to Quiriquiri and Maturin, a disused, extremely rough, rocky, dirt road leads off to the left. This runs straight about four kilometers, and ends abruptly at a long dismantled oil well. This is known as Well Number One and its failure was our gain, for the jungle grew undisturbed along each side of the deserted road, often meeting overhead and with only half a dozen *campesino* squatters who lived in small thatched huts and cultivated little fields of maize, bananas and cassava. This area, together with higher jungle reached by narrow trails farther on, was frequently visited by us.

The country was rolling, densely wooded with medium jungle, and a small stream usually flowed along the bottom of the slopes.

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¹ Contribution No. 708, Department of Tropical Research, New York Zoological Society.

² *Zoologica*, 28: 9, 1943, pp. 53-59.

³ *Zoologica*, 29: 5, 1944, pp. 39-44.

Three of these streams were in the area under consideration, all ultimately directly or indirectly emptying into the main Rio San Juan. One small, nameless stream drained a more or less continuous ditch on one side of Number One Well Road, crossing it at one spot by means of fifty feet of large bore pipe. At the time of our first visit, February 21, this pipe was dry and inhabited by several hundred bats.⁴

The ditch to the east of the road at this date was about half filled with water, already separated into a series of disconnected pools. These were decidedly individual as to superficial appearance, some showing open, but opaque, dark brown water, others with the surface completely covered with thick, green scum. The surface was occasionally troubled with bursting bubbles of marsh gas, but I saw no hint of organic life until one day a half dozen loricate catfish appeared floating dead and badly decomposed, and later twenty-seven *Aequidens*, still more decayed, floated in the same pool. Several hauls with a small seine yielded a few characins, cichlids and catfish but the stench was so great and the underbrush obstacles so troublesome that I shifted our activities to other fields. Day by day as the dry season increased, the water sank lower and lower until long stretches of the ditch became dry and parched, and the occasional logs across which we had picked our way to reach the jungle became elevated and useless.

In one corner of what had been a large pool, more than two meters in depth, the one on which the dead fish had floated, there was at last left only a few inches of damp slime, with no free water visible. One day a lizard which had escaped from my snake bag, dived into this sorry mess of mud and decayed vegetation. I scooped up a handful of the odorous material and to my surprise found that I had two catfishes and seven cichlids as well as the lizard. Life persisting under such conditions was worth investigating and on several occasions, armed with trowel and jars, I scooped and dredged and shovelled at this thick, tropical bilge.

My efforts yielded thirty-eight species of three classes of vertebrates, as well as an interesting collection of aquatic insects—water skaters, ranatras and water beetles—and great numbers of small shrimps. The first mentioned resolved into three species of turtles, one frog and thirty-four species of fish. The turtles and the frog were buried considerably deeper than the fish. All were holed up for the duration of the dry season. The sides of this particular ditch were too precipitous for any of these creatures to climb and make their escape, and, as around other similar sludge pits, I saw no tracks which would indicate attempts at escape.

Several times I marked individual fish living in the last bit of dampness and after several days all were still there.

What they did not seem willing to put up with was the clear, sweet aquarium water in which I placed them at the laboratory. Even with air-pump supplying oxygen they leaped forth at every opportunity, and flicked and jumped about all night, becoming coated with dirt, dust, feathers and cotton, yet as healthy as they had been in their native corruption. When returned to the aquaria they cleansed themselves and immediately jumped out again whenever the wire cover was removed.

Certain of these fish I would have expected to find existing under these adverse conditions. We have come across *Callichthys*, *Gymnotus* (or *Hypopomus*) and several other genera at Kartabo, British Guiana, travelling through low jungle, a considerable distance from water. *Hoplerythrinus*, *Erythrinus* and *Synbranchus* seem almost to prefer thick mud to clear water. But I did not expect to find delicate characins in good health after weeks in almost unswimmable slime, or *Poecilia* bursting with living young. It was a new experience to scoop up species after species of feebly flopping animated bits of mud and green slime, to find them brilliant, scarlet-and-silver "tropicals," apparently in perfect health.

As often before in the case of tropical fresh-water fish I was interested in the number of species, some closely, others very distantly related, which exhibit patches of brilliant scarlet, either on body or fins or both. Under the present abnormal conditions of existence it was hopeless to look for any hint as to adaptive or other reasons, but nine out of fifteen species of characins showed patches of this bright color.

ANNOTATED LIST OF MUD-HOLE VERTEBRATES.

FISHES.

FAMILY PYGIDIIDAE.

Ochmacanthus flabelliferus Eigenmann.

Three specimens, mud-hole, March 6, (1) saved, No. 30,016, length 37 mm. Three specimens of this distinct species were caught in the mud-hole. Two were devoured by *Erythrinus* en route to the laboratory. At night all groups of pigment dots disappeared, leaving the fish a homogeneous translucent brown.

FAMILY CALLICHTHYIDAE.

Callichthys callichthys Linnaeus.

Two specimens, mud-hole, May 7. No. 30,219, length 100 mm. No. 30,220, length 125 mm. Twelve of this species were seen.

⁴ *Carollia perspicillata* (Linnaeus).

in early March floating dead on the surface of this same pool before it evaporated.

***Hoplosternum littorale* (Hancock).**

One specimen, mud-hole, March 19. No. 30,204, length 122 mm.

***Hoplosternum thoracatum* (Cuv. and Valen.).**

Two specimens, one in mud-hole, March 19. No. 30,214, length 77 mm. One in Rio San Pablo, March 19, No. 30,215, length 67 mm.

FAMILY LORICARIIDAE.

***Farlowella acus* (Kner).**

(Plates I & II, Figs. 3, 4 and 5).

Three specimens; (1) mud-hole, March 21. No. 30,007, length 105 mm., Color Plate 1527, Photographs 10,002 to 10,006. (2) Rio San Pablo, March 19. No. 30,007a, length 94 mm.; No. 30,007b, length 135 mm.

Color in Life: All specimens show similar pattern and coloring. The following applies particularly to No. 30,007. Above ochraceous tawny, beginning at the base of the narrow part of the snout, widening on the head to include the upper third of the orbit, and narrowing behind the dorsal fin to a slender median streak. Entire side of the head and body abruptly dark mummy brown; ventral portions of the head and body pale flesh.

Webs of all fins hyaline. All rays with elongate marks of dark brown, those on the first enlarged element of both paired and unpaired fins especially strong, and continued to tips of long caudal filaments. Most of upper half of caudal black, bisected by a vertical pale band; a strong blotch of the same color filling the lowermost webs of the tail fin. Iris, together with its superior lappet, light golden brown.

At night the entire fish changes to a uniform, pale gold buff, and the ocular lappet disappears.

Every part of the fish except nostrils, mouth, anus and fin webs is covered with a dense coat of minute spines, erect on the snout, curved posteriorly elsewhere. The remarkable disparity in actual weight in armored catfish of equal length is shown by a 100 mm. slender, delicate *Farlowella acus* which weighs only 1.5 grams, and a chunky *Callichthys callichthys* of the same length weighing 21 grams, a difference in weight of fourteen times.

In the aquarium this fish spends most of the day resting quietly on the bottom, but at dusk becomes active, clinging with its sucker mouth to the glass, and slithering slowly about over all four sides.

***Loricaria typus* (Bleeker).**

One specimen, mud-hole, April 23. No. 30,226, length 255 mm. Six fish resembling the above were floating on the surface of the

pre-mud-hole pool on March 5 in advanced stage of decomposition. These I tentatively named *L. maculata* but they may very well have been the present species as named by Dr. Schultz. No. 30,226 was taken from the same locality as the others but after the ditch pool had evaporated to mud and rotted leaf sludge in one corner of the bottom. In the laboratory this individual leaped constantly out of its aquarium and for more than fifty hours at one time lived behind trunks and boxes, matted with dirt but showing no later ill effects.

FAMILY CHARACIDAE.

***Aphyocharax erythrurus* Eigenmann.**

Two specimens: (1) mud-hole, April 23, No. 30,230, length 45.5 mm. (1) Rio Caripe, March 21. No. 30,230a, length 48.5 mm.

Day Coloring: Silvery yellow with pronounced pale silvery lateral band; two-thirds of the caudal fin and somewhat less of the other fins bright scarlet. A black shoulder blotch. *Night Coloring:* The yellow and the scarlet become fainter, and the shoulder spot disappears. *Post-mortem Coloring:* The scarlet and the shoulder spot vanish completely.

These fish lived well in small laboratory aquariums, and for at least two weeks retained their full coloring. The paling was as complete the first night as on succeeding ones.

***Astyanax bimaculatus* (Linnaeus).**

Twelve specimens preserved out of 32 examined. A very abundant species, more than 250 taken in one seine haul in Rio Caripe. (2) No. 30,264, lengths 26 and 30 mm., Rio Caripe, March 21. (5) No. 30,266, lengths 33 to 35 mm., Rio Caripe, March 28. (1) No. 30,272, length 86 mm., mud-hole, April 23. (4) No. 30,270, lengths 41 to 45 mm., mud hole which now was a pool, the ditch half filled with water, August 10.

Diurnal Coloring: Dark greenish above tinged with silvery on head, body and lip; clear silvery lateral line; sides and below yellowish-silvery, as well as lower four-fifths of opercula and chin. Strong black humeral spot and one on side of the peduncle, the latter drawn out posteriorly as a narrow black streak to the tip of the median caudal rays. In some individuals, especially the larger ones (90 to 125 mm.), there was a less pronounced second black blotch back of the shoulder spot. Base of dorsal, upper caudal and entire adipose red. In five out of 32 specimens the red on the fins was replaced with pink or yellow.

***Astyanax metae* Eigenmann.**

One specimen, No. 30,225, length 83.5 mm mud-hole, April 23. From my series of tentatively named *A. bimaculatus* Dr. Schultz has distinguished this individual as *A. metae*.

named by Eigenmann from the Rio Negro in Colombia. The shoulder spot is lacking; the peduncle spot is faint but the caudal fin mark is wider and more conspicuous than in *bi-maculatus*.

***Bryconamericus beta beta* Eigenmann.**

Thirteen specimens: (1) No. 30,004, length 42 mm., mud-hole, March 21. (12) out of 22 seined. No. 30,247, lengths 23 to 45 mm., Rio Caripe, April 23.

Diurnal Coloring: The entire fish is silvery but patternless except for a black peduncle spot. The tips and edges of the fins pearly white. The basal half of the anal end of the caudal and upper fifth of the iris are bright red. When extremely excited a vertically elongated humeral spot appears, but soon vanishes when the fish becomes quiet. In an aquarium the fish keep in the central part of the water in a loose school but with complete individual independence, swimming back and forth apparently without rest, day and night. *Post-mortem Coloring*: Soon after death the humeral spot appears and in some cases remains. The red soon goes.

***Copeina arnoldi* Regan.**

Five specimens: (4) No. 30,241, length 22 to 30 mm., mud-hole, May 23. (1) No. 30,236, length 27 mm., mud-hole, August 10. At this later date rain had relieved the stagnant condition, but there was still no connection with adjoining pools along the ditch.

Diurnal Coloring: The red in the ventrals, anal and top of caudal is suffused rather than definite. The most conspicuous mark is the black and white spot at the base of the dorsal.

***Creagrutus beni* Eigenmann.**

Two specimens preserved out of 86 taken: (1) No. 30,063, length 59 mm., Rio Caripe, March 21. (1) No. 30,248, length 50 mm., mud-hole, April 23.

Diurnal Coloring: Greenish-yellow with silvery sheen, two more or less blue body bands; a very broad oxydized silver lateral band. Like so many small species of characins, much of the dorsal, anal and caudal fins is scarlet, as is the entire iris. *Nocturnal Coloring*: All body pigment bands and most of the red color disappear at night, and the same is true after death.

This is the most restless, nervous fish we observed, never quiet a moment, swimming and twisting about the other fish without stopping, usually in the bottom fifth of the aquarium. At night, when it closely resembled other species, this nervousness would always identify the specific individuals.

***Erythrinus erythrinus* (Block and Schneider).**

Four specimens preserved, many others taken, all from mud-hole: (1) No. 30,271, length 80 mm., April 11. (2) No. 30,221,

lengths 100 and 130 mm., May 7. (3) No. 30,233, lengths 29 mm., August 10.

My detailed color notes on these voracious fish, which in life resemble giant minnows, are of little value, because in life I confused the two genera *Hoplías* and *Erythrinus*. The scarlet of the anal and the upper quarter of the caudal is a persistent pattern. There is considerable difference between the sexes and especially between young and adults. Nocturnal changes are not extreme.

Their voracity almost equals that of the caribé. They will begin to kill, cut up and devour all they can hold, a few seconds after being caught by hand and dropped into a pail of fish. Long after they have eaten their fill they will continue to bite off the fins of any other fish confined with them, and will even mutilate one another.

Although not able to climb the vertical walls of the jungle ditches, I now and then found this species in my artificial pits which were dug at considerable distances from water. They refused to remain in an aquarium, unless confined by a wire top, and at night would join the armored catfish in scrambling about the laboratory floor for many hours. Although soon becoming completely coated with a dense fur of dust, when washed off, they seemed never the worse, even after a night and part of the day.

***Gephyrocharax valencia* Eigenmann**

Seven specimens: (1) No. 30,246, length 35 mm., mud-hole, March 8. (1) No. 30,250, length 26 mm., Rio Caripe, March 21. (3) No. 30,273, lengths 25 to 27 mm., mud-hole, April 11. (2) No. 30,229, lengths 35.5 and 36 mm., mud-hole, April 23.

***Hemigrammus unilineatus* Gill.**

Sixteen specimens preserved out of 48 taken: (1) No. 30,244, length 25 mm., Rio Caripe, March 6. (2) No. 30,249, lengths 25 and 28 mm., Rio Caripe, March 21. (1) No. 30,227, length 39 mm., mud-hole, April 23. (12) No. 30,274, lengths 13 to 20 mm., mud-hole, August 10.

A very abundant little characin, with a superficial resemblance to *Pristella riddlei*, but is never as brightly colored. The median fins are marked with yellow and black. The reddish tail color is unchanged at night, but vanishes with death.

***Hoplerythrinus unitaenitus* (Spix).**

Four specimens from mud-hole, numerous others seined in Rio Caripe: (2) No. 30,237, lengths 34 and 37 mm., April 10. (1) No. 30,039, length 87 mm., April 11. (1) No. 30,068, length 225 mm., April 25.

Color in Life: The nine-inch fish from the mud-hole, No. 30,068, was dark gray above, with a slightly lighter line along the side. There was no trace of the pronounced black

lateral band so distinctive of younger fish. Sides bronzy yellow with greenish scale bases. Fleshy white below. Circumorbital cheek plates golden with several dark bands radiating back from the eye. A large black spot on the operculum, and the lower part of this bone clear iridescent bronze green; chin the same. Median fins yellowish with black mottlings. Tail dull reddish-brown, with indistinct mottling. I did not record the ontogenetic and daily changes in color and pattern, but these are very marked. Indians and Venezuelans were seen now and then with strings of these fish up to ten inches in length, speared in small jungle pools and creeks.

Moenkhausia sp.

Ten specimens, No. 30,262, lengths 15.5 to 25 mm., mud-hole, April 11.

Odontostilbon pulcher (Gill).

One specimen, No. 30,245, length 41.5 mm., mud-hole, April 23. Dominant color, a broad, silvery lateral band; dorsal and anal fins pinkish.

Paragoniates alburnus Steindachner.

One specimen, No. 30,263, length 60 mm., mud-hole, April 11. The only definite marking is the peduncle-caudal dark spot, and the deep yellow tinge on the median fins.

Pristella riddlei (Meek).

One specimen kept, a few others seen: (1) No. 30,240, length 22 mm., mud-hole, May 23. The mud-hole has been changed to a pool two feet deep, but with no connection with any adjacent pool.

This lovely little characin is apparently as rare in Caripito as it is abundant at Kartabo in British Guiana. Now and then brilliant individual fish were visible in a school of *Hemigrammus*, very probably this species, but the only one preserved was among my collection from the odorous mud-hole. The dominance in the dorsal and anal of black and contrasting bright yellow, and the brilliant red tail fin, characterize the species.

Serrasalmus eigenmanni Norman.

Two specimens, No. 30,231, lengths 32 and 33 mm., mud-hole, April 23.

FAMILY GYMNOTIDAE.

Hypopomus beebei Schultz.

Four specimens, all from mud-hole: (4) No. 30,040, lengths 129 to 150 mm., April 11.

On casual examination in the field I tentatively labeled these fish *Gymnotus carapo*, a common species, and made no detailed notes. The fifteen or more narrow, dark bars across the body form the most distinctive feature in life and they persist after death.

In his description of this as a new species, Dr. Schultz gives the following color and pattern notes: "Body light brownish in alcohol, with 17 narrow dark brown bars across sides to end of anal fin; sometimes an incomplete or broken bar occurs between most or all the nearly complete bars; pectoral fins and anal fin with numerous dark brown pigment specks; tail beyond anal fin with about 3 more brown bars more or less obscure or absent."

These fish lived for two weeks in a small aerated aquarium. They were as persistent dry land travelers as *Erythrinus* and escaped three times from their tank. Twice they made their way the full length of a twenty-foot corridor, and thoroughly encased in dust and floor debris, were then close to the outer door. Although stiff with dirt, they flapped vigorously when I picked them up and after being cleansed were none the worse for their adventure.

When they swam to the end of the aquarium they seldom bothered to turn around, but like *Gymnotus*, reversed the rippling anal fin and swam backward with the utmost facility.

FAMILY SYNBRANCHIDAE.

Synbranchus marmoratus Bloch.

Seven specimens preserved out of about twenty, all from mud-hole: (3) No. 30,041, lengths 88 to 108 mm., April 11. (4) No. 30,261, lengths 82 to 104 mm., May 6.

FAMILY CICHLIDAE.

Aequidens pulchrum (Gill).

Five specimens preserved, out of many seen or taken: (2) Nos. 30,006c, 30,006d, lengths 69 mm., Rio San Pablo, March 19. (1) No. 30,006e, length 68 mm., Rio Carive, March 21. (2) Nos. 30,006a, 30,006b, lengths 75 and 62 mm., mud-hole, March 21.

I have already recorded the changes of pattern and coloration of the individual fish No. 30,006a, under the name *Aequidens tetramerus*.⁵ When complete records are obtained of diurnal, nocturnal, ontogenetic, emotional and post-mortem pattern and color variations and changes, we may perhaps expect some final shifts and decisions in species nomenclature.

Early in March, 27 of these fish, badly decomposed, were floating on the surface of the pool which later evaporated to our mud-hole.

Cichlasoma bimaculatum (Linnaeus).

Three specimens preserved of many taken, all from mud-hole: (2) No. 30,235, lengths 30 and 37 mm., April 11. (1) No. 30,223, length 60 mm., May 7.

⁵ *Zoologica*, 28: No. 3, 1943, pp. 13-16.

Coloring: In recently caught fish of larger size (ca. 60 mm., st. length) several pattern elements are visible. In order of distinctness these are: a large ocellus at upper extremity of peduncle, a sub-ocular spot, a mid-lateral ocellus and a broad dark, lateral band connecting the eye with the mid-lateral spot. In these larger fish the peduncle ocellus is perfectly round and does not extend down to the level of the lateral line. In smaller individuals (30 to 35 mm.) the peduncular marking is narrow and elongate, extending clear to the lateral line.

***Crenicichla alfa* Eigenmann.**

One specimen, No. 30,010, length 51 mm., mud-hole, March 21.

***Crenicichla macrophthalmus* Haeckel.**

Three specimens, No. 30,228, lengths 41 to 63 mm., mud-hole, April 23.

***Crenicichla saxatilis* (Linnaeus).**

Two specimens, No. 30,222, lengths 91 and 112 mm., mud-hole, May 7.

***Nannacara anomala* Regan.**

Three specimens, No. 30,238, lengths 27 to 31.5 mm., mud-hole, April 11.

FAMILY POLYCENTRIDAE.

***Polycentrus schomburgki* Müller and Troschel.**
(Plate II).

Four specimens kept out of 10, all from mud-hole: (3) No. 30,182, lengths 22 to 37 mm., March 10. (1) No. 30,042, length 35 mm., April 11. Color Plate 1566.

Diurnal Pattern and Color Changes: The individual No. 30,042, taken from the mud-hole on April 11, showed the following major changes, all in the daytime, the description and the paintings of which were made on the first day in captivity in the laboratory aquarium. Plate II, fig. 5. Two weeks later, a check up showed three of the changes and several intermediate stages, both in the same individual and in other fish.

Phase One: Jet black with numerous white dots scattered over the body.

Phase Two: The background changes to grayish-brown, with five, broad, vertical dark brown bands across the body. The white dots of phase one are now seen to bound these bands, none being in the bands themselves or in the pale inter-spaces. Two black bands extend back from the eye, one obliquely up and back, and the other down and back, at right angles.

Phase Three: The chief change is the obliteration of some or all of the vertical bands, the whole fish being often light brown, irregularly dotted with roundish, dark brown spots. The median fins may now have wide, alternating, vertical bands of dark and light.

Phase Four: The upper anterior fourth of the head and body becomes uniform pale

brown, the remainder of the fish being dark and mottled. In all these light phases the ocular lids are permanent. The iris is mottled dark brown, with a very narrow, very brilliant scarlet inner ring.

Nocturnal Color: At night the entire fish becomes pale grayish-white, immaculate.

A favorite resting position is on the elongated rays of the anterior part of the pelvic fins. The first ray is thick and brown; the second projects well beyond the first, is white and thread-like and curled anteriorly; the third ray is elongate, jet black and used as a support. When resting quietly on the bottom, the fish sways continually as in a current, and the extensive dorsal and anal fins are widely expanded, making the fish look like a serrated leaf, as in the species of closely related genera. When slowly moving ahead, or around, or upside down as is frequently the case, the motor power is confined altogether to the pectorals and to the elongate soft, posterior rays of the dorsal and anal fins. These are perfectly transparent and thus detract not at all from the inorganic activity of a drifting dead leaf. The character of the movement adds to this effect, the pectoral and the motor portions of the median fins never waving slowly, but vibrating in a swift blur which enhances their invisibility.

Now and then, without any warning, one or the other of the fish everts its mouth, the lips being elevated and projected forward on a complex membranous support of unexpected anterior extension. It is a slow, elaborate yawn, a habit common to other members of the family.

FAMILY CYPRINIDAE.

***Lebistes reticulatus* (Peters).**

Two specimens, No. 30,282, lengths 16 and 18 mm., mud-hole, April 11.

***Poecilia vivipara* Bloch and Schneider.**

Twenty-two specimens preserved out of hundreds: (4) No. 30,038, lengths 18 to 25 mm., mud-hole, April 11. (16) No. 30,265, lengths 17 to 27 mm., Rio San Pablo, May 6.

The majority of these fish were bursting with living young when caught.

***Rivulus hartii* (Boulenger).**

One specimen, No. 30,239, length 34 mm., mud-hole, April 11. General body color buffy yellow with many scarlet dots. Caudal fin wholly yellow in life.

***Rivulus* sp.**

Six specimens preserved from about 20: (5) No. 30,015, lengths 32.5 to 67 mm., mud-hole, March 6. (1) No. 30,234, length 54 mm., Rio San Pablo, August 10.

This unnamed species is brown, spotted with darker above, the pectorals and pelvics lemon yellow, caudal broadly margined with black.

AMPHIBIA.

FAMILY PIPIDAE.

Pipa pipa (Linnaeus).

large male, not breeding, well down
mud, full activity. Length 122 mm.,
hole, May 6.

REPTILIA.

FAMILY MYDIDAE.

Geoemyda punctularis (Daudin).

small specimens of this straight

necked, red-marked chelonian. One March
21, one June 13. Mud-hole, Color Plate 1597.
No. 30,137.

FAMILY CHELYDIDAE.

Batrachemys nasuta (Schweigg.).

One small specimen, mud-hole, June 2.
Single-keeled. No. 30,147.

Platyemys platycephala (Schneider).

One specimen, mud-hole, June 2. Double-
keeled. No. 30,148.

EXPLANATION OF THE PLATES.

PLATE I.

- Fig. 1. Jungle Mud-hole two weeks before the last water evaporated.
- Fig. 2. *Farlowella acus*, Specimen No. 30,007, from Color Plate 1527 by George Swanson, length 105 mm. \times 1.3.
- Fig. 3. *Farlowella acus*, side view of head. \times 6.

PLATE II.

- Fig. 4. *Farlowella acus*, ventral view of mouth a few minutes after death. \times 12.
- Fig. 5. *Polycentrus schomburgki*. Four pattern and color phases of the same individual fish. Specimen No. 30,042, length 35 mm. Painting by George Swanson. \times 1.3.



FIG. 1.

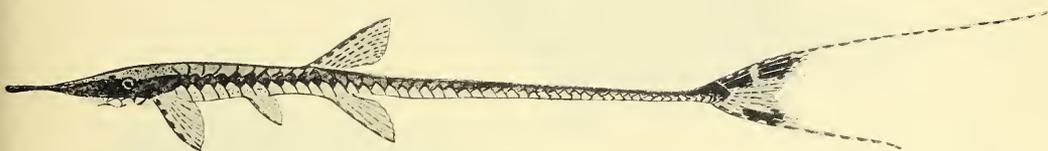


FIG. 2.



FIG. 3.

VERTEBRATE FAUNA OF A TROPICAL DRY SEASON MUD-HOLE.

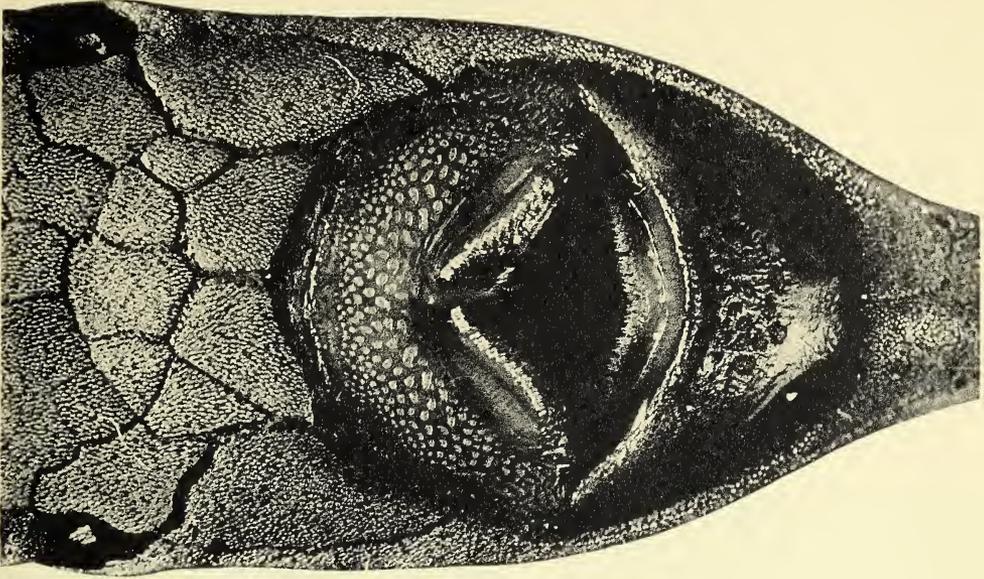


FIG 4.

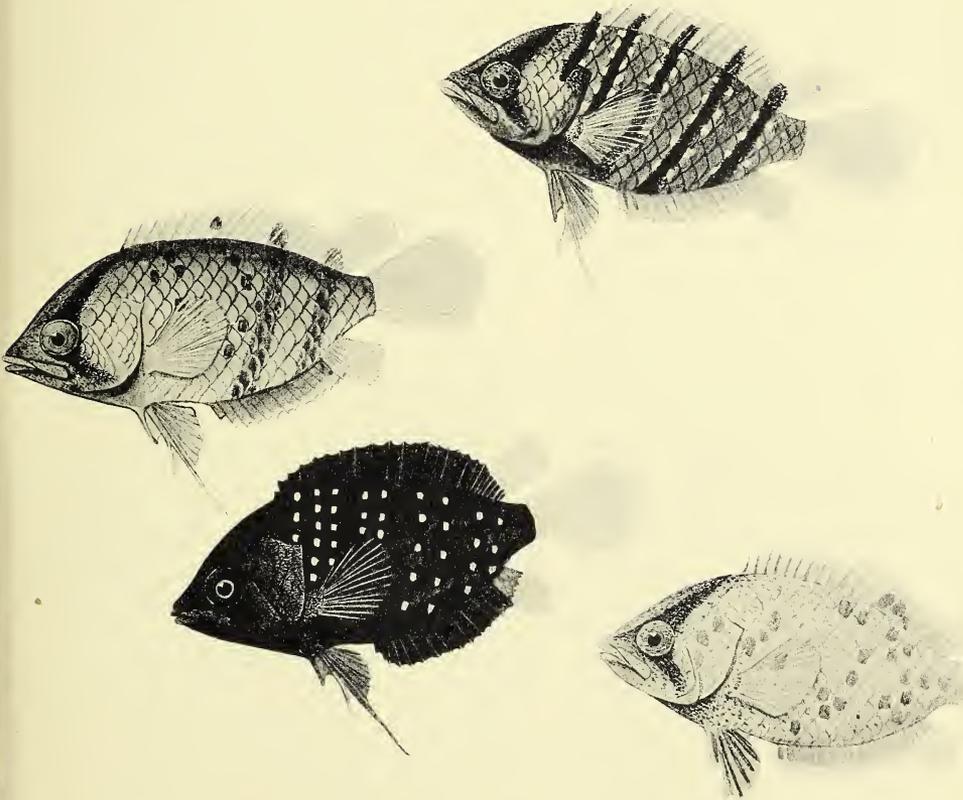


FIG. 5.

VERTEBRATE FAUNA OF A TROPICAL DRY SEASON MUD-HOLE.

9.

A Comparison of Length and Voltage in the Electric Eel,
Electrophorus electricus (Linnaeus).

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&

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(Text-figures 1-5).

In observations on a number of electric eels, *Electrophorus electricus* (Linnaeus), made during the last few years, it appears that there is a voltage-length relationship which is more or less constant for eels of any given length, and which differs between length groups, the shorter eels having a higher voltage value per unit length, the longer fish a lesser voltage. While there are individual differences between one fish and another of identical length, these are within the general range of the group.

Since the fish depends entirely upon its electricity for protection against enemies and for securing food, it seems likely that the smaller ones must develop a sufficiently high voltage early in life to be effective, but once this effective voltage is achieved, there is no need for it to increase with increasing length.

It has not been possible for us to measure eels of very small size, so that we make no conjectures for these, but we were recently afforded the opportunity of making measurements on 59 eels, secured in September, 1944, for purposes other than this paper. The lengths of these fish ranged from 34.5 cm. to 191 cm.

Since these fish were freshly caught before the first group of measurements was made, and had been in captivity for several months when the second measurements were made, it is as well to point out that we have found no significant differences in voltage between fish kept in tanks in New York and fish which were in their native waters in Brazil.

Some of the measurements were made in October, 1944, and the rest in January, 1945. The fish employed at the earlier dates were not kept segregated afterwards, and it is therefore likely that some of them were among those measured at the later date. This is not a disadvantage, however, since a good deal of growth took place between the two

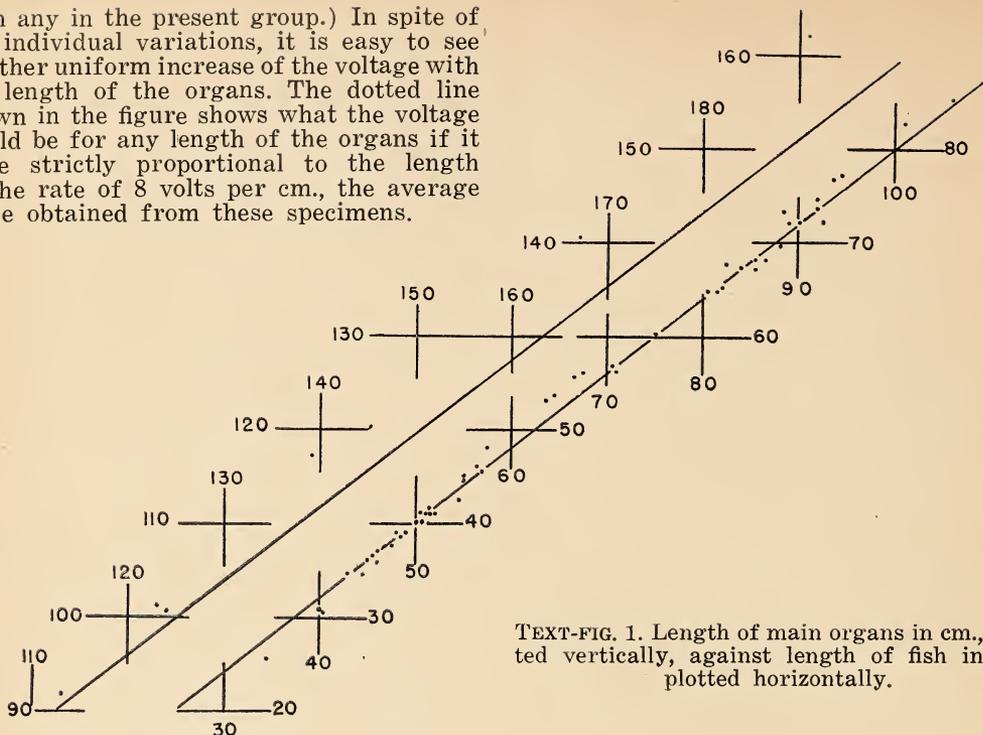
dates, and the purpose of the measurements was to learn how the electrical characteristics of the fish are changed by growth.

Because only a limited time was available for the observations and it was desired to make them on a large number of specimens, only the simplest measurements were made. One of these was the measurement of the length of the main electric organs.

The anterior end of these organs is just behind the very soft tissue of the visceral cavity and is easily discernible through the skin if a slight pressure is exerted. The posterior end of the organs is at the tip of the tail. Consequently it was quite easy to determine the length of these organs and compare it with the length of the fish. The comparison is shown in Text-fig. 1. It will be seen that for any one length of the fish there is little variation in the length of the organs. Also there is a remarkable uniformity in the ratio of the length of the organs to the length of the fish. The average value of this ratio is 0.80, and the average deviation is less than 2 per cent.

By connecting a cathode-ray oscillograph to electrodes at the ends of the main organs, the maximum voltage developed in the discharge of these organs was measured for each fish. The fish was out of water and no current was drawn from the organs except that flowing in circuits closed within the body of the fish. Here the individual variations are much more marked than in the length of the organs. Also the relation of the maximum voltage to the length of the organs, instead of being regular, shows a rather abrupt change as the organs attain a length of about 50 cm. The measurements on the smallest twenty-five specimens, those with electric organs under this length, are shown in Text-fig. 2. (There is shown also, by a dot, a measurement made by one of us some years ago in Brazil on a specimen smaller

than any in the present group.) In spite of the individual variations, it is easy to see a rather uniform increase of the voltage with the length of the organs. The dotted line drawn in the figure shows what the voltage would be for any length of the organs if it were strictly proportional to the length at the rate of 8 volts per cm., the average value obtained from these specimens.



TEXT-FIG. 1. Length of main organs in cm., plotted vertically, against length of fish in cm., plotted horizontally.

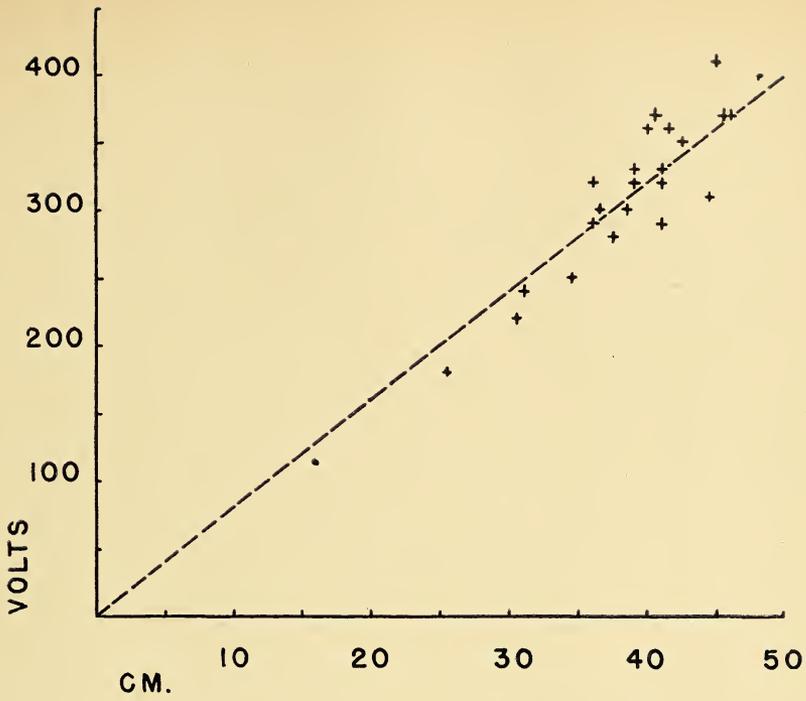
If this rate were maintained at all lengths, the largest fish in these observations, with organs 162 cm. long, would have a maximum voltage of almost 1,300 volts. Actually the maximum voltage of this fish was only 340 volts. The measurements made on the whole group of larger fish, shown in Text-fig. 3, do not indicate an increase in voltage with increasing length of the organs. The voltages regardless of length seem to be randomly scattered around their average value, 370 volts. The highest voltage measured, 550 volts, was produced by almost the smallest fish of the group. Evidently, then, the increase of voltage with growth shown by the observations on the group of smaller fish stops, apparently with some suddenness, when a certain length is attained. The fact that the individual variations are markedly greater among the larger fish suggests that the greatest voltage is attained at different lengths in different specimens.

Though this is the most extensive comparison of the lengths and voltages of electric eels which we have been able to make, we have observed over a number of years that the voltages of large fish bore to those of small fish a ratio less than the ratio of their lengths. At one time we ventured the opinion that the limiting factor in the increase of voltage with length was the speed at which the impulse runs along the electric organs (1). If, during the discharge of the anterior part of the organs, the impulse should traverse

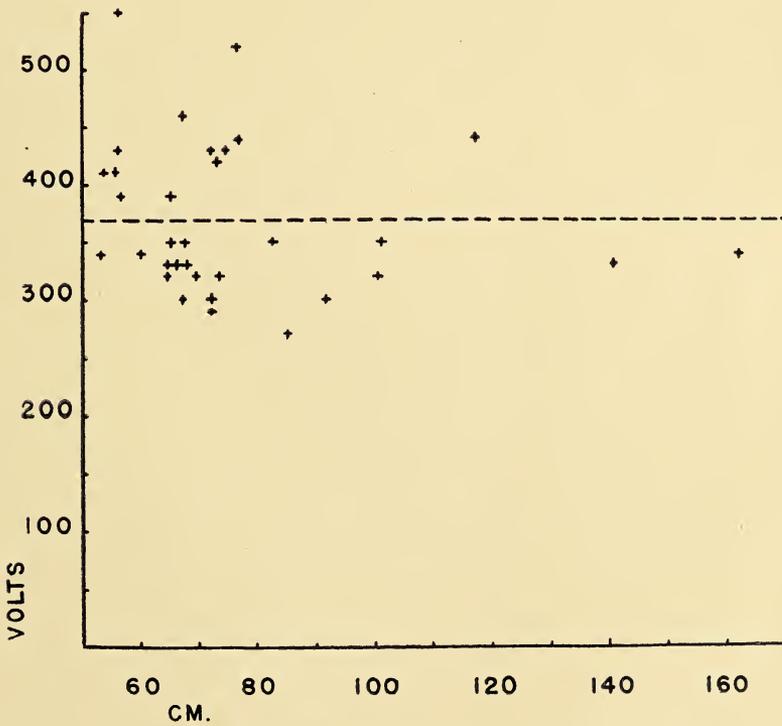
only a certain fraction of their length, then the parts posterior to this fraction would only prolong the discharge without increasing the voltage. The speed was found to have a value of the right order to make this explanation seem plausible. However, measurements of voltage between electrodes near together at the anterior end of the organs show that the factor which limits the increase of voltage with length is actually something else than the speed of the impulse.

These measurements are shown in Text-figs. 4 and 5, in which the maximum voltages per unit length at the anterior end of the organs are plotted against the length of the organs. For the smaller fish, as shown in Text-fig. 4, the voltage per cm. shows no systematic change with the length of the organs. For the larger fish, on the other hand, the voltage per cm. shows a decrease with increasing length discernible despite the wide individual variations.

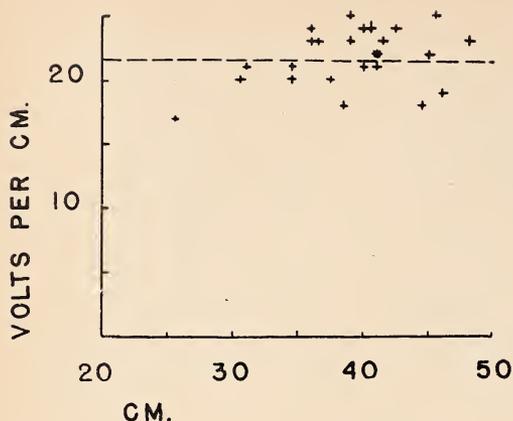
Now, these measurements were made with electrodes 5 cm. apart. The speed of the impulse at the anterior end of the organs is of the order of 2 meters per millisecond. Hence the time lag in 5 cm. would be only about .02 or .03 millisecond, roughly 100 times less than the duration of the discharge. Thus the time lag can have no appreciable effect on the voltage measured in so short a length of the organs. Nevertheless the voltage per cm. is less in the large fish than in those with organs less than 50 cm. long, and it is less



TEXT-FIG. 2. Maximum voltage of main organs against length of organs, smaller fish.



TEXT-FIG. 3. Maximum voltage of main organs against length of organs, larger fish.



TEXT-FIG. 4. Maximum voltage per cm. at anterior end of main organs, against length of organs, smaller fish.

in a proportion about enough to account for the observed independence of voltage and length among the larger fish.

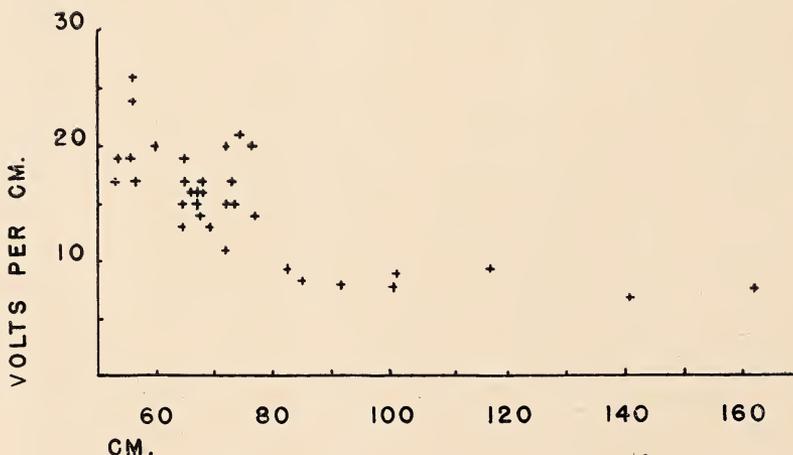
The individual variations are large enough to allow still the possibility that the speed of the impulse may contribute something to the limitation of voltage, but there is no positive evidence that it does. If there is no such effect, it may be that the speed of the impulse increases with the growth of the fish and so has the same effect on the voltage in long fish as in short ones. The speed has not been measured in enough specimens to be certain on this point, though the few measurements made show the greater speed in the longer fish. (1)

It will be recalled that when the voltage was measured between the ends of the organs, the average voltage per unit length among the smaller fish, in which it was

highest, was found to be 8 volts per cm. At the anterior end of the organs, however, the average voltage per unit length was found to be 22 volts per cm., almost three times as high as for the organs as a whole. This variation of the voltage per cm. along the length of the organs has been observed before and correlated with the variation of the number of layers of electroplaxes per cm. in series along the organ (2, 3). The voltage per electroplax layer was found to be roughly uniform along the organs and to have in several different fish the same order of magnitude, about 0.14 volt. It seems reasonable, therefore, to ascribe the differences in the voltage per cm. found in the group of longer fish mainly to the same cause. It may be supposed that when the organs attain a length around 50 cm., further growth takes place not by an increase in the number of electroplax layers but by an increase in the thickness of the layers. This supposition is confirmed by observations on a few specimens in which, in connection with other experiments, the number of layers per cm. was counted in specimens of different lengths (4).

In this connection it may be mentioned that Cox and Breder, in comparing embryo and adult specimens of the electric ray, *Narcine brasiliensis* (Ölfers), found that the enlargement of the electroplaxes would account for most of the growth of the electric organs (5).

If it be supposed that among the electric eels with organs less than 50 cm. in length the voltage per electroplax layer also does not appreciably change with growth, then it must be concluded, in order to account for the increase in the voltage of the whole organs, that growth up to this length takes place by an increase in the number of electro-



TEXT-FIG. 5. Maximum voltage per cm. at anterior end of main organs, against length of organs, larger fish.

plax layers. If this is true, so that there is a radical change in the process of growth around this length, then it may be somewhat surprising that this change is not accompanied by a change in the ratio of the length of the organs to the length of the fish. As was shown in Text-fig. 1, this ratio remains remarkably constant. An alternative explanation would be that the voltage per electroplax layer increases in the early stages of growth without an increase in the number of layers. On this explanation, however, it would be surprising that the voltage of the whole organs is so nearly proportional to the length among the smaller fish as it is found to be and that the voltage per cm. at the anterior end is so nearly uniform. It seems to us more likely, on the present evidence, that the voltage per electroplax layer does not depend much, if at all, on the length of the organs, and that the early growth is mainly an increase in the number of electroplax layers, while the later growth is mainly an increase in their thickness. Of course it would be possible, by dissecting the organs of enough specimens of different sizes, to determine definitely the process of growth, but the question does not seem at present to have enough importance to justify the sacrifice of the fish that this would require.

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10.

Compensating Reactions to the Loss of the Lower Jaw
in a Cave Fish.

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(Plate I; Text-figures 1-2).

INTRODUCTION.

Malformations of the head of teleosts have frequently been described and form the basis of a considerable part of the literature of fish teratology. These items chiefly concern loss or poor development of certain cranial elements, aside from the purely monstrous, such as partial twinning, either spontaneous or experimentally induced. They fall into three natural causative groups; injury and developmental (either genetically or environmentally induced). Although it is frequently impossible to be absolutely certain which a given case represents there are frequently good presumptive indications of origin. A curious case of cephalic abnormality, different from any so far described, and with certain interesting implications, appeared in connection with studies on the Mexican blind characins and forms the basis of the present communication.

The author is grateful to Mr. Albert Greenberg of Tampa, Florida, for the privilege of studying this specimen. Mr. Greenberg, an accomplished fish culturist, who has reared thousands of this form, *Anoptichthys jordani* Hubbs and Innes, has seen only this single specimen, which was hatched in his establishment. He also kindly supplied the data on its behavior in life. Thanks are due to Mr. Paul Benzer who was kind enough to clear and stain the fish for the study of the skeletal elements. Dr. W. K. Gregory and Dr. Myron Gordon kindly contributed critical comments on the manuscript.

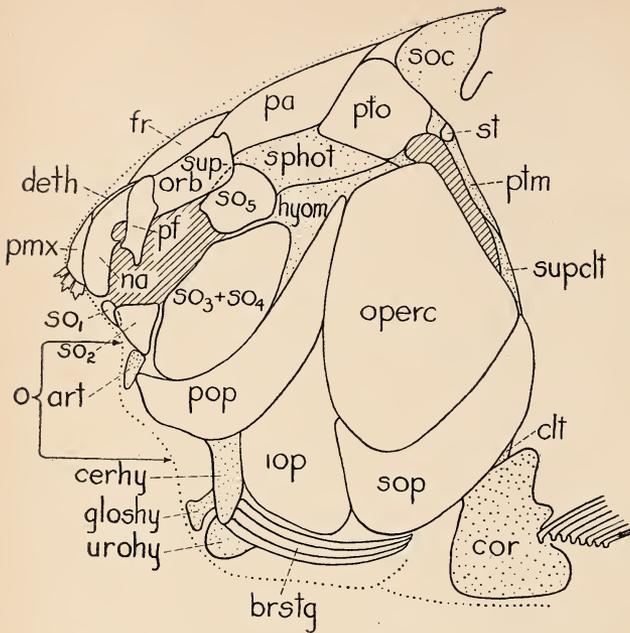
DESCRIPTION.

The general external aspect of the head of the fish here considered is shown in Plate I. The lateral view shows the front of the head to be obliquely truncate. Viewed ventrally it can be seen that the oral orifice is a slightly asymmetrical vertical slit extending from what is evidently the anterior end of the hyoid apparatus upwards to a

point somewhat behind the pointed "snout." This fish fed, respired and grew to a standard length of 37 mm. in six months in spite of this malformation of the oral apparatus. Food was taken in with the accompaniment of side to side movements of the sides of the vertical "mouth," while the fish fed at an angle of about 45° to the bottom when first noted and later at an angle of nearly 90° according to Mr. Greenberg's observations. Growth was in keeping with the normal tank mates for the first three months of life but after that was slower. This slowing of growth approximately coincided with the change in feeding posture. The cause of death is unknown, but the preserved fish showed no evidence of malnutrition and it seems that direct starvation did not occur.

The basic nature of this peculiar fish head was evident only by staining and clearing and is shown in Plate I. The skull as sketched by camera-lucida is given in Text-figure 1, in which the outlines of the incompletely ossified dermal bones are indicated. The prominent difference from the normal skull is the absence of the dentary and maxillary. The angular and quadrate could not be found and evidently they too are absent. The other skull bones are all intact and most are identifiable as is indicated by the lettering. There is no evident suture between so_3 and so_4 , making the elements of this series somewhat uncertain although the rest appear in their normal relative positions. The variations in the sub-orbitals of these cave fish, especially so_3 , have been noted by Breder (1944) and this apparent fusion may have no direct connection with the other peculiarities of this particular specimen. The identification of the ceratohyal, glossohyal and urohyal is provisional. These items are of minor importance, however, to the present considerations.

The most remarkable and striking feature of this skull is the manner in which the angled preopercular bones have grown for-



TEXT-FIG. 1. Skull of cave fish with lower jaw absent. **art**—articular, **brstg**—branchiostegal, **certhy**—ceratohyal, **cft**—cleithrum, **cor**—coracoid, **deth**—dermethmoid, **fr**—frontal, **glos**—glossohyal, **na**—nasal, **o**—oral opening, **operc**—opercular, **pa**—parietal, **pf**—prefrontal, **pmx**—premaxilla, **pop**—preopercular, **ptm**—post-temporal, **pto**—pterotic, **so**—suborbital, **soc**—supraoccipital, **sop**—subopercular, **sphot**—sphenotic, **st**—supratemporal, **supcft**—supracleithrum, **suporb**—supraorbital, **urohy**—urohyal. See text for full explanation.

ward and inward to form the biting vertical "jaws" of this pseudo-mouth. The remaining elements of the skull have all shifted and changed their form slightly, fitting to the new conditions, as may be noted by a comparison with Plate I and Text-figure 2, B, both of which show a normal blind-fish skull. The tooth-bearing premaxilla is remote from the new oral opening as may be noted in Text-figure 1 in which arrows from "O" indicate the vertical extent and position of this orifice. Actually the central teeth form the greatest anterior reach of the fish and could in no way be supposed to be able to function in reference to food. The non-cranial skeletal elements, except the associated pectoral girdle, appeared normal in every way as did the intact body of the fish posterior to the head.

The modifications of the musculature accompanying these changes could not be worked out on this single specimen, first because such myological dissection on so small a fish before the disposition of the bones was known would have been impracticable and later after clearing such dissection was impossible.

DISCUSSION.

Since respiration and food prehension are essential activities from shortly after hatching in such fishes, it follows that in order for this jawless fish to survive, it had to "improvise" the required apparatus to an extent which was adequately functional at the proper early time. This immediate need has distinct bearing on the possible genesis of this abnormality.

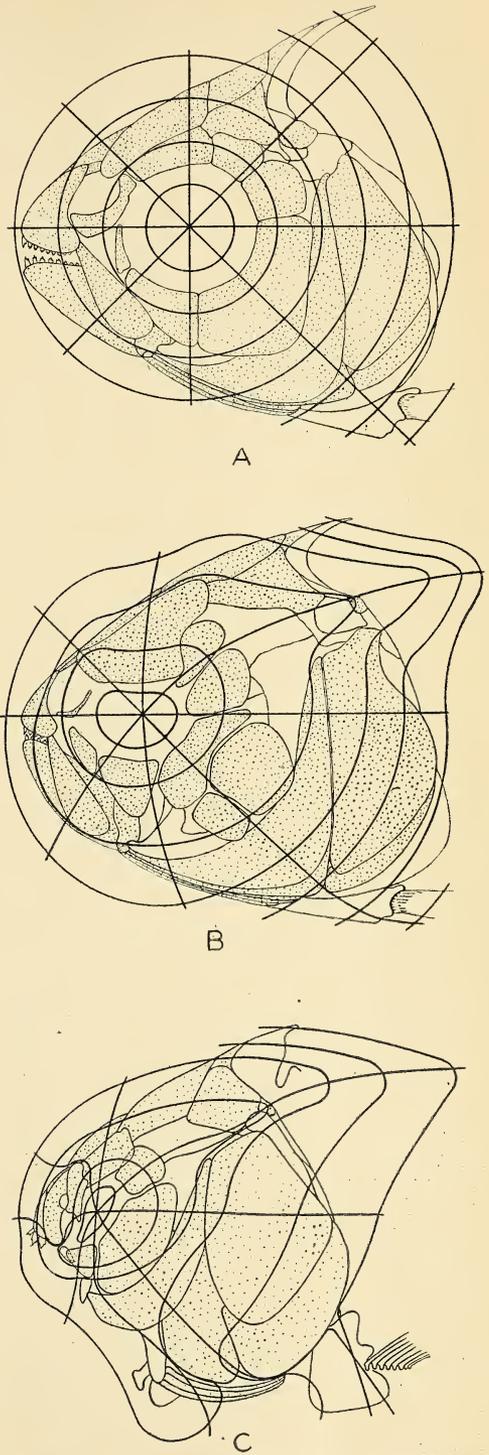
The likelihood of it being traumatic seems very remote, if not fully impossible. Such an injury to this kind of a fish larva would be certainly lethal because of the extreme delicacy and fragility during this period of life. Furthermore the symmetry of the skull would make such an accident most unlikely. A rebuilding of the face in time to have it functionally useful would be clearly impossible. Injury at a later time has these last two difficulties still present and in addition the whole head and pectoral girdle would hardly show just this kind of transformation as a consequence, after the skull had ossified normally.

Considering the two types of developmental modification possible, that of environmental effect would seem to be ruled out on the basis that this egg was one of a batch of more than one hundred hatched along with it. The rest were all normal and furthermore there is no known environmental condition that would lead to just this kind of modification and leave the rest of the fish unaffected. Considering the cause of such abnormalities as due to a retardation of development as elaborated by Stockard (1921), it is hard to imagine how any environmental accident to this single egg could lead to such a type of malformation. Consequently if actually either of the above two possible causes did not operate, the only alternative left is to suppose that the defect is genetic in origin. Due to the early need of a properly functioning mouth, as above indicated, it would seem that the basic pattern of this newly formed type of face must have been established early in the egg.

Whether or not it is a rare mutant must be left until sufficient time has elapsed to see if others appear in the same strain. This is a long inbred stock, now in its eleventh generation, and the present is the first to show this deficiency. The only other defect noted in thousands of individuals were three or four cases of slight kyphosis.

Since the specimen eventually died of some obscure cause at an age of about six months, after growing at a normal rate for the first half of its life and showed no evidences of starvation, it is difficult to associate death clearly with the malformation. Its reduction of rate of growth, however, is evidence that there was some factor involved which worked against its continued existence. Judging from the shape of the face it would seem to have no great difficulty in obtaining food from the bottom after the manner of its kind if at an angle of nearly 90° as noted by the observer. The change from an earlier feeding position of 45° may have been associated with a change in the proportions of the face with growth. It may be noteworthy in this connection that these fishes tend to become more prognathous as they develop. Since starvation seems not to be involved, it may well be that some other associated difficulty not evident from the preparations may have been the cause of death or even some cause not in the least associated with the condition.

In the native habitat of these fishes there is no food problem for the bottom is deeply floored with food substances as shown by Breder (1942). Presumably practically any form of face could obtain nourishment under such conditions, and furthermore this one did so under less advantageous circumstances as found in a hard-floored aquarium with separate food particles supplied from time to time, competing successfully with its normal tank mates. Since no such cases have come from the cave which is inhabited by this form, although in all relatively few have been collected, as compared to the thousands raised by Mr. Greenberg, inquiry may be made into the possibilities of such survival in the native state. They seem to be several in number. (1) If a rare recessive mutant, it may be that it has only been brought out by the close inbreeding and back crossing and could hardly be expected to be found or established in a larger wild population. (2) It may be that it is not a rare mutant and of more or less regular occurrence but of such a nature that its late survival is exceedingly rare. This could be because of associated but less evident deficiencies or because of a more usual failure of the remaining parts to succeed in forming a successfully functional mouth of an adequate type. (3) It may be that actu-



TEXT-FIG. 2. Transformations of polar coordinates centered in the eye. **A.** Normal-eyed river fish. **B.** Fully blind specimen from La Cueva Chica. **C.** Aquarium reared descendent from La Cueva Chica with lower jaw missing. Two upper figures from Breder (1944).

ally it is rare only in that successful competition with normal individuals is unusual and the present case is one of those chance survivals of an individual primarily unfit. If this latter is true it may be that the slowing of growth actually was a stunting, if not a starvation effect, because of a slightly inadequate diet due to competition in the presence of a limited food supply.

An extension of the polar coordinates used by Breder (1944) is shown in Text-figure 2. Unlike the smooth flowing regularity of the fish therein discussed, concerned with the progressive reduction of the eye, the present loss of a terminal member involves the lines of the grid in a most complicated fashion. However here again it was found that the concentric ordinates were largely of an exponential nature while the radial ones were not.

While the exact operation of these extemporized jaws is not clear, due to the impossibility of working out the myology, it would appear that since the preopercle is attached to the operculum, as the latter lifts in respiration there would be a tendency for the former to press inwards once its anterior edge was freed of its normal anchorage. Thus it is not unreasonable to suppose that the whole opercular series rocked back and forth so as to open the mouth or gill-cleft alternately, which operation would cause the opening and closing of the false jaws and provide both for respiration and feeding requirements. Evidently the swallowing and pumping mechanism was suitably functional.

Most other malformations of fish heads that have been reported from time to time are clearly of other genesis and significance. The so-called pug-headed condition in fishes which is not particularly uncommon would seem most likely to be a true achondroplasia induced by some pituitary disturbance. Gudger (1929 and 1933) discusses at length some such cases and gives a history of the literature of that subject. Whatever the cause of the present condition, it would seem not likely to be associated with an endocrine difficulty, since there is no known dysfunction of this sort leading to anything even remotely resembling the present condition.

Another cephalic abnormality, of less frequency, is the so-called "two-mouthed" condition which is reviewed by Gudger (1930). This is evidently a purely traumatic condition in which the floor of the mouth has been torn open so that the hyoid apparatus is detached from the lower jaw just behind the symphysis. This clearly has no relation to the present problems nor has the side to side mouths of imperfectly separated twin heads.

The reports of fully or partially occluded mouths, which may or may not be accom-

panied by the loss of associated skeletal elements, would seem to be most nearly related to the present condition, but no specimens previously reported have been able to improvise functional "jaws" out of the remaining parts. Nor have the preopercular bones, in these cases, shown any detachment of their anterior ends, a prerequisite to the functioning of such false "jaws." In these other cases dermal tissues have overgrown the places that would have normally been occupied by the missing bones, reducing the mouth to a more or less ineffectual orifice. While achondroplasia may enter into these cases, they are frequently far from the typical pug-headed condition. It is perhaps pertinent that all such cases of occluded mouths with loss of bony elements refer to the Ostarophsi, specifically to the Cyprinidae and the Catosomidae, and most of these to *Cyprinus carpio* Linnaeus. See for example Lawrence (1875), Fehlmann (1912) and Spillmann (1938). On the other hand the true pug-headed condition is widespread in many groups of fishes. Dean (1916) under "teratology" gives a long list of references to both types of malformation.

The series of studies on this form of blind fish has shown evolutionary changes almost entirely in the nature of loss. The only exception so far found has been that involving an increase in the chemical sense organs. The taste buds have shown a numerical increase and the nasal capsule some modification as has been indicated by Breder and Rasquin (1943). Those features involving the supporting architectural elements are all of loss as well as those of eye and ear, Breder (1943). Whether there is an associated tendency to drop other structures related to a dark, protected environment with an abundance of food present, somewhat after the fashion of an intestinal parasite, poses a rather pretty problem on which the following has a distinct bearing. Do these fish regularly show an early mortality due to the production of an unusually large number of defective individuals doomed to disappear shortly after hatching? The preservation of large numbers of newly hatched young could determine this with some degree of accuracy. If such losses in general are of the magnitude of the present example it should not be surprising that few develop to a macroscopic size.

SUMMARY.

1. A single specimen of blind characin, one of a normal brood, developed with the lower jaw completely absent and lived to reach a standard length of 37 mm.
2. The front end of each preopercular bone grew forward and around in front of the face to form a "mouth" which formed

a vertical slit, the "jaws" working from side to side by means of which the fish both fed and respired.

3. Growth was normal for the first three months of life but later became retarded.
4. This is evidently a genetic loss and in order for the improvised buccal apparatus to be adequately functional soon enough, the development must have formed early, very likely its main features being established within the egg.
5. This specimen is unique among the reported cases of cephalic abnormalities in fishes, in that it developed a substitute jaw mechanism.

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EXPLANATION OF THE PLATE.**PLATE I.**

- Fig. 1 Lateral view of cave fish lacking lower jaw.
Fig. 2 Ventral view of same specimen.
Fig. 3 Lateral view of cleared head of cave fish lacking lower jaw.
Fig. 4 Lateral view of cleared head of a normal cave fish.
(A.M.N.H. photographs).



FIG. 1.



FIG. 3.



FIG. 2.



FIG. 4.

COMPENSATING REACTIONS TO THE LOSS OF THE LOWER JAW IN A CAVE FISH.



11.

The Presence of a Myxobacterium, *Chondrococcus columnaris* (Davis) Ordal and Rucker (1944), on *Fundulus heteroclitus* (Linn.).

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&

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(Plate I).

INTRODUCTION.

Davis (1922) recorded an organism inducing a fatal disease among certain fishes in the warm fresh waters of the Mississippi Valley. The disease is manifest as a mold-like growth on the skin. The lesion is one of simple tissue destruction in which the epidermis and the underlying layers are gradually disintegrated by the action of the organisms. The microorganism producing this disease was called *Bacillus columnaris* by Davis. He also observed the disease in smallmouth bass and common perch in the St. Lawrence River at Ogdensburg, N. Y. Nigrelli (1943) found a similar organism on catfishes (*Ameiurus platycephalus*, *A. nebulosus* and *Opladelus olivaris*) in the tanks of the New York Aquarium. The infection made its appearance in the spring of the year while the temperature was rising, and persisted for most of the summer.

Ordal and Rucker (1944) and Garnjobst (1945) independently discovered the true nature of this microorganism. It was placed in the "slime bacteria" (Order, Myxobacteriales). This is the first member of this interesting group to be reported as pathogenic. The life history is divided into two stages: the first, or swarm stage, is a period of active multiplication of rod-shaped motile cells; the second is a period in which they become quiescent and enclosed in cysts, forming fruiting bodies. The second part of this life cycle was noted by Ordal and Rucker in material cultured from infections on fingerling blueback salmon (*Oncorhynchus nerka*) reared in hatcheries. They also observed these fruiting bodies in material from adult fishes taken from the Columbia River. From this and other morphological observations they assigned the species to the genus *Chondrococcus*, family Myxococ-

ceae. Similar fruiting bodies were noted in the material found on *Fundulus heteroclitus* reported in the present paper. Garnjobst (1945), however, did not find a fruiting body stage in her material, and because of this called the organism *Cytophaga columnaris*. It is not certain whether or not these investigators are dealing with the same strain or even the same species. Ordal and Rucker (1944) reported that they found a second strain of myxobacteria from the gills of trout and salmon fingerlings which did not produce fruiting bodies.

In the present studies, we have had the opportunity to compare our organism with a strain of *Chondrococcus columnaris* very kindly sent us by Ordal and Rucker. Ordal and Rucker's strain and our strain appeared morphologically and biochemically alike.

Chondrococcus columnaris FROM *Fundulus heteroclitus*.

During the spring of this year an epizootic occurred among killifish brought in from Long Island Sound, in the vicinity of Pelham Bay, New York City. The majority of fish were infected either with gyrodactylid trematodes or with the protozoan *Trichodina*. There was no evidence of *Chondrococcus columnaris*, an infection which is unmistakable when present. Several hundred fish were crowded into a large fresh water tank. The temperature was about 24° C. and the pH about 7.8. At the end of three days many of the fish showed a fungus-like growth, typical of this myxobacterium (Plate I). The growth was grayish with a slightly brownish cast.

Microscopical examination of fresh material showed long slender flexible rods characteristic of the Myxococcaceae. No motility was seen in these water mounts. The cells

were mostly of one type, although occasionally some of the variants described by Garnjobst were present in cultured material. Living vegetative cells measured 4 to 12 microns in length and 0.3 to 0.7 microns in width. They were gram negative. Some of the preparations made from the growth taken from the fish showed spherical brownish masses typical of the fruiting bodies reported and figured by Ordal and Rucker.

Isolation of the organism in pure culture was successful. The shake dilution method was employed, using filtered and sterilized tank water. A buffered semi-solid medium containing 0.2% Bacto-peptone and 0.25% agar was used for culturing. The cultures were kept at room temperature and good growths were obtained in about 48-96 hours. The colonies were yellowish in color, forming flat sheets with irregular outline. Examination of the cultures from time to time showed swarms of flexible rods. In older cultures, brownish fruiting bodies were also present.

Morphologically and physiologically, the *Chondrococcus* isolated from the killifish was similar to the strain sent to us by Ordal and Rucker. The organisms were not influenced by the addition of carbohydrates to the medium, nor were they able to utilize large but non-toxic amounts of lactate, malate, acetate, butyrate, succinate, pyruvate, l-aspartate, l-asparagin, l-glutinate, and dl-alanine. They grew well in a complete mixture of amino acids and also in gelatin and casein hydrolysates. Tryptone and the hydrolysates were about of equal efficacy. Yeast extract (Difco) was definitely inferior. The evidence indicates that no unknown growth factors are required. However, the essential amino acids were not identified. It is concluded from these observations that amino acids are used for energetic as well as for structural purposes.

As was pointed out above, the pathological effects result from tissue destruction. The organisms grow on the surface of the body and extend into the branchial chambers. Eventually the delicate gill tissues become involved, in which case the disease is fatal. This pathogenesis was noted by Davis (1922). Ordal and Rucker (1944) reported that myxobacteria were found in the internal organs of adult chinook and blueblack salmon, steelhead trout, squawfish, whitefish, chubs and suckers taken from the Columbia River. No infection of the internal organs was found in killifish examined. Fish showing typical external lesions were autopsied and the internal organs were found unaffected. Smears made of the spleen, kidneys, heart and intestine showed no organisms recognized as myxobacteria.

Whether the myxobacteria found in the killifish also occur in the feral state was

not determined. As was mentioned above the fish were brought in from the brackish water of the Sound. No typical growths were observed on their arrival. The infection became evident several days after they had been placed in fresh water. The disease was limited in its course to killifish even though other species were present in tanks supplied by the same circulating water. The fish in these other tanks included forms known to be highly susceptible to myxobacteria (e.g., catfish). This would indicate that the pathogen is either a highly specific strain or that, like *Saprolegnia*, it is an invader which infects only fish with abrasions, or fish with other primary lesions such as those due to parasitic protozoa or trematodes. If the latter is true the organism is not a strict parasite but rather a saprophyte like the non-pathogenic members of this highly organized group. From these considerations one may predict that myxobacteria pathogenic for fish will be found to be cosmopolitan in distribution. Myxobacteria have already been reported from fish in waters of Washington, Mississippi Valley, West Virginia, northern and southern New York State.

SUMMARY.

A myxobacterium, *Chondrococcus columnaris* (Davis), is reported for the first time from the skin and gills of the common killifish, *Fundulus heteroclitus*, caught in the vicinity of Pelham Bay, New York City. The organism was isolated and cultured in a semi-solid medium containing 0.2% Bacto-peptone and 0.25% agar. Typical swarming and fruiting bodies were encountered in fresh and cultured material. This myxobacterium resembles one of the strains reported by Ordal and Rucker (1944) in the presence of the fruiting stage in the life cycle. Other strains reported by these investigators, and a form described by Garnjobst (1945) as *Cytophaga columnaris* (Davis), lack these fruiting bodies. The evidence indicates that no unknown growth factors are required. The organism grew well in a complete mixture of amino acids, as well as in gelatin and casein hydrolysates. The essential amino acids, however, were not identified.

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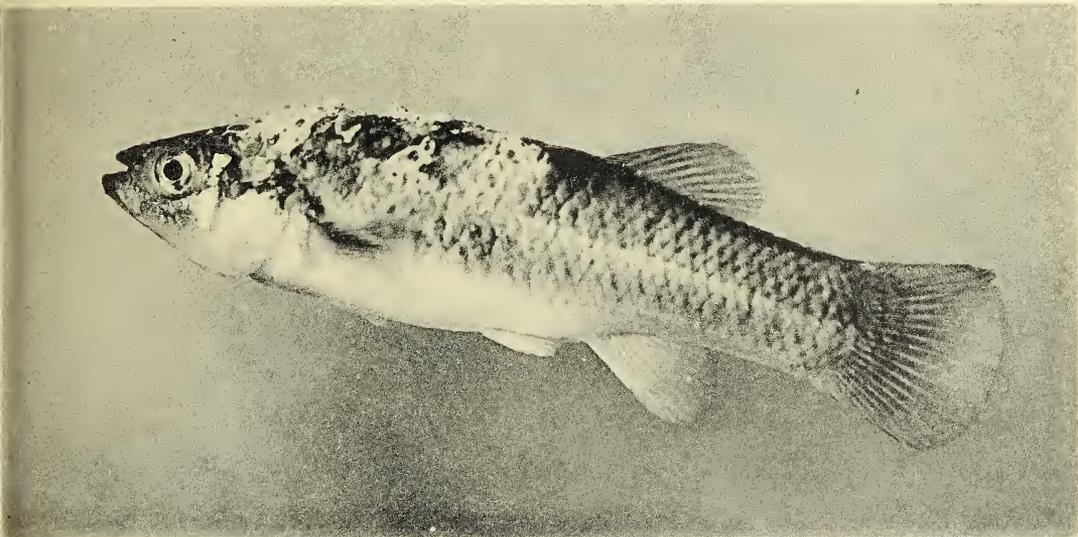
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EXPLANATION OF THE PLATE.

Killifish, *Fundulus heteroclitus*, showing infection of a myxobacterium, *Chondrococcus columnaris* (Davis). About natural size. Photograph by S. C. Dunton, N. Y. Zoological Society.



THE PRESENCE OF A MYXOBACTERIUM, *CHONDROCOCCUS COLUMNARIS* (DAVIS) ORDAL AND RUCKER (1944), ON *FUNDULUS HETEROCLITUS* (LINN.).



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12.

Notes on the Taxonomy of the Birds of the Philippines.

JEAN DELACOUR AND ERNST MAYR.

New York Zoological Society and The American Museum of Natural History.

During an examination of the birds of the Philippines in connection with the preparation of a handbook of the avifauna of that area, the authors were frequently forced to revise the currently adopted classification and nomenclature. Since it would seem unfortunate to include in a popular handbook the reasons for these taxonomic changes, they are published separately in the present paper. The reasons for deviations from the nomenclature of the two standard works on the birds of the Philippines¹ are discussed only if they have not already been stated previously in papers recently published by ourselves or other authors. Since none of the new generic names proposed by Marquess Hachisuka is valid in our opinion, we are not discussing them in the present notes. Full quotations of the original descriptions of all well established names are given by McGregor and Hachisuka, as well as by standard works (Sharpe, Peters). It would have been pedantic and wasteful to repeat them in the present paper. References to the recent literature are given in full.

We are deeply obliged to the curators of the United States National Museum, Museum of Comparative Zoölogy, Chicago Museum of Natural History, Philadelphia Academy of Natural Sciences, Museum of the University of Michigan and the Museum of the University of Minnesota for the loan of much valuable material for comparison.

Each of the two authors has prepared the accounts on about half of the families of the "Birds of the Philippines" (in press). The following discussions of the taxonomy of Philippine birds were also prepared independently by each author, as indicated by the initials in square brackets, but each author is in full accord with the conclusions reached by his collaborator.

Pelicans (Family Pelecanidae). [J. D.]

Pelecanus roseus roseus—Replaces *philippensis* auctorum (Chasen, A Handlist of

Malaysian Birds, 1935, p. 69). Trinomials are used as *P. crispus* is evidently a subspecies of *roseus*, larger and lighter in color, but very similar in all characteristics. Its breeding range is north of that of *roseus*.

Storks (Family Ciconiidae). [J. D.]

Ciconia episcopus—The genus *Dissoura*, created for this species, is not acceptable. The alleged characteristics, woolly feathers on face and neck, forked tail and under tail-coverts very long, stiff and bifurcated, denudation of the forehead and lores, fall entirely within normal specific variation for the genus *Ciconia*; *C. episcopus* is rather closer to *C. nigra* than the latter is to *C. ciconia*. We also consider *Abdimia* and *Euxenura* synonyms of *Ciconia*.

Herons (Family Ardeidae). [J. D.]

We cannot accept the genus *Demigretta*, which is based on the more extended feathering of the tibia, the different length and texture of the feathers of the trains, the shortness of the tarsus and the presence of a dark gray color phase. The latter exists in the Madagascan and African subspecies of *Egretta garzetta*.

Ducks (Family Anatidae). [J. D.]

Our nomenclature is that proposed in our recent revision of the Family Anatidae (1945, *Wilson Bulletin*, vol. 57, pp. 1-55).

Hawks (Family Accipitridae). [E. M.]

Aviceda jerdoni—Peters (1931, Check-List of the Birds of the World, vol. 1, p. 196) recognizes two races of this species in the Philippines, following the lead of earlier authors (Sharpe, McGregor, etc.). Actually all the specimens in collections identified as *magnirostris* (type locality Luzon) are in adult plumage, all *leucopais* (type locality Palawan) are in immature plumage. It is inevitable that *leucopais* (1888) must be considered a synonym of *magnirostris* (1847), until valid distinctions between birds from the various islands have been pointed out.

Pernis—The thorough confusion in the literature between the winter visitor *Pernis*

¹ McGregor, Richard C. A Manual of Philippine Birds, Manila, 1909-1911.

Hachisuka, Marquess. The Birds of the Philippine Islands, London, 1931-1935.

ptilorhynchus orientalis and the two species that are residents in the Philippines, *P. ptilorhynchus philippensis* and *P. celebensis steerei*, makes it impossible at the present time to outline the ranges correctly. For the distinguishing characters of the three forms see E. Stresemann, 1941, *Arch. Naturg.* (N.F.), vol. 9, p. 168.

***Accipiter trivirgatus extimus* Mayr,**
new subspecies.

Type — No. 533337, American Museum Natural History, (Rothschild Collection), ♂ ad., Davao, Mindanao, Philippine Islands, C. Platen Collection.

Adult Male — Similar to *trivirgatus* (Malay Archipelago), but much lighter underneath. Entire lower throat pale tawny rufous, broad cross bars of breast and flanks of the same color, not mixed with brownish or black, bars on thighs less blackish. *Adult Female* — Rufous underneath, not blackish brown as in *trivirgatus*.

Wing ♂ ad. 182, 187, 188, 188, 188; ♀ ad. 208; tail, ♂ ad. 140, 141, 145, 148, 150; ♀ ad. 167. In a series of *trivirgatus* these measurements are: wing ♂ ad. 180, 188, 193, 198, 200; ♀ ad. 207, 209, 209, 210, 216, 217, 218, 227, 230; ♀ imm. 203, 207, 209, 212; tail, ♂ ad. 139, 145, 146, 151, 155, ♀ ad. 153, 154, 157, 159, 163, 163, 165, 178, 180. There is, thus, no conspicuous size difference between Malaysian and Philippine birds.

Range—Negros, Samar, Leyte, Mindanao.

I have not seen any immatures from the Philippines. A single immature female from Palawan is unmarked on the underside except for a few streaks on the sides of the throat and some obsolete vermiculation on the thighs. The black feather centers on crown and nape are narrow. Upper and underparts are strongly washed with tawny ocher. Adults from Palawan and immatures from the Philippines must be examined before the status of the Palawan population can be determined.

Circus aeruginosus spilonotus — Typical *aeruginosus* do not occur in eastern Asia and the Philippines, as pointed out correctly by Steinbacher (in Hartert, Vögel pal. Fauna, Erg. bd., 1936, p. 414). All the records in the literature, as for example in McGregor, are due to confusion with *spilonotus*. The two forms intergrade in central Asia, according to Stegmann, and must be considered conspecific.

Spilornis — The differences between the Philippine form *holospilus* (white spots on nape, no bars on throat) do not seem striking enough to justify specific separation from *cheela* (see also Peters, 1939, *Bull. Mus. Comp. Zool.*, vol. 86, p. 76-77).

Megapodes (Family Megapodiidae). [E. M.]

Megapodius freycinet pusillus — In 1931, Hachisuka described a new subspecies,

tabon, from Mindanao, as being larger than *pusillus* and of slightly different coloration. These differences cannot be confirmed with our material. A series from Mindanao measures 220, 231, 249, 250, 252, thus overlapping widely with *pusillus* (wing length recorded as 230-245).

Pheasants and Quails (Family Phasianidae). [J.D.]

Coturnix chinensis — We fail to find any plausible reason for the retention of the genus *Excalfactoria*. Its very small size, fewer tail-feathers, and a slightly greater degree of sexual dimorphism are insufficient for generic distinction from other species of *Coturnix*. *C. delagorguei* shows a fairly similar pattern in both sexes, and in turn is closely related to *C. coromandelianus*. The African *adansoni* is but a subspecies of *chinensis*. *Synoicus* is another synonym of *Coturnix* (Mayr, 1944, *Bull. Amer. Mus. Nat. Hist.*, 83, p. 145).

Button Quails (Family Turnicidae). [E. M.]

Turnix sylvatica — The validity of the various races described from the Philippines is uncertain. We have seen material of *whiteheadi* only. *Turnix worcesteri* is so similar to *whiteheadi*, according to its description, that it cannot be anything but a subspecies of *sylvatica*.

Plovers (Subfamily Charadriinae). [E. M.]

Pluvialis — The slight difference between the Black-bellied Plover and the Golden Plover, namely the presence of a rudimentary hind-toe in the former species, is not sufficient to justify the recognition of the monotypic genus *Squatarola*. It would be poor systematics to split this natural group of plovers into two monotypic genera (the two species of Golden Plovers form one superspecies). Genera that are based on the loss of a morphological character are rarely valid.

Stint Sandpipers (Subfamily Calidriinae). [E. M.]

Crocethia — The recognition of a separate genus for the Sanderling, based on the absence of the rudimentary hind-toe, is as unjustified as that of *Squatarola*. The Sanderling agrees in every detail of its behavior, color pattern and morphology with the other small stint sandpipers. Hartert established the large collective genus *Calidris* for most of the stint sandpipers as an alternative to the recognition of many monotypic or oligotypic genera. It can be determined only by a thorough revision of the entire group whether this action was justified. The knots at least appear to be rather different from the smaller stint sandpipers. On the other hand, we fail to see any reason for upholding a separate genus for the Semipalmated and Western Sandpipers. The presence of webs between the

toes is not even necessarily a species character (e.g. *Charadrius hiaticula semipalmatus* and *Tringa totanus*). Since *Ereunetes* (1811) has five years' priority over *Erolia* (1816), it would have to be accepted as the generic name for the small stint sandpipers, in case the knots are kept in a separate genus (*Calidris*).

Ereunetes ferrugineus—This is the correct name for the Curlew Sandpiper, as shown by Stresemann (1941, *Ornith. Monatsber.*, vol. 49, p. 21).

Pigeons (Family Columbidae). [J. D.]

We cannot draw a line anywhere in the large group of the green fruit doves, and consider therefore *Leucotreron* a synonym of *Ptilinopus*. The genus *Neoleucotreron* proposed for *marchei* and *merrilli* because of the presence of disintegrated barbs in the secondaries has already been rejected by Peters with good reason. Small differences in the attenuation of the first primary and in the feathering of the tarsus, throughout the group, do not warrant generic distinction.

Ducula aenea—Birds from central northern Luzon (north of 16° Long. N.) have a strongly marked coppery chestnut patch on the nape and are recognized as *D. ae. nuchalis* (Cabanis) with the type locality fixed at Isabella Province. A larger race, *D. ae. fugaensis* Hachisuka, with a variable amount of chestnut on the nape, occupies the northern group of islands (Babuyan and Batan). Birds from the rest of the Philippines have no or very little chestnut tinge on the nape and are referred to *D. ae. chalybura* Bonaparte, type locality fixed at Albay District, S. Luzon. Contrary to previous assertions, birds from the Sulu Islands are similar to those of Mindanao, etc. . . , and not to the Bornean population, as they have the pale gray neck sharply separated from the green mantle on a neat line. There still is a great deal of uncertainty about the geographical variation of this species in the Philippines. *D. ae. nuchalis* and *chalybura* certainly overlap and mix in some districts, since Whitehead found both forms at Cape Engano. Birds from eastern and southern Luzon seem to have pure gray napes with a few exceptions, but further south specimens with a slight reddish tinge are not rare. Manuel (*Phil. Journ. Sci.*, 60, Aug. 4, 1936, pp. 409-412) has dismissed Hachisuka's statement that the chestnut nuchal patch is a seasonal feature and has shown that the great majority of chestnut naped birds occur north of 16° Long. N. He also separates as *D. ae. glaucocauda* the Mindanao-Samar-Baliran population as having "the upper surface rectrices appearing as if covered with a fine gray powder." This is an unreliable characteristic as it depends en-

tirely upon the freshness of the skins. The supposed difference is not substantiated in the series in the American Museum.

More accurate collecting and study are necessary to settle the problem of the geographical races of this species in the Philippines.

Ducula poliocephala poliocephala—Trinomials are used as *D. forsteni* from Celebes is evidently conspecific, differing only in the white, instead of pale vinous pink color of the throat and belly.

Gallicolumba luzonica—All forms of Bleeding-heart Pigeons are geographical representatives and plainly subspecies of *luzonica*, very strongly marked as many of them are. *G. rufigula*, from New Guinea and the neighboring islands, is a very closely allied species.

Parrots (Family Psittacidae). [J. D.]

Loriculus salvadorii Hachisuka, Mindanao, appears to be but unusually large and bright specimens of *L. philippensis apicalis*.

Cuckoos (Family Cuculidae). [J. D.]

Peters has already considered *Hierococcyx* a synonym of *Cuculus* (Check-List of the Birds of the World, IV, p. 14) and the Palawan Malcoha, *harringtoni*, a subspecies of *curvirostris*. We place this last species in the genus *Phaenicophaeus*, as we are unable to admit the genera: *Ceuthmochares*, *Rhopodytes*, *Taccocua*, *Rhinortha*, *Zanclostomus* and *Ramphococcyx*. We also place in the genus *Phoenicophaeus* the two Philippine species *superciliosus* and *cummingi*, considering the genera *Dasylophus* and *Lepidogrammus* as equally unacceptable. There are considerable differences in colors, in the greater and lesser denudation of the face, in the shape of the bill, and particularly of the nostrils which appear extremely variable in obviously closely allied forms. But in general characters and habits the various Malcohas are so closely related that it seems more logical to consider them all as species of a single genus (*Phoenicophaeus*—1815).

As I have pointed out before (*L'Oiseau*, 1940, p. 129, *Penthoceryx* is clearly a synonym of *Cacomantis*. The very slightly thicker bill and shorter tail do not constitute plausible generic characters, and the unique species *sonnerati* is better placed in the genus *Cacomantis*.

We have not been able to ascertain the validity of several subspecies of various cuckoos proposed by Hachisuka, mostly from Polillo, but it seems probable that they are not acceptable.

Owls (Family Strigidae). [E. M.]

Scops megalotis Gray, (1844, *Cat. Acciptr. Brit. Mus.*, p. 45, Manila). It is very desirable that the type specimen and unique ex-

ample of the "species" be reexamined in the British Museum. There is little doubt that the name must refer to one of the Philippine owls. However, it is highly unlikely that it refers to the mountain form *whiteheadi*, as maintained by Hachisuka (1934, Birds of the Philippine Islands, vol. 2, p. 53). The range of *whiteheadi* was inaccessible at the time (prior to 1840) at which *megalotis* was collected.

Pseudoptynx gurneyi Tweeddale — This species differs in a number of characters from the *Pseudoptynx-Ketupa-Bubo* group. However, judging from illustrations and descriptions, we cannot see any justification for the recognition of a monotypic genus *Mimizuku* as proposed by Hachisuka (1934, Birds of the Philippine Islands, vol. 2, p. 50). The species *gurneyi* seems to agree structurally with *Otus* in every detail except for being larger than any other form of that genus. The wing is 236, the tail 122, as against wing 195-203, tail 99-102, in females of *Otus bakkamoena whiteheadi*. This slight increase in size cannot be considered a valid generic criterion.

Bubo—Meise (1933, Ornit. Monatsber., vol. 41, pp. 169-173) has shown that structurally "*Pseudoptynx philippensis* is closer to the eagle owls than to the fish owls. In its color pattern it is closest to *ketupu*, a typical fish owl. Tropical species in this group usually have their tarsi and toes less feathered than their temperate zone relatives; this is true even for the mammal- and bird-eating species. As Meise says correctly, there is such a complete intergradation between the most typical eagle owl (*bubo*) and the most typical fish owl (*ketupu*) that it can hardly be justified to separate them generically, even less to recognize the genus *Pseudoptynx* as one of the intermediate steps.

Ninox philippensis—The resident boobook owls of the Philippines are listed by McGregor as seven species and by Peters (1940, Check-List of the Birds of the World, vol. IV, pp. 142-143) as three species. Several authors have commented on the curious fact that all these species represent each other geographically—that is, that only one form of *Ninox* is found on any one of the islands. Still, no attempt was made to draw the obvious conclusion and consider all Philippine boobook owls as subspecies of a single species. The reason for this reluctance is the striking difference between some of the island forms, particularly the extremes, *philippensis* (Luzon) and *mindorensis* (Mindoro). However, these two forms are only the end links of a chain of intergrading forms, with *spilocephala* (Mindanao) serving as the principal connecting link. It is for this reason that we do not hesitate to consider all the Philippine forms as conspecific. Actually the differences between the sub-

species of *philippensis* are smaller than between those of *jacquinoti* (Solomon Islands) which Peters (op. cit., p. 145) correctly lists as subspecies.

It seems that *Ninox philippensis* belongs to the superspecies *N. novaeseelandiae*, together with *scutulata*, *perversa*, *theomacha*, *meeki-solomonis-odiosa-jacquinoti* and other species.

The geographical races of *N. philippensis* can be arranged in three groups.

A. *Upperparts plain, underparts boldly striped.*

Ninox philippensis philippensis Bonaparte (type locality hereby restricted to Luzon).

Upperparts uniform pale cinnamon brown, with a distinct rufous wash. Well defined light bars on tail. Underparts white, striped with rufous cinnamon. Stripes not well defined, entire breast sometimes washed with tawny rufous. Size small. Wing, 158, 161.5, 162, 166.5, 168.5, 169. Tail long, 75, 76, 78, 81, 83, 83. Tail index (tail length in per cent. of wing length), 46.9, 47.4, 47.9, 48.2, 49.2, 49.8. Found on Luzon (? also northern Luzon), possibly also Marinduque, Samar and Leyte (no material seen).

Ninox philippensis proxima Mayr,
new subspecies.

Type—No. 314872, United States National Museum, ♀ ad., Masbate, Philippine Islands, November 14, 1892, Worcester and Bourns (Menage Expedition).

Similar to *philippensis* but larger and with a relatively shorter tail. Upperparts darker brown, light bars on tail less conspicuous, light spots and bars on upperwing-coverts and outer edge of wing feathers reduced. Stripes of underparts coarser and darker brown. Wing, 175, 175; tail, 79, 82; tail index, 45.2, 46.8. Known from Ticao and Masbate.

Ninox philippensis centralis Mayr,
new subspecies.

Type—No. 314873, United States National Museum, ♂ ad., Siquijor, Philippine Islands, February 28, 1891, Worcester and Bourns (Menage Expedition).

Much larger than *proxima* and with a long tail. Dark earth brown above without a rufous or tawny tint. Light spotting and barring on scapulars and upper wing-coverts much reduced. Stripes of underparts ill defined, white feather margins partly washed with ochraceous.

Four specimens from Siquijor measure as follows: Wing, 181, 185, 187, 191; tail, 89, 90, 92, 93; tail index, 47.1, 49.1, 49.2, 50.3.

This strikingly distinct form was mentioned by Grant as early as 1896 (*Ibis*, p. 531), but he failed to name it. I have not seen any specimens from Panay, Guimaras and Negros, but according to Grant (l. c.) they agree with Siquijor specimens.

B. Head and neck spotted or barred, underparts striped or variegated.

To this group belong the three forms *spilocephala* (Mindanao, Basilan), *reyi*, (Sulu, Tawitawi, Bongao) and *everetti* (Siasi). I have not seen specimens of either of the two Sulu Islands races, but I have examined nine specimens of *spilocephala* from the Zamboanga district of western Mindanao, and eight specimens from Basilan. Both series are unusually variable in all color characteristics, proportions and size.

Wing, Mindanao, 166, 170, 174, 175.5, 177; Basilan, 167, 167, 168, 173, 174, 181, 184, 190. Tail index, Mindanao, 42.2, 43.3, 43.5, 43.6, 45.7; Basilan, 42.0, 42.2, 43.1, 43.7, 44.6, 45.6, 46.3, 47.0.

C. Head and neck spotted or barred; underparts entirely vermiculated or barred. *Ninox philippensis mindorensis* Ogilvie-Grant.

Characterized mainly by its small size and the great regularity of the fine vermiculation of the underparts extending to the flanks and the tarsal feathering. Barring of upperparts not confined to the crown, but extending more or less far onto the back. Scapulars usually with a few large white spots. Size small, but tail very long.

Wing, ♂ 164, 166, 172, 172, 173, ♀ 157, 160, 165, 170, 171. Tail index, ♂ 47.1, 48.2, 49.7, 50.0, 51.7, ♀ 50.0, 52.0, 52.1, 52.2, 55.2.

Ogilvie-Grant was fully justified to separate this small race from *silonota*. It is needless to point out that true *silonota* has never been collected on Mindoro. The type of *plateni* (Rothschild Collection) is a typical specimen of *mindorensis*.

Ninox philippensis silonota Bourns and Worcester.

Without the type and with otherwise insufficient material I am unable to give a full diagnosis of this race. It is undoubtedly larger than *mindorensis*, more coarsely barred, with the barring extending less far down on the flanks and on the back, and with less white on the scapulars and upper wing-coverts.

Two females from Tablas and Sibuyan measure: Wing 188, 194, tail 96, 101, tail index 51.0, 52.1. No specimens from the type-locality (Cebu) were examined by me.

Swifts (Family Apodidae). [E. M.]

Collocalia esculenta—Peters (1939, *Bull. Mus. Comp. Zool.*, vol. 86, p. 96) has recently reviewed the complicated taxonomic history of this species in the Philippine Islands. There are two kinds of Glossy Swiftlets in these islands; some with the rump glossy blue black as the back, others with the feathers of rump narrowly or broadly edged with white. Peters, Oberholser and Hachisuka regard these two kinds of birds as separate species. Stresemann, on the

other hand, considers them as individual variants. A study of a fairly large series of Philippine birds leads me to the conclusion that neither view is entirely correct. Actually the presence or absence of the white edges of the rump feathers is subject both to geographical and individual variation. On the other hand, there is no evidence whatever that two separate species are involved. Why the partly white rump feathers should have been considered a specific character by some authors is not clear. The same character turns up independently in several other subspecies of the species *esculenta*, as an individual variation in *stresemanni* (Bismarck Archipelago) and as a subspecific character in *desiderata* (Rennell Island). Finally in *Collocalia esculenta uropygialis* (southern Melanesia) the rump is completely white. There is no reason why *marginata*, in which there is no more white on the rump than in *desiderata* should be considered a separate species.

Although this species is by no means uncommon, it is unfortunately only poorly represented in collections from the Philippines. This makes a final revision impossible at the present time. The following subspecies can be distinguished in the available material.

Collocalia esculenta isonota Oberholser. Upperparts uniform, feathers of rump uniform or with very narrow or inconspicuous white edges. Back dull and somewhat greenish, clearly contrasting with the darker crown. Abdomen extensively white, feathers of throat and breast with pronounced white edges. Large (wing 102-108) with a well forked (3-4) but short (tail index 36.0-38.8) tail. Restricted to the highlands of northern Luzon.

A single specimen from Mindoro is quite similar but smaller (wing 101, tail index 37.6). Mindanao birds, which average somewhat smaller, have variously either been called *isonota* or been separated subspecifically (*bagobo* Hachisuka, *mindanensis* Hachisuka). More material is required to determine the subspecific status of birds from that island. A single female from Capunuy-pagan, Mindanao, is more glossy on the back, has the rump feathers distinctly edged with white, and is rather small (wing 100.5, tail index 39.8, tail furcation 4). Two specimens from Bongao, Sulu Islands, have a dark rump and agree on the whole well with *isonota* but are smaller (wing 98, 101), but with noticeably longer tail (index 40.6, 41.3). It may be advisable to unite under the name *bagobo* Hachisuka (1930, *Contrib. Birds of Philippines*, no. 2, p. 173) the populations from the southern Philippines (Mindanao, Sulu Islands) which are similar to *isonota* in having no or little white on the rump, but differ by more glossy backs, shorter wings and relatively longer tails.

The characters listed in the original description of *bagobo* are those of freshly collected birds as compared to faded museum specimens.

Three specimens from Palawan do not seem to belong to any other recognized races. They are small (wing 95.5, 96, 99) but have very long tails (tail index 41.4, 42.4, 42.7). The back is dark and the rump is either plain as the back (one specimen) or narrowly margined with white (two specimens). This is apparently an undescribed race but additional material is needed before it can be named.

Collocalia esculenta marginata Salvadori. General coloration very much as in *isonota* but feathers of rump with white margins. The expression of these margins is quite variable, as illustrated by every series of this race.

The populations that are generally recorded as *marginata* actually belong to two different races. Typical *marginata* is found from the lowlands of central Luzon through the central islands south to Cebu (type locality) and Bohol. This includes records from Banton, Tablas, Sibuyan and Masbate. Size small (wing 95-103), tail furcation slight (2-2.5), tail variable (37.6-41.0). The back is rather glossy and not contrasting strikingly with the crown. The white area on the abdomen is less extensive than in most specimens of *isonota*.

A series from the islands north of Luzon (Babuyan, Calayan, Camiguin N.) is larger, paler and more greenish on the back. It may be described as:

***Collocalia esculenta septentrionalis* Mayr,**
new subspecies.

Type No. 19958, Chicago Museum of Natural History; Calayan, Philippine Islands; Nov. 2, 1903, McGregor and Celestino collectors.

Wing, 105, 106; tail, 41-43; furcation, 2.5, 3.5; tail index, 38.7, 40.4. Five specimens examined.

Collocalia.—The dull colored cave swiftlets of the Philippines, excluding the two well defined glossy species, *esculenta* and *troglo-dytes*, continue to be exceedingly confusing. Peters (1940, Check-List of the Birds of the World, vol. IV, pp. 221-227) lists only three species for the Philippines, *white-headi*, "*inexpectata*" *amelis* and "*vestita*" *mearnsi*. In a small series of twenty-five Philippine birds before me no less than five species are represented, but I am unable to identify them as to species. Possibly one or two of them are entirely new. Collectors do not seem to realize the potentialities in this genus. As recently as 1938 I examined a new and still undescribed species from the well explored island of Java (Bartels collection). Much of the material I have seen in recent years consists of one or two specimens from

each locality, often immature or moulting. It is needless to emphasize that with such scanty material no revision of the exceedingly difficult genus *Collocalia* can be undertaken. The taxonomy of the *Collocalia* of the Malay Archipelago cannot be clarified until collectors gather large series at many localities, such as was done by A. Rand and W. Coultas in the Papuan region.

Tree Swifts (Family Hemiprocnidae). [E. M.]

Hemiprogne comata.—Freshly molted specimens of this species have a strong greenish gloss on back and underparts. These parts appear dull bronze brown in worn or faded specimens. I have seen green and bronze brown specimens in the described plumage condition from all parts of the range of this species. It is therefore obvious that the subspecies *nakamurai* Hachisuka (Mindanao) and *barbarae* Peters (Mindoro), both based on fresh specimens with a greenish gloss, cannot be maintained. Mindanao specimens seem to have slightly more white on the lower abdomen than the average of *comata* but the difference is not sufficiently clearcut to justify subspecific separation. Specimens from North Pagi differ in nothing from other specimens of *comata*, and *stresemanni* Neumann can not therefore be recognized either. Ripley (1944, *Bull. Mus. Comp. Zool.*, vol. 94, p. 355) had already come to this conclusion (51 specimens examined).

Kingfishers (Family Alcedinidae). [E. M.]

Halcyon lindsayi and *H. hombroni*.—These two species form a superspecies, together with the Malayan *H. concreta*. In fact, this superspecies has a number of additional geographical representatives, which were listed by recent authors in a different section of the family. Their habits, voice, color pattern and characteristic sexual dimorphism, however, reveal the close relationship of all these forms. These species are "*Monachalcyon*" *monachus* (Celebes) and "*Melidora*" *macrorrhina* (New Guinea). Other relatives of this very primitive group of kingfishers seem to be *Halcyon princeps* (Celebes), *Syma torotoro* (New Guinea) and *Halcyon bougainvillei* (Solomon Islands).

Halcyon winchelli.—A comparison of the type of *Halcyon winchelli nigrorum* Hachisuka (1934, *Birds of Philippine Islands*, vol. 2, p. 142) with other specimens of this species reveals no valid differences.

Halcyon coromanda.—Oberholser, in his revision of this species (1915, *Proc. U. S. Nat. Mus.*, vol. 48, p. 639), seems to have overlooked the fact that the East Asiatic-Japanese race *major* occurs as winter visitor far south of its breeding range, for example as far as Celebes. Most of the Philippine birds examined by us also seem to belong to *major*. On the Sulu Islands and on Palawan birds have been collected which undoubtedly

belong to the richly colored Malaysian race *minor*. As far as the rest of the Philippines is concerned, it is still uncertain whether *Halcyon coromanda* occurs there as a breeding bird and if so, whether it differs from *major* and whether the type of *ochrothorectis* is a winter visitor or a local resident.

Halcyon pileata—There is no evidence that in the Philippines this bird is anything but a winter visitor. *Halcyon pileata palawanensis* Hachisuka (1934, Birds of Philippine Islands, p. 142) is clearly a synonym.

Pelagopsis capensis—There is still considerable confusion in the literature concerning the races of this species in the Philippines. We agree with Manuel (1941, *Phil. Jour. Sci.*, vol. 74, p. 379) that Luzon is to be eliminated from the range of *gouldi*. As far as the other islands are concerned, we find that specimens from the Sulu Islands (type locality of *gigantea*) are distinctly paler buff than those from the rest of the Philippines. The name *smithi* is available for this population which is intermediate between *gouldi* and *gigantea*. It includes the birds from the eastern Philippines (Luzon to Mindanao and Basilan) and from the Visayan group.

Ceyx lepidus margarethae—The tremendous variability of this species is well known. Like Bourns and Worcester (see McGregor, op. cit., p. 316) "we have a practically unbroken series between a bird with a magnificent deep blue upper surface and a bird with fine silvery white upper surface which has not a blue feather on it." Such bluish-white birds have been described as *suluensis* (May 15, 1890), *salamaui* (July, 1890), and *goodfellowi* (1905). Lately Manuel (1941, *Phil. Journ. Sci.*, vol. 74, p. 367) has added another synonym to this unfortunate series. He described a specimen from Tawitawi (Sulu Islands) as *virgicapitus*. This would be a straight synonym of *suluensis* if the whitish-blue birds did belong to a different species from the dark purplish-ultramarine individuals. But, as stated above, there is no doubt that they are all members of a single population of which *margarethae* is the oldest name.

Hornbills (Family Bucerotidae). [J. D.]

We consider "*Hydrocorax*" a synonym of *Buceros*. "*Limnophalus*" *montani* and "*Gymnolaemus*" *marchei* undoubtedly belong to the genus *Anthroceros* as they do not differ from each other and from *malayanus* and *coronatus* more than the latter two between themselves. The naked chin of *marchei* and the black bill of *montani* do not constitute generic characters.

Barbets (Family Capitonidae). [J. D.]

As shown by Ripley (MS) no real generic distinctions can be recognized between the

numerous species of oriental Barbets so far usually assigned to the genera *Megalaelma*, *Chotorrhea*, *Thereiceryx*, *Cyanops*, *Mesobucco* and *Xantholaema*. All species must be placed in the oldest genus *Megalaelma*.

Woodpeckers (Family Picidae). [J. D.]

We cannot recognize the genus *Lichtensteinipicus* as different from *Mulleripicus*, as its only difference is a smaller size. We consider the two forms *funnebris* (1826) and *fuliginosus* (1877) as conspecific. *Thriponax* is a synonym of *Dryocopus*.

Broadbills (Family Eurylaimidae). [J. D.]

We cannot see that the Philippine species *steerei* should be separated generically from the two Malaysian species *ochromalus* and *javanicus* which it resembles closely in general shape, pattern and coloration. We do not consider the presence of a fleshy eye wattle, the only distinctive character of *steerei*, as of sufficient importance to justify the recognition of the genus *Sarcophanops*. Although differing clearly in size and color, the two Philippine forms *steerei* and *samarensis* are in our opinion subspecies of one species: *Eurylaimus steerei*.

Swallows (Family Hirundinidae). [E. M.]

Riparia paludicola—Riley recently described a race *Riparia chinensis tantilla* (1935, *Proc. Biol. Soc. Washington*, vol. 48, p. 147) based on four specimens from Luzon, as "darker above, especially on the pileum and rump." A comparison of the type series with a series from Burma and India reveals no difference in the color of the pileum, but shows that the rump of the four Luzon birds is darker than in Burma birds. However, the Luzon specimens can be matched quite well (allowing for wear) by a single bird from Formosa, as well as by most of the Indian specimens. The type locality of *chinensis* seems never to have been fixed accurately, since it presents a definite problem. Contrary to the assertions of earlier authors, the species seems to be absent from China almost entirely, having been recorded only from Formosa and parts of Yunnan. In view of the slightness of the differences in the rump color of the different populations, the irregularity of distributional pattern and the uncertainty of the type locality of *chinensis*, it cannot be justified to recognize *tantilla* for the Luzon birds.

Cuckoo-shrikes (Family Campephagidae). [E. M.]

Edolisoma macgregori Mearns—Hachisuka (1935, Birds of the Philippines, vol. 2, p. 356) has already pointed out that there is no justification for recognizing the genus *Malindangia* and that *macgregori* is closest to *E. panayensis*. However, the two species are certainly different enough not to be considered conspecific. The plumage of *mac-*

gregori is much softer than that of *panayensis* and the tail feathers are strikingly pointed (a feature elsewhere found only among immature Campephagidae). Sexual dimorphism is much less pronounced in *macgregori* since the females have a black throat as the males, not a gray one as the females of *panayensis*. The central tail-feathers are black in males and females of *panayensis*, and in the females of *macgregori*; they are gray in *macgregori* males. In addition there is an ecological difference between the species. *E. panayensis* is found in the lowland and hill forest, while *macgregori* has been found only in the mountain forest of Mt. Malindang (western Mindanao) at an altitude of 5,750 feet.

Pipits and Wagtails (Family Motacillidae). [J. D.]

The genus *Dendronanthus* (*indicus*) is rejected and considered a synonym of *Motacilla*. The species *indica* does not differ in any important way (proportions, pattern or habits) from the other wagtails. The fact that the middle pair of rectrices in this species is slightly shorter than the others does not constitute a valid generic criterion.

Bulbuls (Family Pycnonotidae). [J. D.]

Our classification and nomenclature of the bulbuls are those of "A revision of the genera and species of the family Pycnonotidae" by Delacour, *Zoologica*, XXVIII, 4, 1943, pp. 17-28, with one exception. The specific name *Microscelis everetti* Tweeddale, 1877, must be changed to *M. rufigularis* Sharpe, 1877, this latter name antedating the former by a few months.

As pointed out in this revision, "*Iole*" *straticiceps* Sharpe, 1888, from Palawan is a straight synonym of *Microscelis charlottae palawanensis* (Tweeddale, 1877). Type in American Museum examined.

Thrushes (Subfamily Turdinae). [J. D.]

Rhyacornis bicolor—The Philippine Water Redstart *bicolor* is certainly congeneric with the Asiatic species *fuliginosa*, which it links to *leucocephala*. All three are better placed in the genus *Rhyacornis*.

The genus *Kittacincla* has been defined as differing from *Copsychus* in its longer, broader and more graduated tail. This character does not apply to the Philippines species, and we consider *Kittacincla* a synonym of *Copsychus*, the slightly more slender bill being only of specific significance. As a result of synonymizing *Kittacincla* with *Copsychus*, a new name must be given to the north Bornean form of *Copsychus saularis* called *C. niger* by Wardlaw Ramsay (*P. Z. S.*, 1886, p. 123) as it becomes preoccupied by *Copsychus niger* (*Kittacincla nigra* Sharpe, *Trans. Linn. Soc.*, 1877, 1, p. 355) from Palawan. I propose for it the name *Copsychus saularis ater*.

Geokichla mindanensis Mearns—We have examined the type and unique specimen of this species and found it to be *Zoothera andromedae*.

Oreocincla is a synonym of *Zoothera*.

Babblers (Subfamily Timaliinae). [J. D.]

Malacocincla—The genera *Leonardina* and *Anuroopsis* are not sufficiently characterized to be retained. Therefore, the species *woodi* (Mindanao) and *cinereifrons* (Palawan) are placed in the large genus *Malacocincla* which also includes the African birds known as *Il-ladopsis* and the Malaysian "*Aethostoma*." *M. cinereifrons* is extremely similar to *M. pyr-rhogenys*, from Malaysia, only differing in its much shorter tail. The bird listed by McGregor as *Turdinus rufifrons* is in reality a well marked subspecies of the Bornean *Malacopteron magnum*: *M. m. palawanense*, much browner and without a black occipital patch.

Stachyris—The genus *Zosterornis* is inseparable from *Stachyris*, having the same general proportions, color pattern, identical bill and nostrils. Ogilvie-Grant, its describer, writes: "The genus is most nearly allied to *Cyanoderma*, but there is no naked space around the eyes, which, on the contrary, are encircled by a ring of short white feathers perfectly similar to that of a true *Zosterops*." The ring of feathers around the eyes is present in only two of the species referred to "*Zosterornis*": *striata* and *whiteheadi*, while it exists also in *Stachyris nigriceps*. As "*Cyanoderma*" (which we do not recognize either) is alleged to differ from *Stachyris* only in the naked space around the eyes, as characterized by its describer himself, it follows that "*Zosterornis*" differs in no way from *Stachyris*.

The group of forms *capitalis-nigrocapitata-affinis-dennistouni* presents an interesting problem. They all replace one another geographically, as *capitalis* and *nigrocapitata* do not overlap in Leyte; *capitalis* inhabits the southern part of that island, Mindanao, Dinagat, Panaon and Basilan, while *nigrocapitata* occurs apparently only in the north and extends to Samar and Bohol. A very similar form found in the southern half of Luzon, *affinis*, is evidently but a subspecies of *capitalis*. The much yellower *dennistouni* is only found in north Luzon. On account of the rather considerable differences in colors, we prefer to consider *capitalis*, *nigrocapitata* and *dennistouni* as three species forming a superspecies.

S. plateni (Mindanao) and *S. pygmaea* (Leyte and Samar) are conspecific, the latter being much grayer and less distinctly marked but quite similar in proportions, pattern and size. The species *speciosa* from Negros and Panay, also belongs to the genus *Stachyris*, its peculiar throat and head ornamentation having no generic significance. It otherwise

resembles *S. dennistouni* very closely. "*Dasyerotapha*" therefore is considered a synonym of *Stachyris*.

A careful examination of the two species of "*Mixornis*" (*flavicollis* and *gularis*)² and of the two *Macronus* (*striaticiceps* and *ptilosus*) shows a complete similarity in the bill and nostrils as well as in general build and proportions. The bill is depressed near its base and thickened towards the end, contrary to that of *Stachyris*, and the nostrils are oval and open, lacking the protective membrane. In all four species the plumage is characteristically thick, long and fluffy; the feathers of the back are very long, with elongated and disintegrated barbs. In *flavicollis* and *gularis*, the rachis remains soft and inconspicuous. In *striaticiceps*, it is slightly stiffened and visible, white in color as well as the base of the barbs, at different degrees according to subspecies. In *ptilosus*, a larger species, the rachis is still more conspicuous, longer, stiffer, and the barbs more disintegrated.

The generic name *Mindoria* Hachisuka (*Tori*, XIII, 38, p. 226, 1934, for *Macronus striaticiceps*) cannot be recognized and since the differences between the four species are evidently restricted to color and pattern, and to degrees in the differentiation of the feathers of the back, we have decided to consider the genus *Mixornis* Blyth, 1842, a synonym of *Macronus* Jardin and Selby, 1835.

Flycatchers (Subfamily Muscipapinae). [E. M.]

Rhipidura superciliaris—Specimens from southeastern Mindanao (Davao Gulf district) are distinctly darker blue than a series from Basilan. The name *apo* is available for this subspecies (Hachisuka, 1930, Contrib. Birds of Philippines, no. 2, p. 184. Mt. Apo).

The genera *Muscicapa* and *Siphia*—Ever since Hartert lumped the majority of the true flycatchers in the genus *Muscicapa*, attempts have been made to subdivide this unwieldy group into natural divisions. Such attempts invariably ended in the recognition of numerous poorly defined genera, mostly monotypic or at best with two or three species. A complete series can be arranged between species with a very flat and depressed bill and such with a relatively slender and more compressed bill, between birds with very short tarsus and very weak feet and such with a longer tarsus and stronger feet, and so forth. The length of the first primary, the length of the rectal bristles, the habitat (treetops or undergrowth), in fact any character used in this group, shows an equally complete intergradation between the extremes. The only group within this large assemblage, which

is relatively well defined, is the group of the typical gray flycatchers (*Muscicapa*+*Hemichelidon*+*Alseonax*). With their very broad bills and short legs, they are the extreme development of the flycatcher type. However, even these gray flycatchers intergrade imperceptibly with the less arboreal types. We have reluctantly come to the conclusion that Hartert's solution is the only logical one. It becomes necessary to combine with *Muscicapa* the following: *Cyornis*, *Muscicapula*, *Dendrobiastes*, *Xanthopygia*, *Cyanoptila*, *Siphia*, *Ficedula* and *Eumyias*. *Rhinomyias* is an undergrowth dweller derived from *Muscicapa*.

The genera *Hypothymis* and *Terpsiphone* belong to the *Monarcha* branch of Old World flycatchers which is far removed from the *Muscicapa* group. There is no justification in keeping *Xeocephus* and *Neoxeocephus* generically separated from *Terpsiphone*, merely because the central tailfeathers are not as much or not at all elongated. They agree with *Terpsiphone* in every other respect. *Terpsiphone cyanescens* indicates the close relationship between *Terpsiphone* and *Hypothymis* in the coloration of both male and female.

Hypothymis—The two species of this genus, which are endemic in the Philippines, and which live there side by side with the widespread *azurea*, are so distinct that they have been made the types of two monotypic genera, *Camiguinia* McGregor for *helenae* and *Cyanomyias* Sharpe for *coelestis*. *Cyanomyias coelestis*, with its light cobalt blue long crest, is a bird of striking beauty and distinction. However, it agrees with *Hypothymis azurea* in every detail of structure, except for the crest. Furthermore, the gap between *azurea* and *coelestis* is bridged completely by the short crested *H. helenae*. The differences between the blue monarchs are certainly not striking enough to justify the recognition of three monotypic genera for *coelestis*, *helenae* and the superspecies *azurea-puella*.

The population of *Hypothymis azurea* from the southern Philippines (Mindanao, Basilan) was recently described by Peters as *compiler* (1939, *Bull. Mus. Comp. Zool.*, vol. 86, p. 111). The chief character of the new form, a greater extent of the white area on the abdomen, is not substantiated in the material of the American Museum. We, therefore, prefer to include all Philippine birds under the name *azurea*. More material may show that females from the Sulu Islands have the back more blue gray, less brownish than females from the other islands.

Muscicapa hyperythra luzionensis—A male and a female from Mindoro fall well within the range of variation of a series from northern Luzon. We have been unable to find any characters which would justify

² See J. Delacour: Revision du genre *Mixornis*. *L'Oiseau*, 1936, pp. 1-27.

the recognition of *mindorensis* Hachisuka (1935, Birds of Philippine Islands, vol. 2, p. 299).

Cyornis banyumas mcgregori Manuel — This subspecies was described by Manuel on the basis of a single female from the hills of Cagayan Province, Luzon (1935, *Phil. Jour. Sci.*, vol. 56, pp. 93-94). The bird is carefully compared with *C. banyumas lemprieri* (Palawan) and a number of differences are noted. In at least some of these characters the specimen in question agrees quite well with the female of *C. heriotti*, but no comparison with that species is made in the original description of *mcgregori*. This is the more to be regretted since there is some indication that *C. heriotti* is nothing but a geographical representative on Luzon of *C. banyumas*, in spite of the blue breast of the male (Stresemann, 1925, *Ornith. Monatsber.*, vol. 33, p. 48). It will be advisable not to accept *mcgregori* as a valid form nor the occurrence of *C. banyumas* on Luzon, until either typical *banyumas* males have been found on Luzon or differences between the females of *heriotti* and "*mcgregori*" have been established beyond doubt.

Titmice (Family Paridae). [J. D.]

Both "*Pardiliparus*" and "*Penthornis*" are synonyms of *Parus*. The species *elegans* and *amabilis* are both very distinct, but no doubt related to *P. venustus* from China and to *P. ater*. *P. tassacourbe* is certainly a close relative of the Japanese *P. varius*, as both have the same long bill and white forehead and face; the hidden white bases of the feathers of the hind neck in *tassacourbe* correspond to the white nuchal patch of *varius*. In young specimens, the white is even more extensive, and there is a conspicuous patch on the back and on the sides of the neck.

Flowerpeckers (Family Dicaeidae). [E. M.]

The generic classification of the Indo-Malayan flowerpeckers has been a matter of much dispute. In spite of the great uniformity of structural characters, some five or six mostly monotypic genera and subgenera were named for species that are slightly aberrant in one respect or another. Except for color pattern there are actually only two characters that vary appreciably: the shape of the bill and the length of the outermost ("first") primary.

The shape of the bill is, unfortunately, utterly unreliable. In every natural group of flowerpeckers there are some species with a long thin bill and some with a short thick bill. For example, *Dicaeum pygmaeum* has a long slender bill, its close relative *D. ignipectus* a thick bill. *Dicaeum nigrilore* (Mindanao) has a long bill, its geographical representative "*Acmonorhynchus*" *ae-rolimbatus* (Celebes) a short one. *Dicaeum*

retrocinctum (Mindoro) has a very slender, well curved, honeyeater (*Myzomela*)-like bill, while that of its geographical representative *D. papuense* is a typical flowerpecker bill. *D. bicolor* seems to be closely related to the *papuense* group but has a short and extremely heavy bill. It would break up a natural group to remove this species to the genus *Anaimos*. "*Anaimos*" *agile aeruginosum* looks like a faded edition of *Dicaeum chrysorrhoeum*, except for its short, very heavy bill. We do not see how this group can be split generically, without dividing the genus *Dicaeum* into many unnatural groups. McGregor (1927, *Phil. Jour. Sci.*, vol. 32, pp. 519-525) recognized as genera and subgenera *Polisornis*, *Bournsia*, *Acmonorhynchus* and *Piprisoma*, but he came no closer to an arrangement of the flowerpeckers into natural groups than if he had put every species in a separate genus. Actually it seems much better to include the thick-billed species in the same genus with the nearly related thin-billed species from which they originated polyphyletically. The second strong morphological characteristic which might be utilized for a classification of the flowerpeckers is the length of the outermost ("first") primary. In most species it is too short to be distinguished on the underside of the wing; these are the species with nine primaries. On the other hand, there are a few species like *olivaceus*, *maculatus*, *percussus*, *xanthopygius* and *thoracicus*, which have a first primary of about half the length of the second. The persistence of the tenth primary is obviously a primitive character, which may have been lost repeatedly among the flowerpeckers. It is therefore possible that the species of *Dicaeum* with nine primaries are a polyphyletic group. On the other hand, it may be useful to unite all the primitive species with ten primaries in a separate genus for which *Anaimos* is the oldest available name. Most of these species have an orange or crimson patch on the crown (except *olivaceus*) and most have a white malar stripe. Both color characters occur also in the nine-primaried *Dicaeum*; the crown patch in *D. anthonyi* and the light malar stripe in *D. annae*, *agile* (part) and *chrysorrhoeum*. (The entirely red crown in *D. geelvinkium*, *cruentatum* and *trochileum* is obviously not related genetically to the small orange or red patch in the middle of the crown in *maculatus* or *percussus*).

Dicaeum pygmaeum—The Palawan population of this species has been separated by Hachisuka as *palawanorum* (1926, *Bull. Brit. Orn. Club*, vol. 47, p. 55). This form is not only larger than typical *pygmaeum*, as stated correctly in the original description, but also whiter below, particularly in the male plumage. Mindoro birds agree with such from Luzon.

Dicaeum papuense—Hachisuka separated Negros birds as *whiteheadi* from *haematostictum* of Panay (1926, *Bull. Brit. Orn. Club*, vol. 47, p. 55). The material of the American Museum indicates that the large size of the black pectoral spot in Whitehead's Negros skins is due to the make-up. Steere's Negros, Panay and Guimaras skins are indistinguishable in this respect. Neither are there any noticeable differences in the colors of the upper-parts. We consider *whiteheadi* a synonym of *haematostictum*.

Dicaeum flaviventer A. B. Meyer—This species, known only from the unique type from Cebu, is exactly like *papuense* according to the original description, except that the ventral stripe is yellow instead of scarlet-vermilion. It is highly probable that the type is a specimen of *papuense*, which had been preserved in alcohol and had lost its red pigment. It will be advisable to regard *flaviventer* henceforth as a doubtful synonym of *papuense*. In spite of much collecting on Cebu no second specimen of *flaviventer* has been found during more than fifty years.

Dicaeum hypoleucum — This variable species is restricted to the eastern Philippines, from Luzon to Mindanao and the Sulu Archipelago. The Luzon form, *obscurum*, is very dull colored, with the two sexes approximately alike. Remarkable is the light flesh brown color of legs and feet. Adjoining in the south, on the Samar-Leyte group, occurs the form *everetti*, which is similar to *obscurum* in general coloration but has the underparts whitish-gray; the legs are dark brown. *D. l. everetti* is exactly intermediate between *obscurum* and the Sulu-Mindanao race *hypoleucum* both in general color and shape of the bill.

Sharpe described *D. hypoleucum* in 1876 from Basilan and Tweeddale *D. mindanense* in 1877 from Zamboanga, western Mindanao, both on the basis of single specimens. The type of *mindanense*, although listed as male, is clearly a female from its description. In fact, there do not seem to be any clearcut differences between specimens from Basilan and Mindanao. It is possible that females from eastern Mindanao are clearer greenish-olive, less sooty than such from Basilan, but we lack females from Zamboanga to determine whether they are equally greenish.

D. h. obscurum is superficially similar to *D. concolor* from the Asiatic mainland, but differs on closer examination in so many characters as to eliminate any possibility of close relationship.

Dicaeum quadricolor — This handsome species is usually listed far from its nearest ally and geographical representative, *D. bicolor*. The two species have a bill of identical shape and the coloration of the under-

parts is also identical. If it were not for the fact that the male of *bicolor* (1894) has the back of a solid blue-black color, while it is scarlet and olive in *quadricolor* (1877), one would not hesitate to unite the two forms in a single species.

Anaimos johannae (Palawan)—This species combines the characters of two Bornean species. It has the yellow rump of *A. xanthopygius*, and the white malar stripe, well defined red throat spot and large crown patch of *A. percussus*. The female is more different from the females of either of the two Bornean species than they are from each other. Perhaps Palawan was originally settled by *percussus* from Borneo, which subsequently reinvaded Borneo in the form of *xanthopygius*. It seems best to treat *johannae* as a full species in view of its complete intermediacy between the two sympatric species *percussus* and *xanthopygius*.

Sunbirds (Family Nectariniidae). [J. D.]

Our classification and nomenclature are those of "A Revision of the Family Nectariniidae," Delacour, 1944, *Zoologica*, XXIX, 4, pp. 17-38, with the following exception:

Anthreptes griseigularis is now considered a subspecies of *A. malacensis*, as a study of records shows that *griseigularis* occupies northeastern Mindanao only and does not overlap with *chlorigaster* found in the western peninsula of that island.

Male specimens of *Nectarinia sperata* found in S. E. Mindanao, in the vicinity of Davao and Mt. Apo, differ from those occurring in the north of the island and northward (*sperata*) as well as those from its western peninsula and Basilan (*juliae*). They are somewhat intermediate. Their breast is vermilion tinged with yellow, instead of scarlet (*sperata*) or yellow slightly mottled with vermilion in the center (*juliae*). Each feather has a yellow band between the dark gray base and the vermilion tip. Females also differ in having the wings washed with reddish brown, while they are olive green in *sperata* and strongly tinged with chestnut in *juliae*.

I propose for this form the name:

Nectarinia sperata davaoensis Delacour, new subspecies.

Type — ♂, American Museum Natural History, no. 687286, W. Goodfellow, Martina (Davao), March, 1903.

Wing 50, tail 31, culmen 14, tarsus 9 mm., 4 males and one female examined from Martina and Davao, S. E. Mindanao.

As pointed out in the revision, *flagrans* is a species of *Aethopyga*, not of *Nectarinia* ("Cinnyris").

Cinnyris picta Hachisuka, *Proc. Biol. Soc. Wash.*, 54, 5, 1941, founded on one old specimen from the Atong-atong plantation,

N. W. Basilan, is probably a hybrid between *sperata* and *jugularis* (see Zimmer and Mayr, 1943, *Auk*, 60, p. 259).

White-eyes (Family Zosteropidae). [E. M.]

Zosterops montana—The Rothschild Collection contains three white-eyes from Mt. Canloan, Negros, identified as *Z. siquijorensis*. After examining these specimens Stresemann classified *siquijorensis* as a race of *chlorates* (= *montana*) (1931, *Mitt. Zool. Mus. Berlin*, vol. 17, p. 216). McGregor (1909, *Manual Philippine Birds*, pp. 614, 617) and other authors, however, have stressed the close relationship of *siquijorensis* with the other Philippine members of *Z. palpebrosa*. A study of the white-eyes in the American Museum together with the material of the U. S. National Museum reveals that the three Negros birds belong to an undescribed race of *Z. montana*, while true *siquijorensis* is indeed a subspecies of *palpebrosa*.

***Zosterops montana pectoralis* Mayr,
new subspecies.**

Type—No. 700150, Amer. Mus. Nat. Hist., Rothschild Collection, ♂ ad., Canloan, Volcano, Negros, Philippine Islands, April 15, 1896, J. Whitehead.

Differs from *whiteheadi* (Luzon) and *vulcani* (Mindanao) by having the yellow of the throat extending over the entire breast. Entire abdomen, particularly along the midline, slightly washed with yellow. White eye-ring broad, interrupted in front by a black spot and with a narrow blackish border toward the cheeks. Upperparts slightly more yellowish than *whiteheadi*. Wing, ♂ 57, 60, ♀ 59. Tail, ♂ 40, 42, ♀ 42. Culmen, ♂ 15.5, 16.5, ♀ 15.5

Range—Known only from the Canloan Volcano (at 6,000 feet), Negros Island. This is by far the most distinct race of *montana* in the Philippines. It differs from *palpebrosa siquijorensis* which seems to occur in the lowlands of Negros by not having the flanks a clear gray, the broader eye-ring, the gray (not brown) iris and the more blackish wings and tail. The species *montana* (formerly *chlorates*) seems to have a much wider distribution than the earlier reviser thought. It seems to me, for example, that *Zosterops novaguineae* might also be included with this species.

Zosterops nigrorum—There has been considerable uncertainty about the respective ranges of the two Luzon races, *luzonica* and *aureiloris*. *Z. luzonica* was reported by Ogilvie-Grant from the type-locality (Mayon Volcano, Albay Province, south Luzon) as well as from Cape Engano, the northernmost tip of Luzon. *Z. aureiloris* from Abra Province, northwestern Luzon (type locality) and from Mindoro.

Material before me (including topotypical specimens from all the mentioned localities) shows that immatures and worn birds are considerably duller than adults in fresh plumage. The Cape Engano bird (imm.) belongs undoubtedly to *aureiloris*. Specimens from Bataan Peninsula and from the Laguna Province also belong to this race. They are characterized by the width of the yellow band on the forehead and to a lesser extent by the reduction of citrine (in favor of yellow) on the sides of the breast and on the flanks. Two paratypes of *luzonica* before me are immature, but two adults from Sorsogon, south Luzon (Philadelphia Academy of Natural Sciences) shows the characters of this race quite well. They are similar to *nigrorum* (Negros) but more citrine, less greenish above, with the black line below the eye ring very inconspicuous, and with the yellow of the underparts deeper.

Weavers (Family Ploceidae). [J. D.]

Our classification and nomenclature are those of "A Revision of the Subfamily Estrildinae," Delacour, *Zoologica*, 28, 11, 1943, pp. 69-86.

Starlings (Family Sturnidae). [E. M.]

Aplonis minor todayensis Mearns—This curious small starling is known only from two females. One was collected by Mearns on July 11, 1904, at Todaya, 4,000 feet, on the slope of Mt. Apo, Mindanao. A second specimen was obtained by Goodfellow two years later at exactly the same locality. The species is reported to be quite common there.

In the forty years since the discovery of this bird, a number of authors have speculated whether it was a good species or a race of *panayensis*. The bird is indeed very similar to *panayensis*, differing only by the more purplish throat and the smaller dimensions (see also *Ibis*, 1906, p. 469). Opposed to the assumption that *todayensis* is a race of *panayensis* is the fact that *panayensis* occurs throughout the Philippines, including the lowlands of Mindanao, without any noticeable geographical variation. Even on Celebes and other neighboring islands *panayensis* is replaced by subspecies that are extremely similar to the nominate race.

It finally occurred to me to compare *todayensis* with *Aplonis minor montosus* from Celebes, and I found indeed a surprising similarity in coloration, size and proportions. *A. m. montosus* differs from *minor* by the reduction of the purple color, particularly on the neck. This is carried even farther in *todayensis* which is all green on the upperparts and has less purple also on the throat. The feathers of head, neck, ear region and throat are more lanceolate in *todayensis* than in *montosus*. However, a series of adult males needs to be examined

before the constancy of this character is assured.

The measurements are as follows (females only): Wing: *todayensis*, 96, *montosus*, 98, 98, *panayensis*, 100, 101.5, 104, 105, 105.5. Tail: *todayensis*, 57, *montosus*, 54.5, 57.5, *panayensis*, 65, 66, 68, 70. Tail index: *todayensis*, 58.3, *montosus*, 55.7, 58.7, *panayensis*, 63.6, 64.3, 65.0, 66.6. Tarsus: *todayensis*, 19, *montosus*, 19.5, 19.5, *panayensis*, 22, 22, 22. Culmen: *todayensis*, 18.5, *montosus*, 18.5, 18.5, *panayensis*, 22.5, 23.5, 24, 24.

Even though the hackles in the plumage in *todayensis* are somewhat better developed than in *minor* and *montosus*, it will have to be considered a race of *minor* in view of the almost identical proportions unless the still unknown adult males reveal characters opposed to this classification.

Orioles (Family Oriolidae). [E. M.]

Oriolus chinensis yamamurae Kuroda — This race supposedly restricted to Basilan, was described (*Tori*, vol. V, No. 23, p. 257) as differing from *chinensis* mainly by smaller size. The measurements of specimens in the American Museum do not confirm these differences: Wing: Basilan, ♂ 154, 155, 155, 155, ♀ 147, 150, 150. Mindanao; ♂ 152, 154, 154, 155, 155, 156, 157, 160, ♀ 148, 148, 150. There is perhaps a slight mean difference in size, but not enough to justify subspecific separation. Luzon birds average still slightly larger than Mindanao birds (wing up to 164), but there is still considerable overlap. Neither does the width of the yellow tip on the central tail-feathers vary sufficiently between northern and southern Philippines to permit the separation of races.

13.

A Study of the Peripheral Blood of a Metamorphosing Anuran
(*Rana pipiens*).HARRY A. CHARIPPER AND RALPH B. WEIL¹*Department of Biology, Washington Square College of Arts and Science,
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The blood of the adult anuran has been extensively investigated by Jordan and his co-workers. These studies have resulted in a rather complete understanding of adult anuran hematology.

The larval anuran, however, although a fairly common laboratory form, has been studied far less intensely. Maximow (1910) and Jordan and Speidel (1923) have described changes in hematopoietic centers during development from the larval to the adult form. McCutcheon (1936) suggests a possible phylogenetic change in the hemoglobin molecule of the metamorphosing *Rana catesbeiana*. Jordan and Speidel (1922-23) designate definite functions to the leucocytes during the metamorphic process. These workers claim the lymphocyte is concerned with the progressive changes and the granulocytes with the regressive changes of metamorphosis. According to these findings it is possible that a systematic study of the circulating blood throughout metamorphosis may clarify the role of the blood in the process.

It is the purpose of this investigation to study the circulating blood of the metamorphosing anuran (*Rana pipiens*) in order to determine whatever changes occur, and how they may be related to definite stages of metamorphosis.

MATERIAL AND METHODS.

The *Rana pipiens* larvae were procured by Rugh's (1934) method of ovulation and fertilization. The larvae were placed in finger bowls in 1/10 Holtfreter's solution until hatching and then were transferred to aerated six-inch high tanks. The animals were fed solely on boiled spinach.

The following stages² were utilized:

- | | |
|-----------------------------|----------------------------------|
| I. 11-13 mm. total length | } Pre-
metamorphic
stages. |
| II. 15-16 mm. total length | |
| III. 20-22 mm. total length | |
| IV. Hind-limb bud length. | |
| V. 3 mm. hind-limb bud. | |

¹ Accepted in partial fulfillment of the requirements for the degree of Master of Science, New York University.

² The stages of metamorphosis are the same as those used by D'Angelo and Charipper, 1939.

- VI. Fully differentiated hind limb.
- VII. 18 mm. hind limb.
- VIII. Fore-limb emergence.
- IX. Tail resorption.
- X. Newly-metamorphosed adult.

The animals were anesthetized by being placed in a chloretone solution. The heart was exposed and blood was drawn directly from the ventricle by means of a micropipette previously rinsed in a dilute sodium citrate solution. All operations were accomplished with the aid of a dissecting microscope.

Smears were obtained by spreading the drop with a cover slip. In the earlier stages it was impossible to make smears due not only to the small amount of blood obtained but also because of its dilute nature, i.e., scarcity of cellular elements. Wright's stain was used exclusively for all smears.

Four cell types were counted in making the differential count—lymphocytes, eosinophiles, neutrophils and thrombocytes. Four hundred cells were counted on each slide; two hundred on one end of the smear and two hundred on the other end. Differential cell counts were not feasible in stages earlier than the 3 mm. hind-limb bud stage.

OBSERVATIONS AND RESULTS.

Stage I (11-13 mm.).

The erythrocyte, lymphocyte, thrombocyte and haemocytoblast are the only discernible elements present. No granulocytes were observed at this stage.

The Erythrocyte: This early stage contains many primitive erythrocytes. They range in shape from a small spherical cell with a large ovoid nucleus, to the definitive erythrocyte possessing an ovoid shape and proportionately, a smaller ovoid nucleus. There are many intermediate cells between these two extremes.

Many of the more primitive cells contain a basophilic cytoplasm and transition stages are present which may denote derivations from haemocytoblasts which are present in the circulating blood.

The cytoplasm of the red blood cells is

vacuolated and contains large numbers of yolk granules. The vacuoles are of varying sizes and are unevenly distributed. There may be only one or two vacuoles or at times a sufficient number as to make the cytoplasm appear alveolar.

Haemocytoblasts are present in rather large numbers in this early stage. These cells conform in all respects to the classical description. In addition they are often vacuolated, and always contain yolk granules.

Typical lymphocytes and thrombocytes are present at this stage.

Three processes are occurring in the erythrocyte at this stage, and to a varying extent persist throughout the rest of the stages of metamorphosis. They are erythroplastid formation, amitosis and mitosis. The erythroplastid formation appears to be similar in all details to what was described by Dawson (1928). Amitosis follows precisely the course described by Charipper and Dawson (1928). Mitosis is typical and all phases of this method of reproduction can be observed.

Stage II (15-16 mm.).

In the 15-16 mm. tadpole the granulocytes are first observed in very small numbers.

The neutrophile is represented by both adult types (typical granulation and polymorphous nucleation) and embryonic types (typical granulation and single or bilobed nucleus).

The eosinophiles are largely embryonic, consisting of a single nucleus and a small number of typical eosinophile granules.

In all other respects the condition of the other elements is identical with the previous stage.

Stage III (20-22 mm.).

The erythrocyte contains less yolk granules and the normoblasts have decreased in number. Haemocytoblasts are still much in evidence. Eosinophiles are still largely immature, the neutrophiles are the same as in the previous stage; mitosis and amitosis occur but with less frequency; erythroplastids persist.

A few atypical erythrocytes are first seen at this stage. They are large cells, which may be vacuolated, containing a large lilac-staining nucleus and a faintly staining cytoplasm, whose periphery is not always discernible. These cells resemble the senile erythrocyte described in the adult by Jordan (1919).

Stages IV through X.

Metamorphosis.

The following stages of metamorphosis introduce no radical changes, except in differential counts. Therefore their gross changes will be discussed together.

The Erythrocyte: The vacuolization decreases with the approach of metamorphosis as does the presence of yolk granules in the cytoplasm.

Five types of erythrocytes are observed throughout the active transformation.

1. The normoblast, although in far smaller numbers.
2. The small erythrocyte with the polarized nucleus.
3. The large erythrocyte.
4. The normal ovoid cell.
5. The senile erythrocyte.

Haemocytoblasts are present in smaller number and in consequence transition forms are less frequently encountered than in the early stages.

Large, medium and small lymphocytes are present, as are the typical thrombocytes. The eosinophiles are observed in small numbers and in the later stages they have assumed the typical adult histology. Transitional stages from the uninuclear neutrophile to the adult polymorphonuclear neutrophile are observed throughout metamorphosis.

Although mitosis and amitosis continue throughout the larval stages and the entire process of metamorphosis and beyond to the newly emerged adult, there is a decrease in both types of intra-vascular reproduction with the onset of the metamorphosis. In the differentiated hind-limb stage there appears to be an increase in mitosis and in the newly-emerged adult amitosis is more prevalent than mitosis, which occurs rarely.

Stages V through X.

The Differential Counts.

The results of the differential counts are summarized in Table I and graphically recorded in Table II.

The lymphocyte is present in greatest numbers in the early part of metamorphosis (Stages V, VI, VII), the greatest number being present at the differentiated hind-limb stage (VI). The amount decreases until the lowest point is reached at the period of tail resorption (Stage IX) and it rises again in the newly-emerged adult (Stage X).

The percentages of thrombocytes follow a precisely opposite course to that of the lymphocytes, except in the fore-limb stage (VIII) where a significant increase in the neutrophiles is observed.

The first significant change in the neutrophile count is observed in the increase in the fore-limb stage (VIII). The amount is slightly decreased in the period of tail resorption, and attains the lowest percentage in the newly-emerged adult. The eosinophiles are never present in large numbers. The counts range from .86% in the newly-emerged animal to 3.1% in the 18 mm. hind-limb length stage and at no time was a significant change recorded.

DISCUSSION.

The most outstanding process occurring in the larval stages, and continuing through-

TABLE I.

Stage	Lymphocyte %		Thrombocyte %		Neutrophile %		Eosinophile %
		Standard Error		Standard Error		Standard Error	
3 mm. Hind-limb Bud	56.5	±4.2	38.5	±2.26	4.0	±2.10	1.27
Diff. Hind-limb Bud	70.4	±2.84	21.74	±2.99	5.41	±1.92	1.0
18 mm. Hind-limb Length	60.45	±2.73	30.06	±2.6	6.9	±1.11	3.1
Fore-limb Emergence	53.43	±3.2	31.65	±3.1	12.21	±2.98	1.7
Tail Resorption	46.41	±3.09	45.9	±.72	7.71	±1.29	1.25
Newly-Metamorphosed Adult	58.74		37.3		3.4		.86

out the entire transformation to a decreasing extent, is that of erythropoiesis in the circulating blood. Although erythropoiesis in the general circulation has never been reported in the adult or larval *Rana pipiens*, it has been observed in many other forms.

Jordan and Speidel (1930b) describe erythropoiesis in the circulating blood of the adult cyclostome. Maximow (1910) in *Rana temporaria* and Ichikawa (1934) working with urodeles find the first erythropoietic loci is distributed throughout the peripheral circulation. Upon splenectomy of the adult *T. viridescens*, Jordan and Speidel (1930a) observed a shift of erythropoiesis to the peripheral circulation. Erythropoiesis also has been described in the circulating blood of the embryonic turtle (Jordan and Flippen, 1913).

This evidence may indicate that the peripheral circulation is a primitive center of erythropoiesis. It is observed in the adult cyclostome, and is only retained in the embryonic and larval stages of some amphibians and reptiles.

Though this investigation does not include an examination of any other possible centers of erythropoiesis, the marked decrease in red cell production in the peripheral blood with the progress of metamorphosis suggests this important function may be more fully assumed elsewhere.

Mitosis and amitosis have never been reported in the circulating blood of the mature adult or larval *Rana pipiens*. However, Dawson (1930) has described mitosis in urodeles, and Charipper and Dawson (1928) have reported amitosis in the peripheral

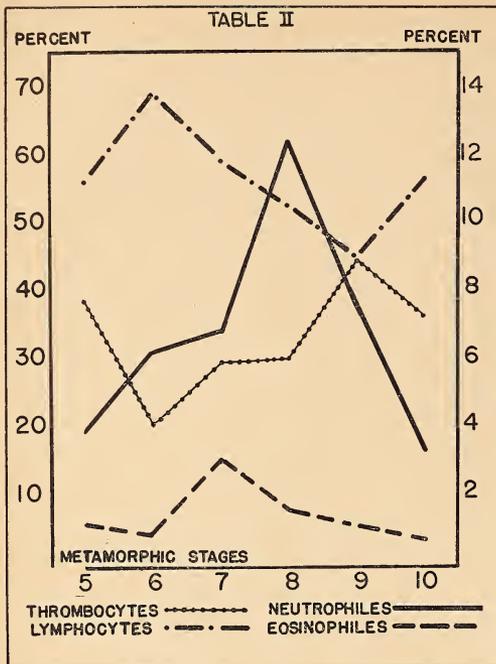
circulation of *Necturus*. The peripheral circulation of the embryonic turtle (Jordan and Flippen, 1913) and the larval *Lepidosiren* (Bryce, 1906) possesses both these methods of reproduction.

The presence of vacuoles (more predominant in the larval stages) in the erythrocyte were also observed by Bryce (1906) in the larval *Lepidosiren* and by Dawson (1931) in the blood of adult *Necturus*. The senile cell observed here was also reported by Jordan and Flippen (1913) and Jordan (1919). It occurs in preponderant numbers in the later stages of metamorphosis.

It is significant to note that the lymphocytes are more numerous in the early stages of metamorphosis, reaching their maximum at the differentiated hind-limb stage (VI), and decreasing for the duration of the transition, to rise again in the newly-emerged adult, whereas the neutrophiles attain their highest significant percentage in the fore-limb stage (VIII).

From statistics on growth throughout active metamorphosis supplied by D'Angelo, Gordon and Charipper (1941), the height of active growth occurs at the early stages of active metamorphosis, and the beginning of regressive changes (changes from the larval body to the adult form, loss of tail, etc.) occurs at fore-limb emergence and reaches its height at tail resorption.

The above two relationships may indicate that the lymphocyte is concerned with progressive changes and the neutrophile with regressive changes. This hypothesis agrees with Jordan and Speidel's (1922-23) conclusion, which maintained the lymphocyte is



responsible for the progressive changes, or growth, during metamorphosis, and regressive changes are caused by granulocytes. The neutrophiles are believed to play an important role in the resorption of the tail, and the eosinophiles are vital for the transformation of the intestine. Grant (1931) on examination, histologically, of *Urodele* larvae, reported an eosinophilia to be present. However, no significant change was observed in this investigation.

On the whole, the thrombocyte's percentages seem to be in direct antithesis to that of the lymphocyte. This fluctuation may be explained by its mode of origin. It is generally accepted that the thrombocyte arises from the lymphocyte, particularly the small lymphocyte. Therefore, it is possible that in the active stages of growth the demand for the lymphocytes is so urgent that they are utilized for progressive changes rather than as progenitors of the thrombocyte.

CONCLUSIONS.

I. Erythropoiesis has been found to occur in the circulating blood of the metamorphosing *Rana pipiens*. This phenomenon is more pronounced in the early stages.

II. The erythrocytes in the early larval stages are characterized by cytoplasmic vacuoles and yolk granules, which are progressively lost as metamorphosis proceeds. The presence of four types of erythrocytes in the adult *Rana pipiens* reported by Jordan (1919) is confirmed in the later stages of metamorphosis.

III. Maturation of granulocytes has been

observed in the circulating blood throughout the metamorphic process.

IV. The concentration of the thrombocytes, in general, varies inversely with those of the lymphocytes. The eosinophiles show a constant low percentage throughout the entire metamorphic process.

V. During metamorphosis the concentration of lymphocytes and neutrophiles fluctuates. In the early stages of this process, the period of most active growth, the concentration of lymphocytes is relatively high, and the neutrophile percentage remains constant, whereas, in the later stages of transformation, which are characterized by regressive changes, the lymphocytes undergo a marked decrease in amount and the neutrophiles demonstrate a significant increase.

VI. These results support the contention of previous investigators (Jordan and Speidel, 1922, 1923) who believe the lymphocyte is associated with progressive growth and the neutrophiles with regressive changes of the metamorphosing anuran.

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14.

Fulgoroidea (Homoptera) of Kartabo, Bartica District, British Guiana.¹

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(Plates I-III).

[This contribution is a result of various expeditions of the Department of Tropical Research of the New York Zoological Society to British Guiana during the years 1917, 1919, 1920, 1921, 1922 and 1924, under the direction of Dr. William Beebe. For maps and ecological data refer to *Zoologica*, Vol. VI, 1925, pp. 1-193.]

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INTRODUCTION.

Dr. William Beebe has asked me to report on the Homoptera taken at the New York Zoological Society's Tropical Research Laboratory at Kartabo, British Guiana. The present collection, while not extensive, does contain many interesting forms and reveals something of the wealth of the tropical jungles which yet await discovery.

In the present report, I have simply given brief notes on the known genera and species. Keys to the families and most of the genera known from the western hemisphere were published recently (Metcalf, 1938a) and need not be repeated here. Known species which have not been illustrated heretofore are illustrated in the present report, and brief diagnostic notes are given on these forms.

This superfamily includes Homoptera which have the head so modified that the antennae are situated below the ventral sinus of the compound eyes. The chief characters for separating the various families are to be found in the modification of the tarsi of the hind legs and in wing venation. Generic characters are found in the modifications of the head, details of wing vena-

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tion and the general characters of the male genitalia which are the chief characters for specific determinations.

The present paper is concerned with 103 specimens of fulgorids, which resolve into 39 species. One genus and 10 species are described as new. All were collected at Kartabo, the field station of the Department of Tropical Research of the New York Zoological Society, in a quarter square mile of jungle, at the junction of the Mazaruni and Cuyuni Rivers.

The field numbers and other data are presented in an Appendix at the end of the present paper. All types of new species are deposited in the collections of the Department of Tropical Research, New York Zoological Society.

FAMILY CIXIIDAE.

This is a family of usually small or medium-sized species, mostly dull or inconspicuously colored forms. The family is a large one and is usually well represented in tropical collections; however, the present collection contains only 3 species.

Bothriocera Burmeister, 1835a:156.

Haplotype *Bothriocera tinealis* Burm.

This is one of the most singular of the genera of the family Cixiidae. The head is twisted so that the ventral sinus is directed cephalad and the antennae are in front of the eyes instead of ventral to the eyes as is normal in most fulgorids. The present collection contains specimens of the widely distributed species, *bicornis*. This species has been recorded heretofore in the United States from New Jersey southwestward to Texas through Mexico, Central America to southern Brazil. There has been, however, much confusion in the species in this genus in the past and it is possible that many of the records for this species do not actually refer to *bicornis*.

Oliarus Stål.

Logotype *Oliarus walkeri* Stål.

This is a large genus comprising 232 recorded species. The genus is practically world wide in distribution and perhaps contains many diverse elements and is in need of real revision. Only 4 species have heretofore been recorded from the South American fauna. The present species is somewhat anomalous in this genus but I hesitate to place it elsewhere as it is more closely related to the *Oliarus* complex than to any other known group.

Oliarus beebei, n. sp.

(Pl. I, figs. 1, 2, 3).

This is a large species of *Oliarus* super-

ficially resembling *Oliarus vicarius* Walker, with a much narrower and more produced crown and distinct male genitalia.

General color of the venter excluding the abdomen but including the legs, the head and the pronotum ochraceous tawny, venter of abdomen and mesonotum dorsally cinnamon brown, tegmina translucent, ochraceous tawny with the veins brown and irregular markings of brownish and rows of brownish setigerous punctures in the cells.

Crown narrow, elongate, about 3 times as long as broad; the lateral carinae strongly elevated converging anteriorly and uniting on the face to form the median carina; lateral areolets indistinct; posterior margin broadly rounded, not angularly emarginate. Frons broad, its greatest width about the level of the antennae, much narrower between the eyes; median carina very distinct; median ocellus indistinct. Clypeus deeply inserted in the frons. Pronotum short and broad; posterior margin broadly angled. Mesonotum large; intermediate carinae very indistinct giving the appearance of a tricarinate mesonotum. Tegmina elongate, narrow; apical and subapical cells elongate and narrow, each cell with a single row of setigerous punctures. Male genitalia with the pygofer elongate, deeply inserted in the abdomen; ventral incision nearly a right angle; plates of the pygofer well developed, biramose on the apical third, each process capitate; genital plate rather small, somewhat hatchet shaped, with the basal portion rather broad and with the apical portion with a finger-like process directed mesially; genital styles with the basal third slender, diverging, the apical two-thirds broad and flat, nearly quadrate with the inner angle more acute than the outer angle and extended; aedeagus long and coiled; anal segment long with an obtuse median ventral process; anal style elongate.

Holotype: ♂; Kartabo, Bartica District, British Guiana; March 10, 1924.

Allotype: ♀; Kartabo, Bartica District, British Guiana; March 27, 1922, at light.

Paratype: 3 ♀♀; all from Kartabo, October 8, 1922.

Pintalia Stål, 1862e:4.

Logotype *Pintalia lateralis* Stål.

This genus is composed of about 22 species which have a fairly wide range from southeastern United States, as far north as Virginia; through Mexico, Central America and Brazil, as far south as Rio de Janeiro. The genus may be briefly characterized as follows: the vertex is separated from the frons by two slightly acute transverse carinae which are nearly parallel to each other and are not contiguous on the median line as in some of our common genera;

mesonotum tricarinate; tegmina steeply tectiform with radius 3 to 5 branched and media 5 branched, first medial sector branched at about the same distance from apical margin as second medial sector; the pygofer of the female is fairly robust; the male pygofer is deeply incised posteriorly with a distinct median tooth at the bottom of the incision, the genital plates broadly expanded apically with slender basal petioles, or elongate, narrow.

There is a single male specimen in the present collection which is rather anomalous in this genus, but it comes closer to the genus *Pintalia* than any other genus known to me and I shall include it here for the present.

Pintalia castanea, n. sp.

(Pl. I, figs. 4, 5, 6, 7).

This species may be recognized by its deep chestnut brown color shading to blackish on some of the carina. The lateral margin of the frons is strongly elevated, sharply carinate ventrad and extending as broad elevated ridges which meet in the median line dorsad. The posterior tibiae unispinose.

The crown nearly as long as broad, consisting of two portions, a rather large median anterior areolet which is horizontal and elongate oval in shape and a posterior portion which is nearly vertical and rather narrow and which merges into the strongly elevated lateral carinae which project very high above the eyes. Frons elongate, narrow, nearly three times as long as the greatest width; dorsal margin nearly as wide as clypeal border; the lateral margins strongly elevated, starting as thin carinate lateral margins on the clypeal border, then widening at about the level of the antennae into broad, flat ridges which meet in the median line on the dorsal border; median carina extending about half the length of the face, rather indistinct; median ocellus large, distinct. Clypeus with the median carina very distinct and lateral margins strongly carinate; cheeks very broad. First segment of the antennae very short; second short, terete. Lateral ocelli large, conspicuous, elevated above the level of the cheeks; ventral sinus of the compound eyes wanting. Pronotum very short; posterior margin deeply incised. Mesonotum large, tricarinate. Tegmina elongate, narrow; radius with 5 apical branches; medius with 5 apical branches; the veins finely but distinctly granulate. Posterior tibiae with a single spine on the apical third. Male genitalia elongate, narrow; the pygofer deeply incised caudad with a short triangular median tooth; the genital plates elongate, narrow, widely separated basad, converging and meeting on the middle line for about a fourth of the total length before

their middles then converging to their broadly rounded apices; aedeagus elongate, slender, elbowed with a pair of lateral curved hooks which are directed caudad; anal segment elongate with a long narrow ventral process; anal style elongate.

General color rich chestnut brown shading to darker brown on the head; the compound eyes blackish-brown and many of the carinae on the head and thorax narrowly black; legs pale ochraceous yellow; tegmina chestnut brown with the veins darker; abdomen ochraceous yellow. Length to apex of tegmina 6.1 mm.

Holotype: ♂; Kartabo, Bartica District, British Guiana; April 8, 1924.

FAMILY ARAEOPIDAE.

This is a large family of small or very small species. Unfortunately, the present collection contains only a single specimen of the genus *Eucanyra*.

Eucanyra Crawford, 1914a:568.

Orthotype *Eucanyra stigmata* Crawford.

In this genus the head is narrower than the pronotum. The antennae are very long; the first segment terete, subequal to the second segment. Mesonotum quinquecarinate, elongate. The genital style short. Anal segment asymmetrical. The aedeagus elongate and much coiled.

Eucanyra bifurcata, n. sp.

(Pl. I, figs. 8, 15).

This species superficially resembles a small pale *Eucanyra stigmata* Crawford. The crown is broader and somewhat shorter. The face is broader, not so much narrowed between the eyes. The forking of the median carina occurs at about the level of the dorsal margin of the eyes. Male genitalia very distinct; pygofer broader and shorter than in *stigmata*, with distinct genital plates; the ventral angles more pronounced; the anal segment more elongate, narrowed basad with a pair of asymmetrical, but quite distinct, anal spines. The anal style much smaller than in *stigmata*. Genital styles smaller, distinctly bifurcate.

Holotype: ♂; Kartabo, British Guiana.

FAMILY DERBIDAE.

This is a family of small or medium-sized fulgorids with small bodies and delicate, elongate tegmina and wings. The head is usually considerably modified, being frequently very much compressed. The face is often reduced to the lateral, strongly elevated carinae which are contiguous on the median line. The present collection contains representatives of 4 genera and 6 species.

Mysidia Westwood, 1840d:83.

Logotype *Derbe pallida* Fabr., Kirkaldy 1903c:216.

This is a genus of medium or medium small species, of various colors but quite frequently pale or whitish in color. The species are all frail. The male and female genitalia furnish the best characters for the recognition of the species. About 27 species are known, ranging from the southern United States to Brazil. Two species, both of which are fairly common and widely distributed in tropical America, are included in the present collection. These are *Mysidia squamigera* Fabr. and *Mysidia costata* Fabr. *Mysidia squamigera* is one of the larger species of the genus with the tegmina heavily marked with fuscous, especially along the costal border. *Mysidia costata* is a somewhat smaller species with the tegmina milky subhyaline, faintly marked with fuscous along the margin and along some of the cross veins.

Mysidia rubra, n. sp.

(Pl. I, fig. 9; Pl. II, fig. 13).

This is a brilliant scarlet species resembling *rubidella* Ball in color but differing materially in structure.

Dorsal half of the body bright scarlet; ventral half, including legs, bright yellow; tegmina and wings fuscous; veins red.

Crown elongate; lateral margin carinate, nearly parallel; the crown projecting in front of the eyes; posterior margin broadly sinuate. Frons elongate; the carinate side nearly parallel between the eyes, then widening to the broader clypeal border. Clypeus with a distinct median carina. Antennae short, the second joint somewhat capitate. Pronotum short, the posterior margin deeply excavate, the lateral fields broadly, rotundately expanded. Tegmina rather broad and short; the venation characteristic. Genital plates rather narrow, elongate, their bases narrow, widely separated; the outer margin broadly curved; the inner margin angles toward the median line on the basal half and then diverges to the obtuse apices. Aedeagus very elaborate.

Holotype: ♂; Kartabo.

Neocenchrea Metcalf, 1923a:193.

Orthotype *Cenchrea heidemanni* Ball.

This genus may be distinguished by the following characters: head narrow with narrow crown and forehead, both of which have strongly elevated lateral margins and are without a median carina. Antennal foveae on pronotum strongly developed. Tegmina long and narrow; three main veins of corium bifurcate; radius separated from subcosta before the level of the apex of

clavus, media branched just beyond the apex of clavus and first cubital sector, branching at about the same level as the union of claval veins.

The 5 species which have been assigned to this genus previously, range from southern United States through Mexico to Panama. The species described below is the first to be recorded from South America proper.

Neocenchrea ochracea, n. sp.

(Pl. I, figs. 10, 11, 13).

There is in the present collection a single specimen of this genus. The specimen represents a species close to *pallescens* Metcalf, but the crown is much narrower and more elongate and the tegmina have the principal cells faintly tinged with ochraceous buff.

General color of the body ochraceous orange; eyes brown; legs ochraceous yellow with the lateral areas of the pronotum and the posterior border of the pronotum ochraceous yellow; tegmina and wings milky subhyaline; the cells of the tegmina marked with ochraceous buff.

Crown narrow, elongate, about two and a half times as long as its greatest width; the lateral margins strongly elevated in broad ridges which are marked off by transverse carinae into small areolets; the lateral margins meeting in the median line at the anterior end of the head. Frons elongate, narrow, the lateral margins strongly elevated in thin carinae; no median carina. Clypeus about half as long as the frons; median carina distinct. Pronotum short and broad, deeply incised posteriorly. Mesonotum large with a faint median carina. Tegmina narrow, elongate; subcosta-radius branching about the middle; media branching beyond the middle and cubitus branching before the middle. The female last genital segments large, broader than long, the median flap very large, nearly circular in outline.

Holotype: ♀; Kartabo, Bartica District, British Guiana, March 4, 1924.

Syntames Fowler, 1905a:138.

Haplotype *Syntames delicatus* Fowl.

This genus can be recognized by the broad, nearly parallel-margined crown and forehead, pronotum with a distinct antennal fovea; tegmina broad; subcostal cell long, with a distinct discal cell from which the 5 or 6 branches of media arise; cubitus bifurcate before the level of the union of claval veins.

This genus contains 9 species which range from the northern United States through Mexico and Central America, with a single

species having been described previously from British Guiana.

***Syntames serratus*, n. sp.**

(Pl. I, figs. 12, 14; Pl. II, fig. 12).

In general coloration this species resembles *brunneus* McAtee, but the genitalia are entirely different. General color of clypeus, the lateral margins of the frons and crown, the pronotum, the tegmina, and the legs, fawn; the central area of the face and crown, the compound eyes and the mesonotum, dark chestnut brown.

Lateral margins of the frons nearly parallel but little widened below; distinctly granulate. Clypeus as long as the frons. Crown not as long as its greatest width, distinctly produced in front of the compound eyes. Pronotum broad, deeply incised posteriorly. Mesonotum large with a distinct median carina. Pregenital plate large, posterior flap rotundately produced, the posterior border finely but distinctly serrate.

Holotype ♀; Kartabo, Bartica District, British Guiana, February 28, 1924.

***Anotia* Kirby, 1821a:20.**

Haplotype *Anotia bonnetii* Kirby.

All the species have very compressed heads, the forehead reduced to a mere keel and the second antennal segment elongate nearly as long as the forehead. The tegmina two or more times as long as the body; with subcosta and radius united for about one-third their length; medius with 4 or 5 branches; cubitus one with 2 branches ending in the extended claval vein. The male genital plates consist of horizontal lamelliform plates usually narrowly ovoid with a vertical ridge on the dorsal surface forming a blunt recurved tooth near the middle.

Seven species of this genus have been described from eastern North America and seven from Central America. There is a single badly mutilated specimen which has the characteristics of *Anotia rubescens* Fowler.

FAMILY FULGORIDAE.

This family contains the largest and most spectacular species of fulgorids. It is in this family that the head reaches its greatest development. In addition to the spectacular species, there are many smaller and more obscure species which have the head but little modified. The present collection contains only 7 species, which are of rather wide distribution and fairly well known.

***Cathedra* Kirkaldy, 1903b:179.**

Haplotype *Fulgora serrata* Fabr.

[*Pristiopsis* Schmidt, 1905b:332].

[Orthotype *Fulgora serrata* Fabr.]

This genus contains but a single remark-

able species, *Cathedra serrata* Fabricius, which has a wide distribution in northern South America and Central America, having been definitely recorded from Costa Rica, Colombia, Surinam, French Guiana, Peru and Brazil as far south as Sao Paulo. There is in the present collection a single specimen of this species from Bartica, British Guiana. *Serrata* may be recognized by the elongate cephalic process which has a row of stout spines, 8 or 9 in number, along each dorso-lateral margin. In addition there is a pair of dorsal spines at the base of the middle third of the cephalic process and another pair at the base of the apical third of the cephalic process. The general color of the venter including the legs, the dorsal part of the cephalic process, the pronotum, mesonotum, and tegmina, is ochraceous tawny marked with fuscous and black, especially on the margins of the spines on the cephalic process. The hind wings are chiefly dusky brown irrorate with creamy white basad and with a large circular spot of deep chrome yellow at the apex of the anterior area; the venation is chiefly black in the darker areas of the hind wing, but dark yellow in the yellow spot; the dark areas are more or less varied with pale bluish-white. Total length of the body to the tip of the abdomen 54 mm; of the cephalic process 25 mm; wing expanse 98 mm.

***Fulgora* Linnaeus, 1767a:703.**

Logotype *Fulgora latermaria* Linnaeus.

This genus is also represented by a single specimen which I assigned to the species *Fulgora latermaria*. This genus may be recognized by the inflated cephalic process which gives the head of this insect a superficial resemblance, especially in side view, to the head of an alligator. The species *latermaria* has been recorded from Mexico, Central and South America, although it is probable that Mexican and Central American records refer to the closely related species *servillei*. The species *latermaria* may be distinguished from the closely related species by the fact that the cephalic process at its greatest width is nearly equal in width to the pronotum, and by the fact that the posterior ocellated spot on the hind wing is large, not small and punctiform as it is in the other closely related species.

***Aracynthus* Stål, 1866a:136.**

Logotype *Fulgora sanguinea* Oliv.

This is another genus that contains but a single species. It may be readily recognized by the following characters: the head narrow, about half as wide as the pronotum. The crown broad and short, nearly three times as broad as long. The frons broad ventrad, narrowing between the eyes; the median carina bifurcates almost from the

clypeal margin and the 2 branches unite with the intermediate carina in a large callosity at the dorsal margin of the frons. The frons slightly reflexed on the dorsal surface. The tegmina elongate, narrow, the costal area broad and reticulate and the costal margin somewhat sinuate.

Aracynthus sanguineus Oliv.

The species *sanguinea* may be recognized by the general tawny color of the venter, including the legs, the head, pronotum, mesonotum, and tegmina. Each hind wing has its base bright red, rather heavily marked on most of the veins and cross veins with black. The apical area is fuscous with irregular translucent spots. Total length to apex of abdomen 24 mm.

Lystra Fabricius, 1803a:56.

Logotype *Lystra lanata* Linnaeus.

This genus may be recognized by the following points: frons nearly quadrate, the lateral margins strongly, broadly carinate, with median and intermediate carinae, the latter diverging strongly from the clypeal border. Crown short and broad, the lateral margin being elevated into a pair of strong teeth above the eyes. Pronotum short and broad with a pair of short, stout teeth behind the eyes. Tegmina long and narrow. Legs long and slender. This genus is represented in the South American fauna by 2 common species and a number of rare forms. The present collection contains only the species known as *lanata* Linnaeus. In this species the general color of the body and tegmina is black with the lateral margin of the clypeus and forehead and crown orange red. The tegmina black with 2 broad stripes along the commissural margin pale bluish-green, and the general surface of the tegmina irregularly spotted with the same color. Hind wings fuscous brown; the veins chiefly black. In well preserved specimens the abdomen of the female terminates in long, white, waxy filaments.

Calyptoproctus Spinola, 1839a:266.

Logotype *Lystra stigma* Fabr.

Nine species recorded from North, Central and South America are at present included in this genus. They are chiefly dull colored, inconspicuous species with total lengths to the apex of the tegmina varying from 10 to 20 mm. Crown about four times as broad as long, nearly parallel margined. The frons broad, distinctly ampliate dorsad. The tegmina relatively long and narrow. The sixth abdominal segment produced, nearly as long as the first five segments of the abdomen combined; tricarinate, the carinae parallel.

There are in the present collection 3 specimens, all females, which apparently

represent 2 species. One of these I identify as *elegans* and the other as *marmoratus*. For the guidance of other students, I include a tentative key to the species of this genus. This key is based chiefly on color characters as 2 of the species are unknown to me in nature. The key will have to be revised before it is in satisfactory shape and the color characters correlated with structural characters. However, it may serve as a guide to our present knowledge of these species.

Key to the Known Species of *Calyptoproctus* Spin.

1. Hind wings transparent, veins only darker2
1. Hind wings not entirely transparent, colored on the base at least.....6
2. Dorsum of abdomen uniformly colored 3
2. Dorsum of abdomen not uniformly colored4
3. Tegmina grayish, reddish toward the base. Dorsum of abdomen ochraceous . . . *guttipes* Walker 1858b: 50 (Mexico)
3. Tegmina subhyaline, with a narrow indistinct fuscous fascia before the middle and the veins sparsely fuscopunctate. Dorsum of abdomen black . . . *exsiccata* Stål, 1854b: 245 (Brazil)
4. Frons with a median black vitta. Lateral areas of the abdominal segments marked with greenish-yellow . . . *confusus* Distant, 1906m:195 (Mexico and Guatemala)
4. Frons not vittate with black5
5. Basal third of tegmina grayish-green. Frons marmorate . . . *marmoratus* Spinola, 1839a:271 ("North America")
5. Basal third of tegmina reddish. Frons not marmorate . . . *elegans* Olivier, 1791a:574 (Brazil)
6. Dorsum of abdomen uniformly colored . . . *aridus* Stål, 1869a:88
6. Dorsum of abdomen not uniformly colored7
7. Apical area of hind wings transparent, basal area colored8
7. Hind wings fuliginous, darker apically . . . *fuscipennis* Distant, 1906m:197 (Ecuador)
8. Basal area of hind wings green . . . *coloratus* Distant, 1906m:196 (Ecuador)
8. Basal area of hind wings dull yellow . . . *stigma* Fabricius, 1803a:58 (Brazil)

Calyptoproctus elegans Oliv.

This is a large species of *Calyptoproctus*. The general color of the head, the thorax,

the legs and the ventral side of the abdomen ochraceous buff, more or less marbled with fuscous. The tegmina rosy red at the base, translucent apically. The hind wings transparent. The abdomen above bluish-black with the posterior borders of the basal segments pale bluish-green fading to ochraceous, a pair of large spots of the same color on the sixth segment.

The crown about four times as broad as long, nearly parallel margined; the frons broad, distinctly ampliate dorsad; central areolet indistinct. Pronotum with a strong median carina which ends in a strong transverse ruga posteriorly; post-ocular incisions deep. Sixth dorsal abdominal segment produced, nearly as long as the basal segments combined; tricarinate, the carinae parallel.

This species was described from Guiana and has been recorded from Brazil and Panama.

Calypoproctus marmoratus Spin.

This species was described from "Amerique septentrionale," and, so far as I am aware, has not been definitely recorded since the original description except when confused with *Alphina glauca* Metc., which is an entirely different species (Metcalf, 1938a:348). Since the present specimen agrees more closely with the original description of *marmoratus* than any thing else, I have concluded to place it here for the present, at least, although this specimen is somewhat larger than the original description would indicate. This species differs chiefly from *elegans* in coloration; structurally the chief differences that I note are the more elongate sixth abdominal segment of the female which in *marmoratus* is about as long as segments two to five inclusive, whereas in *elegans* only about as long as segments three to five inclusive. In *elegans* the sixth segment is rather broad, broadly rounded on the caudal margin, whereas in *marmoratus* the sixth segment is more nearly triangular with the caudal margin obtuse between the intermediate carinae. In *marmoratus* the frons, crown, pronotum and mesonotum are obscurely irrorate. The tegmina are grayish-fuscous with heavy markings of blackish-fuscous, especially on the apical area. In *elegans* the frons is not irrorate and the wings are bright rosy red on the basal third with the apical two-thirds translucent; veins and cross veinlets rosy red and the whole area sparsely spotted with brownish-fuscous.

Enchophora Spinola.

Enchophora tuba Germar.

This species has previously been synonymized with *recurva* Oliver. For the present, however, I prefer to keep them separate. In *tuba* the dorsal surface of the abdomen is

bright red like the basal field of the hind wings. The cephalic process is slender and directed upward at an angle of about 45 degrees, then bent sharply horizontal with apex tripartate and erect.

FAMILY DICTYOPHARIDAE.

Although the present collection is small, containing only 7 species, it enables me to straighten out some previous errors.

Dictyophara Germar, 1833a:175.

Logotype *Dictyophara europaea* Linnaeus.

This is a large genus with some 85 or 90 species recorded from most of the major regions of the world. Three species are included in the present collection.

In this genus there is a definite cephalic process which may be elongate cylindrical or short and pyramidal, with the crown either oblong, with the lateral carinae nearly parallel, or triangular with the lateral carinae converging. The tegmina are elongate, transparent, with characteristic venation with the apical portion reticulate and the basal area without cross veins. In the basal area, there are 3 main veins, subcosta and radius united to the apical area where they divide, subcosta forming a distinct nodal area with usually 3 to 5 or more cells; media and cubitus both branch before the apical area.

Dictyophara brachyrhina Walker.

(Pl. II, fig. 2; Pl. III, fig. 12).

This species was described from Colombia and is also known from Guatemala, Ecuador and Panama. There are a number of specimens in the present collections from Bartica District, British Guiana.

This species may be recognized by the broad cephalic process which is about twice as long as broad and nearly parallel-sided. Most of the specimens are dull ochraceous orange but a few have the carinae and the veins of the tegmina bright grass green.

The male genitalia are illustrated. They are of the typical dictyopharid pattern with the terminal filaments of the genital styles rather broad and bent at right angles to the base.

Dictyophara platyrhina Walker.

(Pl. III, figs. 8, 13, 14).

This is a rather large species of *Dictyophara* with an elongate cephalic process which is about two and one-half times as long as the width between the eyes; the lateral carinae nearly parallel to the apex; the frons is elongate, somewhat spatulate, with the lateral margin somewhat angulate just above the clypeal suture. Male genitalia not of the typical dictyopharid pattern; genital styles broad and flat, somewhat bilobed apically without the elongate terminal filament characteristic of the other

species of *Dictyophara* known to me; genital plates broad, somewhat triangular in form, with the dorsal angle produced spine-like. Aedeagus biramose, long and slender; the apices somewhat recurved and spine like.

Dictyophara beebei, n. sp.

(Pl. II, fig. 1; Pl. III, fig. 3).

This species resembles a small *Dictyophara obtusifrons* but the genitalia are entirely different. Crown elongate, triangular; the lateral carinae converging toward the apex. The lateral margins of the frons visible from above, giving the dorsal aspect a somewhat spatulate appearance; frons rather short, barely narrowed between the eyes; the lateral margins not expanded toward the clypeal border. Tegmina elongate, narrow; stigma with three cells, elongate, slender. The genital plates, viewed from the venter, are elongate, narrow, obtuse caudad; viewed from the side, they are broadly triangular with the dorsal angle produced into a broad, obtuse tooth. The genital styles are broad and flat without a terminal filament. Aedeagus long and slender, biramose, with the apical processes bent and directed cephalad.

Holotype: ♂; February 29, 1924, Kartabo, Bartica District, British Guiana.

Allotype: ♀; March 11, 1924, Kartabo, Bartica District, British Guiana.

Paratypes: 2 ♂♂; and 1 ♀; all from Kartabo.

Taosa Distant, 1906n: 355.

Orthotype *Taosa suturalis* Germ.

This genus includes 15 species from Central and South America. They are all short-headed dictyopharids with the crown usually broader than long or at most as long as broad, slightly projecting in front of the eyes, with definite lateral areolets and a definite carina between the crown and the face; face tricarinate, ampliate ventrad; tegmina with only a few cross veins in the apical area.

This genus was established by Distant for the single species, *Flata suturalis*, which had previously been placed in various genera. Later, in 1913, Kirkaldy (1913a:14) established a new subgenus *Cuernavaca* of the genus *Dictyophara* to include the *Fulgora herbida* Walker. This, I believe, should be retained as a subgenus of *Taosa* to include those forms which have the crown about as long as wide, definitely projecting in front of the eyes. The typical *Taosa* would then include those forms which have the crown nearly twice as broad as long, not projecting in front of the eyes.

Taosa muiri, n. sp.

(Pl. II, figs. 3, 7; Pl. III, fig. 2).

There are 2 species in this collection

which are assigned to this genus. In general appearance, this species resembles *bimaculifrons* Muir, but the genitalia and coloration are entirely different. In coloration it resembles *viridis* Muir, but the crown is much narrower than in *viridis*.

Crown rather small, about one and one-half times as broad as its median length; without a median carina; lateral areolets large; frons rather short and broad; median carina distinct; intermediate carinae indistinct; median carina of the pronotum short but well elevated; carinae of the mesonotum very distinct; the intermediate carinae continued as the lateral margins of the mesonotum. Nodal area of the tegmina with three cells. Hind tibiae with 3 lateral spines. Genital styles elongate, slender, with the apices elongate, somewhat curved and overlapping.

General color green with the crown and mesonotum more or less clouded with raw sienna, with 2 elongate, shining, black spots on the intermediate carina of the frons near the dorsal margin; a small black spot on the lateral margins of the mesonotum near the base of the tegmina; 3 black spots on the lateral areas of the metathorax and a large, black, elongate stripe on the hind coxae.

Length to apex of tegmina 12 mm.

Holotype: ♂; Bartica District, British Guiana.

Taosa (Cuernavaca) paraherbida Muir.

(Pl. II, fig. 11).

There is a single female specimen of this species in the present collection. It agrees with all the essential characters of this species save color. The general color of body, including legs and veins of the tegmina, is dull raw sienna with the eyes dull brown.

Hydriena Melichar, 1912a:50.

Orthotype *Hydriena distanti* Mel.

This genus was established by Melichar (1912a:50) for a single species from Guiana. This is one of the short-headed dictyopharid genera with the crown about three times as long as broad, projecting about a third of its length in front of the eye; lateral margins nearly parallel to near the apex; separated from frons by a distinct transverse carina. Frons elongate with 2 parallel intermediate carinae; narrow between the eyes, gradually widening to the clypeal border, median carina wanting. Clypeus with a median carina. Pronotum short and broad; anterior margin projecting between the eyes; posterior margin deeply incised; lateral margin with 2 parallel carinae. Mesonotum large with 3 nearly parallel carinae. Tegmina of the usual dictyopharid pattern with few cross veins in the apical area.

Hydriena distanti Mel.

(Pl. II, fig. 14; Pl. III, figs. 7, 9, 11).

This species was described from Bartica, British Guiana, and Paramaribo, Dutch Guiana. There is a small series in the present collection from Kartabo.

The general color of fresh specimens is dull green with the intermediate carinae of the frons rust red; the other carinae of the body and the segments narrowly margined with black; other areas of the body marked with black or blackish brown or brown as follows: a large, shining, black spot at the dorsal margin of the frons, a spot in the lateral field of the pronotum, 2 irregular spots in the lateral fields of the mesonotum, and the posterior border of each abdominal segment. Tegmina smoky transparent, veins and cross veins brown. Length to the apex of the tegmina 15 to 18 mm.

Lappida Amyot and Serville, 1843a:505.Haplotype *Lappida proboscidea* Spin.

This genus may be recognized by the elongate, slender cephalic process which is usually expanded apically. The tegmina are transparent with supernumerary longitudinal veins but not many cross veins; the stigma usually brightly colored with 3 or 4 cells. The anterior tibiae are elongate, longer than the femora; the hind tibiae have 4 or 5 spines.

There are 14 species known from Mexico, Central and South America.

There is in the present collection a single female specimen of this genus which resembles *fusca* Metc. (Pl. III, fig. 4.) in general body structure, especially in the short, slender cephalic process. The coloration, however, is entirely different, and I place the present specimen in this species with some hesitation. The general color of the present specimen is rufus orange with the cephalic process green except the carinae which are blackish; the median and lateral areas of the frons are green with the intermediate carinae and the lateral carinae rufus orange.

FAMILY TROPIDUCHIDAE.

This is a small family of fulgorids containing about 80 genera and approximately 200 species. Many of the genera include only a single species. A majority of the described species come from the eastern hemisphere. However, the family is fairly well represented in tropical America, a few species reaching the southern United States. The present collection contains but a single species representing the well known genus *Alcestis*.

There is usually a distinct suture which restricts the posterior angle of the mesonotum. In most genera there is a transverse row of cross veins or a cross line across the

tegmina on the apical third. The head is various, sometimes with and sometimes without a cephalic process. The former genera superficially resemble members of the family Dictyopharidae but may be readily distinguished by the small second joint of the hind tarsi, with a spine on each side.

Alcestis Stål, 1862e:11.Haplotype *Alcestis pallescens* Stål.

This is a genus of short headed and broad winged tropiduchids. The crown is short, usually about twice as broad as its median length. Frons about twice as long as broad; the lateral margin slightly arched and carinate. The median carina very broad. Tegmina broad, costal margin broadly rounded; venation distinct; subapical line indistinct; costa separated from the costal margin for a short distance at the base; costal vein united to the costal margin by three or more branches; subcosta and radius united for a short distance beyond the basal cell; subcosta with numerous branches united to the costal margin; radius, media and cubitus branching at about the same level; radius into 2 main branches, media into 3 main branches, and cubitus into 2 main branches.

Nine species are known from Central and South America.

Alcestis surinamensis Schmidt.

(Pl. II, figs. 8, 15; Pl. III, figs. 1, 6, 10).

This species was described from Surinam and Brazil. There are 4 specimens in the present collection that agree in all essential details. The crown is about twice as broad as long. Frons elongate; the median carina thick. Costa with 3 or 4 branches to the costal border; the basal cell elongate, about three times as long as broad; the subapical line wanting. The male genitalia are illustrated for the guidance of future students.

FAMILY FLATIDAE.

This is a large family of fulgorids with approximately 175 genera and some 865 described species. This family has a world wide distribution and the number of species to be found in tropical regions of the world is beyond present calculations, if the small samples which I have seen from these regions is any indication of what real systematic collecting would reveal.

Poekilloptera Latreille, 1796a:90.Haplotype *Poekilloptera phalaenoides* Linn.

Melichar 1923a:22 includes 4 species in this genus. In addition 4 other species have been assigned to this genus by other authors. All the species in this genus are fairly large flatids from 15 to 30 mm. in length to the apex of the tegmina. The tegmina vary from light buff to ochraceous orange in

color with a number of black spots in the cells.

Poekilloptera phalaenoides Linnaeus.

This common and very variable species is widely distributed in the Americas, ranging from Mexico through Central America to Colombia, Venezuela, Peru, Bolivia and as far south as Rio de Janeiro, Brazil. It is very variable in size and coloration and no less than 4 varieties have been recognized and described. This species has not been listed from British Guiana previously, but there is in the present collection a series of specimens from Kartabo. The largest females in this series are somewhat intermediate between the varieties *aperta* Melichar and *parca* Jac. while the smaller males represent the typical variety *phalaenoides*.

Leptormenis Melichar, 1923a:65.

Orthotype *Leptormenis relicta* Fabr.

This genus may be recognized from the other genera of ormenids with two subapical lines by the fact that the first subapical line is undulate and connected with the costal vein; the second subapical line is regular, not connected with the costal vein; costal margin broad, broader than the costal cell. Crown broad, broader than long.

Leptormenis confusa Melichar.

There is a single specimen in the present collection which agrees in all essential details with Melichar's original description of this species which was based on a specimen from French Guiana. Melichar did not include this species in his catalog of the species of flatids in 1923. However, since the specimen before us agrees with the original description and comes from the same general region, I have included it under this name.

Ormenis Stål, 1862e:68.

Logotype *Ormenis perfecta* Walk.

This is a genus of some 30 known species. I believe that it should be confined to species from the western hemisphere, although 2 species from the eastern hemisphere have been assigned to it. The chief distinguishing characters are the following: face broader than long; tegmina rather narrow elongate with the costal membrane wider than the costal cell; 2 regular subapical lines about equidistant from each other and from the apical border, both connected with the costal vein; the first subapical line slightly undulate; the longitudinal veins beyond the second subapical line mostly bifurcate.

Ormenis retusa Fabr.

This species was described from French Guiana and there is a single specimen in

the present collection which I place here. It may be recognized by its small size, about 10 mm. in length, with the usual generic characters and in general of a pale greenish color with the wings strongly powdered with white wax and the veins and cross veins dull orchraceous orange.

Anormenis Melichar, 1923a:68.

Orthotype *Anormenis tortricina* Germ.

This genus was described to include those American species of the *Ormenis* group which have a very short, broad crown and a forehead as long as or longer than broad with the median carina indistinct or indicated dorsad only. The tegmina have 2 nearly parallel subapical lines which may be equidistant from each other or closer to each other than the second is to the apical margin, and the costal membrane is usually broader than the costal cell. The present collection contains representatives of 2 species.

Anormenis media Melichar.

This small species was described from Colombia and has been recognized from Panama. The present collection contains 3 specimens from Kartabo which seem to agree in all essential details. It is a small, pale greenish-white species with very irregular subapical lines.

Anormenis nigrolimbata Fowler.

This species was described from Panama and there is a single specimen in the present collection which agrees in most of the details. The face is longer than broad; the tegmina with 2 rather indistinct subapical lines which are about equidistant from each other and the apical border. The general color is pale ivory yellow with a distinct black spot beyond the apex of the clavus and the apical border with quadrate fuscous spots in the cells and the whole apical border clouded with pale smoky brown.

Melormenis Metcalf, 1938a:395.

Orthotype *Melormenis quadripunctata* Fabricius.

This genus has a wide distribution from eastern North America through Mexico, Central America and the West Indies to Brazil and Argentina.

Melormenis may be characterized as follows: face longer than broad, with a fairly distinct median carina; tegmina with a single subapical line some distance from the apical border.

Melormenis regularis Fowl.

This is a small bright green species with the tegmina narrowly infuscated along the costal and apical margins; the tegmina are

elongate and narrow, with the face longer than broad.

This species was described from Mexico. The present collection contains a single specimen from Bartica. This would extend the range of the species to cover most of the Caribbean region.

Eurocerus, n. gen.

Orthotype *Eurocerus sinuata* n. sp.

This genus belongs to that group of the tribe Selizini which has the sutural and apical margins sinuate, not rounded as in the other genera of this group. It differs also from the other genera in this group in having the venation much more irregular and heavier and in having the subapical line very irregular. It differs from *Neocerus* Melichar in having the dorsal margin of the face nearly straight, not triangularly incised, and in having 2 spines on the posterior tibiae. From *Eurocalia* Van Duzee it differs in having the crown short with the lateral margins flaring anteriorly. The base of the crown is overlapped by the extended anterior margin of the pronotum. It differs from both of these genera also in having the costal margin of the hind wings sinuate.

Eurocerus sinuata n. sp.

(Pl. II, figs. 4, 9).

Crown about twice as broad as its median length; longer than the pronotum. Frons slightly broader than the median length; the lateral margin broadly rounded and then constricted to the narrower clypeus. The dorsal margin nearly straight, not deeply incised as in *Neocerus*. Clypeus broadly inserted in the frons.

General color ochraceous buff marked with black and dark fuscous. The dorsal margin of the crown is blackish shading to fuscous laterad and ventrad. This blackish mark is continued as a median stripe across the crown and as a dark cloud across the pronotum and mesonotum. Tegmina ochraceous buff marked with spots and clouds of black and blackish-fuscous. The costal margin is marked with dark and the apical third of the tegmina is chiefly dark. The tubercles on the clavus are chiefly black. Hind wings fuscous. Length to apex of the tegmina 8.5 mm.

Described from a single female from Kartabo.

Holotype No. 1961, September 12, 1919.

Carthaeomorpha Melichar, 1902a:33.

Logotype *Carthaeomorpha rufipes* Mel.

Crown broad and short, nearly four times as broad as long; anterior and posterior margins nearly parallel, broadly curved; with a distinct carina separating the crown from forehead. Forehead slightly longer than broad; flat, lateral margins strongly

elevated, broadly curved; median carina distinct dorsad. Tegmina large; apex truncate; sutural angle strongly produced; venation reticulate; longitudinal veins distinct; costal cell broader than the costal membrane; media branched before the first cubital sector. Hind tibiae with 2 spines on the apical third.

Carthaeomorpha rufipes Mel.

General color bright grass green fading to ochraceous orange. Transverse carina of the head, anterior, intermediate, and posterior tarsi tinged with bright red. Commisural margin narrowly fuscous; conspicuous row of fuscous granules along the second claval vein; 2 small black dots in the middle of the corium, each surrounded by a rust red border.

This species was described from Colombia and has been recorded from Panama. The present specimen will extend its range eastward in the Caribbean region.

Flatoidinus Melichar, 1923a:117.

Orthotype *Poeciliptera convivus* Stål.

In this genus the crown is broader than long but the head is narrower than the pronotum. The pronotum is about as long as the crown with the mesonotum broader than long; forehead elongate; tegmina elongate; costal margin about twice as broad as costal cell; 2 irregular subapical lines, the second short; hind tibiae with 2 spines.

Flatoidinus kartaboensis, n. sp.

(Pl. III, figs. 5, 15).

This is a very variable but distinct species with costal margin of the tegmina faintly undulate; the crown conically produced on the median area only. While the colors are very variable, the following markings seem to be constant: a blackish spot at the apex of the head, a brownish triangular spot at about the middle of the clavus which extends almost completely across the clavus. Crown about twice as broad as long; the median area produced in a broad flat cone; the lateral carinae projecting distinctly in front of the compound eyes. Frons elongate, the lateral margin strongly elevated; median carina wanting; pronotum with the median area broad and flat almost semi-circular in outline; the posterior margin shallowly incised; mesonotum with the median area strongly elevated, bordered by heavy carina. Tegmina elongate, narrow, somewhat narrowed apically; the costal margin softly undulate; the 2 subapical lines nearly equidistant from each other and the apical margin; costal membrane about twice as broad as the greatest width of the costal cell; venation fairly distinct; hind tibiae with 2 spines.

Color very variable, ranging from dull

ivory white to dull olive green. Dark markings also very variable. In some specimens the head, pronotum, mesonotum and tegmina are heavily dotted with fuscous and black. In other specimens the dark markings are almost completely wanting. The round fuscous spot at the apex of the head, 2 pairs of spots on the lateral fields of the mesonotum and the brownish triangle at the middle of the clavus seem to be constant.

Length to the apex of the tegmina 8 mm.

Holotype: ♂; Kartabo, Bartica District, British Guiana, July 17, 1922.

Allotype: ♀; Kartabo, Bartica District, British Guiana, April 2, 1924.

Paratypes: 1 ♂; April 5, 1920; 1 ♀; March 8, 1924, all from Kartabo.

FAMILY ACANALONIIDAE.

This is a small family of about 13 genera and 62 species. The species thus far described are known only from North and South America and Africa, a single species having been described from Christmas Island in the Indian Ocean.

In this family the tegmina are large, held vertical in repose. In this respect they resemble members of the family Flatidae. They differ from the Flatidae in lacking a costal area and in having the clavus not granulate. Acanalonids resemble issids somewhat but the tegmina are generally larger in the acanalonids; the hind tibiae are without spines.

Acanalonia Spinola, 1839b:447.

Haplotype *Acanalonia servillei* Spin.

This is the well known North and South American genus with about 45 or 50 species, many of which are widely distributed in North and South America. Some species range from the southern United States to Brazil. A number of species have been recorded previously from Mexico, Central America, West Indies and Brazil, but none have heretofore been recorded from British Guiana.

Head, including the eyes, narrower than the pronotum; crown broad, median length much shorter than the width between the eyes, usually gently rounding into the face. The anterior margin of the crown usually broadly rounded, sometimes somewhat angulate. Face with the lateral margin usually broadly rounded and sharply carinate. Median carina usually present, sometimes very conspicuous. Clypeus without lateral carinae. Pronotum broad and short with anterior margin sometimes broadly projecting between the eyes. The posterior margin usually broadly, angulately emarginate. Mesonotum large; tegmina large with costal and posterior margins broadly rounded. The entire surface of the tegmina closely re-

ticulate with the longitudinal veins conspicuous at the base only.

Acanalonia umbraculata Fabr.

This well known South American species has been widely recorded in Brazil from as far south as Rio de Janeiro to the Amazon Valley and in Bolivia. There is a small series in the present collection from Bartica, British Guiana.

The general color is green shading to cinnamon buff on the thorax, head and legs; eyes brown, lateral carinae of the face brown; tegmina with a row of marginal brown dashes starting near the apex of subcosta and extending around the apical margin and fading out on the commissural margin of the clavus.

Length to the apex of the tegmina 10 to 11 mm.

FAMILY ISSIDAE.

The present collection contains 2 species from this family which I have identified as *Thionia coriacea* Fabr. and *Colpoptera marginalis* Burm.

Thionia Stål.

Thionia coriacea Fabr.

This species has been recorded previously from Brazil and Panama. It is a small dark-colored species about 8.5 mm. in length, broadly oval with a crown about twice as broad as long. The forehead is subquadrate and there are no conspicuous markings of any kind.

There is a single teneral specimen of what I believe is this species. The species may be recognized in its fully developed condition by its dark color, by the broad crown, and by the pale stigmatal spot.

Colpoptera Burmeister.

Colpoptera marginalis Burm.

This species has been recorded previously from Mexico and Central America. So far as I know, this is the first record of this species from South America.

FAMILY NOGODINIDAE.

This family has been included previously as a sub-family of the Ricaniidae but as has been pointed out by Muir, it is more closely related to the Issidae. Only a single species is included in the present collection.

Nogodina Stål.

Haplotype *Flata reticulata* Fabr.

In this genus the forehead is longer than broad with the lateral margins elevated and a distinct percurrent median carina. The tegmina are large; the costal membrane is crossed by numerous cross veins. There is a single subapical line parallel to the apical margin.

***Nogodina reticulata* Fabr.**

Reticulata has a wide range from Central America to Brazil. The typical form is well represented in the present collection.

FAMILY LOPHOPIDAE.

This is a small family comprising about 37 genera and 180 described species. All the species are confined to the eastern hemisphere with the exception noted below.

***Hesticus* Walk., 1862e:305.**

Haplotype *Hesticus pictus* Walk.

This genus is a somewhat anomalous one. It was placed by Walker in the family Dictyopharidae. It has a general resemblance to certain members of the family Tropiduchidae, especially in the well developed cross lines on the apical third of the tegmina. In the characters of the hind tarsi, however, it clearly belongs in the family Lophopidae where Muir has placed it. In this genus the head is narrower than the pronotum. The crown is longer than broad, bounded anteriorly by the branches of the median carina of the frons; frons narrow, elongate, the lateral carinae strongly elevated, especially ventrad, median carina distinct especially dorsad where it branches, a very indistinct transverse carina on the dorsal part of the frons. Clypeus large, lateral carinae strongly, rotundately elevated dorsad. Antennae elongate with second segment about four times as long as the first segment; sides parallel. Pronotum short and broad, somewhat overlapping the crown; posterior margin incised; median and strongly curving lateral carinae distinct. Mesonotum large, tricarinate. Tegmina elongate, transparent; subcosta and radius united to near the first cross line where they branch in what appears to be radius 1 plus subcosta and radial sector; subcosta with about 4 branches to the costal margin, forming an indefinite stigma; radius 1 with 3 or 4 branches to the costal margin; radial sector branching at the cross lines into 2 branches; media unbranched before the cross vein where it branches into 3 distinct branches; subcosta 1 branching before the cross line; cross veins in the apical third of the tegmina forming a distinct subapical line. Fore femora and tibiae broadly flattened; tarsi slender; middle and hind legs elongate; hind tibiae with 3 spines laterad and irregular rows of spines at the apex; hind basi-tarsus elongate, slender; second segment of hind tarsus long, without spines.

***Hesticus pictus* Walk.**

(Pl. II, figs. 5, 6, 10).

This species was described from Brazil. There is a single specimen in the present collection from Kartabo. The general color

of the head and thorax is pale orange yellow. The abdomen is bright red and the fore femora and tibiae are also bright red in color. The eyes and antennae are chiefly scarlet with a patch of the same color in front of the eyes and on the lateral fields of the pronotum. There is an indefinite pale scarlet stripe along the median line of the mesonotum. Sub-basal area of the clypeus is fuscous. This color extends across the sides of the pro- and mesonotum toward the tegulae. The apices of all the femora and tibiae are clouded with fuscous. In the tegmina, the stigmal spot is blackish-fuscous as are the two cross lines and a large area on the apical margin.

APPENDIX.**Field Data of the Study Material.*****Bothriocera bicornis*.**

4 specimens: 130 (May 5); 201626 (May 12); 20918 (July 15); 20404 (Oct. 22).

***Olarus beebei* n. sp.**

4 specimens: Holotype, 241017 (March 10); Allotype, 221148 (March 27); Paratypes, 221149 (May 30); 221150 (Oct. 8).

***Pintalia castanea* n. sp.**

1 specimen: Holotype, 241018 (April 3).

***Eucanyra bifurcata* n. sp.**

1 specimen: Holotype, 201628 (May 6).

***Mysidia squamigera*.**

1 specimen: 241019 (March 6).

***Mysidia costata*.**

1 specimen: 201627 (Oct. 22).

***Mysidia rubra* n. sp.**

1 specimen: Holotype, 20572 (May 14).

***Neocenchrea ochracea* n. sp.**

1 specimen: Holotype, 241020 (March 4).

***Syntames serratus* n. sp.**

1 specimen: Holotype, 241021 (March 28).

***Anotia rubescens*.**

1 specimen: 201629 (July 7).

***Cathedra serrata*.**

1 specimen: 241022 (May 15) (Color Plate 739).

***Fulgora laternaria*.**

1 specimen: 201638 (June 18).

***Aracynthus sanguineus*.**

1 specimen: 221151 (July 4).

***Lystra lanata*.**

22 specimens: 221155 (Feb. 15); 241023 (March 4); 241024 (March 4); 221152

(March 18); 221153 (April 16); 1957 (June 6); 201630 (June 9); 241025 (June 11); 201632 (June 22); 201633 (June 22); 1958 (June 30); 1959 (July 4); 221156, 221157, 221158, 221159, 221160 (July 10); 2262 (Aug. 2); 221154 (Aug. 6); 201631 (Aug. 23); 20545 (Aug. 23); 20567 (Aug. 23).

Calyptoproctus elegans.

2 specimens; 1960 (June 24); Hemip. 282 (Feb. 4).

Calyptoproctus marmoratus.

1 specimen: 221161 (April 2).

Enchophora tuba.

1 specimen: 22158 (July 6).

Dictyophara brachyrhina.

5 specimens: Hemip. 16-301 (Feb. 16); 241026 (May 2); 221162 (May 18); 241027 (June 1); 221163 (May 18).

Dictyophara platyrhina.

11 specimens: 241028 (March 3); 221164 (March 17); 221165 (April 1); 241029 (May 6); 221166 (July 18); 221167 (July 19); 221168 (Aug. 4); 221169 (Aug. 4); 2067 (Sept. 1); 201634 (Oct. 21); 20330 (Oct. 6).

Dictyophara beebei n. sp.

4 specimens: Holotype, 241030 (Feb. 29); Allotype, 241031 (March 11); Paratypes 241032 (March 10); 241033 (July 19).

Taosa muiri n. sp.

1 specimen: Holotype, 16-131 (March 4).

Taosa (Cuernavaca) paraherbida.

1 specimen: Hemip. 16-328 (March 10).

Hydriena distanti.

3 specimens: 241036 (May 16); 241034 (April 24); 241035 (July 25).

Lappida fusca.

1 specimen: 221186 (May 20).

Alcestis surinamensis.

3 specimens: 221171 (May 24); 221170 (Sept. 2); 20979 (Nov. 5).

Poekilloptera phalaenoides.

6 specimens: (Georgetown, 16245 (Feb. 12); 221172 (April 3); 221173 (April 3); 16251 (March 4); 241037 (May 3); 241038 (May 6).

Leptormenis confusa.

1 specimen: 221174 (March 31).

Ormenis retusa.

1 specimen: 241039 (April 18).

Anormenis media.

4 specimens: 221176 (March 29); 241049

(May 3); 221175 (Aug. 4); 221177 (Sept. 2).

Anormenis nigrolimbata.

1 specimen: 241047 (Feb. 29).

Melormenis regularis.

1 specimen: 241042 (April 6).

Eurocerus sinuata n. sp.

1 specimen: 1961 (Sept. 12).

Carthaeomorpha rufipes.

1 specimen: 221178 (May 29).

Flatoidinus kartaboensis n. sp.

3 specimens: Holotype, 221179 (July 11); Allotype, 221180 (April 2); Paratype, 201635 (June 5).

Acanalonia umbraculata.

3 specimens: 221182 (March 26); 221181 (March 29); 221183 (May 19).

Thionia coriacea.

2 specimens: 201636 (Aug. 14); 201637 (Aug. 14). Both 60 feet up trees.

Colpoptera marginalis.

1 specimen: 241043 (March 6).

Nogodina reticulata.

5 specimens: 221184 (March 20); 221185 (March 23); 241044 (May 6); 241045 (June 4); 216 (Aug. 3).

Hesticus pictus.

1 specimen: 24958 (May 10).

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EXPLANATION OF THE PLATES.

PLATE I.

- Fig. 1. *Oliarus beebei* n. sp. Dorsal view of head and thorax.
 Fig. 2. *Oliarus beebei* n. sp. Ventral view of ♂ genitalia.
 Fig. 3. *Oliarus beebei* n. sp. Lateral view of ♂ genitalia.
 Fig. 4. *Pintalia castanea* n. sp. Frontal view of head.
 Fig. 5. *Pintalia castanea* n. sp. Dorsal view of head and thorax.
 Fig. 6. *Pintalia castanea* n. sp. Lateral view of ♂ genitalia.
 Fig. 7. *Pintalia castanea* n. sp. Ventral view of ♂ genitalia.
 Fig. 8. *Eucanyra bifurcata* n. sp. Ventral view of ♂ genitalia.
 Fig. 9. *Mysidia rubra* n. sp. Lateral view of ♂ genitalia.
 Fig. 10. *Neocenchrea ochracea* n. sp. Dorsal view of head and thorax.
 Fig. 11. *Neocenchrea ochracea* n. sp. Frontal view of head.
 Fig. 12. *Syntames serratus* n. sp. Dorsal view of head and thorax.
 Fig. 13. *Neocenchrea ochracea* n. sp. Ventral view of ♀ genitalia.
 Fig. 14. *Syntames serratus* n. sp. Ventral view of ♀ genitalia.
 Fig. 15. *Eucanyra bifurcata* n. sp. Lateral view of ♂ genitalia.

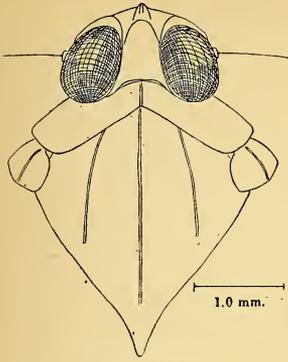
PLATE II.

- Fig. 1. *Dictyophara beebei* n. sp. Ventral view of ♂ genitalia.
 Fig. 2. *Dictyophara brachyrhina* Walk. Lateral view of ♂ genitalia.
 Fig. 3. *Taosa muiri* n. sp. Lateral view of ♂ genitalia.
 Fig. 4. *Eurocerus sinuata* n. sp. Dorsal view of head and thorax.
 Fig. 5. *Hesticus pictus* Walk. Ventral view of ♂ genitalia.
 Fig. 6. *Hesticus pictus* Walk. Lateral view of ♂ genitalia.
 Fig. 7. *Taosa muiri* n. sp. Ventral view of ♂ genitalia.

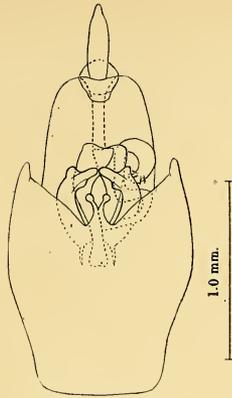
- Fig. 8. *Alcestis surinamensis* Schmidt. Frontal view of head.
 Fig. 9. *Eurocerus sinuata* n. sp. Right tegmen.
 Fig. 10. *Hesticus pictus* Walk. Dorsal view of head and thorax.
 Fig. 11. *Taosa paraherbida* Muir. Dorsal view of head and thorax.
 Fig. 12. *Syntames serratus* n. sp. Frontal view of head.
 Fig. 13. *Mysidia rubra* n. sp. Ventral view of ♂ genitalia.
 Fig. 14. *Hydriena distanti* Mel. Ventral view of ♂ genitalia.
 Fig. 15. *Alcestis surinamensis* Schmidt. Right tegmen.

PLATE III.

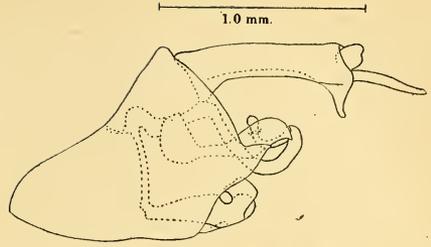
- Fig. 1. *Alcestis surinamensis* Schmidt. Lateral view of ♂ genitalia.
 Fig. 2. *Taosa muiri* n. sp. Dorsal view of head and thorax.
 Fig. 3. *Dictyophara beebei* n. sp. Lateral view of ♂ genitalia.
 Fig. 4. *Lappida fusca* n. sp. Dorsal view of head and thorax.
 Fig. 5. *Flatoidinus kartaboensis* n. sp. Ventral view of ♂ genitalia.
 Fig. 6. *Alcestis surinamensis* Schmidt. Ventral view of ♂ genitalia.
 Fig. 7. *Hydriena distanti* Mel. Frontal view of head.
 Fig. 8. *Dictyophara platyrhina* Walk. Ventral view of ♂ genitalia.
 Fig. 9. *Hydriena distanti* Mel. Lateral view of ♂ genitalia.
 Fig. 10. *Alcestis surinamensis* Schmidt. Dorsal view of head and thorax.
 Fig. 11. *Hydriena distanti* Mel. Dorsal view of head and thorax.
 Fig. 12. *Dictyophara brachyrhina* Walk. Ventral view of ♂ genitalia.
 Fig. 13. *Dictyophara platyrhina* Walk. Dorsal view of head and thorax.
 Fig. 14. *Dictyophara platyrhina* Walk. Lateral view of ♂ genitalia.
 Fig. 15. *Flatoidinus kartaboensis* n. sp. Lateral view of ♂ genitalia.



Oliarus beebii Metc.

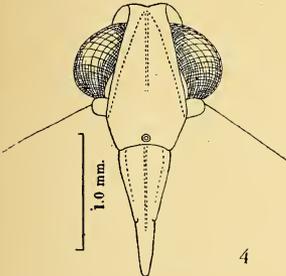


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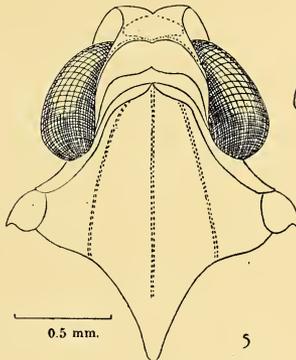


Oliarus beebii Metc.

3

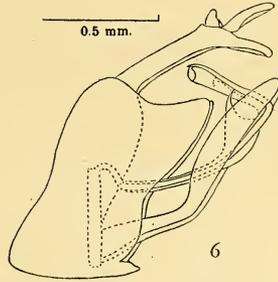


Pintalia castanea Metc.



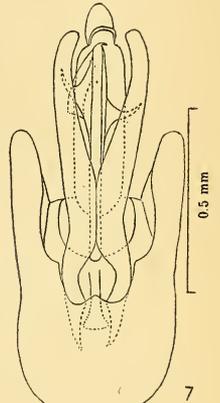
Pintalia castanea Metc.

5



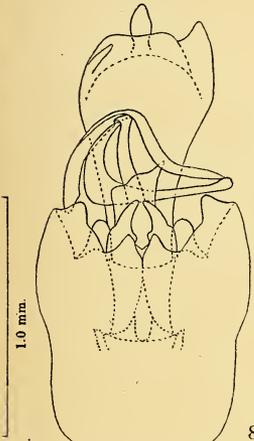
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6



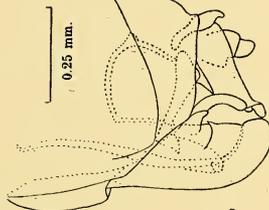
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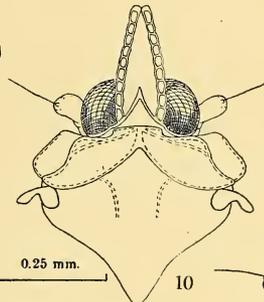
Eucanyra bifurcata Metc.

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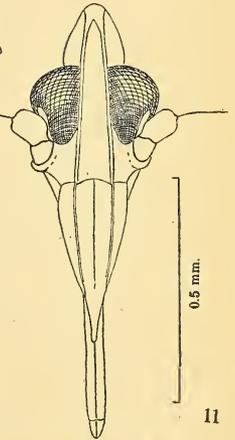
Mysidia rubra Metc.

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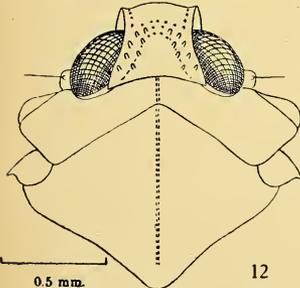
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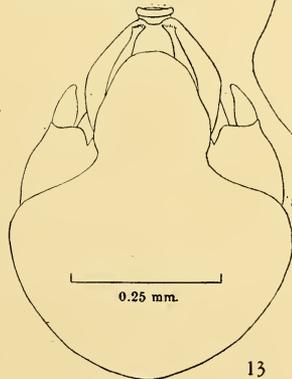
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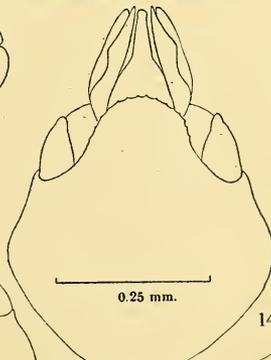
Syntames serratus Metc.

12



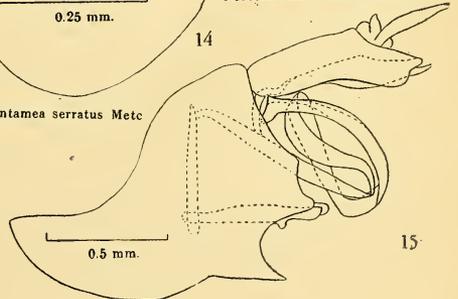
Neocenchrea ochracea Metc.

13



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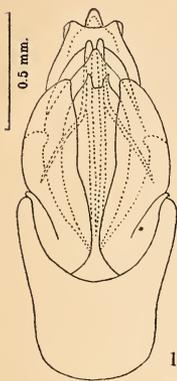
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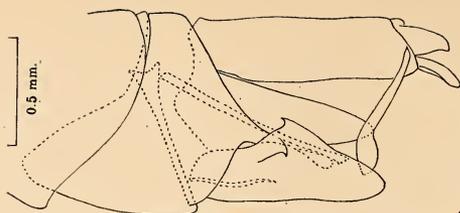
Eucanyra bifurcata Metc.

15

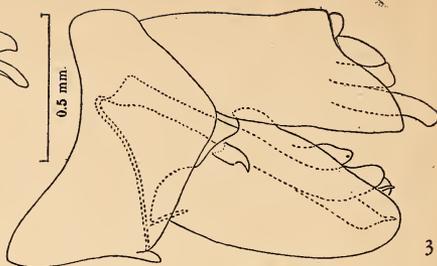
Sue D Sparks, del.



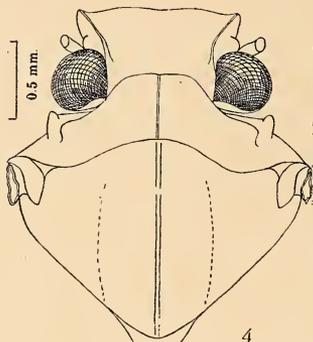
Dictyophara beebii Metc.



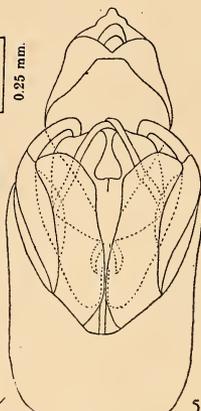
Dictyophara brachyrhina Walk.



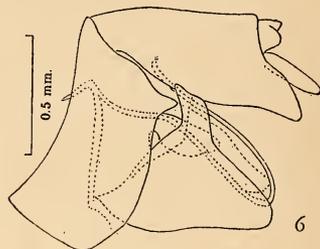
Taosa muiri Metc.



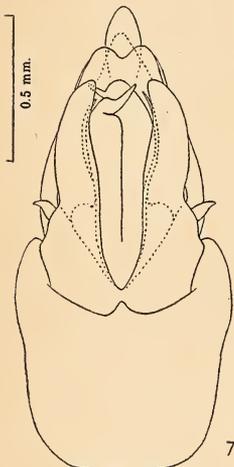
Eurocerus sinuata Metc.



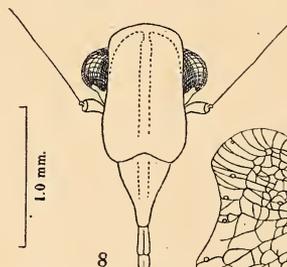
Hesticus pictus Walk.



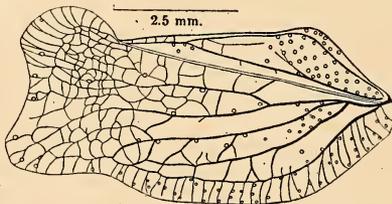
Hesticus pictus Walk.



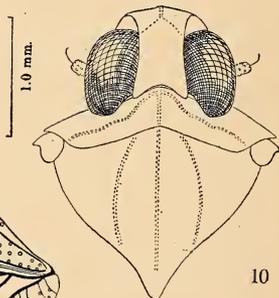
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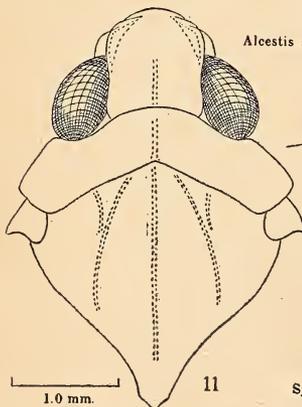
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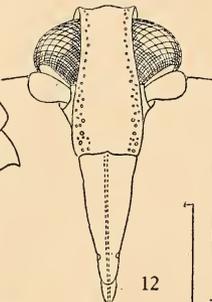
Eurocerus sinuata Metc.



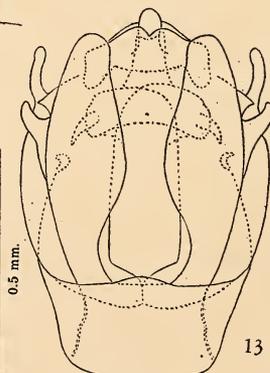
Hesticus pictus Walk.



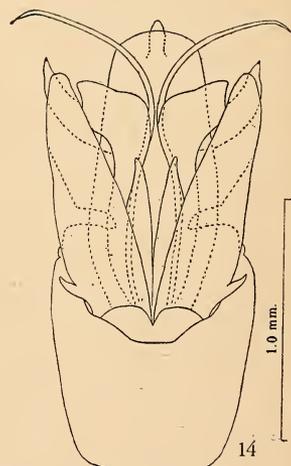
Taosa paraherbida Muir



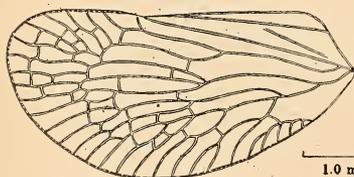
Syntames serratus Metc.



Mysidia rubra Metc.



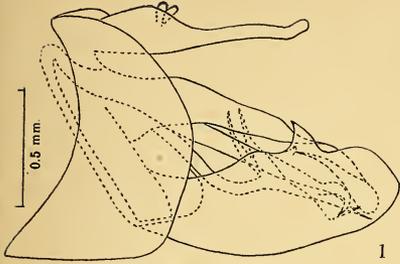
Hydriena distanti Mel.



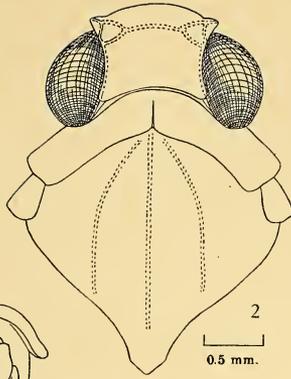
Aleestis surinamensis Schmidt

Sue D Sparks, del.

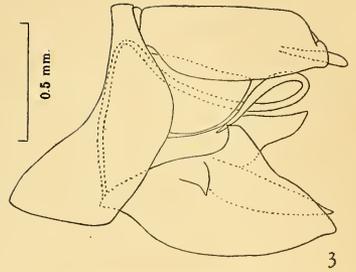
FULGOROIDEA (HOMOPTERA) OF KARTABO, BARTICA DISTRICT, BRITISH GUIANA



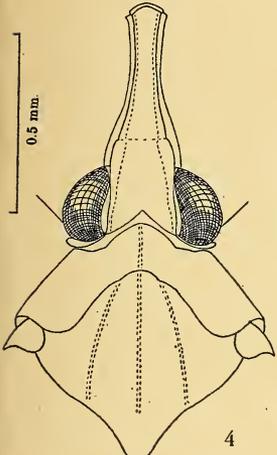
Alcestis surinamensis Schmidt



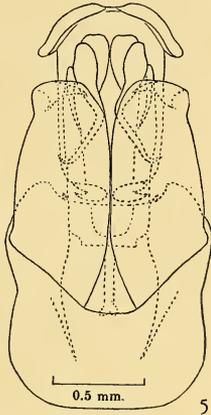
Taosa muiri Metc.



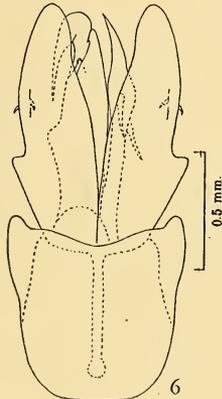
Dictyophara beebei Metc.



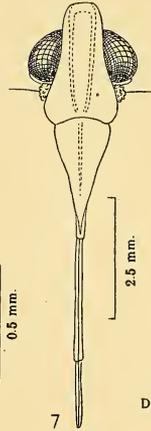
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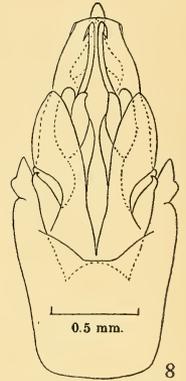
Flatoidinus kartaboensis Metc.



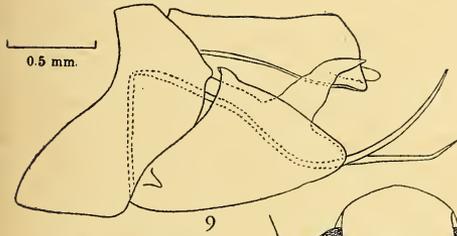
Alcestis surinamensis Schmidt



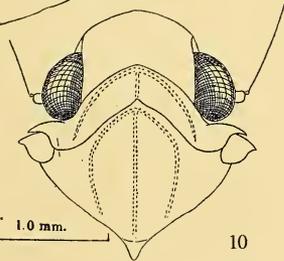
Hydriena distanti Mel.



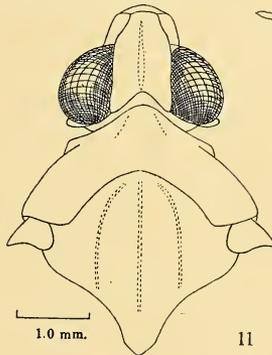
Dictyophara platyrhina Walk.



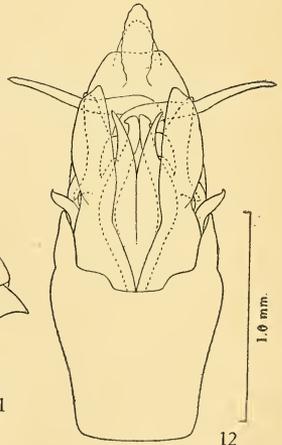
Hydriena distanti Mel.



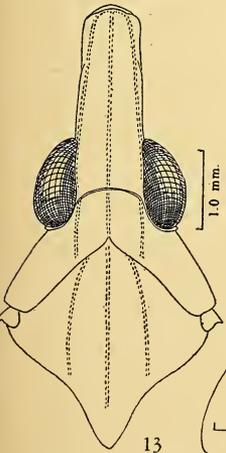
Alcestis surinamensis Schmidt



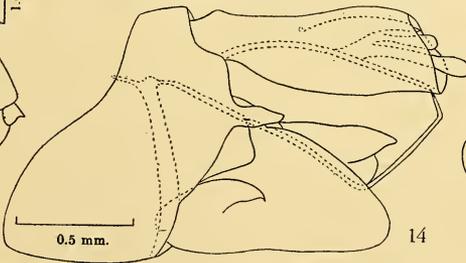
Hydriena distanti Mel.



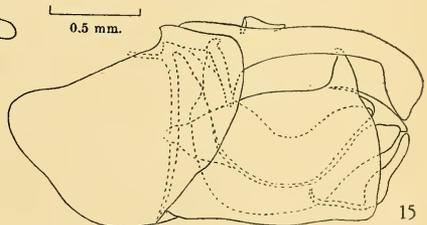
Dictyophara brachyrhina Walk.



Dictyophara platyrhina Walk.



Dictyophara platyrhina Walk.



Flatoidinus kartaboensis Metc.

Sue D Sparks, del.

FULGOROIDEA (HOMOPTERA) OF KARTABO,
BARTICA DISTRICT, BRITISH GUIANA



15.

Plankton of the Bermuda Oceanographic Expeditions. XI. Bathypelagic Nemerteans of the Bermuda Area and Other Parts of the North and South Atlantic Oceans, with Evidence as to Their Means of Dispersal.¹

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Osborn Zoological Laboratory, Yale University,
and the Scripps Institution of Oceanography,
University of California.²

(Plates I and II; Text-figures 1-26).

[This is one of a series of papers dealing with the plankton collections of the Bermuda Oceanographic Expeditions of the Department of Tropical Research, New York Zoological Society, made under the direction of Dr. William Beebe during the years 1929, 1930 and 1931. For complete trawling data, refer to Beebe, *Zoologica*, Vol. 13, Nos. 1 (1931), 2 (1931) and 3 (1932).]

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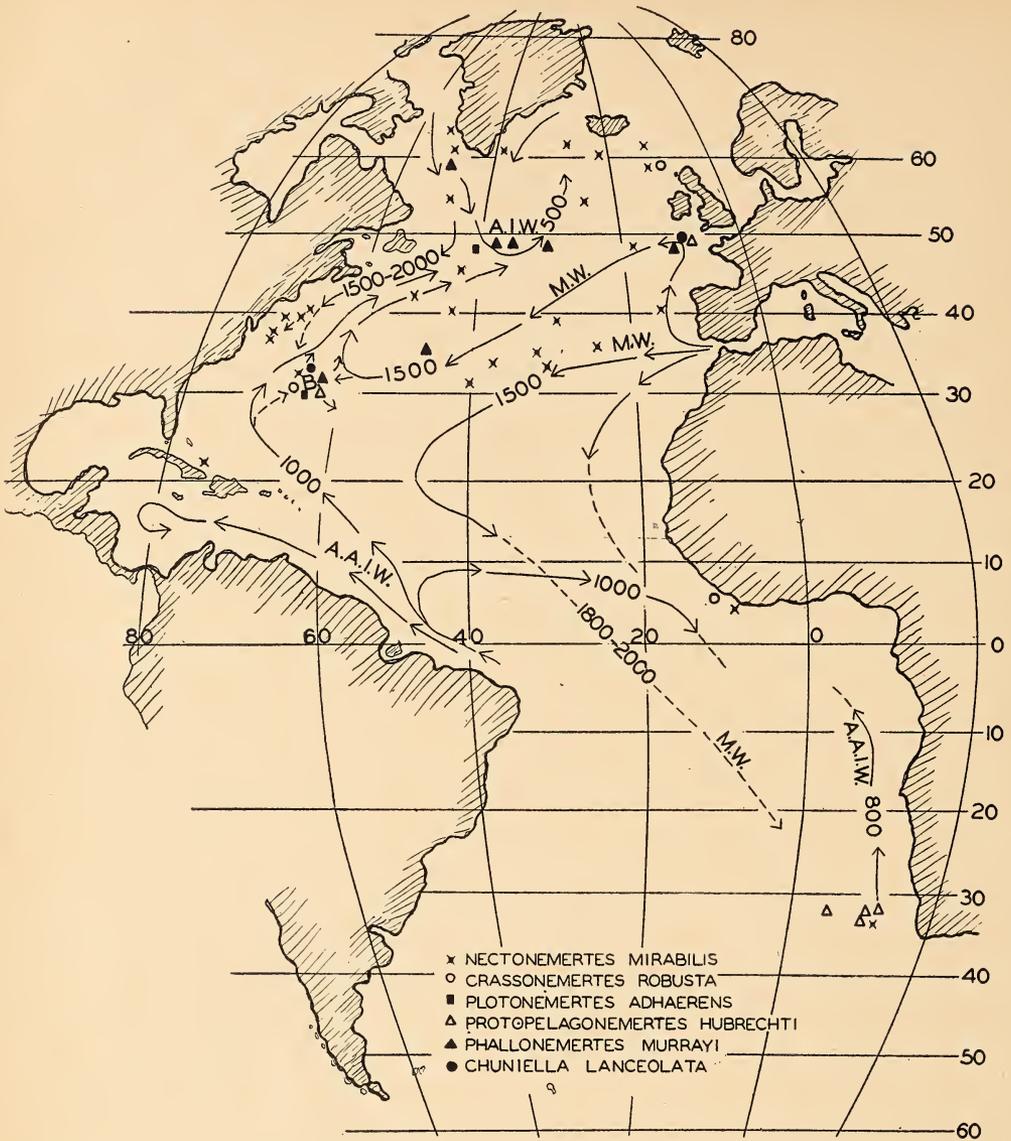
INTRODUCTION.

Previous reports (Coe, 1935, 1936) on the bathypelagic nemerteans taken in the years 1929, 1930 and 1931 by the Bermuda Oceanographic Expeditions of the New York Zoological Society under the direction of Dr. William Beebe contained an account of the 79 specimens which were available for study at that time. These included 12 species belonging to 10 genera, of which 6 species and one genus were new to science. The collections also contained material which made possible the description of both sexes in 4 species of which only one of the two sexes had been previously described.

The 1936 report was illustrated by photo-

¹Contribution No. 716, Department of Tropical Research, New York Zoological Society.

²Contributions from the Scripps Institution of Oceanography, New Series No. 261.



TEXT-FIG. 1. Correlation of the distribution, insofar as at present known, of six of the species of bathypelagic nemertean found in the Bermuda area with the approximate directions of flow of the water masses which they inhabit. Numerals indicate the approximate distances from the surface at which the intermediate water masses are flowing. Broken lines are used for less well authenticated currents. Abbreviations indicate: **A.I.W.**, arctic intermediate water; **A.A.I.W.**, antarctic intermediate water; **M.W.**, Mediterranean water; **B.**, Bermuda area. (Modified from Sverdrup, Johnson and Fleming, "The Oceans," 1942, with additional data through the courtesy of Dr. Sverdrup).

graphs of preserved specimens of each species, as well as by drawings showing the internal anatomy. Descriptions were given of such of the morphological details of each species as had not been previously reported. Information was also included as to the depth at which each specimen was found, together with the geographical distribution of the species as known up to that time.

The present, supplementary, report is based upon additional material which was collected at the same time as that included in the earlier reports and which has since become available for study. It includes descriptions and figures of two new species, *Mononemertes scarlata* and *Parabalaena-nemertes nigra*, and the diagnosis of one new genus, *Calonemertes*.

DISTRIBUTION.

The collections were all made by Dr. William Beebe in a relatively minute portion of the deep subtropical Atlantic Ocean. This portion was a circular column of water eight miles in diameter, with its center located at 32°12' N. Lat., 64°36' W. Long., about nine miles southeast of Nonsuch Island, Bermuda. The nets were drawn horizontally across this area so as to collect samples simultaneously at 200-meter intervals from depths of about 1,000 to 2,000 meters. During the years 1929, 1930 and 1931 a total of 1,042 nets one meter in diameter were drawn at these depths in all directions across this eight-mile cylinder of water.

Because of the fact that the nets were drawn to the surface while still open, there is always a possibility that any particular individual may have actually been caught at a higher level than that at which the net was drawn horizontally. However, if the same species was not also caught in any of the nets drawn horizontally at the higher levels there is small probability that the species lives there.

The nets were drawn horizontally for periods of about four hours after the bottom net had reached the depth of about 2,000 meters and then drawn vertically to the surface. It must be remembered, however, that the nets did not enter exactly the same water in successive years nor even in successive days, for the ocean currents are constantly transporting the water from one portion of the ocean to another. Through the agency of these currents the constituent planktonic fauna of any particular water mass is being slowly but continually distributed to other geographical areas.

Because of this continuous flow of the water masses the actual volume of water through which the nets passed during the three summers must have been vastly greater than that of an equal cylinder of stationary water. The water masses at the locality mentioned during the summer of one year were doubtless far distant the following summer and the bathypelagic fauna collected on any particular date must have arrived at that locality just in time to be caught by the nets. We may therefore assume that the sexually mature worms contained in the collections studied may have originated as young individuals some miles distant and that their offspring may live in some other part of the ocean not too far away.

It must not be assumed, however, that these water masses with their suspended faunas are flowing like a river in a single direction, for oceanographers have determined that the generally onward movement

of the water is the resultant of innumerable streams with side eddies flowing in all directions. Hence it is not inconceivable that an individual which may have once narrowly escaped the net in the Bermuda area may nevertheless have been caught in the same net at the same place some weeks or months later, after having made a circuit outside the area in the meantime.

The water layer which forms the habitat of most species of bathypelagic nemerteans lies at a depth of 1,200 to 2,000 or more meters in the Bermuda area. The temperature averages about 4° Centigrade, being 5.3° at 1,200 meters and 3.5° at 2,000 meters. The salinity is from 34.99 to 35.08 parts per thousand. Water masses with these characteristics are continuous throughout the North Atlantic, being at a higher level in the north and deeper in the south. Because of the low temperatures at these depths, the viscosity of the water is sufficient to enable the nemerteans with their horizontally flattened, gelatinous bodies to support themselves with a minimum of muscular effort.

The region off the coast of Bermuda where the collections were made is particularly favorable for a wide variety of bathypelagic animals because of the admixture of ocean waters derived from several widely separated sources (Sverdrup, Johnson and Fleming, 1942)³. Such evidence as is at present available indicates that the intermediate ocean water which the nemerteans inhabit, at depths of 1,200 to 2,000 meters, has a large component of water of subantarctic origin (Text-fig. 1). This moves in a generally northerly direction at a rate which has been estimated as at least one-half centimeter per second or perhaps 400 meters per day. That would indicate a movement approaching one mile in four days. If it could be assumed that such a flow is continuous and at a rate of approximately 90 miles per year, it would require a period of only about 40 to 50 years to bring a population of these worms from the South Atlantic to the Bermuda area. From the Bermuda area the population may be carried farther to the north or deflected toward the east and thence to the middle Atlantic. Other currents may return the population southward and thence to the South Atlantic.

A second source of the intermediate water off Bermuda is a current originating in the subarctic region of the Atlantic (Text-fig. 1). This flow is less well differentiated than that from the South Atlantic but it doubtless brings from higher levels

³ For additional data relative to the movements of these water masses of intermediate depths, the writer is indebted to Dr. H. U. Sverdrup, Director of the Scripps Institution of Oceanography.

in the north, water which sinks to greater depths off Bermuda. Consequently it need occasion no surprise to find that *Nectonemertes mirabilis*, which may be found only 500 meters from the surface in the seas near Greenland, lives at depths of 1,300 to 1,800 meters or lower in the Bermuda area. After mixing with the South Atlantic water the flow may return northward or be diverted toward the eastern North Atlantic.

A third source of water which may mingle with the flows from north and south already mentioned is the Mediterranean outflow (Text-fig. 1). Although there are no bathypelagic nemerteans in the Mediterranean Sea, the populations in the eastern North Atlantic may be brought into the currents of mixed water as they flow from east to west through the central North Atlantic.

Hence, it may be expected that populations from any or all of these and perhaps from other sources may be found drifting past the Bermuda area in one direction or another whenever a net is lowered to the depth at which each species finds the conditions for survival and reproduction most favorable. But the populations encountered may differ from month to month or even from day to day, although one species, *Nectonemertes mirabilis*, appears to be present at all times. This species is found not only in the Bermuda area but also throughout the North Atlantic and it has also been reported from the South Atlantic. (Text-fig. 1). Hence it is obvious that no matter what may be the direction of the flow at the time of the collection or from whence the water may have come, that species will always be present, either in the net or in the vicinity.

Another species, *Plotonemertes adhaerens*, seems to find the mixed waters of the Bermuda area particularly favorable for reproduction, since a total of 35 representatives of this species has been obtained in that area, while only a single specimen has as yet been found in all the rest of the oceans. It is possible however that the nets used elsewhere were not lowered to the appropriate depth, for this species lives near the lowest limits reached by any of the nets in the Bermuda area. The single specimen known from the middle North Atlantic was likewise taken in the lowest net. Consequently the lowest limit of the population has not been determined.

The fact that in several cases only a single specimen of a species was obtained in a total of more than 600 nets lowered to the depth at which that specimen was found and drawn there horizontally for four hours indicates how sparse must have been the population at those levels and at those times. It may have been only a lucky

chance that brought the net to the exact position occupied at that moment by the nemertean. Or perhaps by an unlucky chance the nets barely missed catching other individuals. At lower levels or at other times it is quite conceivable that the results might have been different.

With a drifting population which may be carried in various directions throughout the vast expanse of the North and South Atlantic oceans, the chances of finding with a one-meter net even a single representative of a species composed of millions of individuals must be very small. It seems highly probable, moreover, that portions of the population may be carried to levels or to regions unfavorable for survival, perhaps too near the surface or to too great depths. These nemerteans, however, in spite of their feeble musculatures, have some capacity for resisting such currents as might tend to carry them above or below the level of their natural habitats. Individuals of *Nectonemertes mirabilis* and *Pelagonemertes rollestoni* have been observed to swim with considerable vigor for a brief period in spite of the great changes in temperature and pressure which they must have endured while being brought from their natural depths to the surface.

The influence of eddies and returning currents may be of great importance in the localization of populations and it is not improbable that there are some regions where a species could remain within a more or less closely circumscribed area indefinitely. From such an endemic area representatives of the species might be carried to distant parts of the ocean, reproducing successive generations on the way.

If the direction and extent of these deep ocean currents were fully known it would be possible to predict the probable distribution of such of the bathypelagic species as inhabit particular water masses. And conversely the distribution of the various species of these nemerteans will doubtless furnish reliable clues as to the extent of the movement of water masses having physical and chemical characteristics to which they are adapted.

If the oceanographers had not already obtained satisfactory evidence of the transfer of South Atlantic water northward across the equator, the known distribution of *Nectonemertes mirabilis* and other species would indicate that the water mass which they inhabit, actually does move across the equator (Text-fig. 1). But since the place of origin of that species is unknown there would be no evidence as to whether the water flows north or south.

With the information now available as to the circulation of the Atlantic water

masses, it is not surprising to find that the species mentioned appears to be distributed all the way from the South Atlantic to the seas east and west of southern Greenland. It has already been found in the South Atlantic west of South Africa, in the equatorial Atlantic, near the West Indies, off the eastern coast of North America, through the width of the North Atlantic to near the coast of Spain and northward to the latitude of southern Greenland. This indicates a range of nearly 100 degrees of latitude, from 34° S. Lat. to 64° N. Lat. (Text-fig. 1).

Protopelagonemertes hubrechtii has likewise been found in the South Atlantic west of South Africa, in the Bermuda area and in the eastern North Atlantic southwest of Ireland. *Crassonemertes robusta* has been reported from the equatorial Atlantic (7° N. Lat.) near the coast of Africa, in the Bermuda area and northwest of Great Britain (58° N. Lat.). These are the only species that have as yet been found both in the tropical or South Atlantic and in the Bermuda area, but it must be remembered that up to the present time relatively few samples of the bathypelagic fauna of the Atlantic between 30° S. Lat. and 30° N. Lat. have been obtained.

Another species with a wide geographical range is *Pelagonemertes rollestoni*, although it has not been found in the Bermuda area nor in any part of the North Atlantic north of 7° N. Lat. This species occurs throughout the entire width of the South Atlantic and it has also been taken in the northern part of the Indian Ocean, as well as far south of Australia. This range covers nearly 180 degrees of longitude and about 55 degrees of latitude. The depth at which the species lives is definitely known, for it has been taken in closing nets at depths between 850 to 1,600 meters (Wheeler, 1934). The great differences in surface temperatures at these far distant regions presumably have little influence on the natural habitat of these worms so far beneath the surface. The general circulation of the water masses at these depths in the southern oceans appears to be such as to aid the distribution of the species from east to west. A northern branch of this circumpolar flow seems to have carried the species northward along the west coast of Africa to a region beyond the equator. (Text-fig. 1).

Only two individuals of *Chuniella lanceolata* are known at present. One of these was found in the Bermuda area and the other in the North Atlantic southwest of Ireland. The former specimen was caught at a depth of about 1,600 meters and the latter at 1,000 meters.

If the collected specimens have been correctly identified, another species with a

wide geographical distribution is *Dinone-mertes investigatoris*, for the type specimen came from the northern Indian Ocean, while two other representatives were taken in the central North Atlantic at Lat. 34° and 48° N. Even if it be assumed that a single population of this species extends at the present time throughout the range indicated, such a population would find essentially uniform conditions in its normal habitat at depths between 1,000 and 2,000 meters in all parts of this wide expanse of oceans. *Nectonemertes minima* has been taken at various localities in the eastern Atlantic oceans, from a point northwest of Ireland, across the equator to near the Cape of Good Hope. This represents a distance of 92 degrees of latitude (57° N. to 35° S.).

As a consequence of this wide circulation of the ocean waters it seems quite possible that all the species of bathypelagic nemerteans that have been found in any part of the North or South Atlantic may at times drift through the Bermuda area. This must likewise be the case with such of the other populations of the bathypelagic faunas as are adapted for drifting along with the currents. Nevertheless Beebe (1937) found that certain populations of fishes in the Bermuda area remained nearly stable for the three successive years when the collections were made. Because of their greater motility, however, the fishes are presumably able to remain in any suitable locality regardless of the movements of the water.

It seems highly improbable, however, that the populations are distributed uniformly over the wide expanse of the oceans between the two or more localities where their representatives have been found. Nor should a species be thought to be restricted to a closely limited area simply because it has been taken at only a single locality. It seems more probable that the populations of one or more species are associated in more or less widely dispersed groups which drift about in the currents or eddies generation after generation as long as the regions to which they are carried offer favorable conditions for existence.

Up to the present time 34 species, representing 21 genera, have been reported from the Atlantic oceans outside the Bermuda area. Only 6 of these have as yet been found within that area and 8 species have been collected in the Bermuda area that have not yet been discovered elsewhere.

This report brings the total number of species reported from the Atlantic oceans to 42, assigned to 10 families and 22 genera, including 14 species, belonging to 12 genera, from the Bermuda area. In addition to these, 15 other species have been collected in the Pacific and Indian oceans, bringing

to 57 the total number of species of bathypelagic nemerteans at present described. Further exploration of the oceans will presumably greatly increase this number, perhaps several fold.

The finding of so many more species in the North Atlantic than in the other oceans should not be considered as valid evidence that they are more abundantly represented in the North Atlantic than elsewhere but that this is merely the result of more intensive exploration. Only 6 species have thus far been found in the Indian Ocean, of which 2 occur also in the Atlantic. None of the 11 species collected in the Pacific Ocean has been found in the Atlantic; the deep waters from one of these two great ocean basins can not circulate directly into the other so far north as those regions in which collections have been made.

In order to facilitate the identification of these species, revised analytical keys are included for all the families of bathypelagic nemerteans and for such genera and species as are known to live in the Atlantic oceans. Most of the species are illustrated by Text-figures and anatomical details of the two new species are shown in Plates I and II.

The distribution of each of the 57 species, in so far as known at the present time, is shown in the following lists.

DISTRIBUTION OF SPECIES.

Distribution of species known to inhabit the North or South Atlantic oceans, or both. Reported from the Bermuda area (B); from other parts of the North Atlantic (N); from the South Atlantic (S); from the Indian Ocean (I).

Family Protopelagonemertidae.

1. *Protopelagonemertes beebeyi*. (B)
2. ——— *hubrechtii*. (B,N,S)
3. *Calonemertes hardyi*. (S)
4. *Plotonemertes adhaerens*. (B,N)
5. ——— *aurantiaca*. (B)
6. *Pendonemertes levensini*. (N)

Family Planktonemertidae.

7. *Planktonemertes vanhoeffeni*. (S)
8. *Mononemertes sargassicola*. (N)
9. ——— *scarlata*. (B)
10. *Crassonemertes robusta*. (B,N)
11. ——— *rhomboidalis*. (N)
12. *Pachynemertes obesa*. (B)

Family Buergeriellidae.

13. *Buergeriella notabilis*. (N)

Family Dinonemertidae.

14. *Paradinonemertes drygalskii*. (N)
15. ——— *wheeleri*. (B)
16. *Dinonemertes alberti*. (N)
17. ——— *grimaldii*. (N)

18. ——— *investigatoris*. (I,N)
19. *Planonemertes labiata*. (B)

Family Phallonemertidae.

20. *Phallonemertes murrayi*. (B,N)

Family Chuniellidae.

21. *Chuniella agassizii*. (N)
22. ——— *elongata*. (N)
23. ——— *lanceolata*. (B,N)

Family Nectonemertidae.

24. *Nectonemertes minima*. (N,S)
25. ——— *mirabilis*. (B,N,S)
26. ——— *primitiva*. (N,S)

Family Armaueriidae.

27. *Armaueria rubra*. (N)

Family Pelagonemertidae.

28. *Natonemertes acutocaudata*. (N)
29. *Gelanemertes richardi*. (N)
30. *Pelagonemertes rollestoni*. (N,S,I)
31. *Parabalaenanemertes fusca*. (N)
32. ——— *nigra*. (B)
33. ——— *zonata*. (N)
34. *Probalaenanemertes irenae*. (S)
35. ——— *wijnhoffi*. (N)

Family Balaenanemertidae.

36. *Balaenanemertes chavesi*. (N)
37. ——— *grandis*. (N)
38. ——— *hjordii*. (N)
39. ——— *lata*. (N)
40. ——— *lobata*. (N)
41. ——— *minor*. (B)
42. (?) ——— *musculocaudata* (=lobata?). (N)

Distribution of species which are not at present known to occur in either the North or South Atlantic Ocean.

Family Planktonemertidae.

- Planktonemertes agassizii* Woodworth, Pacific Ocean.
Mergonemertes woodworthii Bürger, Indian Ocean.
Neuronemertes aurantiaca Coe, Pacific Ocean.

Family Dinonemertidae.

- Dinonemertes mollis* Coe, Pacific Ocean.
Planonemertes lobata Coe, Pacific Ocean.

Family Chuniellidae.

- Chuniella pelagica* Bürger, Indian Ocean.

Family Nectonemertidae.

- Nectonemertes japonica* Foshay, Pacific Ocean.
 ——— *pelagica* Cravens and Heath, Pacific Ocean.

Family Armaueriidae.

- Proarmaueria pellucida* Coe, Pacific Ocean.
Cuneonemertes gracilis Coe, Pacific Ocean.

Family Pelagonemertidae.

- Pelagonemertes joubini* Coe, Pacific Ocean.
 ——— *moseleyi* Bürger, Pacific Ocean.
 ——— *brinkmanni* Coe, Pacific Ocean.
Nannonemertes indica Wheeler, Indian Ocean.

Family Balaenanemertidae.

- Balaenanemertes chuni* Bürger, Indian Ocean.

KEY TO FAMILIES.

1. Anterior end of body without tentacles in either sex 2
1. Anterior end of body with pair of tentacles in one or both sexes 9
2. Dorsal blood vessel extends entire length of body 3
2. Dorsal vessel ends blindly in rhynchocoel a short distance posterior to brain Pelagonemertidae
3. Posterior end of body narrow, not differentiated into caudal fin 4
3. Posterior end of body broad and flat, usually terminating in flattened caudal fin 6
4. Musculature of proboscis sheath of interlacing circular and longitudinal fibers Protopeleonemertidae
4. Musculature of proboscis sheath of separate circular and longitudinal layers 5
5. Intestinal diverticula numerous, with few branches and without distinct ventral branch Chuniellidae
5. Intestinal diverticula few, divided repeatedly into numerous slender branches Buegeriellidae
6. Dorsal vessel does not enter rhynchocoel Armaueriidae
6. Dorsal vessel enters rhynchocoel 7
7. Intestinal diverticula with both dorsal and ventral branches, the latter extending laterally beneath the nerve cords Planktonemertidae
7. Intestinal diverticula without distinct ventral branches 8
8. Body broad and flat; spermaries without external phalli Dinonemertidae
8. Body slender; spermaries with external phalli Phallonemertidae
9. Anterior portion of body with pair of lateral tentacles in adult males only; dorsal vessel extends entire length of body Nectonemertidae
9. Head with pair of small lateral tentacles in both sexes; dorsal vessel rudimentary, ending blindly in rhynchocoel Balaenanemertidae

FAMILY

PROTOPELEONEMERTIDAE.

Key to Genera.

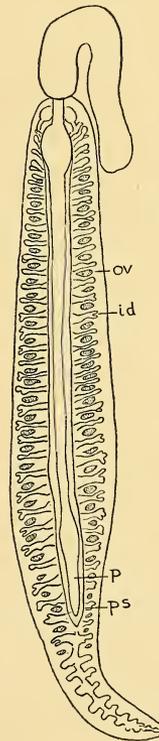
1. Mouth and proboscis opening united; proboscis sheath extends to posterior end of body..... *Protopeleonemertes*
1. Mouth and proboscis opening separate 2
2. Proboscis sheath about half as long as body; nerve-cord muscles present; glandular adhesive organs absent *Pendonemertes*
2. Proboscis sheath at least three-fourths as long as body 3
3. Proboscis sheath three-fourths as long as body; nerve-cord muscles absent; ventral surface of body with pair of convoluted glandular organs, more highly specialized in the male *Plotonemertes*
3. Proboscis sheath extends to posterior end of body; convoluted glandular organs absent *Calonemertes*

Genus *Protopeleonemertes* Brinkmann.

1. *Protopeleonemertes beebei* Coe, 1936.

Text-figure 2.

The only representative of this species as yet known was taken in the Bermuda area at a depth of about 1,646 meters. This was a mature female measuring 24 mm. in length and 7 mm. in width. The color in life



TEXT-FIG. 2. *Protopeleonemertes beebei*. Outline of body of female with partially everted proboscis, showing extent of proboscis sheath (ps) and proboscis (p), 30 pairs of ovaries (ov) and 40 pairs of lobed intestinal diverticula (id). (After Coe).

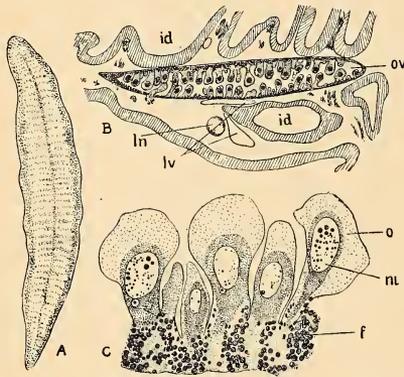
was orange yellow, with paler lateral margins.

2. *Protopelagonemertes hubrechtii* Brinkmann.

Bathynectes hubrechtii Brinkmann, 1912, 1917, 1917a; *Protopelagonemertes hubrechtii* Brinkmann, 1917a Nachtrag; Coe, 1926, 1935, 1936; *Bathynemertes hubrechtii* Wheeler, 1934.

Text-figure 3.

Three representatives of this species were contained in the collection from the Bermuda area reported previously (Coe, 1936). All of these, as well as the type specimen, were females. One additional female measuring 37 mm. long and 6 to 8 mm. wide was found in the supplementary collection. No male has as yet been discovered.



TEXT-FIG. 3. *Protopelagonemertes hubrechtii*. A, typical shape of body; B, ovary (ov); C, portion of ovary showing relation of ova (o) to follicle cells (f); other letters indicate: id, intestinal diverticula; ln, lateral nerve; lv, lateral blood vessel; nu, nucleus. (After Brinkmann).

The depths at which the Bermuda specimens were found ranged from 1,400 to 1,800 meters but inasmuch as one of the 4 specimens was found at the level reached by the lowest net, it is probable that the habitat in the Bermuda area may extend to still greater depths.

The colors in life are described as red, scarlet or orange.

Geographical distribution. In addition to the Bermuda area the species has been reported from the eastern North Atlantic southwest of Ireland, at a depth of 2,000 meters, and from the eastern South Atlantic west of the southern point of Africa at depths of 1,000 meters or less to 2,500 meters or less. One of the specimens from the South Atlantic is known to have been taken at a depth between 1,310 and 1,410 meters.

Genus *Calonemertes*, new genus.

Species of this genus resemble those of *Protopelagonemertes* in general appearance

but differ in having separate openings for mouth and rhynchodeum. Because of these characteristics this new genus must be adopted for the species described by Wheeler (1934) as *Bathynemertes hardyi*.

Body narrowed at both ends, rounded and moderately slender, without indication of lateral or caudal fins; mouth separate from rhynchodeal opening, provided with frilled lips when opened; esophagus absent; proboscis sheath extends entire length of body, musculature of interlaced longitudinal and circular fibers.

3. *Calonemertes hardyi* (Wheeler).

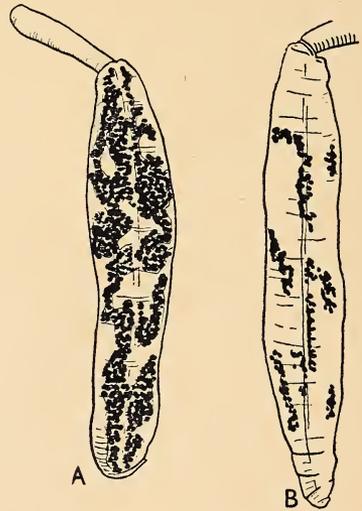
Bathynemertes hardyi Wheeler, 1934.

Text-figure 4.

A single female represents the type of this species. It is one of the largest of all the bathypelagic nemerteans, the type specimen measuring 110 mm. in length, 25 mm. in width and 13 mm. in thickness. This specimen agrees in many respects with the large female described and figured by Coe (1936) as an unusually large individual of *P. hubrechtii* but differs in having separate openings for mouth and rhynchodeum. The body is narrow, rounded and without lateral or caudal fins.

The proboscis sheath extends the entire length of the body and its muscular wall is composed of interlacing longitudinal and circular fibers. The color of the body in life was scarlet with irregular patches of black pigment (Text-fig. 4).

This species is known only from the type specimen which was obtained in an open net lowered to a depth of 1,000 meters and



TEXT-FIG. 4. *Calonemertes hardyi*. Outlines of body from ventral (A) and dorsal (B) surfaces, showing the irregular patches of black pigment. (After Wheeler).

drawn to the surface. The locality was in the eastern South Atlantic west of the Cape of Good Hope.

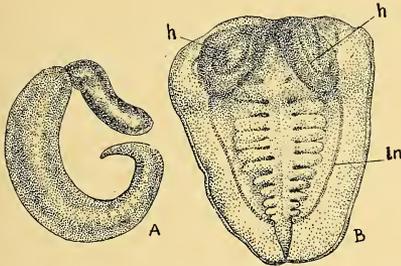
Genus *Plotonemertes* Brinkmann.

4. *Plotonemertes adhaerens* Brinkmann, 1917.

Text-figure 5.

P. adhaerens Brinkmann, 1917, 1917a; Coe, 1926, 1935, 1936.

In addition to the 27 specimens previously reported from the Bermuda area (Coe, 1935, 1936), the present collections contained 8 individuals, representing both sexes. These varied in length from 8 to 16 mm. One specimen was taken at a depth of about 1,100 m., 5 from a depth of 1,500 m. and two from 1,800 m.



TEXT-FIG. 5. *Plotonemertes adhaerens*. **A**, type specimen with everted proboscis; **B**, ventral surface of posterior end of body, showing pair of glandular organs (**h**) and lateral nerves (**ln**). (After Brinkmann).

The 27 specimens included in the earlier report (Coe, 1936) came from depths of 1,300 to 1,830 m. Since none of the nets was lowered below 1,830 m., it seems possible that the species may also inhabit somewhat greater depths in that region. The type specimen came from about 2,000 m. The number of individuals caught increases with depth from 1,100 to 1,600 m. and then diminishes with increasing depths to 2,000 m. Hence the optimum depth of the species in the Bermuda area would seem to be about 1,600 m.

With the exception of *Nectonemertes mirabilis*, this was the most abundant bathypelagic nemertean in the Bermuda area between the depths of 1,100 and 1,830 m. at the times when these collections were made. It was not taken in any of the nets drawn at higher levels. Only a single specimen has been found in any other part of the ocean and this was collected near the middle of the North Atlantic (47°34' N. Lat., 43°11' W. Long.).

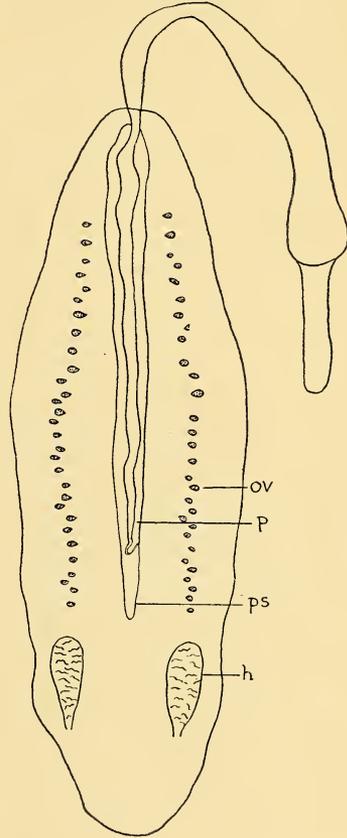
Mature individuals of both sexes vary from 12 to 30 mm. in length and 2 to 9 mm. in width. The colors in life are reported as pink, pinkish-orange, orange and red. De-

tailed descriptions and figures of the organ systems may be found in the papers by Brinkmann (1917a) and Coe (1936).

5. *Plotonemertes aurantiaca* Coe, 1936.

Text-figure 6.

Only the type specimen of this species is known at present. This was a mature female 40 mm. in length, 11 mm. in width and 5 to 7 mm. in thickness. The color in life was bright orange, with yellow margins, caudal fin and proboscis. It was taken in the Bermuda area at a depth of about 1,463 meters.



TEXT-FIG. 6. *Plotonemertes aurantiaca*, ventral surface of body of female, showing pair of glandular organs (**h**), ovaries (**ov**), extent of proboscis sheath (**ps**), and attachment of proboscis (**p**). (After Coe).

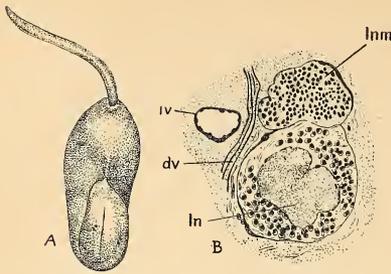
Genus *Pendonemertes* Brinkmann.

6. *Pendonemertes levensini* Brinkmann, 1917.

P. levensini Coe, 1926.

Text-figure 7.

The three known representatives of this species were taken in the eastern North Atlantic (Lat. 35° to 50° N., Long. 7° to



TEXT-FIG. 7. *Pendonemertes levensini*. **A**, female from ventral surface; **B**, transverse section of lateral nerve cord (ln) with accompanying nerve-cord muscle (lnm), lateral blood vessel (lv) and dorsoventral muscles (dv). (After Brinkmann).

11° W.) at depths of 1,000 to 2,260 meters. All were females.

FAMILY PLANKTONEMERTIDAE.

Key to Genera Known to Occur in the Atlantic Oceans.

- 1. Mouth and proboscis united into a short atrium 2
- 1. Mouth and proboscis opening separate 3
- 2. Body broad and flat without distinct caudal fin *Planktonemertes*
- 2. Body broad in middle third, narrowed at both ends, with caudal fin
Mononemertes
- 3. Body short, broad and thick; caudal fin narrow and sharply demarcated from body; intestinal diverticula much divided, with well-developed ventral branches *Crassonemertes*
- 3. Caudal fin slightly differentiated; intestinal diverticula without ventral branches *Pachynemertes*

Genus *Planktonemertes* Woodworth.

7. *Planktonemertes vanhoeffeni* Brinkmann.

P. vanhoeffeni Brinkmann, 1915, 1917, 1917a; Coe, 1926.
Text-figure 8.

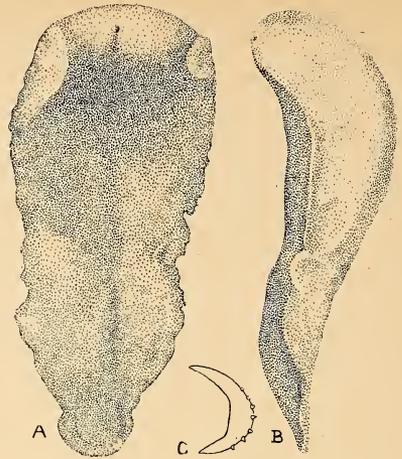
Known only from a single female collected by the German South Polar expedition in a net drawn from a depth of 3,000 meters to the surface in the South Atlantic Ocean west of the Cape of Good Hope.

Genus *Mononemertes* Coe.

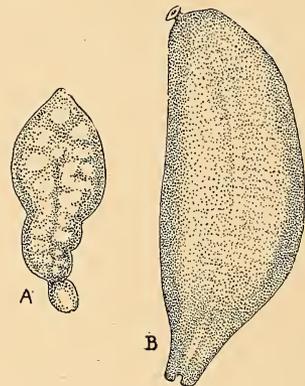
8. *Mononemertes sargassicola* (Joubin).

Planktonemertes sargassicola Joubin, 1906;
Mononemertes sargassicola Coe, 1926.
Text-figure 9, A.

Known only from a single specimen collected in a net drawn from a depth of 2,225



TEXT-FIG. 8. *Planktonemertes vanhoeffeni* **A**, **B**, type specimen from dorsal and lateral surfaces respectively; **C**, stilet basis. (After Brinkmann).



TEXT-FIG. 9. **A**, *Mononemertes sargassicola* (after Joubin); **B**, *Crassonemertes robusta* (after Brinkmann).

meters to the surface by the Prince of Monaco expedition in the Sargasso Sea (Lat. 27°36' N., Long. 38°29' W.). The internal anatomy has not as yet been described.

9. *Mononemertes scarlata* new species.

Plate I, figures 1-8.

The type specimen of this new species was somewhat similar to that of *Planktonemertes vanhoeffeni* morphologically but differed in shape of body, in having a caudal fin, in having a dorsal core in each of the lateral nerve cords, in a less sharply curved stilet basis, in number of proboscis-dial nerves, and in other morphological details.

Body short and broad; oval in outline

and rather thin; narrowed posteriorly to form a thin caudal fin which is not sharply demarcated from body (Pl. I, fig. 1).

Length of type specimen, which represents a nearly sexually mature male, 15 mm., width 9 mm., thickness 2 to 3 mm. Color in life scarlet.

Body walls. Musculature of body wall thin, the longitudinal muscles being arranged in separated bands. Although the body is provided with a caudal fin, the reduction of the musculatures indicates an inability for rapid movements. Because of the low specific gravity due to the high water content of the tissues, slight undulatory movements would be sufficient to keep the body suspended. Dorsoventral muscles are present in each of the interdiverticular spaces but are highly developed only in the caudal fin (Pl. I, fig. 1). The surface epithelium remained in place only on the ventral side in the posterior fourth of the body. Where present, it is composed of slender ciliated and glandular cells and is somewhat greater in thickness than that of the musculatures and basement layer combined (Pl. I, fig. 4).

Proboscis sheath. Mouth and proboscis opening united into a short atrium when proboscis lies in natural position in body (Pl. I, figs. 1, 2). Proboscis sheath about seven-eighths as long as body, terminating at base of caudal fin. Musculature of proboscis sheath composed of interlacing longitudinal and circular or spiral fibers but with some indication of a three-layered condition, since many of the circular fibers form incomplete outer and inner layers with most of the longitudinal fibers between them (Pl. I, fig. 5).

Proboscis large but less than twice as long as the body, loosely coiled in rhynchocoel. Posterior chamber short, with a short retractor attached by means of interlacing muscular fibers to the dorsal wall of sheath near posterior end of latter. There were in the type specimen 17 distinct proboscoidal nerves, with several additional enlargements of the intermuscular nervous plexus in the anterior portion of the organ, where the number may appear to be 20 or 21. The armature consists of the usual form of curved basis, asymmetrically crescentic in optical section, with perhaps 20 or more small pits from which, in this specimen, the minute stylets had been dissolved (Pl. I, fig. 7). Accessory stylet pouches were not found.

Digestive system. The mouth opens from the atrium directly into the stomach, the esophagus being absent as in some other bathypelagic species. The walls of the stomach are folded in such a manner as to indicate that they may be everted from the

atrium to serve as lips to hold the prey at the time of feeding (Pl. I, fig. 2). The pylorus is short, with a correspondingly short caecum but the number of pairs of caecal diverticula could not be determined. There were in the type specimen about 40 pairs of intestinal diverticula, each with a broadly lobed but not profusely divided dorsal branch and a similar, but somewhat smaller ventral branch between the nerve cord and the body wall (Pl. I, fig. 3). The ventral branches become smaller posteriorly and disappear anterior to the caudal fin, allowing the nerve cord to come in contact with the ventral body wall (Pl. I, fig. 4).

Blood-vascular system. Lateral and dorsal vessels as in related genera. Dorsal vessel enters anterior end of rhynchocoel and remains on the ventral wall of this cavity throughout the length of the pylorus region; it then leaves the rhynchocoel and continues posteriorly on the ventral side of the proboscis sheath to the posterior end of that organ. Posterior to the proboscis sheath the dorsal vessel lies beneath the dorsal body wall and joins the lateral vessels in the caudal fin.

Nervous system. Lateral nerve cords with large ventral fibrous core and a much smaller and rather inconspicuous dorsal core (Pl. I, fig. 8).

Reproductive organs. The type specimen was a nearly mature male with 8 pairs of spermaries near the anterior end of the body (Pl. I, fig. 1). They are situated near the ventral sides of the nerve cords, the most anterior ones being close behind the brain. From each spermary a small spermatid duct leads to the ventral surface of the body.

Geographical distribution. This new species is as yet known only from a single individual collected in the Bermuda area at a depth of about 1,500 meters.

Type Specimen: Holotype, Cat. No. 31247; Net 1025; June 16, 1931. In the collections of the Department of Tropical Research, New York Zoological Park, New York City.

Genus *Crassonemertes* Brinkmann.

10. *Crassonemertes* (?) *rhomboidalis*
(Joubin).

Planktonemertes rhomboidalis Joubin,
1906; *C. (?) rhomboidalis* Coe, 1926.

This species was described from the external appearance of the body only, and nothing is as yet known as to the internal morphology. Consequently the status of the species must remain doubtful until a more complete study of the type specimen is made. The specimen was collected in the Sargasso Sea in a net drawn from 2,000 meters to the surface.

11. *Crassonemertes robusta* Brinkmann.

Text-figure 9,B.

Brinkmann, 1917, 1917a; Coe, 1926, 1936; Wheeler, 1934.

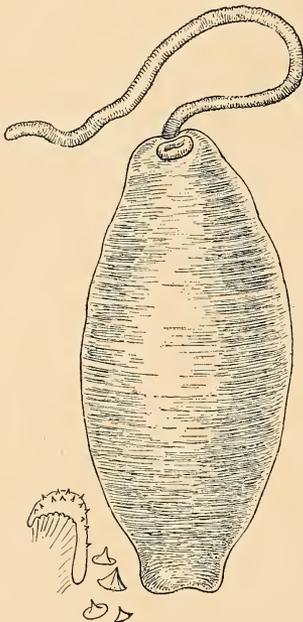
This species is known from 3 specimens; 2 of these were females, while the sexuality of the other could not be determined. Hence the male remains undescribed. The type specimen was collected in the North Atlantic, northwest of Great Britain (Lat. 57°41' N., Long. 11°48' W.) at a depth of about 1,666 meters; the second came from the Bermuda area at a depth of 1,100 meters and the third from off the west coast of Africa (Lat. 6°55' N., Long. 15°54' W.). This distribution appears to cover a triangular area across the width of the North Atlantic and extends through more than 50 degrees of latitude. It is not known, however, whether the species occurs at intermediate localities but the ocean currents are such as to make a wide distribution probable (Text-fig. 1).

Genus *Pachynemertes* Coe.

12. *Pachynemertes obesa* Coe, 1936.

Text-figure 10.

Known only from the type specimen measuring 16 mm. in length, 8 mm. in width and 5 mm. in thickness. This was a mature female collected in the Bermuda area at a depth of about 1,600 meters.



TEXT-FIG. 10. *Pachynemertes obesa*. Strongly contracted specimen, showing mouth and everted proboscis; also stylet basis and several stylets. (After Coe).

FAMILY BUERGERIELLIDAE.

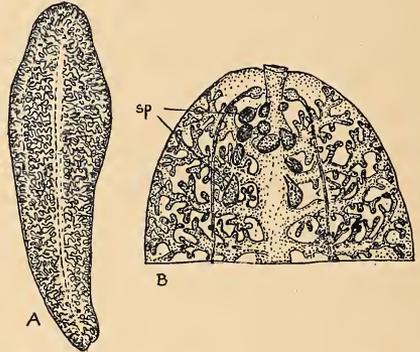
Genus *Buergeriella* Brinkmann.

13. *Buergeriella notabilis* Brinkmann, 1917.

B. notabilis Brinkmann, 1917a; Coe, 1926.

Text-figure 11.

Only a single representative of this species is at present known. This was a male 52 mm. in length, 15 mm. in greatest width and only 2.5 to 4 mm. in thickness. This was collected in the North Atlantic (Lat 48° 29' N., Long. 13° 55' W.) at a depth of 1,333 meters.



TEXT-FIG. 11. *Buergeriella notabilis*. A, type specimen, showing profusely branched intestinal diverticula; B, anterior end of body, showing spermaries (sp). (After Brinkmann).

FAMILY DINONEMERTIDAE.

Key to Genera at Present Known from the Atlantic Oceans.

1. Mouth on ventral surface of head, well separated from rhynchodeal opening; proboscis sheath almost as long as body; wall of sheath of interwoven longitudinal and circular fibers

Paradinonemertes

1. Mouth anterior to brain; wall of proboscis sheath composed of separate muscular layers 2
2. Proboscis sheath limited to anterior two-thirds of body.....*Dinonemertes*
2. Proboscis sheath nearly as long as body*Planonemertes*

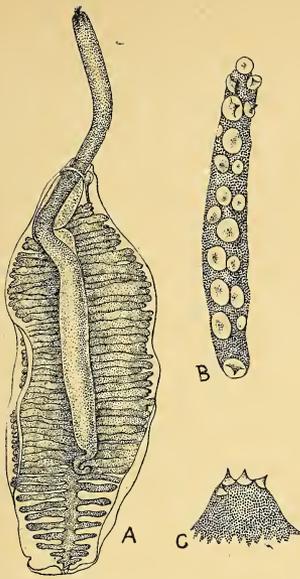
Genus *Paradinonemertes* Brinkmann.

14. *Paradinonemertes drygalskii* Brinkmann.

P. drygalskii Brinkmann, 1915, 1917; Coe, 1926.

Text-figure 12.

Two representatives of this species, both of which were males, were taken by the *Michael Sars* expedition in the North Atlantic west of the Cape Verde Islands (Lat. 17°28' N., Long. 29°42' W.) in a net drawn from a depth of 3,000 meters to the surface.



TEXT-FIG. 12. *Paradinonemertes drygalskii*. **A**, outline of body, showing unbranched intestinal diverticula and extent of proboscis sheath; **B**, stylet basis; **C**, transverse section of basis with stylets. (After Brinkmann).

15. *Paradinonemertes wheeleri* Coe, 1936.

Text-figure 13.

Six individuals belonging to this species were obtained in the Bermuda area. The body is broad, flat and thin, with broad caudal fin not sharply demarcated from body. The length of these specimens varied from 11 to 42 mm. and the width from 4 to 15 mm. The males have 3 to 5 spermaries in an irregular row on each side of the body close behind the brain and mature females 30 to 36 pairs of ovaries.

This species is known only from the Bermuda area, where it was found to live at depths of 1,400 to 1,800 meters.

Genus *Dinonemertes* Laidlaw.

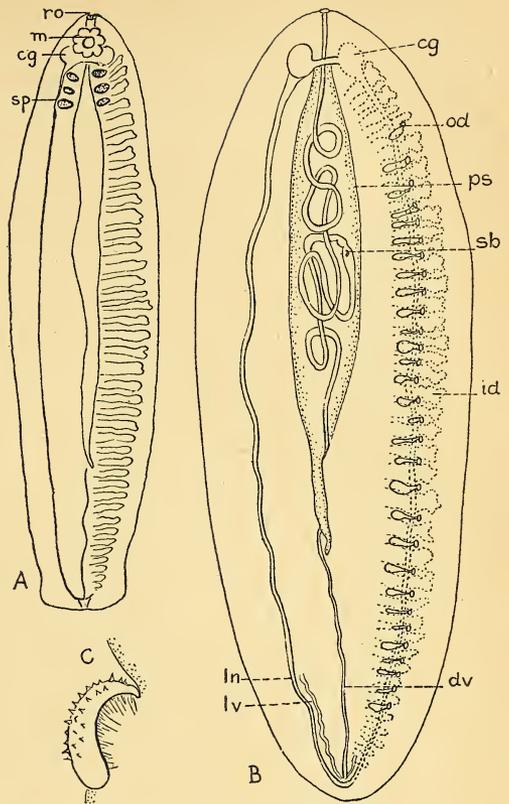
16. *Dinonemertes alberti* (Joubin).

Planktonemertes alberti Joubin, 1906;
D. alberti Brinkmann, 1917; Coe, 1926.

Text-figure 14,A.

In this, as in other species of the genus, the body is broad, flat and thin, with nearly parallel lateral margins. The type specimen was 85 mm. long and 27 mm. wide, while the three other individuals which have thus far been collected were from 66.5 to 76 mm. in length and from 19 to 22 mm. in width.

The male, as figured by Joubin, has a row of 6 or more closely placed spermaries on each side of the body back of the brain. The females have 18 to 25 pairs of ovaries.



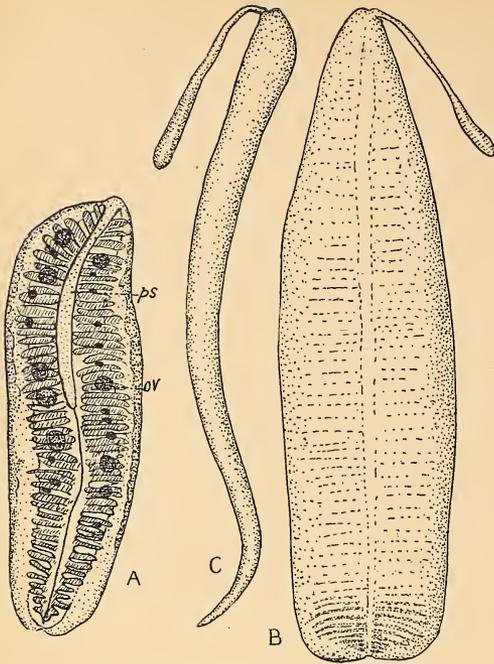
TEXT-FIG. 13. *Paradinonemertes wheeleri*. **A**, male with 3 pairs of spermaries (**sp**); **B**, female with 30 pairs of ovaries and oviducts (**od**); other letters indicate: **cg**, cerebral ganglia; **dv**, dorsal vessel; **id**, intestinal diverticula; **ln**, lateral nerve cord; **lv**, lateral vessel; **m**, mouth; **ps**, proboscis sheath; **ro**, rhynchodeal opening; **sb**, stylet basis of proboscis; **C**, stylet basis with minute stylets. (After Coe).

This species has been found only in the northern part of the North Atlantic (Lat. 63° to 71° N.), between Greenland and Norway. The nets were lowered to depths of 1,300 to 3,300 meters and drawn to the surface.

17. *Dinonemertes grimaldii* (Joubin).

Planktonemertes grimaldii Joubin, 1906;
D. grimaldii Brinkmann, 1917; Coe, 1926.

The two specimens, each about 40 mm. long and 10 mm. wide, which Joubin considered as representing a species distinct from *D. alberti*, have as yet been studied only superficially. Until the essential features of the internal anatomy are known the status of the species must remain in doubt. The specimens were collected in the middle North Atlantic (Lat. 31° to 37° N.) between 3,000 meters and the surface.



Joubin; **B, C**, after Brinkmann). showing intestinal diverticula, ovaries (**ov**) and short proboscis sheath (**ps**). **B, C**, dorsal and lateral views of *D. investigatoris*. (**A** after Joubin; **B, C**, after Brinkmann).

18. *Dinonemertes investigatoris* Laidlaw, 1906. *D. investigatoris* Brinkmann, 1917, 1917a; Coe, 1926.

Text-figure 14,B,C.

Individuals of this species are the giants among the bathypelagic nemerteans, the broad and flat body of the three specimens thus far obtained measuring from 107 to 203 mm. in length and 23 to 56 mm. in width. All were mature females.

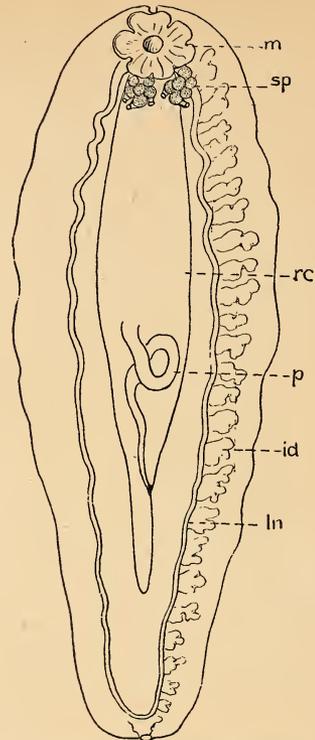
The type specimen was taken from a depth of about 2,000 meters in the Indian Ocean, southwest of India. Two other specimens which Brinkmann (1917) referred to this species were collected in the middle North Atlantic (Lat. 34° and 48°) in nets lowered to 2,000 meters. If Brinkmann was correct in his identification, this species has a wider geographical range than is known for any other bathypelagic nemertean, with the exception of *Pelagonemertes rollestoni*. No examples have as yet been found at intermediate stations. Only these two species have been collected both in the Indian Ocean and in the North Atlantic.

Genus *Planonemertes* Coe.

19. *Planonemertes labiata* Coe, 1936.

Text-figure 15.

This species is known only from the Ber-



TEXT-FIG. 15. *Planonemertes labiata*. Outline of body of male, showing spermaries (**sp**), extent of rhynchocoel (**rc**) with posterior attachment of proboscis (**p**), lobed intestinal diverticula (**id**), mouth with everted lips (**m**) and lateral nerve cord (**ln**). (After Coe).

muda area, where two individuals, one male and one female, were taken at a depth of about 1,800 meters.

FAMILY PHALLONEMERTIDAE.

Genus *Phallonemertes* Brinkmann.

20. *Phallonemertes murrayi* (Brinkmann).

Bathynectes murrayi Brinkmann, 1912, 1917, 1917a; *P. murrayi* Brinkmann, 1917; Coe, 1926, 1936.

Text-figure 16.

Two specimens of this species were taken in the Bermuda area at depths of 1,500 and 1,800 meters. Previously reported from various localities in the North Atlantic from Lat. 35° N. to near the southern point of Greenland at depths of 1,600 to 2,000 meters.

FAMILY CHUNIPELLIDAE.

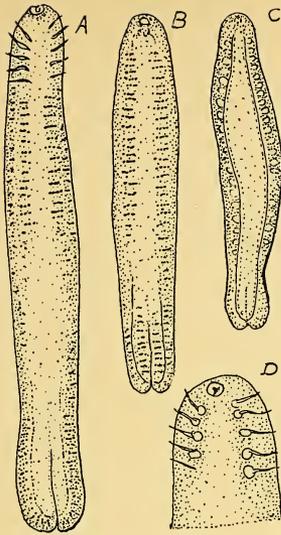
Genus *Chuniella* Brinkmann.

21. *Chuniella agassizii* (Bürger).

Planktonemertes agassizii Bürger, 1909; *C. agassizii* Brinkmann, 1917; Coe, 1926.

Text-figure 17, B, C.

The single known representative of this



TEXT-FIG. 16. *Phallonemertes murrayi*. A, D, males with external, tubular genital papillae; B, C, females. (After Brinkmann).

species was an immature female collected in the equatorial Atlantic (Lat. 9°N.) off the coast of Sierra Leone, Africa, in a net drawn from a depth of 1,300 meters.

22. *Chuniella* (?) *elongata* (Joubin).

Planktonemertes elongata Joubin, 1906; *C. (?) elongata* Brinkmann, 1917; Coe, 1926.

As only the type specimen is known and this has been described only superficially, the status of this species still remains in doubt. The specimen was taken near the middle of the North Atlantic (Lat. 34° N.) in a net drawn from 4,000 meters to the surface.

23. *Chuniella lanceolata* Brinkmann, 1917.

C. lanceolata Coe, 1926.

Text-figure 17, A.

Only two specimens of this species have been discovered up to the present time. One of these was a female taken at a depth of about 1,600 meters in the Bermuda area, while the type specimen was a male collected in the North Atlantic (Lat. 48° 29' N.) southwest of Ireland in a net lowered to only 1,000 meters.

FAMILY NECTONEMERTIDAE.

Genus *Nectonemertes* Verrill.

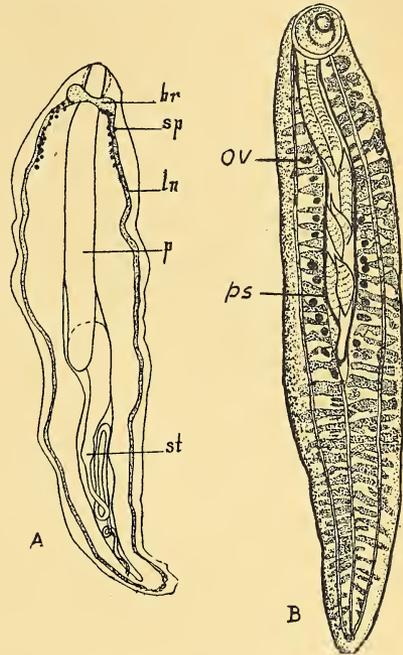
24. *Nectonemertes minima* Brinkmann, 1915.

Hyalonemertes atlantica Bürger, 1909; *N. minima* Brinkmann, 1917, 1917a; Coe, 1926.

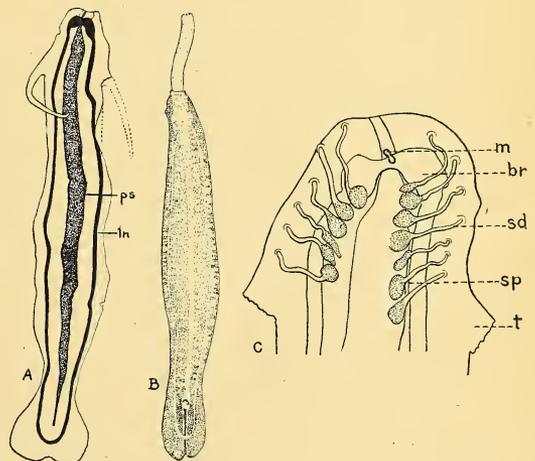
Text-figure 18.

This species is widely distributed in the

eastern North and South Atlantic oceans from 57° north latitude to 35° south latitude. This range of 92 degrees of latitude extends from a point northwest of Ireland,



TEXT-FIG. 17. A, *Chuniella lanceolata*, male showing spermaries (sp) in an irregular row behind the brain (br), the long proboscis (p) with stylet chamber (st) and the lateral nerve cords (ln). B, C, *agassizii*, female with ovaries (ov) and short proboscis sheath (ps). (A after Brinkmann, B after Bürger).



TEXT-FIG. 18. *Nectonemertes minima*. A, outline of body of male; B, female; C, anterior end of body of male, showing position of spermaries (sp); other letters indicate: br, brain; ln, lateral nerve cord; m, mouth; ps, proboscis sheath; sd, sperm duct; t, base of tentacle. (After Brinkmann).

across the equator to near the Cape of Good Hope.

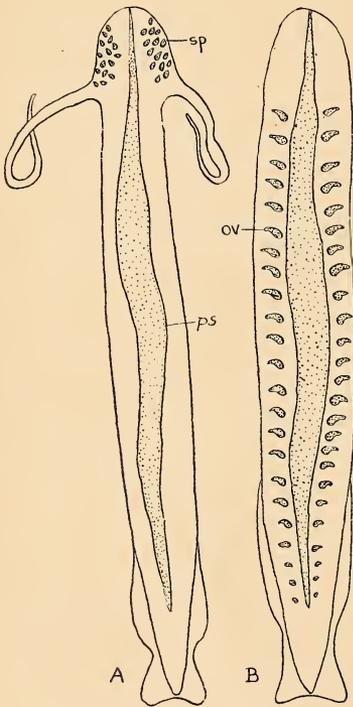
The males are distinguished from those of *N. mirabilis* and *N. primitiva* in having 5 to 7 spermaries on each side of the body back of the head. The female has about 25 pairs of ovaries.

25. *Nectonemertes mirabilis* Verrill.

N. mirabilis (*Hyalonemertes atlantica*) Verrill, 1892; Brinkmann, 1917, 1917a; Coe and Ball, 1920; Coe, 1926, 1936; Wheeler, 1934; *N. grimaldii* Joubin, 1904, 1906; *N. kempfi* (?) Wheeler, 1934.

Text-figure 19.

The collections previously reported from the Bermuda area (Coe, 1935, 1936) contained 32 representatives of this species. The supplementary collections from the same area included 12 additional specimens. These represented both sexes and various stages of sexual maturity. One of these was caught at a depth of about 1,100 meters, 6 at 1,300 m., 2 at 1,460 m., 1 at 1,640 m. and 2 at 1,830 m.



TEXT-FIG. 19. *Nectonemertes mirabilis*. **A**, male with cephalic spermaries (**sp**); **B**, female with 23 pairs of ovaries (**ov**); **ps**, proboscis sheath.

The 32 specimens of this species previously obtained from this area came from depths of 900 to 1,830 meters, with the largest numbers coming from near the maxi-

mum depth. Consequently it may be surmised that the species might also have been found if the nets had been lowered to somewhat deeper levels. The range is from 500 to 2,000 meters but the greater portion of population seems to be limited to a rather definite water layer having a temperature of 3.5° to 5° C. and a salinity of about 3.5 per cent. This layer is found at a depth of 1,200 to 2,000 meters in the Bermuda area but is nearer the surface in the northern part of the North Atlantic. There the species is found at a correspondingly higher level.

This species has a wide range of geographical distribution, being found throughout the North Atlantic Ocean from near Cuba to the latitude of southern Greenland and from the American to the European continental slopes. It also extends southward through the tropics to the South Atlantic in the latitude of South Africa (Text-fig. 1). It appears to be by far the most abundant of all the bathypelagic nemerteans which up to the present time have been discovered in the North Atlantic Ocean.

The morphological characteristics of this species have been described in detail by Coe and Ball (1920). The colors of the females in life are described as yellow or orange and of the males red or scarlet. The young are paler, sometimes white.

Wheeler (1934) reported from the eastern equatorial Atlantic (Lat. 7° N., Long. 16° W.) a specimen which he supposed to represent a new species which he described as *N. kempfi*. There is nothing in his description, however, which does not apply equally well to young individuals of *N. mirabilis*. Therefore there seems to be no good reason for considering *N. kempfi* to be a valid species.

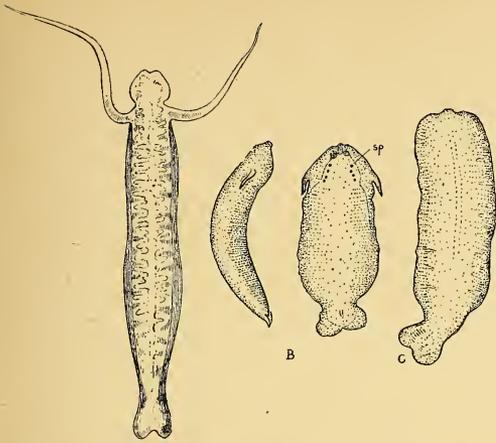
26. *Nectonemertes primitiva* Brinkmann, 1917, 1917a.

N. primitiva Coe, 1926; *Nectonemertes mirabilis* Bürger, 1909.

Text-figure 20.

One of the three known representatives of this species was taken in the equatorial Atlantic (Lat. 3°55' S., Long. 7°48' W.) off the west coast of French Congo in a vertical haul from 3,000 meters; the other two come from the central North Atlantic (Lat. 31° N., Long. 35° W. and Lat. 35° N., 33° W.) at depths of 665 and 2,000 meters respectively.

The male is distinguished from that of *N. mirabilis* in having a single row of 4 to 6 spermaries on each side of the body close behind the brain (Text-fig. 20), while the female has about 10 pairs of ovaries.



TEXT-FIG. 20. *Nectonemertes primitiva*. **A**, outline of body of living individual, with slender body and tentacles (after Bürger). **B**, lateral and ventral views of male with body contracted after preservation; **sp**, spermaries; **C**, female (after Brinkmann).

FAMILY ARMAUERIIDAE.

Genus *Armaueria* Brinkmann.

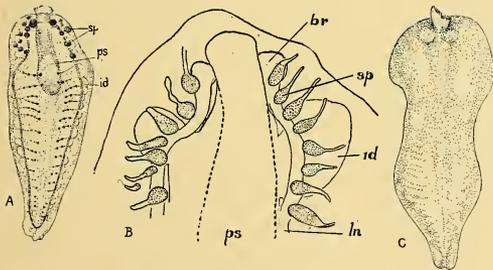
27. *Armaueria rubra* Brinkmann, 1917.

A. rubra Coe, 1926.

Text-figure 21.

Individuals of this species are small, even when sexually mature, the four known representatives being only 5.3 to 9.5 mm. in length and 2 to 7 mm. in width. The proboscis sheath is limited to the anterior half of the body (Text-fig. 21). The male has 8 to 12 spermaries in an irregular row on each side of the body close behind the brain (Text-fig. 21), while the single female at present known has 8 pairs of ovaries.

Known only from the central North At-



TEXT-FIG. 21. *Armaueria rubra*. **A**, male, showing spermaries (**sp**) and short proboscis sheath (**ps**); **B**, anterior end of body of male, showing position of spermaries (**sp**) relative to brain (**br**); **C**, female, showing dorsal position of rhynchodeal opening; other letters indicate: **id**, caecal diverticulum; **ln**, lateral nerve cord. (After Brinkmann).

lantic (Lat. 45° to 55° N., Long. 25° to 43° W.), where four specimens were collected at depths of 800 to 1,600 meters.

FAMILY PELAGONEMERTIDAE.

Key to Genera Found in the Atlantic Oceans.

1. Body pointed at posterior end, without caudal fin 2
1. Body with more or less well demarcated caudal fin 3
2. Spermaries in a single row on each side of body near brain *Gelanemertes*
2. Spermaries in a compact group on each side of body near brain *Natonemertes*
3. Caudal fin not distinctly demarcated..... *Parabalaenanemertes*
3. Caudal fin well developed 4
4. Intestinal diverticula closely appressed *Probalaenanemertes*
4. Intestinal diverticula separated by much gelatinous tissue..... *Pelagonemertes*

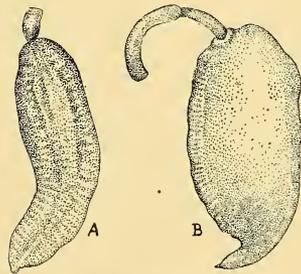
Genus *Natonemertes* Brinkmann.

28. *Natonemertes acutocaudata* Brinkmann, 1917.

N. acutocaudata Coe, 1926.

Text-figure 22.

Only two representatives of this species are at present known. Both were males with a compact group of four or five spermaries on each side immediately posterior to the brain. They were collected in the northern part of the North Atlantic (Lat. 58° to 61° N., Long. 12° to 17° W.) in a net lowered to depths of 1,200 to 1,400 meters.



TEXT-FIG. 22. *Natonemertes acutocaudata* in different states of contraction. (After Brinkmann).

Genus *Gelanemertes* Coe.

29. *Gelanemertes richardi* (Joubin).

Pelagonemertes richardi Joubin, 1906; *G. richardi* Coe, 1926.

The single known representative of this species has not yet been studied sufficiently

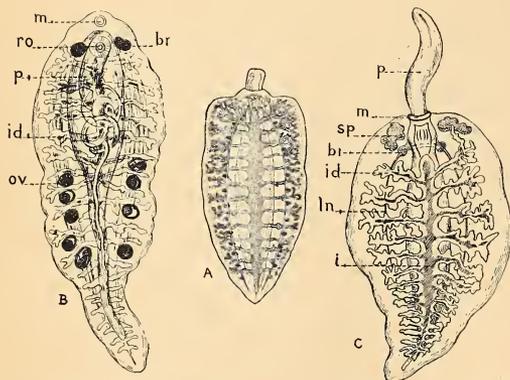
to determine the details of the internal anatomy. The general appearance of the body resembles that of species of *Pelagonemertes* but indicates a different genus because the spermaries are situated in a single row on each side of the body. This specimen was taken in the central North Atlantic (Lat. 30°36' N., Long. 26°05' W.).

Genus *Pelagonemertes* Moseley, 1875.

30. *Pelagonemertes rollestoni* Bürger, 1909;
Brinkmann, 1915, 1917; Coe, 1926;
Wheeler, 1934.

Text-fig. 23.

This appears to be one of the most abundant as well as the most widely distributed of all the bathypelagic species. It has been taken in the equatorial Atlantic (Lat. 0° N., Long. 7° W.) off the west coast of Africa, across almost the entire width of the South Atlantic at 30° to 50° of latitude, near Ceylon in the Indian Ocean (Lat. 5° N.) and in the ocean far south of Australia (Lat. 50° S., 123° W.) This indicates a range of 55 degrees of latitude and 130 degrees of longitude. Some of the specimens were taken in closing nets at depths of 700 to 950 meters, while the others were caught in open nets lowered to depths of 1,000 to 3,500 meters.



TEXT-FIG. 23. *Pelagonemertes rollestoni*. A, female with 13 pairs of small ovaries (after Moseley). B, female; C, male (after Bürger). Letters indicate: br, brain; i, intestine; id, intestinal diverticula; ln, lateral nerve cord; m, mouth; ov, ovaries; p, proboscis; ro, rhynchodeal opening; sp, spermaries.

Genus *Parabalaenanemertes* Brinkmann.

31. *Parabalaenanemertes fusca* Brinkmann,
1917.

P. fusca Coe, 1926.

The three known specimens, one male and two females, were taken in the northern part of the central North Atlantic (Lat. 46° to 55° N., Long. 7° to 28° W.) at depths of 650 to 1,800 meters.

32. *Parabalaenanemertes nigra*, new species.

Plate II, figs. 1-5.

One female which evidently represents a new species of this genus was found among the collections made in 1931. This specimen resembled in many respects the corresponding sex of *P. fusca* as described by Brinkmann (1917) but when sectioned was found to differ in having but a single fibrous core in each of the lateral nerve cords, in having an almost complete lack of dorsoventral muscular fibers even in the posterior end of the body, in having both dorsal and ventral branches of the intestinal diverticula profusely branched, in a much larger and longer proboscis, in having the long posterior chamber of the proboscis deeply pigmented and in other details.

This specimen was small, although it was sexually mature. The body was oval in shape, narrowed at both ends but more slender posteriorly and only slightly flattened (Pl. II, fig. 1). It measured 7 mm. in length, 3 mm. in greatest width and 2 mm. in thickness. It should be mentioned that one of the females of *P. fusca* studied by Brinkmann was of exactly the same dimensions.

Color. The specimen was labeled by the collector "black worm," presumably as an indication of the color in life. After preservation for ten years, however, the color had mostly disappeared except for the intensely black pigmentation of the long posterior chamber of the proboscis. There remained also some traces of the original pigment in the granular contents of the intestinal diverticula.

Body walls. The musculature of the body walls is remarkably thin, especially toward the lateral margins of the body. The basement layer which in life supports the surface epithelium is likewise much thinner than in most bathypelagic nemerteans but it has the usual cup-like depressions to allow for the firm attachment of the epithelial cells. As so often happens with these worms, most of the epithelium was lost at the time of collection.

Proboscis sheath. The rhynchodeum opens at the tip of the head, immediately dorsal to the mouth. The proboscis sheath extends the entire length of the body and is so large that it occupies about three-fourths the vertical axis of the body in the median line and about one-third the width of the body. Its musculature is generally three to six times as thick as that of the body wall and is arranged in two distinct layers. Of these the outer is spiral and the inner longitudinal. The spiral layer is about twice as thick as the longitudinal layer and both are

considerably thinner along the ventral side than elsewhere (Pl. II, fig. 3).

At the anterior end of the sheath, in the brain region, the muscular layers are more or less distinctly reversed, the separated bundles of longitudinal muscles being bordered internally by a layer of circular muscles and externally by a thin layer of spiral fibers. For a short distance posterior to the brain region the spiral and longitudinal bundles are interlaced but in the region of the foregut the longitudinal fibers become separated into a distinct internal layer. That relation of the two layers continues throughout the rest of the body.

Through the anterior four-fifths of the body the sheath remains nearly uniform in diameter, the rhynchocoel being nearly filled with the three loops of the proboscis. The sheath then becomes somewhat enlarged to accommodate the many loops of the posterior chamber of the proboscis (Pl. II, fig. 1). The terminal portion of the sheath is narrowly constricted but the musculatures remain thick enough to allow a firm attachment for the interlacing fibers of the proboscis retractor muscles.

Proboscis. This organ is much larger than in most bathypelagic species and with its long retractor measures between four and five times the length of the body. In this type specimen, although the proboscis was partially everted at the time of preservation, it remains in three longitudinal loops, each of which is nearly as long as the body (Pl. II, fig. 1). The narrowed posterior end of the sheath retains its thick, two-layered walls and the long retractor is interlaced with the musculature of the dorsal wall (Pl. II, fig. 1).

The middle chamber is provided with a curved, spoon-shaped basis which in life must have borne a dozen or more stylets, but the latter had been dissolved in the preserved specimen. Accessory stylets were also missing. There are 12 large proboscical nerves which occupy the usual positions in the distal portion of the longitudinal muscular layer. The external and internal circular musculatures are relatively thin.

The posterior chamber of the proboscis is itself longer than the body, being looped back on itself repeatedly in the widened posterior portion of the sheath (Pl. II, fig. 1). In a single transverse section of the body there were as many as nine sections of these loops. The epithelial cells of this portion of the proboscis form an intensely black secretion which retains its pigmentation for at least ten years after preservation. This black pigment appears in conspicuous patches in the preserved specimen and doubtless presented a characteristic feature of the body in life.

Digestive system. The mouth and rhynchodeum open separately. The epithelium lining the mouth is much folded, the outer folds protruding beyond the ventral surface of the head as a circle of folded lips (Pl. II, fig. 1). The size of the mouth indicates that the worm is capable of ingesting comparatively large objects but as the digestive organs were empty, no information as to the nature of the prey is available. Other bathypelagic nemerteans are known to feed upon various worms and crustaceans.

The foregut, including pylorus, is very short, necessitating an equally short caecum. The single pair of caecal diverticula, which extend forward to the dorsal side of the brain, are profusely branched. The diverticula of the midgut are correspondingly branched, with a profusion of lobules extending laterally on both dorsal and ventral sides of the nerve cords (Pl. II, figs. 4, 5). This type specimen had 12 pairs of well-formed diverticula, in addition to three small posterior pairs with small lobes only (Pl. II, fig. 1).

Blood-vascular system. Cephalic lacunae and lateral vessels are present in the usual positions. A rudimentary dorsal vessel lies beneath the proboscis sheath for a short distance posterior to the brain region and then enters the rhynchocoel. It terminates in a small lacuna a fraction of a millimeter farther back.

Nervous system. The brain is so large that it fills most of the space within the cephalic walls in the region that it occupies. The lateral nerve cords extend posteriorly between the dorsal and ventral branches of the midgut diverticula and about equidistant between the proboscis sheath and the lateral margins of the body. There is only a single fibrous core (Pl. II, fig. 2). No trace of the dorsal core which Brinkmann (1907) describes and figures for *P. fusca* could be recognized. A thin sheet of nerve-cord muscles extends along the dorsomedian surface.

The dorsal nerve is small and inconspicuous, as is usually the case with species having very thin body musculatures.

Reproductive system. The only specimen available for study was a mature female with 10 pairs of ovaries, each with a closed oviduct leading to the ventral surface of the body. The ovaries occupy the usual positions between adjacent intestinal diverticula and with one exception on the dorsal sides of the nerve cords (Pl. II, figs. 1, 5). The ovary produces but one or two mature ova at any one time and this specimen offers no evidence as to whether the oviduct opens to allow the egg to be fertilized before it is discharged from the body. The mature ovum is large and is provided with thousands of deeply-stained yolk granules.

In addition to the one or two large ova, the ovary contains several small ovocytes without yolk and these presumably begin in sequence to form yolk as soon as the mature ovum has been discharged. It is uncertain whether development of the embryo may begin within the body, for no evidence to that effect has yet been found in any of the bathypelagic species.

Habitat. The single known representative of this species was taken in the Bermuda area at a depth of about 1,200 meters.

Type Specimen: Holotype, Cat. No. 311-599; Net 1217; August 24, 1931. Deposited in the collections of the Department of Tropical Research, New York Zoological Park, New York City.

33. *Parabalaenanemertes* (?) *zonata*
(Joubin).

Planktonemertes zonata Joubin, 1906; *Parabalaenanemertes* (?) *zonata* Coe, 1926.

Two specimens, which have as yet been studied only superficially, were collected in the central North Atlantic in nets drawn from 3,000 meters to the surface.

Genus *Probalaenanemertes* Brinkmann.

34. *Probalaenanemertes irenae* Wheeler, 1934.

The two known representatives of this species were taken in the South Atlantic west of the Cape of Good Hope in a net drawn from a depth of 1,000 meters. Both were females. They were associated with *Protopelagonemertes hubrechtii* and *Pelagonemertes rollestoni*.

35. *Probalaenanemertes wijnhoffi* Brinkmann, 1917.

P. wijnhoffi Coe, 1926.

The single known individual of this species, which was a mature female, was taken in the northern part of the North Atlantic (Lat. 56° N., Long. 31° W.) at a depth of about 800 meters.

FAMILY BALAENANEMERTIDAE.

Genus *Balaenanemertes* Bürger.

36. *Balaenanemertes chavesi* (Joubin).
Nectonemertes chavesi Joubin, 1906; *Balaenanemertes chavesi* Brinkmann, 1917;
Coe, 1926.

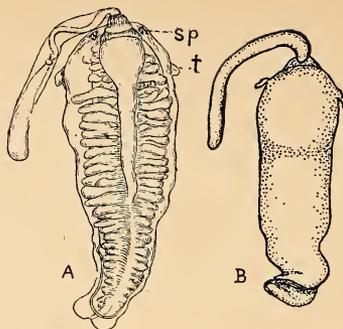
Text-figure 24, A.

The single known specimen was taken in the central North Atlantic in a vertical haul from 3,000 meters.

37. *Balaenanemertes grandis* Brinkmann, 1917.

B. grandis Coe, 1926.

The two known representatives of this



TEXT-FIG. 24. A, *Balaenanemertes chavesi*, dorsal surface of male, showing spermaries (sp) and tentacles (t); B, *B. lobata*, female, body contracted after preservation. (A after Joubin B, after Brinkmann).

species were taken in the northern North Atlantic at depths of 660 and 1,200 meters, respectively.

38. *Balaenanemertes hjorti* Brinkmann, 1917.

B. hjorti Coe, 1926.

Only a single individual has as yet been obtained; it was collected in the central North Atlantic at a depth of about 1,000 meters.

39. *Balaenanemertes lata* Brinkmann, 1917.

B. lata Coe, 1926.

This species is likewise known from but a single specimen taken from a depth of about 1,300 meters in the central North Atlantic.

40. *Balaenanemertes lobata* (Joubin).

Nectonemertes lobata Joubin, 1906; *Balaenanemertes lobata* Brinkmann, 1917; Coe, 1926. (Includes *B. musculocaudata* Brinkmann?).

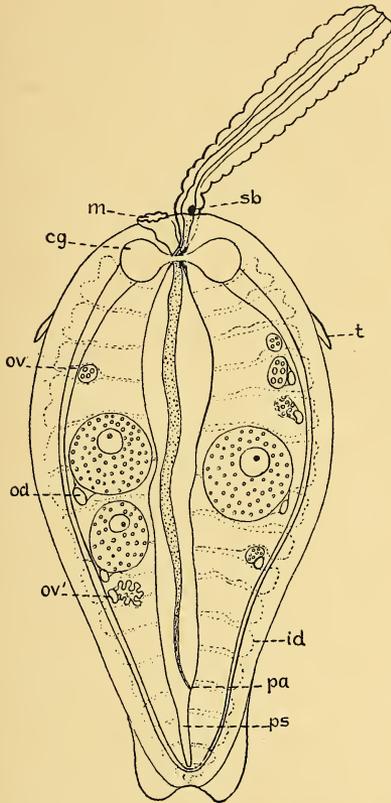
Text-figure 24, B.

Eight individuals which have been referred to this species have been taken in the central and northern North Atlantic (Lat. 36° to 59° N.) in nets lowered to depths of 400 to 3,000 meters. Seven of these were females; at three stations the females were associated with males of *B. musculocaudata*, which are closely similar anatomically except for the gonads but differ in color. Brinkmann himself suggests that such anatomical differences as he found might be merely sexual distinctions. If this supposition is correct, the name *B. musculocaudata* is a synonym of *B. lobata*. In several species of bathypelagic nemertean the two sexes differ in color.

41. *Balaenanemertes minor* Coe, 1926.

Text-figure 25.

This species is known only from the Bermuda area, where a single individual was caught at a depth of 549 meters.

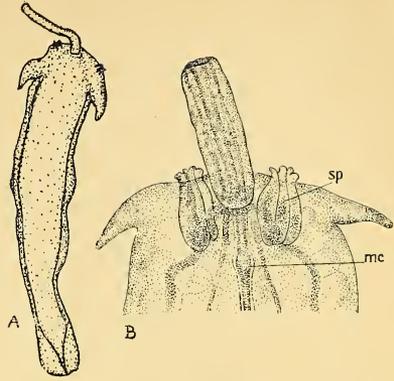


TEXT-FIG. 25. *Balaenanemertes minor*. Outline of body of mature female with partially everted proboscis, showing 3 large ovaries each containing a single ripe ovum and 6 small ovaries (ov, ov') from which the eggs have been discharged; other letters indicate: cg, cerebral ganglia; id, intestinal diverticula; m, mouth; od, oviduct; pa, attachment of proboscis to proboscis sheath (ps); sb, stylet basis; t, tentacle. (After Coe).

42 (?). *Balaenanemertes musculocaudata* Brinkmann, 1917.*B. lobata* (Joubin) ?*B. musculocaudata* Coe, 1926.

Text-figure 26.

The five individuals thus far obtained were all males; they were collected in the northern North Atlantic; at three stations they were associated with females of *B. lobata*. For the reasons stated above it seems probable that these males actually represent the latter species, but it seems advisable to retain both specific names until further evidence is available.



TEXT-FIG. 26. *Balaenanemertes musculocaudata* (*lobata*?). A, male with partially everted proboscis; B, anterior end of body, showing spermaries (sp) and middle chamber of proboscis (mc). (After Brinkmann).

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EXPLANATION OF THE PLATES.

PLATE I.

Mononemertes scarlata.

- Fig. 1. Outline of body, showing extent of proboscis sheath and proboscis; on one side the 8 spermaries are indicated and on the other side the lobed intestinal diverticula.
- Fig. 2. Diagram of anterior end of body, indicating relation of proboscis and mouth, which open together into a short atrium.
- Fig. 3. Portion of transverse section of body, showing dorsal and ventral branches of one of the intestinal diverticula.
- Fig. 4. Portion of transverse section near posterior end of body, showing intestinal diverticulum without ventral branch. The epithelium covering entire body wall in life is still retained on ventral surface.
- Fig. 5. Portion of transverse section of proboscis sheath, showing interlacing of longitudinal and circular or spiral muscular fibers.
- Fig. 6. Portion of section through caudal fin, with commissure at posterior end of nerve cords and the well developed dorsoventral musculature.
- Fig. 7. Outline of stylet basis, with indications of sockets from which the minute stylets have been dissolved.
- Fig. 8. Transverse and longitudinal sections of lateral nerve cord, showing dorsal fibrous core (**dc**).

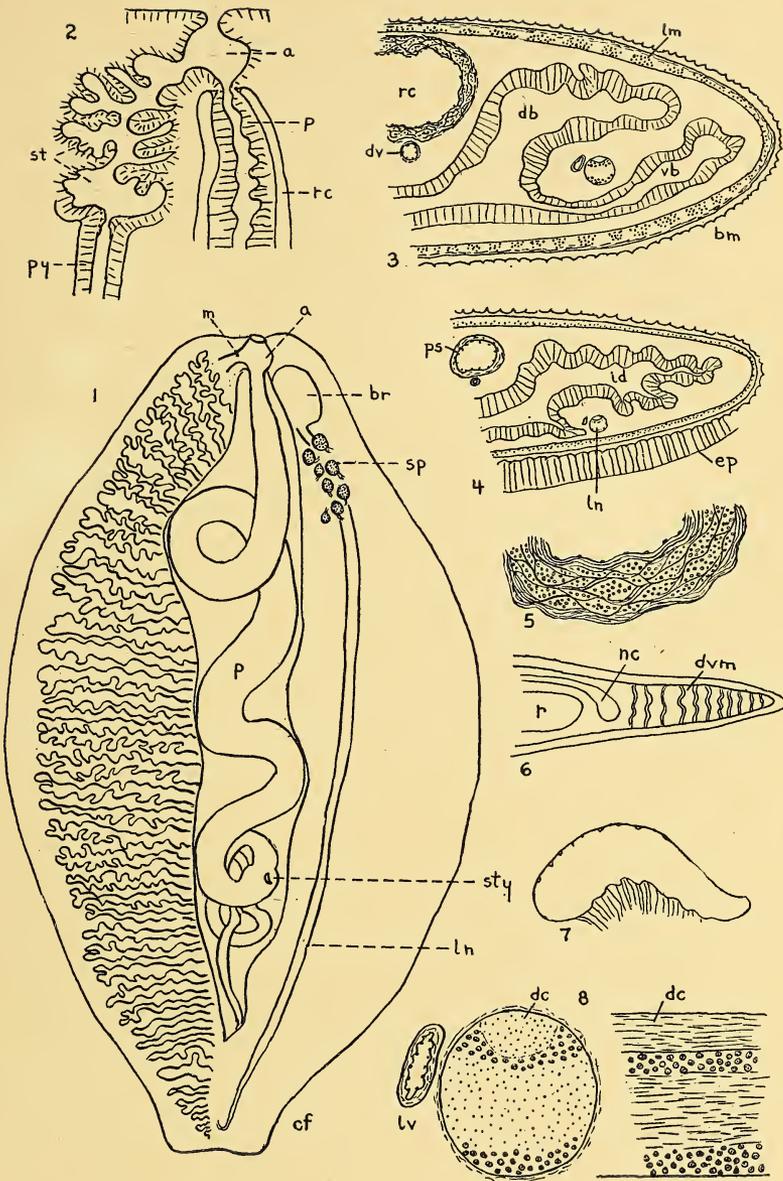
Letters indicate: **a**, atrium; **bm**, basement layer underlying surface epithelium in life; **br**, brain; **cf**, caudal fin; **db**, dorsal branch of intestinal diverticulum; **dc**, dorsal core of

nerve fibers; **dv**, dorsal blood vessel; **dvm**, dorsoventral muscles; **ep**, epithelium; **ln**, lateral nerve cord; **lv**, lateral vessel; **m**, mouth; **nc**, nerve-cord commissure; **p**, proboscis; **ps**, proboscis sheath; **py**, pylorus; **r**, rectum; **rc**, rhynchocoel; **sp**, spermaries; **st**, stomach; **sty**, stylet basis; **vb**, ventral branch of intestinal diverticulum.

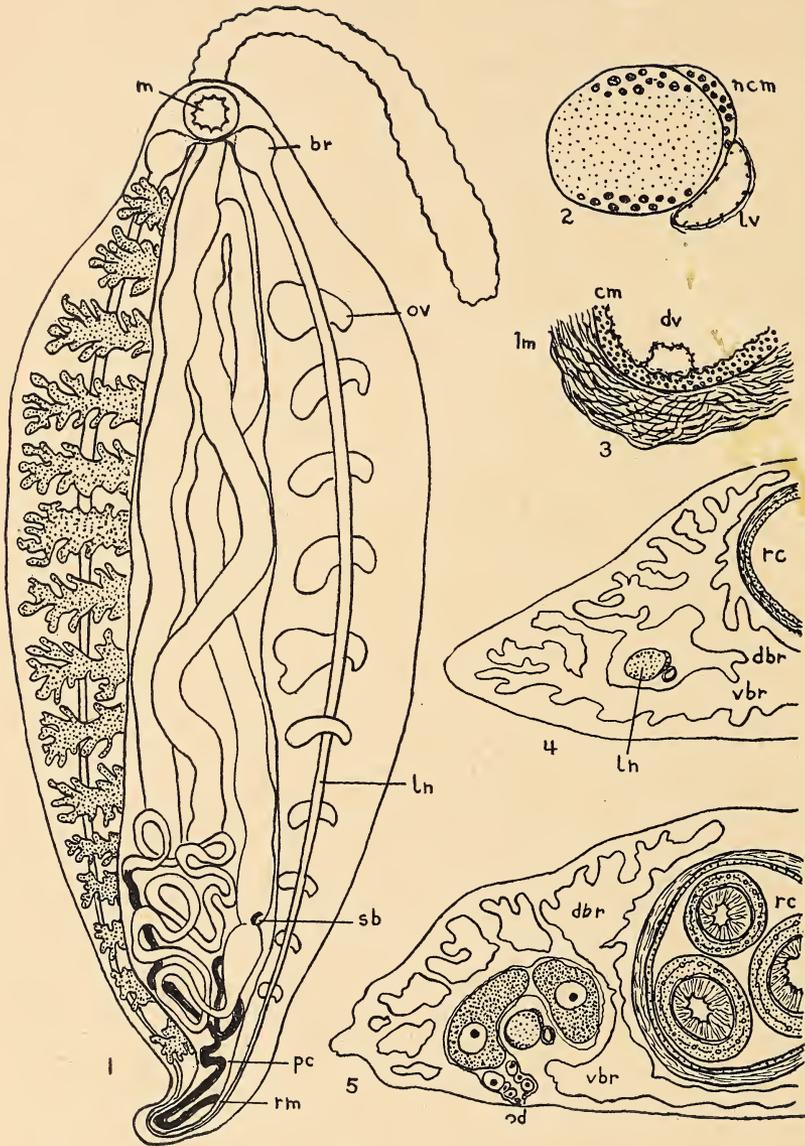
PLATE II.

Parabalaenanemertes nigra.

- Fig. 1. Outline of body of type specimen, showing intestinal diverticula on one side of the body and ovaries (**ov**) on the other side, with the rhynchocoel containing the extremely long, coiled proboscis occupying the central axis; other letters indicate: **br**, brain; **ln**, lateral nerve cord; **m**, mouth; **pc**, posterior chamber of proboscis; **sb**, stylet basis; **rm**, retractor muscle.
- Fig. 2. Transverse section of lateral nerve cord with accompanying nerve-cord muscle (**ncm**) and lateral vessel (**lv**).
- Fig. 3. Portion of transverse section of proboscis sheath with dorsal vessel (**dv**); **cm** and **lm**, circular and longitudinal muscular layers respectively.
- Fig. 4. Portion of transverse section of body, showing the dorsal (**dbr**) and ventral (**vbr**) branches of the intestinal diverticula; **rc**, rhynchocoel; **ln**, lateral nerve cord with accompanying vessel and nerve cord muscle.
- Fig. 5. Portion of transverse section in posterior third of body showing the ovary and oviduct (**od**); letters as in Fig. 4.



BATHYPELAGIC NEMERTEANS OF THE BERMUDA AREA AND OTHER PARTS OF THE NORTH AND SOUTH ATLANTIC OCEANS, WITH EVIDENCE AS TO THEIR MEANS OF DISPERSAL.



BATHYPELAGIC NEMERTEANS OF THE BERMUDA AREA AND OTHER PARTS OF THE NORTH AND SOUTH ATLANTIC OCEANS, WITH EVIDENCE AS TO THEIR MEANS OF DISPERSAL.

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16.

Studies on Virus Diseases of Fish.

IV. Lymphocystis Disease in Centrarchidae.

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(Plates I—III).

INTRODUCTION.

The lymphocystis virus disease of fish is prominent among other virus diseases by the fact that the infected cells represented by fibroblasts and osteoblasts undergo a gigantic hypertrophy. By a characteristic metamorphosis the host cells are transformed into the so-called lymphocystis cells. They contain cytoplasmic inclusion bodies which at early stages resemble in their configuration those observed in certain other virus diseases (mammalian pox group for instance). In connection with the conspicuous hypertrophy of the host cell, however, the inclusion bodies in the lymphocystis disease grow to enormous dimensions, unique hitherto in the pathology of virus diseases.

The lymphocystis disease of fish first studied in Europe has been observed among American fish since 1936 in several marine species of the Atlantic coast of the United States (blue angelfish, *Angelichthys isabellita* [Smith and Nigrelli, 1937], hogfish, *Lachnolaimus maximus* [Weissenberg, Nigrelli, Smith, 1937], orange filefish, *Aleutera schoepfi*=*Ceratacanthus schoepfi*, [Weissenberg, 1938; Nigrelli and Smith, 1939], common killifish, *Fundulus heteroclitus*, [Weissenberg, 1939a]). Among North American fresh water fish the occurrence of lymphocystis disease has been described hitherto only in the perch *Stizostedion*. It has been studied especially in *Stizostedion vitreum*, the so-called wall-eyed pike perch (cf. Mavor and Feinberg, 1918; Hyde, 1937; Weissenberg, 1939b).

Since 1938 I had the opportunity to ascertain the occurrence of lymphocystis disease in several species of the Centrarchidae or sunfish which are known to represent a large and significant family of fresh water fish peculiar to North America.

The first information that lymphocystis disease sometimes occurs in Centrarchidae was given to me by Dr. R. R. Kudo, University of Illinois, Urbana, Ill., in 1937, soon after my arrival in the United States. Dr. Kudo wrote me concerning the lymphocystis disease of *Stizostedion* and incidentally men-

tioned that in the preceding years he had observed lymphocystis tumors in specimens of the white crappie, the black crappie and the bluegill taken in Illinois. Dr. Kudo has not published his observations and was so kind as to send me in 1939 some preserved material of affected Centrarchidae for my comparative study. In the meantime I had discovered and observed a lymphocystis epidemic of bluegills and common sunfish at the Aquarium of Philadelphia in the winter of 1938-1939. These fish were taken from the Schuylkill River in Philadelphia. I am greatly indebted to Dr. Robert O. Van Deusen, Director of the Philadelphia Aquarium, for placing infected specimens at my disposal. In that winter I had excellent facilities for keeping sunfish and bluegills in laboratory aquaria at the E. B. Morris Biological Farm of the Wistar Institute of Anatomy and Biology, Bristol, Pa. The epidemiological and experimental observations on these Centrarchidae are a part of my researches done at the E. B. Morris Biological Farm.

In the following winter I observed again at the Philadelphia Aquarium a lymphocystis epidemic of sunfish and bluegills. Furthermore, I saw in 1939, 1940 and 1941 several cases of lymphocystis disease in other species of Centrarchidae, partly collected also from the Schuylkill River in Pennsylvania, partly from other regions of the United States. For providing material of lymphocystis-affected Centrarchidae from Ohio, Michigan, Missouri and New Mexico, I am very grateful to Dr. R. V. Bangham, Wooster College, Wooster, Ohio, and to Dr. C. L. Hubbs, then at Univer. of Michigan, Museum of Zoology, Ann Arbor, Mich.

PROPAGATION OF LYMPHOCYSTIS DISEASE AMONG CENTRARCHIDAE.

The present study of the lymphocystis disease of the Centrarchidae is chiefly based on the numerous infected specimens of *Lepomis gibbosus* (Linnaeus), common sunfish, and *Lepomis macrochirus* Rafinesque, bluegill, in which I was able to follow the

T A B L E I.

Material of lymphocystis diseased Centrarchidae (Genus *Lepomis*)

Species	Places of Collection	Epidemics	Specimens Studied In Detail	First Inspected By	Length Of Specimens	Dates Of Collection	Greatest Size Of Lymphocystis Cells	Young Lymphocystis Cells (Reinfection)
<i>Lepomis gibbosus</i>	Schuylkill River at Philadelphia, Pennsylvania	Philadelphia Aquarium Dec. to May a) 1938/39 b) 1939/40	18	Weissenberg	8-15 cm.		601 × 515 micra	observed in several specimens
<i>Lepomis macrochirus</i>	Schuylkill River at Philadelphia	Philadelphia Aquarium cf. above	20	Weissenberg	8-20 cm.		669 × 624 micra	observed in several specimens
	Illinois		1	Kudo			440 micra	missing
Hybrid <i>Lepomis cyanellus</i> × <i>Lepomis macrochirus</i>	Dexter, New Mexico	U. S. Fish Serv. Hatchery Dexter, New Mex. in winter 1940/41	1	Hubbs		Dec. 19, 1940	300 micra	missing
<i>Lepomis megalotis</i>	St. Francis River near Greenville, Missouri		1	Hubbs		July 11, 1941	170 micra	missing

course of the disease on the living fish in Philadelphia. Further by study of individual cases the occurrence of the disease has been ascertained in the following species¹: 1) hybrid, *Lepomis cyanellus* Rafinesque × *Lepomis macrochirus* Rafinesque. 2) *Lepomis megalotis* Cope, long-eared sunfish. 3) *Pomoxis nigro-maculatus* (LeSueur), black crappie or calico bass. 4) *Huro salmoides* (Lacépède), large-mouthed bass. 5) *Micropterus pseudaplites* Hubbs, Kentucky bass or spotted bass.

Thus lymphocystis disease has been ascertained in six species of Centrarchidae and in a hybrid of which the male parent represents a seventh, different species. To the host list may be further added *Pomoxis annularis* Rafinesque, the white crappie, in which species Dr. Kudo observed lymphocystis-infected specimens in Illinois (personal communication). The eight members of the Centrarchidae which have thus been ascertained as occasional hosts of lymphocystis disease belong to four different genera, namely *Huro*, *Lepomis*, *Micropterus* and *Pomoxis*. Therefore, it can be stated that susceptibility to lymphocystis disease is indeed widespread in the Centrarchidae.

Tables I and II give more detailed information about the material studied. From column 2 it can be seen that the infected specimens were taken from waters of six different states (Illinois, Michigan, Missouri, New Mexico, Ohio, Pennsylvania).

Therefore, it can be stated that lymphocystis disease is without any doubt widely spread in the United States. The disease seems to occur rather frequently, at least in *Huro salmoides* and some of the species of *Lepomis*.

Several of the Centrarchidae listed play an important role not only as game fish but also as food fish. Therefore, the study of this disease is not only of scientific interest but is also of some economic significance. I am referring, for instance, to the epidemic in hybrids of *Lepomis cyanellus* × *macrochirus* observed in the Hatchery of the U. S. Fish and Wildlife Service at Dexter, New Mexico. Likewise, it is of interest to note that many young specimens of the large-mouthed bass were affected in a lake in Ohio. Furthermore, the outbreaks of lymphocystis disease among the common sunfish and the bluegills which I observed at the Philadelphia Aquarium involved numerous specimens.

Concerning the season of the occurrence of the disease, column 3 of Table I shows that the lymphocystis disease of *Lepomis gibbosus* and *macrochirus*, observed as epidemics at Philadelphia in two successive years, was restricted to the cold weather period. The outbreak of lymphocystis disease in the hybrids at the U. S. Fish Hatchery at Dexter, New Mexico, likewise occurred during the winter season.

On the other hand there are observations of the occurrence of lymphocystis disease in other species of Centrarchidae in the sum-

¹The nomenclature follows mainly Hubbs and Lagler, 1939.

TABLE II.

Material of lymphocystis diseased Centrarchidae (Genera *Pomoxis*, *Huro*, *Micropterus*)

Species	Places of Collection	Epidemics	Specimens Studied In Detail	First inspected By	Length of Specimens	Dates Of Collection	Greatest Size of Lymphocystis Cells	Young Lymphocystis Cells (Reinfection)
<i>Pomoxis nigromaculatus</i>	Illinois		1	Kudo			380 micra	missing
	Schuylkill River at Philadelphia, Pennsylvania		1	Weissenberg	7 cm.	Nov. 1939	148 × 103 micra	missing
<i>Huro salmoides</i>	Half Moon Pond north of St. Mary's Ohio	numerous young specimens diseased	1	Bangham	7 cm.	July 19, 1939	300 micra	observed in sizes up to 81 micra
	Schuylkill River at Philadelphia		1	Weissenberg	13.5 cm.	Sept. 15, 1939	535 micra	observed in sizes up to 117 micra
	Huron River mouth of Silver Creek Wayne Co., Michigan		1	Hubbs	13.2 cm.	Oct. 12, 1941	330 micra	observed in sizes up to 150 micra
<i>Micropterus pseudoplites</i>	Wheeler Reservoir Ohio		1	Bangham	"adult"	Sept. 26, 1938	300 micra	missing

mer time. A rather young lymphocystis infection was seen in a specimen of *Lepomis megalotis* taken and preserved in the first half of July. It was also in the summer season that the frequent occurrence of lymphocystis disease in young large-mouthed bass was observed in a pond in Ohio. The only infected specimen of this species which I secured at the Philadelphia Aquarium had been taken from the Schuylkill River about the middle of September, which is still in the warm weather period for Philadelphia. It is of interest to note that this was at least seven weeks before bluegills and common sunfish taken at the same locality showed any macroscopic signs of lymphocystis disease.

Concerning the maximal diameters of lymphocystis cells observed in the collected Centrarchidae and listed in Tables I and II, it should be understood that only in *Lepomis gibbosus* and *macrochirus* the diameters in column 8 represent the greatest size of full-grown lymphocystis cells as observed in material from several specimens. Concerning all the other species listed, the diameters in column 8 refer to lymphocystis cells of the recorded specimen only and do not represent measurements of full-grown cells.

It is of interest to compare the maximal diameters observed in the full-grown lymphocystis cells of the common sunfish (601 microns) and the bluegill (669 microns) with those stated in other fish groups. In

reference to the largest dimensions of lymphocystis cells hitherto described, the two Centrarchidae are intermediate in position between *Lachnolaimus* and *Acerina*. In *Lachnolaimus* tumors, lymphocystis cells of 530 microns were observed. In *Acerina* the lymphocystis cells reach 700 microns. In comparison with full-grown lymphocystis cells of *Stizostedion* (1,200 microns) and *Pleuronectes* (2,000 microns), the lymphocystis cells of the two Centrarchidae only reach medium dimensions at the end of their growth period.

COURSE OF THE LYMPHOCYSTIS DISEASE IN *Lepomis gibbosus* AND *macrochirus*. SOME INFECTION EXPERIMENTS.

The general aspect of the lymphocystis tumors in the Centrarchidae is similar in appearance to that of the lymphocystis disease in other fish groups. Round nodules or oblong growths two to three millimeters in length protrude from the skin. The growths are covered by the epidermis and by a thin layer of connective tissue containing pigment cells. The chief component of the growths is represented by the hypertrophied and transformed fibroblasts, the so-called lymphocystis cells. When inspected through the magnifying glass or in later stages with the naked eye, these cells appear more or less distinctly as round bodies shining through the covering layers.

The lymphocystis tumors of the Centrarchidae

chidae when compared with those of the perch *Stizostedion* show the following peculiarities. 1) The tumors are, as a rule, restricted to the fin borders. Very seldom the skin of the trunk is affected. 2) Usually only a few tumors develop, which in the average consist of less lymphocystis cells than in the perch. Sometimes only a very small number of fibroblasts or osteoblasts of a fin become transformed into scattered lymphocystis cells. 3) The color of the tumors in *Lepomis gibbosus* and *macrochirus* is not much modified by covering pigment cells. Tumors in advanced stages of growth appear white because the lymphocystis cells of the Centrarchidae become white and opaque as soon as they have reached macroscopic dimensions. Therefore, rather full-grown tumors are clearly visible on the swimming fish even at a distance and growths which contain only a few lymphocystis cells can be recognized as white dots.

Previous observations on *Acerina cernua* and *Pleuronectes flesus* had shown that lymphocystis disease is very infectious for these fish when kept together with diseased specimens of their own species (Weissenberg, 1914, 1921b). The observations on the common sunfish and bluegills in the large tanks of the Philadelphia Aquarium as well as in the laboratory aquaria confirmed this experience, at least in principle. It is true that not always under these conditions did infection occur, but about 60 percent. of healthy fishes became infected when living in the same container with diseased specimens of the same species. After several weeks they developed lymphocystis tumors, or at least some lymphocystis cells which after reaching macroscopic size became clearly visible as white spots.

The epidemic discovered in the Philadelphia Aquarium in December, 1938, among specimens taken from the Schuylkill River, came to its end during the spring. In May the last carriers of tumors became clean by sloughing. These observations corresponded with the results in the laboratory. From May on, infection experiments no longer gave any positive results. So it seems that the susceptibility of the common sunfish and the bluegills persisted only during the cool weather period.

For experimental infection I applied with success the two methods which I developed in previous experiments with perches and *Pleuronectes*. An emulsion of the tumors was either put into the aquarium water or it was sprayed into the pharynx of specimens through the mouth or through the opercular clefts.

Most efficient was an emulsion of tumor material which was very finely comminuted, first by cutting and teasing the tumors, and then by grinding them thoroughly in a mortar. The tumors used in preparing this

emulsion were not emulsified immediately after their excision but were first placed in the refrigerator for 24 hours. Further, the emulsion itself was kept in the laboratory for several hours before it was applied to the fishes. This procedure was followed with the idea in mind that the efficiency of the material for infection might be increased by changes going on within the lymphocystis cells after the excision of the tumors.

In contrast to the successful infection results obtained with tumor emulsions it is of interest to note that the feeding of whole pieces of sunfish tumors to three sunfish did not produce infection.

On specimens of *Lepomis gibbosus* and *macrochirus* kept in laboratory aquaria I observed that the whole course of the disease took only 16-18 weeks. The macroscopic manifestation of the lymphocystis disease in the common sunfish was the same as in the bluegill. The whole course of the disease can be described for these two Centrarchidae with regard to macroscopic observation as follows: After infection about six weeks elapsed until the tumors became conspicuous to the naked eye as gray transparent swellings. After another week they had increased in size and began to appear whitish. During the following weeks the tumors, now definitely white, continued to grow. The full grown stage was reached approximately twelve weeks after infection. Two weeks later the tumors seemed to be still intact but after another two weeks they looked considerably smaller as a result of shedding of numerous lymphocystis cells or of sloughing off of whole pieces of tumors. The process of shedding was finished about two weeks later. Thus, the whole process occurred in sixteen to eighteen weeks. This statement applies to common sunfish and bluegills which were kept from December to June in laboratory aquaria without running water. The rooms in which the aquaria were situated were moderately heated during the winter.

The observation that the skin of the diseased Centrarchidae became clean again soon after the termination of the growth of the tumors is in a certain contrast to my previous experience with *Acerina*. At least a few of the infected specimens of this perch did not slough off their tumors but carried them still seven weeks after the expiration of the growth period of the lymphocystis cells. About that time an intercurrent *Saprolegnia* infection terminated their life in the laboratory aquarium. The persistent tumors consisted mainly of degenerated lymphocystis cells. The observation of the healing of the lymphocystis disease in the two Centrarchidae is, on the other hand, in complete accordance with the observations of Nigrelli and Smith on the filefish. It may be that in *Acerina* also the percentage of infected fish

showing final loss of their tumors would have been larger if it had been possible to keep them for a longer period of observation.

The statement that the lymphocystis disease in the two Centrarchidae healed, as a rule, two weeks after the end of the growth period of the lymphocystis cells refers to the macroscopic appearance of the fish. I do not doubt that a microscopic examination would still be able to demonstrate traces of the recent disease. For instance the resistant membranes of degenerated lymphocystis cells may persist for some time or some stunted cells may be found which never reached macroscopic dimensions due to arrested development at an early stage.

Persistence of such small lymphocystis cells from a previous infection can, of course, become a source of error in judging results of infection experiments. There is the danger of confusing such arrested cells with young lymphocystis cells produced by the experiment at hand. Because in the experiments with the two centrarchids the fish chosen for the experimental treatment were from the same river from which carriers of tumors were taken, great care was necessary to avoid possible sources of error.

A confusion of arrested cells of a previous infection with young lymphocystis cells could, however, be excluded by the following procedure which is based on the fact that the borders of the fins represent a favorite place for the development of lymphocystis cells. Three weeks before the start of the infection experiment the border zone of the tail fin and the anal fin of the specimens to be experimented with was amputated. When the infection experiment started the regeneration of the fins had already progressed well. Three weeks later the fin borders were amputated again and examined microscopically. Should they now contain small lymphocystis cells within the regenerated zone, then it was evident that these lymphocystis cells were young lymphocystis cells developed during the period of the experiment, and could not be any arrested remnants from an old infection.

Plate III, Fig. 11, from a positive infection experiment, shows as an example of such a preparation a whole mount of the border region of the tail fin of a bluegill. The epithelium has been removed to a large extent with a brush. The upper part of the figure shows the regenerated zone (**re**) which can easily be recognized by the dark staining of the tissue still in differentiation. New end portions of the fin rays already can be seen (**rf**), but bony plates are not yet developed in them, in contrast to the clearly-visible bony plates (**bo**) of the old fin rays in the lower part of the figure. Some debris of bone plates (**d**) show dis-

tinctly the level at which the amputation was performed. The pigment cells (**p**) are larger in the nonregenerated zone. The preparation shows very clearly small lymphocystis cells (**l**). Some of them lie isolated, some form small groups. In the middle of the preparation they are assembled in a large cluster. The important fact is that all these small lymphocystis cells are developed exclusively in the regenerated zone. Here they lie between or on the regenerating fin rays. Thus this preparation gives the clear evidence for the positive result of such an infection experiment.

Specimens of *Lepomis gibbosus* and *macrochirus* and also of some other species of the collected Centrarchidae with tumors containing large lymphocystis cells frequently showed in the tumors also young lymphocystis cells representing the manifestation of a second attack of the disease (cf. Tables I and II, column 9). Common sunfish and bluegills still bearing tumors of a previous infection could be experimentally re-infected by administration of tumor emulsion. In some specimens three subsequent lymphocystis infections were seen during four months. In contrast to observations made on *Acerina* (Weissenberg, 1921b, p. 1367), it was observed in the two centrarchids that a second infection might follow a first one after only a few weeks.

Experiments in which I tried to infect common sunfish or bluegills with an emulsion of *Stizostedion* lymphocystis cells were unsuccessful. This result corresponds with the negative result of previous experiments in which I attempted to transmit lymphocystis disease from *Stizostedion* to *Fundulus heteroclitus* and *diaphanus* (Weissenberg, 1939a). That experience has led me to the conclusion that different kinds of lymphocystis viruses have to be distinguished which are adapted to different fishes (Weissenberg, 1939a, p. 255).

In considering the question as to how strictly the virus strains may be adapted to their hosts it must, of course, be kept in mind that *Stizostedion* and *Fundulus*, and also *Stizostedion* and *Lepomis*, belong to separate families which are more or less remote in their systematic relationship. Experiments in transmitting lymphocystis disease from one species to another species of the same genus had not been hitherto performed. The simultaneous occurrence of lymphocystis disease in the two species of *Lepomis* at the same locality now raised the question as to whether the epidemics of the sunfish and bluegills were produced by the same type of virus, or if here also two different strains have to be distinguished. This problem was approached by the following experiment. An emulsion of full-grown tumors of a bluegill, prepared as described above, was sprayed into the pharynx of

three bluegills and two sunfish. Twenty days later all these five fishes showed in their fins young lymphocystis cells at the same stage of development. The infection of one sunfish was especially severe. None of the two sunfish carried any remnants of lymphocystis cells from a previous infection which could have been the source for a re-infection. Thus the referred experiment indicates that the bluegill virus is transmissible to the common sunfish.

Unfortunately the season was too advanced to start any more similar experiments, and in the following winter I no longer had the facilities at my disposal for a continuation of the experimental work. As far as a conclusion may be derived from only one experiment, the referred observation is in favor of the presumption that the simultaneous epidemics among the two species of *Lepomis* in the Schuylkill River were caused by the same agent.

MICROSCOPIC STRUCTURE OF THE LYMPHOCYSTIS CELLS. THE CYTOPLASMIC INCLUSION BODIES IN SEVERAL STAGES OF DEVELOPMENT.

The lymphocystis cells of the Centrarchidae show, in comparison with those of other fish groups, some morphological peculiarities. However among the various host species within this family, there are not significant differences, on the basis of my present knowledge. Especially for the lymphocystis cells of the common sunfish and the bluegill, of which I have seen the most material, is it true that they are not essentially different in their structure.

Corresponding with the findings in other fish groups the lymphocystis cells of the Centrarchidae have a spherical or oval shape and are surrounded by a glassy homogeneous membrane which shows a strong index of refraction. In fresh preparations the membrane represents a thick envelope; however, it shrinks during fixation, especially in younger cells. Therefore, in Pl. I, Figs. 1-3, 6, 7, the membrane (*m*) appears only as a single contour. The membrane shows a basophilic staining reaction, but like mucin or the ground substance of cartilage it does not keep the basic staining so firmly as the chromatin does.

The lymphocystis cell contains a large vesiculated nucleus which is rather poor in chromatin content especially in advanced stages of the growth period. Occasionally binucleated lymphocystis cells are found as in other fish groups. With regard to the number of acidophil nucleoli the lymphocystis cells of the Centrarchidae resemble those of the perches. Usually the nucleus contains a single nucleolus as can be seen in most figures of Pl. I and in Pl. III, Fig. 10. By exception two nucleoli are found (Pl. II, Fig. 9).

The most conspicuous structures within the cytoplasm of the lymphocystis cells are their inclusion bodies which grow rapidly within the hypertrophying cells. Their configuration shows some differences in the lymphocystis cells of various fish groups. It seems, however, that they always pass through a stage in which they resemble very much the Guarnieri bodies which appear in the cells of mammals infected by vaccinia virus. I have always laid great stress upon the demonstration of this stage of development because it so clearly illustrates the similarity of the lymphocystis inclusion bodies to characteristic features known in other virus diseases (mammalian pox group). Pl. I, Figs. 1-3, show the "Guarnieri body stage" of the inclusions in bluegill lymphocystis cells and Fig. 4 in a lymphocystis cell of the common sunfish. The inclusions are in this stage represented by small round or oval bodies which are surrounded by a halo.

In respect to the number of the inclusion bodies which attain full development, the lymphocystis cells of the different fish groups represent two types. In the first type normally only one inclusion body sprouts out and additional inclusion bodies usually remain as rudiments. This type is represented by the lymphocystis cells of the perches (*Acerina*, *Stizostedion*). The lymphocystis cells of *Macropodus*, *Sargus* and *Aleutera* (filefish) belong likewise to this type. In the second type numerous inclusions develop into larger bodies. This type is represented by the lymphocystis cells of the Pleuronectidae and of *Lachnolaimus*.

The lymphocystis cells of the common sunfish and the bluegill belong to type I. Usually the young lymphocystis cells contain only one inclusion body, as Fig. 1 demonstrates for the bluegill and Fig. 4 for the common sunfish. In some lymphocystis cells additional inclusion bodies are found; as a rule, however, these remain rudimentary. In Fig. 2 (bluegill cell) there is to be seen in addition to the right inclusion body which has already grown larger an accessory small inclusion on the left side. Fig. 3 shows, likewise in a bluegill lymphocystis cell, the rare case of two accessory inclusions.

In the perches (*Acerina*, *Stizostedion*) the young inclusion body then takes the shape of a fenestrated calotte which lies to one side of the nucleus. As Fig. 5 demonstrates in a lymphocystis cell of *Lepomis gibbosus*, also in the Centrarchidae sometimes the expanding inclusion body develops as a calotte. Usually, however, the growth of the inclusion body progresses mainly in the longitudinal dimension, so that the body forms a long cord which embraces the nucleus. Fig. 7 shows this in a sunfish lymphocystis cell which is cut in

two sections (A and B). Fig. 6 demonstrates the same in a bluegill cell. The portion of the inclusion cord situated beneath the nucleus is shown in the drawing in lighter color. A modification, in which the growth of the inclusion body extended predominantly in the longitudinal dimension but also to some degree in the transverse, is represented by a sunfish lymphocystis cell in Fig. 8 in two sections (A and B). Here the inclusion has more the form of a broad belt than of a cord.

The cord-shaped inclusion may already develop buds which have a globular shape. The inclusion of the cell in Fig. 6 shows many of them so that the cord here begins to take the appearance of a rosary. Later there is the tendency for such buds to be pinched off. In Fig. 8A this can be seen on the bud (**b**) which is still joined to the main cord, but only by a thin bridge.

Relatively late, when compared to the development of the inclusions in the lymphocystis cells of the perches, fenestrations appear in the inclusion bodies of the Centrarchidae. One hole (**h**) can be seen in the cord-shaped inclusion of the sunfish cell in Fig. 7B. Fig. 8B shows the belt-shaped inclusion pierced by three holes. In the lymphocystis cells of perches fenestrations of the inclusions appear earlier, already when the inclusions have still the shape of a calotte, and the perforations soon become so numerous that the inclusion bodies can be described as coarse networks.

In the following stages of the growth period of the lymphocystis cells of the Centrarchidae the inclusion bodies continue to expand in the cytoplasm. A number of globular buds sprout into branches, and more perforations develop. The branches and fenestrations then increase in size. So the whole configuration of the inclusion body rather frequently assumes the aspect of a "mycelium," as demonstrated in Pl. II, Fig. 9, in a bluegill lymphocystis cell of 225 microns in diameter. The cell is shown at three levels of focus of the microscope (Figs. 9 A, B, and C). The inclusion body had expanded in the peripheral zone of the cytoplasm and embraces the nucleus (**n**) which shows here, by exception, not one but two nucleoli (**e**). The most parts of the inclusion are connected as branches of one large "mycelium." This is also true for most portions of the inclusion which appear in the optical section B as separated. The portions marked **c**¹ and **c**² represent the areas where the "mycelium" from the lower level (C) can be followed into the next higher section (B) and from there into the top section (A). On the other hand, the small piece (**s**) in B, which can still be recognized also in A, is definitely isolated from the "mycelium," probably as a bud which was pinched off.

Not always, however, in bluegill lymphocystis cells of this size does the inclusion body still represent a connected "mycelium." Sometimes the "mycelium" is already fractionated into several globular portions. Such a partition of the inclusion body into separated fractions is the rule in the stages of the further development (cells of diameters of 300-600 microns).

It may be that the fractioning of the inclusion into numerous round bodies occurs earlier in the lymphocystis cells of the common sunfish than of the bluegill. Thus Pl. III, Fig. 10, shows numerous inclusion portions scattered through the peripheral zone of the cytoplasm in a sunfish cell of 200 × 185 microns. Many of them, especially the round forms, have not only the appearance of separated bodies in the section but are definitely isolated, as has been determined by study of the complete series of sections through this cell.

No essential difference was seen in the morphology of the inclusions between common sunfish and bluegill on one hand, and other species of Centrarchidae on the other hand. The lymphocystis cells of all contained, in the advanced stages of development, numerous separate inclusions which apparently also originated by budding and fragmentation of the original inclusion body.

As I have mentioned in a short note in 1937, also in the *Lachnolaimus* lymphocystis cells the shape and the condition of the inclusions in certain stages indicate their multiplication by budding and fragmentation. Such secondary increase in number by partition must be distinguished from the primary development of numerous inclusion bodies which appear independently one after the other in young lymphocystis cells. I described primary development of numerous inclusions in 1921b for the lymphocystis cells of *Pleuronectes*; however, on the basis of my observations in Centrarchidae and *Lachnolaimus*, it seems to me probable that, in addition to the primary development of numerous inclusion bodies, there may also occur in *Pleuronectes* a secondary increase in number by budding.

With regard to the distribution of the inclusions within the cytoplasm it is characteristic that the development of the inclusion bodies in the lymphocystis cells of the Centrarchidae remains restricted in the advanced stages to the cortical zone of the cell. A large central zone of cytoplasm which surrounds the nucleus is unoccupied by them as Pl. II, Fig. 9B (bluegill cell), and Pl. III, Fig. 10 (sunfish cell) demonstrate. This distribution of the inclusions resembles the position of the inclusion bodies in the lymphocystis cells of *Aleutera* and *Angelichthys*, but represents a striking contrast to the conditions found in full-grown lympho-

cystis cells of *Pleuronectes* and *Stizostedion*. In large *Pleuronectes* lymphocystis cells the whole cell body is filled with relatively thick inclusion bodies. In *Stizostedion* lymphocystis cells likewise in the advanced stages not only the cortical zone but the whole cell body is interspersed with thin folds of a single inclusion body which has sprouted into a garland with an enormous surface increase.

FINER STRUCTURE AND STAINING REACTION OF THE INCLUSION BODIES.

In the early stages the inclusions are represented by small bodies which look homogeneous (cf. Figs. 1, 3, 4, and left inclusion in Fig. 2). They stain intensively with nuclear dyes such as hematoxylin or safranin. As soon as they have reached a diameter of more than four microns their structure becomes differentiated (Fig. 2, right inclusion). Small clear vacuoles appear which in the following growth period progressively split up the basophil substance. The expanding inclusion bodies (Figs. 5-8) consist of a basophil framework which is interspersed with a ground substance staining lightly with hematoxylin or safranin. The framework appears in optical sections as a network of meshes of various sizes (Pl. I, Figs. 5-8).

It is very probable that the smallest meshes represent optical sections of alveoles. The larger ones, examined by focusing up and down, seem to be the components of a three-dimensional lattice-like structure. They vary in shape and thickness and may appear as threads, bands or lamellae. In the thicker portions of this basophil lattice small vacuoles can often be recognized, indicating the continuation of a splitting of the basophil substance which, on the other hand, apparently continues to increase in mass. As a matter of fact, the expansion of the inclusion within the cytoplasm is accompanied by a continuous increase in the number of the lattice meshes.

The smallest meshes have a diameter of only 0.8 microns. The openings of the largest meshes may reach a diameter of five microns. Often the inclusions contain some larger central spaces surrounded by a peripheral layer of smaller meshes which may represent either finer lattice networks or the walls of small alveoles (cf. Pl. I, Figs. 5 and 7).

In the thicker portions of the inclusions, for instance in the globular buds, several layers of lattice networks joined with each other by connecting meshes can be followed by focusing up and down. On the other hand, the lattice may approach a two-dimensional structure where the inclusion has expanded into a thin plate.

In the drawings of the inclusions in Pl. 1, Figs. 5-8, representing preparations stained with hematoxylin or safranin, attention was given chiefly to the configuration of the basophil framework and the microscope focused correspondingly. The vacuoles and the matrix in the smaller meshes appear in the drawings very palely shaded. In some of the larger central spaces, as in Fig. 5 (g) and Fig. 7A, the ground substance can be recognized more distinctly.

Figs. 5-8 show the structure of the lattice as it appears in a magnification of 625 \times when examined with an oil immersion objective and a low power ocular. In higher magnification the meshes of the lattice do not always appear homogeneous but may show a pattern of fine spots varying in depth of stain. Under most favorable optical conditions (powerful lenses, thin sections, appropriate differentiation of the staining) very fine basophil granules can be demonstrated as components of the basophil substance of the lattice. I intend to describe these finest structures in detail in a separate paper with figures which will show the inclusion bodies in considerably higher magnifications than here in Plate I.

As in my previous studies on the lymphocystis cells of *Acerina* and *Pleuronectes* the Biondi staining method was applied in the two Centrarchidae for the finer analysis of the components of the inclusion bodies. In the Biondi method the basic dyestuff, methyl green, is used in combination with two acid dyes, acid fuchsin and orange G. In confirmation of my previous findings it has been observed that also in *Lepomis* the basophil framework of the inclusions is electively stained with methyl green, exactly like the basichromatin of the nuclei. This staining reaction corresponds very well with the result obtained by Jirovec with the Feulgen reaction. Jirovec described in 1932 that the framework of the lymphocystis inclusions in *Pleuronectes* gives an intensely positive Feulgen reaction. Thus it seems justified to say that the framework of the lymphocystis inclusions consists of a substance which in its staining and microchemical reaction resembles basichromatin.

The vacuoles and the ground substance in *Pleuronectes* lymphocystis cells stain pink with the acid fuchsin in the Biondi method. It was on the basis of such Biondi preparations that I described in 1921 the "ground substance" of the lymphocystis inclusions generally as acidophilic. In the two Centrarchidae the result of the Biondi staining in this respect has been different. The vacuoles and the ground substance between the smaller meshes of the lattice remained either unstained or were slightly stained with methyl green. Only in the larger central spaces of the inclusions the ground substance stained pink in the Biondi method

and thus showed an acidophil staining reaction as in *Pleuronectes*. The cytoplasm stained likewise pink in these preparations. Cytoplasm and acidophil ground substance further resemble each other in their structural appearance. After fixation in Flemming's fluid or in a mixture of absolute alcohol (9.5 parts) and acetic acid (0.5 parts) both show a finely granulated structure.

The inclusion bodies in larger lymphocystis cells (cells of more than 200 microns in diameter) show the basophil substance as well developed only in the cortical zone. In the central portions of the inclusions the lattice has disappeared to a large extent. The central zone of the inclusions now consists of large confluent spaces filled with acidophil ground substance into which incomplete lattice septa project from the cortex. Usually the cortex layer of the lattice is perforated at one area so that the acidophil ground substance from the central zone blends into the surrounding cytoplasm. Therefore, an originally globe-shaped enlargement of the inclusion body may now resemble a bowl or a basket. Under these circumstances the possibility has to be considered that the acidophilic ground substance in the inclusions of the Centrarchidae may be cytoplasm which has penetrated into the inclusion. However, such an interpretation would not preclude the possibility that the "cytoplasm" within the central portions of the inclusions might have become modified by addition of particles originating in the basophil substance of the lattice.

ORIGIN OF THE INCLUSION BODIES.

The left inclusion body of the lymphocystis cell in Plate I, Fig. 2, represents a rather early stage of development. The diameter of the homogeneous corpuscle is less than one micron. Thus the corpuscle is much smaller than the nucleolus. It lies at some distance from the nucleus, is embedded in the cytoplasm and surrounded by the characteristic halo.

In *Acerina* and *Pleuronectes* I was able to follow the microscopic appearance of the inclusion bodies from the very beginning (Weissenberg, 1914, 1920, 1921b). They first become recognizable within the cytoplasm as very tiny granules. In such an early phase they can be distinguished from the ordinary cytoplasmic granules only by the surrounding halo. In the experimental infection of *Acerina* many fibroblasts begin to hypertrophy in the early part of the second week. Several of these hypertrophying cells soon become transformed into lymphocystis cells by the appearance of surrounding glassy membranes. Then several days pass in which the lymphocystis cells increase in size but do not yet show inclusion bodies. It was not before the *Acerina* lymphocystis cells had reached the end of the

second week in the infection experiments, that I was able to discover in their cytoplasm the earliest stages of the inclusion bodies as those tiny basophil granules surrounded by halos.

Thus I did not observe in the development of the inclusion bodies any morphological relationship whatsoever to components of the nucleus of the host cell. Later when the grown inclusion has the shape of a calotte and lies to one side of the nucleus, it is true that the inclusion body in its coarse appearance might show a certain similarity with the nucleus due to the basophil staining of its framework. But with higher magnification I never found it difficult to distinguish the inclusion body from the nucleus of the host cell because the nucleus of the lymphocystis cells always contains at least one large acidophil nucleolus². Under these circumstances I cannot agree with the suggestion of Nigrelli and Smith who in their filefish paper (1939) have considered a nuclear origin of the inclusion body.

THE APPEARANCE OF VARIOUS STAGES OF LYMPHOCYSTIS CELLS IN TRANSMITTED AND REFLECTED LIGHT.

As briefly mentioned above, the transparency of the lymphocystis cells of *Lepomis gibbosus* and *macrochirus* changes when the cells have reached the size of 200 microns. The smaller lymphocystis cells appear gray and transparent in reflected light and do not show a special color in transmitted light. In cells larger than 200 microns in diameter the cytoplasm shows a yellowish color in transmitted light in contrast to the nucleus and the inclusion bodies which appear colorless. Inspected with reflected light under the microscope or in low magnification these cells appear white.

It might be thought that the change in the transparency and color is caused by the gradual increase in mass of cytoplasmic particles interfering with the course of the light. But the fact that the white color seems to appear somewhat suddenly at a certain stage of growth, rather suggests some alteration in the composition of the cytoplasm. Coarse refractive structures which could produce the optical effect of the white color are only occasionally to be seen in these "white" lymphocystis cells. Therefore, the supposition of a change in the microstructure of the cell at the size of about 200 microns is suggested.

Mitochondria, which I studied in the lymphocystis cells of *Acerina* with special methods (Weissenberg, 1921b), are not yet investigated in the lymphocystis cells of Centrarchidae. Thus it remains unknown whether lymphocystis cells larger than 200

²In *Pleuronectes* numerous nucleoli are formed in the nucleus of the lymphocystis cells during the growth period.

microns in diameter are different from smaller lymphocystis cells in the development and distribution of mitochondria or other minute cell structures which might be demonstrated only by application of special methods. In routine preparations of fixed material, however, not any difference could be seen between the structure of the cytoplasm of the smaller and that of the larger lymphocystis cells. During the whole period of growth the cytoplasm shows under high magnification a finely granulated structure.

At present no evidence has been established to show that the suggested change in the microstructure of the cell body may be caused by a distribution of refractive virus particles within the cytoplasm of the lymphocystis cell. As a working hypothesis, however, such a possibility seems to me worthy of consideration. I may refer in this connection to observations made in studies on parasitic protozoa. In microsporidial diseases of fish, for instance in the infection of *Gasterosteus aculeatus* by *Glugea anomala* (Weissenberg, 1913, 1921a), the hypertrophying host cells appear transparent as long as they contain only the chains of schizonts of the microsporidium which have no refractive envelopes. But as soon as spores are formed which reflect the light, the zone of the host cell containing the spores appears white in reflected light.

Comparative observations on half-grown lymphocystis cells of *Stizostedion* in fresh condition indicate that such optical phenomena are not restricted to the lymphocystis cells of the Centrarchidae. They can also be seen in the *Stizostedion* lymphocystis cells but are not so conspicuous there. *Stizostedion* cells, of about 400 microns in diameter, appear whitish-gray in reflected light and pale yellowish in transmitted light. In this comparison it must be taken into consideration that in *Stizostedion* lymphocystis cells of this size the inclusion networks are not restricted to the peripheral zone of the cell; moreover, the whole cytoplasm is here interspersed with folded festoons of the inclusion network. Therefore, the conditions underlying the optical appearance of the whole cell body must be somewhat different from those of the lymphocystis cells of the Centrarchidae.

DISCUSSION.

Hypertrophy of host cells produced by the stimulus of intracellular parasites has been observed in various branches of the animal kingdom. The parasites which provoke this striking reaction are many different microorganisms belonging to bacteria or lower fungi or various groups of protozoa. In fish is known the occurrence of an enormous hypertrophy of host cells invaded by microsporidia. I myself have studied the gigantic

growth of ganglion cells of *Lophius* infected by the microsporidium *Nosema lophii* (Weissenberg, 1911). Another striking example is the infection of certain connective tissue cells of *Gasterosteus aculeatus* by the microsporidium *Glugea anomala*. The round cells invaded by the microsporidium have at first only a diameter of about eight microns. Through the stimulus of the multiplying and sprouting intracellular parasite the host cells can reach ultimate diameters of 3,000-4,000 microns (Weissenberg, 1921a and 1913). In many of these examples of intracellular parasitism the hypertrophy of the host cell is accompanied by a characteristic metamorphosis.

It was on the basis of such observations that I have interpreted from the beginning the lymphocystis cells as fish cells stimulated to their gigantic growth and characteristic metamorphosis by an intracellular parasite. However, no bacterium, fungus or protozoon could be discovered in the lymphocystis cells. On the other hand, the lymphocystis disease proved to be very infectious. Furthermore, the development of the conspicuous inclusion bodies was observed in the cytoplasm of the growing cells and it was discovered that these inclusions pass through a stage in which they closely resemble the compact stage of the Guarneri bodies of the variola virus infection. Thus, in 1914 and 1921b, I arrived at the conclusion that the supposed intracellular parasite might belong to the tiny parasitic microorganisms which v. Prowazek had described as Chlamydozoa and which at present are listed as "viruses." Under the general name "viruses" are united various obligatory cell parasites of very small dimensions. They are either of submicroscopic size or, as in their largest types (for instance the viruses of variola, vaccinia, fowl-pox, psittacosis), at the border of microscopic visibility.

It is true that it is not yet determined by filtration or ultracentrifugation experiments how small the size of the infectious particles is which transmit the lymphocystis disease from one host to another. Nevertheless, the formation of the conspicuous cytoplasmic inclusion bodies which in their development resemble those of some other virus diseases indicates clearly that the infectious agent of the lymphocystis disease represents a virus.

I have already pointed out that the early stage of the compact lymphocystis inclusion bodies closely resembles the compact stage of Guarneri bodies produced by the viruses of the mammalian pox group. Points of comparison are not only the shape of the bodies and the surrounding halo but also the basophil staining reaction.

In the following stage of the beginning differentiation numerous vacuoles are

formed in the lymphocystis inclusions so that the latter appear as alveolar structures. In this stage the lymphocystis inclusions resemble very much the vacuolated plaques which have been described by Rake and Jones (1942) in the development of the inclusions of lymphogranuloma venereum. Vacuolated inclusion bodies of a rather similar appearance are also described in certain plant virus diseases, e.g. by Kunkel in the cells of the sugar cane in the Fiji disease, as demonstrated in Pl. 3, Fig. 10, of Kunkel's chapter in Rivers, "Filterable Viruses".

In the course of the further differentiation of the lymphocystis inclusions the characteristic lattice framework is formed which shows a staining and microchemical reaction like basichromatin. It is of interest that in the differentiated Guarnieri bodies certain structures are described by Bland and Robinow (1939) which have a corresponding basophil staining reaction and also give a positive Feulgen reaction. These structures have the shape of lumps and rods and sometimes split into small basophil granules in advanced stages. This basophil material is evidently the same substance which von Prowazek had already described in 1907 and 1912 as the chromatoid component of the Guarnieri bodies.

It is true that in no other virus disease such a considerable growth of inclusion bodies is observed as in the lymphocystis disease. But evidently this outstanding phenomenon of the enormous growth of the lymphocystis inclusion bodies is closely connected with the gigantic hypertrophy of the host cell which in no other virus disease is observed hitherto in such a degree. It is of interest that a certain increase in size of the infected host cells also occurs in some other virus diseases, e.g. in fowl-pox, in the polyedral diseases of insects, in the mosaic disease of corn³. But the enlargement of the host cells observed in these virus diseases is insignificant in comparison with the enormous growth of the lymphocystis cells. Small fibroblasts after transformation into spherical lymphocystis cells reach diameters of about 600-660 microns in the Centrarchidae, of 1,200 microns in *Stizostedion*, of 2,000 microns in *Pleuronectes*. This gigantic hypertrophy of the lymphocystis cells is obviously the indispensable prerequisite to the enormous growth and spreading of the inclusion bodies.

Concerning the significance of the lymphocystis inclusion bodies I suggested in 1921 that they might be carriers of sprouting colonies of a tiny cell parasite. The size of the individual unit of this intracellular microorganism was supposed to be very small and perhaps beyond microscopic visibility.

My present view differs from this interpretation in certain details but corresponds

to it in the general concept. The growing inclusions seem to me to represent the manifestation of the growth of an intracellular parasite of which the earliest stages as well as the final stages of transmission are of very tiny size. A number of facts support such a view. 1) The inclusion bodies grow more rapidly than other components of the hypertrophying host cell. Thus the inclusion bodies sprout out through the cytoplasm. In Percidae and Centrarchidae where, as a rule, only one inclusion body continues to grow, it develops into a network or a "mycelium" which soon embraces the nucleus and then extends through the cortical zone of the cell (Centrarchidae) or throughout the whole cell body (Percidae). The rate of its growth surpasses the pace of the hypertrophy of the other cell components for a long period. 2) After the metamorphosis and hypertrophy of the host cell has indicated its invasion by the virus, several days pass in which inclusion bodies are not yet recognizable within the cytoplasm. Then they become visible at first as tiny points surrounded by halos and continue to increase in size during the following days and weeks. 3) In the lymphocystis cells of Percidae (*Acerina* and *Stizostedion*) I observed that accessory inclusion bodies, as a rule, remain rudimentary. This fact can be compared to the poor development that colonies of bacteria or fungi may show under unfavorable conditions of nutrition. 4) The budding and sprouting of the inclusion bodies, as described in the present paper in *Lepomis lymphocystis* cells, strongly suggest that the increase in size of the inclusion resembles that of a living material capable of growth and self-propagation.

The general view that the sprouting of the lymphocystis inclusions represents the manifestation of the expansion of the cell parasite within the host cell is in accordance with the observations and conclusions of many investigators who have studied cytoplasmic inclusions in other virus diseases.

To cite only a few examples, I refer first to the development of the Negri bodies characteristic of the lyssa virus infection. Paul and Schweinburg (1926) and Schweinburg (1937) have stated that these inclusions appear at first as tiny points in the infected nerve cells and then grow gradually to become the Negri bodies. These authors have likewise interpreted this development as the expansion of a parasitic organism within the host cell.

In a number of other virus diseases tiny granules, the so-called elementary bodies, have been observed in the infected tissues. By careful investigations in several laboratories during the past 18 years ample evidence has been established to show that very probably the elementary bodies represent the infective units of the respective

³cf. Goodpasture, 1928; Glaser, 1928; Kunkel, 1928.

viruses. The elementary bodies have in vaccinia⁴ and in fowl-pox a size of about 0.25 microns, in psittacosis of about 0.3 microns, in lymphogranuloma venereum (Rake and Jones, 1942) a size of about 0.4 microns. To the cytoplasmic inclusions of these viruses the elementary bodies are correlated in various respects. First of all, it has been stated that the inclusion bodies disintegrate at the end of their growth period into a large number of elementary bodies. Secondly, the development of the inclusion bodies has been followed from early stages in which they represent small corpuscles of about 1 micron or still less in diameter. These "initial bodies" are supposed to be enlarged elementary bodies which after entering the host cell have been transformed into the anlagen of inclusion bodies. Whether the increase in size of the elementary body is due to growth or to the deposition of some coating material, possibly produced by the host cell, has been discussed by Bland and Robinow (1939) in their study of the development of the Guarneri bodies of vaccinia. Thirdly, in psittacosis and lymphogranuloma venereum the growing inclusion bodies have been demonstrated to be composed of relatively large granules of about 1 micron in size. These large granules are embedded in a matrix which holds them together. The large granules have been interpreted as developmental stages of the virus (Bedson and Bland, 1932 and 1934; Bland and Canti, 1935; Rake and Jones, 1942). They are derived from the original elementary body as products of repeated divisions. The large granules in the inclusions of lymphogranuloma continue to grow into plaques up to 4 microns in diameter (Rake and Jones). Within these plaques then appear elementary bodies of the original size. In psittacosis the large granules have been described as undergoing progressive divisions by which they decrease in size. The end products of these divisions are again elementary bodies.

The Guarneri bodies of vaccinia are evidently more complicated in their structure and development. In advanced stages of these inclusions elementary bodies were seen by Bland and Robinow. But these authors were unable to identify elementary bodies within the growing Guarneri bodies. Nevertheless, Bland and Robinow consider it very probable that the Guarneri body during its whole development contains elementary bodies enveloped in a matrix which is possibly produced by the host cell. Thus they interpret the Guarneri bodies as colonies of the virus units and conclude that they

represent an obligatory stage of the multiplication of the virus within the host cell.

The cited examples show that the interpretation of cytoplasmic inclusions as colonies of the virus or as carriers of multiplying stages of the virus is a familiar concept in the modern virus literature. It is of decisive importance that in fowl-pox conclusive evidence has been established to show that the inclusion bodies do contain the infective material. Woodruff and Goodpasture succeeded in 1929 in producing a typical fowl-pox lesion by transplantation of an isolated inclusion body into the skin of a hen.

It may be gathered from this review that the general interpretation of the lymphocystis inclusion bodies as the manifestation of the growth of the virus within the host cell is in harmony with the structural analysis and the dominant interpretation of cytoplasmic inclusions in a number of other virus diseases.

Any attempt to put the general idea of the association of the lymphocystis inclusion bodies with the growing virus into a precise form has to deal with an old problem. Does the whole inclusion body represent substance of the cell parasite or have two components to be distinguished in the inclusion body: 1) developmental stages of the cell parasite and 2) a surrounding substance produced by the host cell? The latter opinion was established in 1907 by von Prowazek who described cytoplasmic inclusion bodies in virus diseases as complex structures consisting of tiny microorganisms and of an enveloping substance produced by the host cell as a reaction product. Von Prowazek considered the formation of the reaction product under the stimulus of the cell parasite as so characteristic that he called the infectious agents of virus diseases "Chlamydozoa" which name means literally animals equipped with a mantle⁵.

It was on the basis of von Prowazek's theory that in 1921 I interpreted the lymphocystis inclusion bodies likewise as complex structures. I supposed that they consist of colonies of a tiny microorganism which are interspersed with structures produced by the host cell as a reaction product. I suggested that the granular acidophil ground substance, as described in the inclusion bodies of *Pleuronectes* and *Acerina*, might represent the location of the virus colonies. I interpreted the chromatin framework of the lymphocystis inclusion bodies as a reaction product of the host cell which might serve a mechanical function by localizing the growth of the sprouting colonies within the cytoplasm.

At that time the acidophil ground substance was the only component of the lymphocystis inclusion bodies in which a gran-

⁴The elementary bodies of vaccinia have been studied by Green, Anderson and Smadel by means of the electron microscope (1942). The electron micrographs in a magnification of 7,100 x 4 show the vaccinia particles as rectangular bodies with the shape of a brick and a structure which in several respects approaches that of bacteria.

⁵cf. Cowdry in Rivers "Filterable Viruses," pp. 114 and 115.

ular structure was observed. In the chromatin meshes of the lattice no finer structures were described besides the frequent appearance of small vacuoles. My recent studies of sections with powerful lenses have shown, however, that the chromatin meshes of the lattice not always appear homogeneous. They may show a pattern of fine spots varying in depth of staining, and, under favorable optical conditions, fine basophil granules can be demonstrated as components of the lattice framework.

Under these circumstances, the possibility gains weight that the chromatin lattice might consist of virus substance or might contain developmental stages of the virus. The fact that the substance of the lattice contains nucleoprotein, as proved by selective staining and the Feulgen reaction, would be in favor of such an interpretation. It has been shown by chemical analysis that certain plant viruses are large molecules of a nucleoprotein which contains yeast nucleic acid (cf. Stanley, 1938, 1940). The studies of Rivers and coworkers of the more complex chemical composition of the vaccinia virus have demonstrated that among its constituents is again a nucleoprotein. This nucleoprotein is of the thymonucleic acid type. The nucleoprotein in the lymphocystis lattice framework is likewise of the thymonucleic acid type, as proved by its positive Feulgen reaction (Jirovec, 1932). Hoagland, Smadel and Rivers have shown in 1940 that 5.0 per cent. of the elementary body of vaccinia is thymonucleic acid. This result of the chemical analysis is in accordance with the fact that elementary bodies of vaccinia, when resuspended in aqueous media, give a positive Feulgen reaction in the test tube (Bland and Robinow, 1939; Smadel, Lavin and Dubos, 1940). In sections through cells infected by the vaccinia virus an intensively positive Feulgen reaction of the substance of the smaller Guarnieri bodies during their compact stage has been stated by Bland and Robinow (1939). In the larger differentiated Guarnieri bodies the basophil lumps and rods, which I have above compared with the chromatin framework of the lymphocystis inclusion bodies, remain distinctly Feulgen positive (Bland and Robinow).

An interpretation of the chromatin lattice of the lymphocystis inclusions as consisting of the growing virus substance or as containing developmental stages of the virus would not exclude the possibility that end products of the multiplication of the virus might become accumulated in the ground substance of the inclusion bodies. Should such end products serving as stages of the transmission of the virus become further distributed throughout the cytoplasm of the larger lymphocystis cells, then an explanation for the optical phenomenon of the white

color of these cells might be offered, provided that mature stages of the virus units are represented by refractive particles. The presumption of such an optical appearance of the infective units is supported by the fact that the elementary bodies of several viruses such as vaccinia have been indeed characterized as refractive particles. In the description of the inclusion bodies of inclusion blennorrhoea (Lindner, 1910) and of ectromelia (Barnard and Elford, 1931) the high refractility of the elementary bodies has been emphasized (cf. Findlay, 1938, p. 310, and Elford, 1938, p. 193). Furthermore, I refer to the macroscopic appearance of fowl-pox lesions. Goodpasture (1928) describes eruptions of fowl-pox on the mucosa surfaces as white, opaque spots.

Several of the problems touched upon in the above discussion can be solved only by further experimental work. In comparison to the conditions in other virus diseases it might seem that the large size of the lymphocystis cells and their inclusion bodies would present very favorable conditions for an experimental study of the properties of the inclusions and their constituents, with special reference to their infectivity. On the other hand, an essential impediment to the extension of the infection experiments with lymphocystis virus has hitherto been the difficulty of obtaining a sufficient supply, from noncontaminated waters, of highly susceptible fishes which can well withstand transportation and can easily be kept in laboratory aquaria.

In the experiments with the two Centrarchidae only some of these prerequisites were fulfilled. Under more favorable local conditions, Centrarchidae may present rather good prospects for further experimental work with lymphocystis virus although after my experience with *Lepomis gibbosus* and *macrochirus* it can hardly be hoped that it will be possible to keep a stock of lymphocystis-infected specimens permanently throughout the different seasons.

It would be very desirable for further experimental work if lymphocystis disease should be discovered in one of the many small "tropical aquarium fishes" which can easily be maintained in small aquaria. In any respect, it will be of interest to follow lymphocystis disease in still other fish groups, not only to obtain a more suitable object for further experimental work, but also to study still more varied manifestations of this virus disease so outstanding in its morphology.

RESULTS AND CONCLUSIONS.

1. Susceptibility to lymphocystis disease is widespread in the Centrarchidae and the disease is widely propagated in the United States.

2. Because lymphocystis epidemics have been observed in centrarchids which are not only game fish but are also of value as food fish, the disease is of some economic significance.
3. As a rule, the lymphocystis disease of *Lepomis gibbosus* and *macrochirus* heals by sloughing off the tumors about four weeks after the expiration of their growth period.
4. Experimental attempts to transmit lymphocystis disease from *Stizostedion* to *Lepomis* remained unsuccessful. The experiment, however, to transmit the disease from *Lepomis macrochirus* to *L. gibbosus* had a positive result.
5. When the lymphocystis cells of *L. macrochirus* and *gibbosus* in their growth period have reached about 200 microns in diameter, their appearance in reflected light changes from gray and transparent into white and opaque.
6. The cytoplasmic inclusion bodies in the lymphocystis cells show certain similarities to inclusion bodies in some other virus diseases with regard to their development and some of their structures. The enormous increase in size of the lymphocystis inclusion bodies is inseparably connected with the gigantic hypertrophy of the host cells which represents a hitherto unique phenomenon in the pathology of virus diseases.
7. A number of facts supports the view that the growing lymphocystis inclusions represent the manifestation of the growth of the virus organism within the host cell.
8. By the positive Feulgen reaction (Jirovec, 1932) and by selective staining with methyl green it is proved that the basophil framework of the lymphocystis inclusions contains nucleoprotein of the thymonucleic acid type.
9. The basophil framework inspected under high magnification does not always look homogeneous but sometimes shows a pattern of fine spots varying in depth of stain. Under favorable optical conditions fine basophil granules can be demonstrated as components of the framework.
10. In consideration of these structures and further of the fact that the framework contains nucleoprotein in its chemical composition, the suggestion is presented that the basophil substance of the lymphocystis inclusions either consists of virus substance or contains developmental stages of the virus.

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EXPLANATION OF THE PLATES.

PLATE I.

- Figs. 1-8. Young lymphocystis cells of *Lepomis gibbosus* (common sunfish) and *macrochirus* (bluegill).
General labels: (e) nucleolus; (m) cell membrane; (n) nucleus; (i) inclusion body.
- Fig. 1. Bluegill. Lymphocystis cell of 14 microns in diameter from a section. Fixation with Flemming's fluid; safranin-light green stain. $\times 1,000$.
- Fig. 2. Bluegill. Lymphocystis cell of 21 microns in diameter from a section. Fixation with Flemming's fluid; safranin-light green stain. $\times 625$.
- Fig. 3. Bluegill. Lymphocystis cell of 22 \times 20 microns from a section. Fixation with Flemming's fluid; safranin-light green stain. $\times 1,000$.
- Fig. 4. Common sunfish. Lymphocystis cell of 22 \times 19 microns from a whole mount preparation. Fixation with absolute alcohol 95 parts, glacial acetic acid 5 parts; Delafield's hematoxylin stain. $\times 625$.
- Fig. 5. Common sunfish. Section through a lymphocystis cell of 64 \times 54 microns. Fixation with Flemming's fluid; safranin-light green stain. $\times 625$.
(g) ground substance.
- Fig. 6. Bluegill. Section through a lymphocystis cell of 80 \times 64 microns. Fixation with Flemming's fluid; safranin-light green stain. $\times 625$.
(b) buds of the inclusion; (d) portion of the inclusion which lies beneath the nucleus.

- Fig. 7. Common sunfish. Two sections (A) and (B) through a lymphocystis cell of 66 \times 61 microns. Fixation with Flemming's fluid; safranin-light green stain. $\times 625$.
(h) fenestration of the inclusion body.

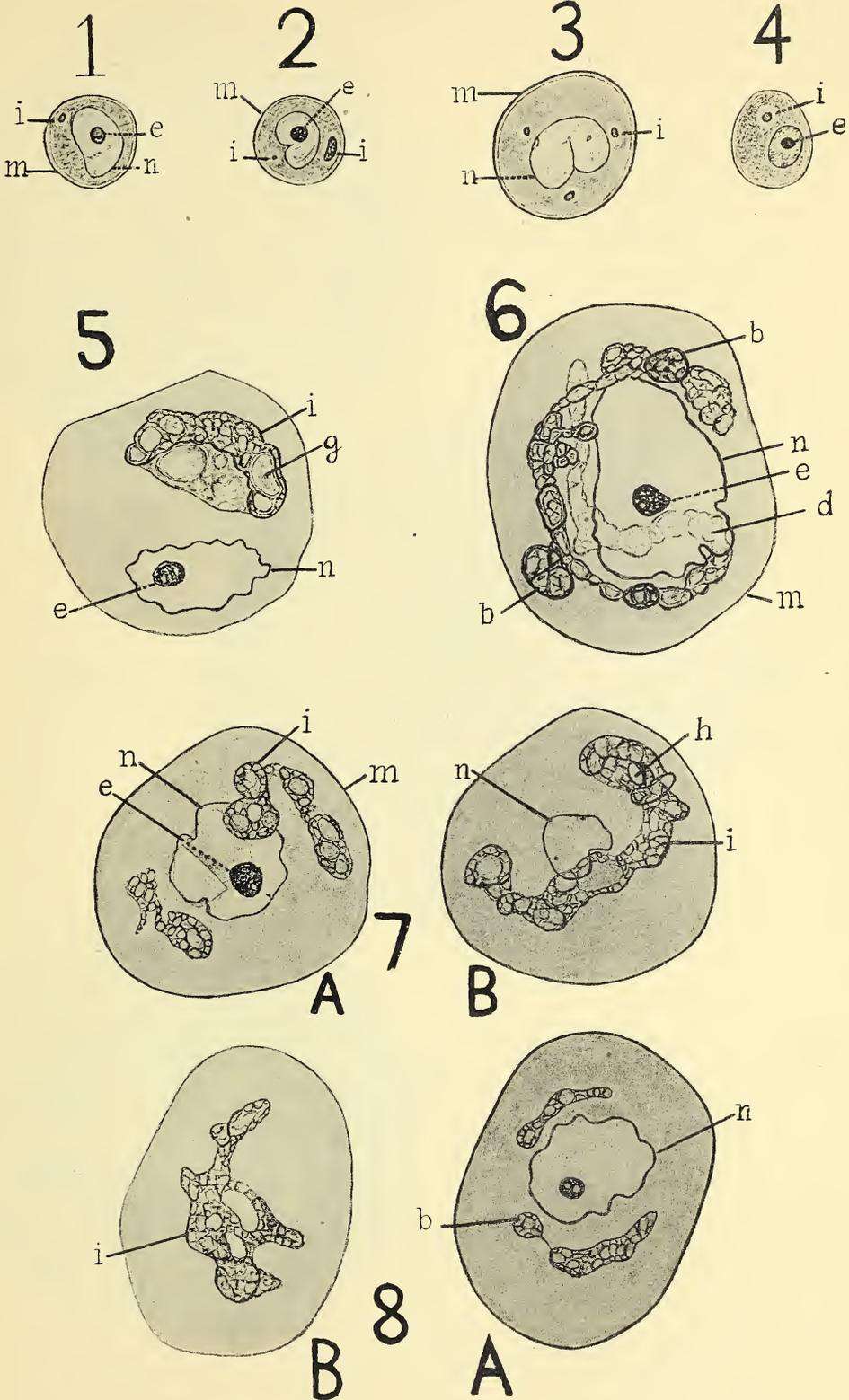
- Fig. 8. Common sunfish. Two sections (A) and (B) through a lymphocystis cell of 72 \times 54 microns. Fixation with Flemming's fluid; safranin-light green stain. $\times 625$.
(B) bud of the inclusion connected with the main inclusion body by a thin bridge.

PLATE II.

- Fig. 9. Bluegill lymphocystis cell, 225 microns in diameter, from a whole mount preparation. Drawings made by focusing: (A) through upper third of the cell; (B) through equator of the cell; (C) through lower third of the cell.
Acetic alcohol fixation (cf. Fig. 4); Delafield's hematoxylin stain. $\times 340$.
(c¹) and (c²) portions of the inclusion body which can be followed through the three adjustments as points of connexion; (e) nucleolus; (i) inclusion body; (m) cell membrane; (n) nucleus; (s) separated piece of the inclusion.

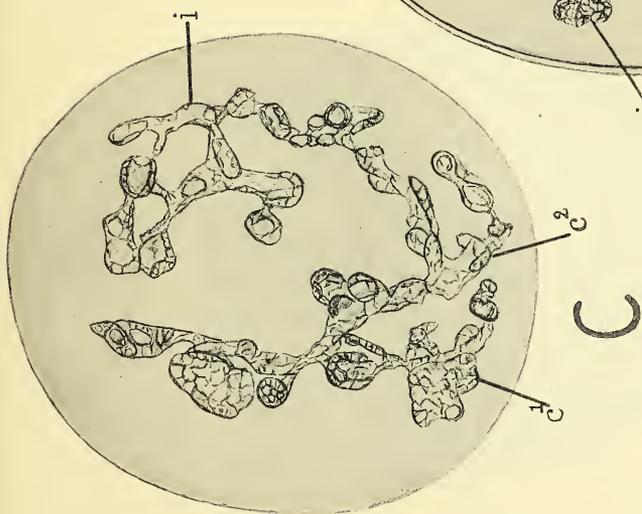
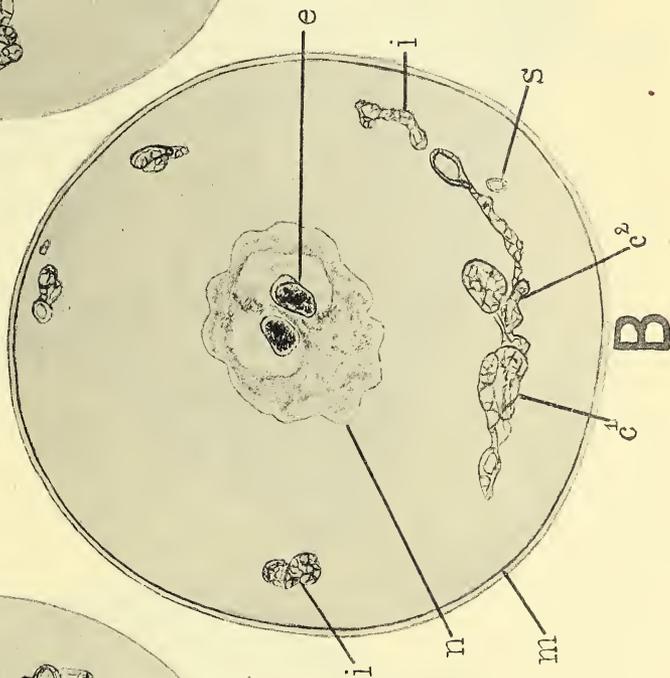
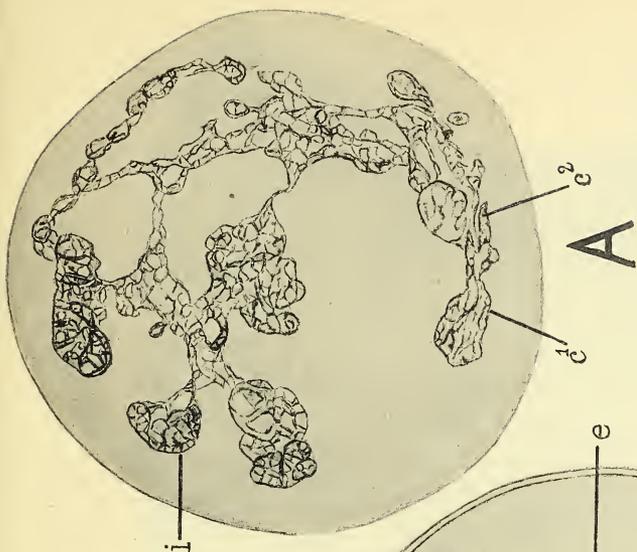
PLATE III.

- Fig. 10. Common sunfish. Section through a lymphocystis cell of 200 \times 185 microns. Fixation with Flemming's fluid; safranin-light green stain. $\times 340$.
(e) nucleolus; (i) inclusion bodies; (m) cell membrane; (n) nucleus.
- Fig. 11. Bluegill. Stage of the 21st day of experimental infection. Whole mount preparation of the tail fin border. Three weeks before the start of the infection experiment the margin of the fin was amputated. At the time of the experimental infection the regeneration of the fin border was in progress. The preparation shows the development of young lymphocystis cells within the regenerated tissues. The epithelium has been brushed off to a large extent.
Acetic alcohol fixation (cf. Fig. 4); Delafield's hematoxylin stain. $\times 35$.
(bo) bony plates of fin rays below the level of the amputation; (d) debris of bony plates which indicate the level at which the amputation was performed six weeks ago; (l) young lymphocystis cells; (p) pigment cells; (re) regenerated tissue of the fin membrane; (rf) regenerating end portions of the fin rays in which bony plates have not yet developed.

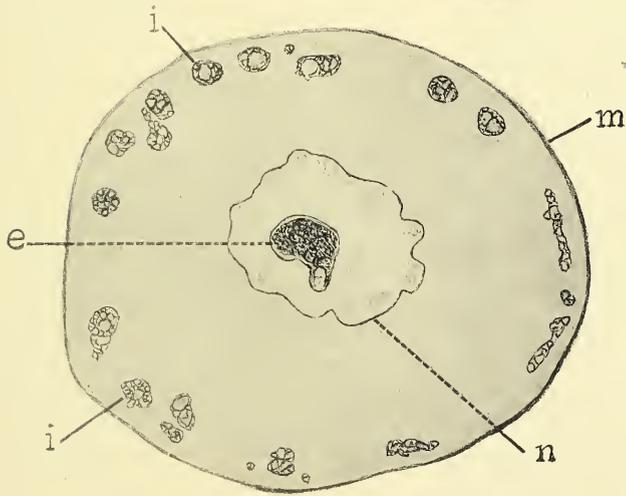
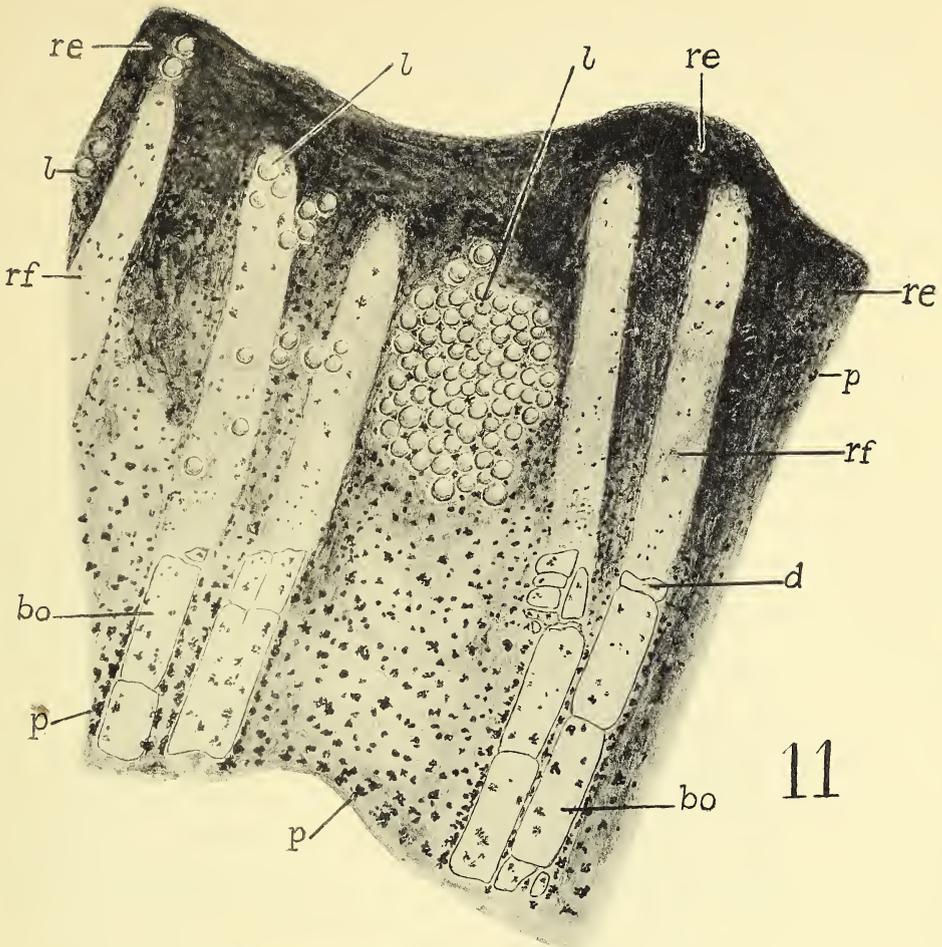


STUDIES ON VIRUS DISEASES OF FISH.
LYMPHOCYSTIS DISEASE IN CENTRARCHIDAE.

9.



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STUDIES ON VIRUS DISEASES OF FISH.
LYMPHOCYSTIS DISEASE IN CENTRARCHIDAE.

17.

The Amphipoda of the Bermuda Oceanographic Expeditions, 1929-1931.¹

CLARENCE R. SHOEMAKER

U. S. National Museum

(Text-figures 1-48).

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¹ Contribution No. 729, Department of Tropical Research, New York Zoological Society.

INTRODUCTION.

This collection of Amphipoda from Bermuda was obtained on the Bermuda Oceanographic Expeditions of the Department of Tropical Research of the New York Zoological Society. The Expeditions concerned were under the direction of Dr. William Beebe, and were Numbers 23, 24 and 25 of the Department, in the years 1929, 1930 and 1931. They were organized for the purpose of making an intensive survey of a limited area of the deep subtropical ocean. The area chosen was roughly circular, eight miles in diameter, with its center at 32° 12' north latitude and 64° 36' west longitude, a point about nine miles southeast of Nonsuch Island, Bermuda. The total depth of water in this area increases from 1,000 fathoms at the inner rim of the circle to nearly 1,500 fathoms at the outer edge. All nets, trawls and deep-sea dives were made within this circular area of the open sea. During the three years when the present collection was made, 1,350 nets were drawn, from the surface to 1,200 fathoms.²

The collection of Amphipoda treated in the present paper is the most extensive which has come from the western North Atlantic. It consists entirely of pelagic or bathypelagic species, the greater part of which, as in every extensive collection, are well known. Rare forms are present, however, some of which have been recorded only once before, and a few are new to science.

The Gammaridea are represented by 20 genera comprising 22 species. The Hyperidea are represented by 41 genera comprising 76 species and 4 varieties. One genus, 3 species, and 2 varieties are here described as new.

The measurements given are from the front of the head to end of the farthest reaching urosome appendage. Stebbing's system of designating the peraeopods in "Das Tierreich, Amphipoda," is here used; viz., gnathopods 1 and 2 and peraeopods 1 to 5.

SYSTEMATIC ACCOUNT.

ORDER AMPHIPODA.

Suborder 1. Gammaridea.

FAMILY LYSIANASSIDAE.

Koroga megalops Holmes.

Koroga megalops Holmes, 1908, p. 503, fig. 13.

A single specimen was taken at a depth of 800 fathoms.

Distribution.—This species was described by S. J. Holmes from a single female taken at *Albatross* Station 4257, vicinity of Funter

Bay, Lynn Canal, Alaska. In 1904 the *Thor* took a single immature female at Station 183, (61°30' N., 17°08' W., south of Iceland, Stephensen). In 1928 a single female was taken off the southwest coast of Greenland by the Godthaab Expedition (Stephensen). In 1937 Barnard recorded an immature female from the southern Arabian Sea. Elsa D. Thorsteinson recorded two mature females and several small specimens from the Gulf of Alaska in 1941.

Holmes's and Thorsteinson's specimens each measured 10 mm. Barnard's measured 7.5 mm. The Bermuda specimen is a mature female, about 8 mm. in length, carrying seven large eggs. The male of this species has not yet been recorded.

Scopelocheirus coecus Holmes.

Scopelocheirus coecus Holmes, 1908, p. 500, figs. 10-12.

A single specimen was taken at a depth of 800 fathoms.

Distribution.—This species was described from a single female by S. J. Holmes in 1908 from *Albatross* Station 4405, off San Clemente Island, California, 654-704 fathoms. I have found among the unidentified material in the U. S. National Museum collection another specimen taken by the *Albatross* at Station 4793, off Kamchatka, 54°48' N., 164°54' E., 300 fathoms. There are also in the National Museum four somewhat mutilated specimens taken from a duck stomach at Pacific City, Oregon, in 1931, by the U. S. Biological Survey. The present record from Bermuda is the first from the Atlantic.

Holmes's specimen measured 20 mm. The Bermuda specimen, which I believe to be a female, measures about 17 mm. and agrees very well with the type. The second gnathopod in this species is subchelate, whereas in the other two species of *Scopelocheirus* it is slightly chelate. Holmes, in his figure, shows the first and second urosome segments coalesced, though he does not refer to it in his text. All the specimens show these segments entirely free and movable. The first urosome segment in the present specimen is indented, though not as much as Sars shows for either *S. crenatus* or *S. hopei* (1895, pl. 19). All the specimens which I have examined have this indentation, so it appears that the urosome of this species has not been quite correctly represented by Holmes as far as these two characters are concerned.

Eurythenes gryllus (Lichtenstein).

Gammarus gryllus 1822 (H. Lichtenstein in:) Mandt, *Observ. Groenl.*, p. 34.

Eurythenes gryllus Smith, 1884, p. 54.

Euryporeia gryllus Sars, 1891, p. 86, pl. 30.

Katius obesus Chevreux, 1905d., p. 1, figs. 1-3.

² For detailed accounts of localities, nets and methods of collecting see Bermuda Oceanographic Expeditions, 1929 and 1930; William Beebe, *Zoologica*, Vol. XIII, 1931, No. 1, pp. 1-14; Individual Nets and Data, No. 2, pp. 15-36. No. 3, pp. 37-45.

Forty-four specimens were taken at depths between 500 and 1,000 fathoms.

Distribution.—Spitzbergen; Greenland; North Atlantic; South Atlantic (45° South, Barnard); North Pacific (Gulf of Alaska, Shoemaker); South Pacific (Kermadec Islands, Chilton); Indian Ocean (Arabian Sea, Barnard). The species is new to the Bermuda Islands.

Dr. K. Stephenson (1933, pp. 12-20), who has made a study of *Eurythenes gryllus* and *Katius obesus*, has shown that they are the two sexes of the same species, the former being the female and the latter the male. Chilton (1911, p. 564) says, "It is celebrated as being one of the largest of the *Amphipoda*, the length sometimes being as much as 90 mm." In the U. S. National Museum collection there is a female taken by the steamer *Albatross* at Station 2097, off Chesapeake Bay, which measures 95 mm. from the front of the head to the end of the uropods. There are also three somewhat smaller females taken by the *Albatross* at Station 3342, off Queen Charlotte Islands, B. C. The *Albatross* took a male at Station 2571 (40°09'30" N., 67°09'00" W.), which is about 8° north of Bermuda. The specimens of the present collection are all males, the largest of which measures about 37 mm.

Eurythenes gryllus was recorded as having been taken at Point Barrow and Point Franklin by the International Polar Expedition to Point Barrow, Alaska, 1881-1885. I have examined these specimens, which are in the National Museum collection, and I find that they are all *Anonyx nugax* (Phipps).

Cyphocaris anonyx Boeck.

Text-fig. 1 a, b.

Cyphocaris anonyx (Lütken in MS.) Boeck, 1871, p. 104.

Cyphocaris anonyx Boeck, 1872, p. 141, pl. 6, fig. 1.

Cyphocaris micronyx Stebbing, 1888, p. 656, pl. 16.

Cyphocaris anonyx Schellenberg, 1926 b, p. 210, figs. 2b, 5a-b, pl. 5, fig. 2.

Twenty-six specimens were taken at depths between 600 and 1,000 fathoms.

Distribution.—North and South Atlantic; North and South Pacific; East Indies; Indian Ocean. There are in the National Museum specimens taken by the U. S. Fish Commission off the east coast of the United States (40° N., 70° W.), and a specimen taken off Lower California (28°23' N., 126°57' W.). It has not heretofore been recorded from the Bermuda region.

Stebbing (1906, p. 29) says, "Peraeopods 1 and 2 subchelate, the sixth joint being distally widened and having a palm margin set with teeth and spines, finger powerful, curved, acute." There appears to be con-

siderable variation in this character. Boeck's figures (1872, pl. 6, fig. 1 l-m) show no trace of a palm with teeth and spines, while Stebbing (1888, pl. 16, *C. micronyx*) shows a well developed palm with teeth and spines. All degrees of variation between these extremes occur. The Bermuda specimens show this character in an intermediate stage as I have figured. This species reaches a length of about 12 mm.

Cyphocaris challengerii Stebbing.

Text-fig. 1 c.

Cyphocaris challengerii Stebbing, 1888, p. 661, pl. 17.

Cyphocaris alicei Chevreux, 1905b, p. 1, figs. 1-2.

Cyphocaris challengerii Schellenberg, 1926 b, p. 212, figs. 6-10; pl. 5, fig. 3.

Cyphocaris kincaidii Thorsteinson, 1941, p. 58, pl. 3, figs. 25-30.

Fifteen specimens were taken at depths between 200 and 900 fathoms.

Distribution.—North and South Atlantic; North and South Pacific; Indian Ocean.

In the North Pacific this species extends into the Gulf of Alaska (*C. kincaidii*). On February 3, 1914, the steamer *Bache* took a specimen of *C. challengerii* in latitude 32°26' N., and 69°21' W., which is only about 4° west of Bermuda, but the present records are the first for the immediate vicinity of the islands. It has also been taken by the steamer *Albatross* on the west coast of Florida.

The characters of this species vary considerably with age. Stebbing's description was taken from a young specimen measuring about one-fifth of an inch in the bent position. In his specimen the second joint of the third peraeopod bore seven teeth on the hind margin. As the animal increases in size this second joint becomes relatively longer and the teeth are gradually lost (Text-fig. 1c). The shape of the first mesosome segment is also subject to considerable variation, as Schellenberg has shown (1926, p. 213, fig. 6). This species reaches a length of 14 mm.

Cyphocaris richardi Chevreux.

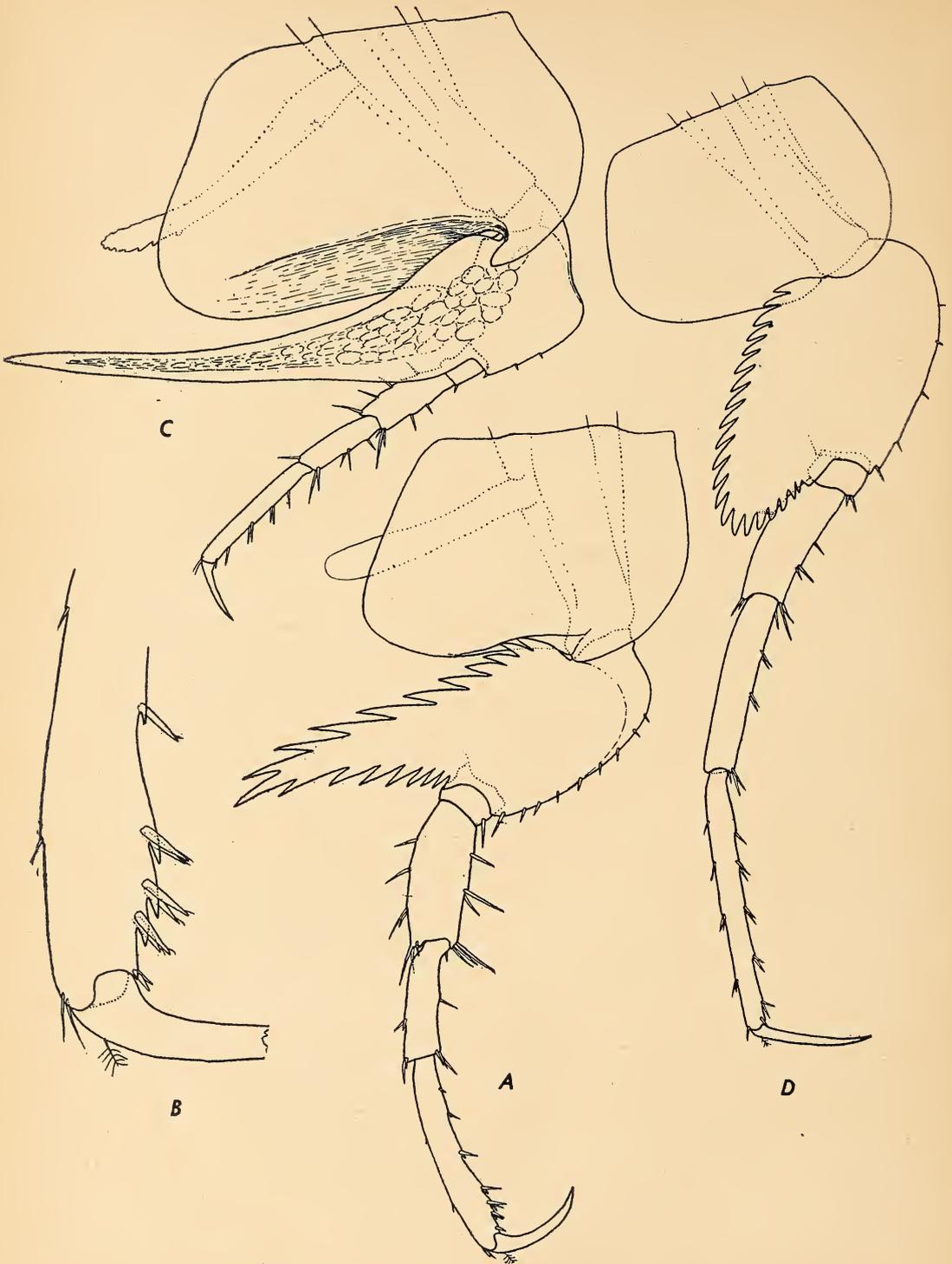
Text-fig. 1 d.

Cyphocaris richardi Chevreux, 1905a, p. 1, figs. 1, 2a-g.

Cyphocaris richardi Schellenberg, 1926a, p. 245, fig. 4.

Two specimens were taken, one at 900 fathoms, the other at 1,000 fathoms.

Distribution.—North Atlantic (56°56' N., 51°17' W., Stephenson, 1933); South Atlantic (62°27' S., 58°11' W., Barnard, 1932); South Pacific (taken by the *Albatross* between 4°43' S. and 14°28' S., off the coast of Ecuador and Peru, Schellenberg, 1929).



TEXT-FIG. 1. *Cyphocaris anonyx* Boeck, female. **A**, peraeopod 3; **B**, end of peraeopod 3 greatly enlarged. *Cyphocaris challengerii* Stebbing, female, **C**, peraeopod 3. *Cyphocaris richardi* Chevreux, female, **D**, peraeopod 3.

Chilton recorded it as *C. anonyx* from 71°50' S., 23°30' W.). The present records are the first from the Bermuda region, but a specimen was taken by the *Albatross* off Marthas Vineyard (40°02'49" N., 68°49'00" W.).

The largest specimens of this species are those recorded by Barnard (1932, p. 35) from the South Shetland Islands; a female 38 mm. and a male 40 mm. in length. The usual length is from 10-20 mm. The Bermuda specimens are about 10 mm.

***Paracyphocaris praedator* Chevreux.**

Text-fig. 2.

Paracyphocaris praedator Chevreux, 1905c, p. 1, figs. 1-3.

Four specimens were taken at depths between 500 and 1,000 fathoms.

Distribution.—This rare species has been taken only in the North Atlantic at the following localities: 46°15' N., 7°09' W., 36°46' N., 26°41' W., 38°02' N., 10°44' W. (Chevreux); South of Iceland (62°10'08" N., 19°36'00" W. (Stephensen); 3°10' N., 5°28' E. (Schellenberg); 6°19' N., 56°00' W. (Stephensen).

Up to the present time only six specimens of this species have been recorded and, as Stephensen has already remarked, they have all been males or immature, the sex of which could not be determined. Of the four Bermuda specimens, the largest, a fully matured male possessing sexual organs, measures 15 mm. The other three specimens, measuring about 10 mm., are immature and the sex cannot be determined.

In the mature male the mesosome is very broad, with the ventral surface greatly distended and filled with a dark reddish substance giving the animal much the appearance of some of the lanceolids. The mesosome narrows gradually to the normal metasome.

The first antenna of this large male is not slender, as figured by Chevreux (1905, p. 3, fig. 2a), but is much thickened. The first joint of the flagellum is nearly as thick as, and a little longer than, the second and third peduncular joints combined, the following five or six flagellar joints tapering off to normal slender proportions. In the immature specimens the first antenna is as figured by Chevreux.

***Metacyphocaris helgae* Tattersall.**

Metacyphocaris helgae Tattersall, 1906, p. 29, pl. 3, fig. 1.

Metacyphocaris helgae Schellenberg, 1926b, p. 216, figs. 26c, 27.

Thirty-three specimens were taken at depths between 600 and 1,000 fathoms.

Distribution.—This species was described from off the coast of Ireland. It has since been recorded from the west coast of Greenland (64° N.), off Southern Greenland and

south of Iceland (Stephensen); off Madeira Islands (Pirlot); Gulf of Guinea (Schellenberg); South Atlantic (35° S., 19° W., Barnard); Indian Ocean (Schellenberg); North Pacific (Gulf of Alaska, Thorsteinson); South Pacific (*Albatross* Station 4711, 7° S., 94° W., Schellenberg).

The present records are the first for the Bermuda area.

Barnard recorded a female measuring 17 mm. with brood pouch, from the mid-Atlantic. In the Bermuda material is an immature female measuring about 15 mm. This specimen has partially developed marsupial plates, and the ventral surface is distended as I have described for the mature male of *Paracyphocaris praedator*, which Barnard thinks may be indicative of a bloodsucking habit. The mandible has a 2-jointed rudimentary palp as noted by Barnard (1932, p. 37, fig. 5).

***Crybelocephalus megalurus* Tattersall.**

Text-fig. 3.

Crybelocephalus megalurus Tattersall, 1906, p. 33, pl. 3, fig. 1, pl. 5, figs. 1-4.

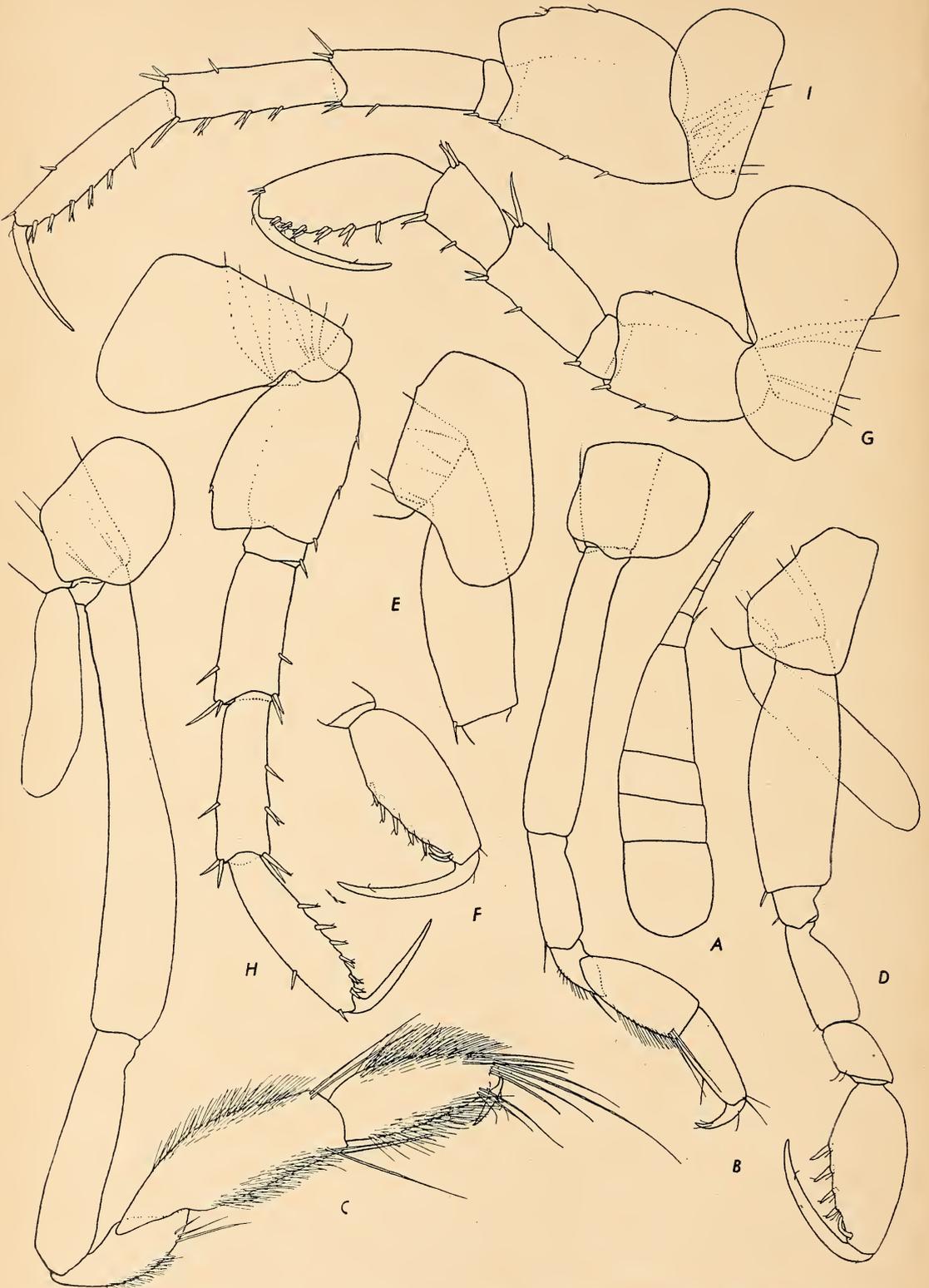
Five specimens were taken at depths of 600 and 900 fathoms.

Distribution.—Described from off the southwest of Ireland; the *Thor* took a specimen at 61°30' N., 17°08' W., and one at 49°27' N., 13°33' W. (Stephensen); a specimen was taken by the scientific expeditions of the Prince of Monaco at Station 3448 in the North Atlantic (Chevreux); the Godthaab Expedition, 1928, took a single specimen, 63°19' W., 26°50' W. (Stephensen).

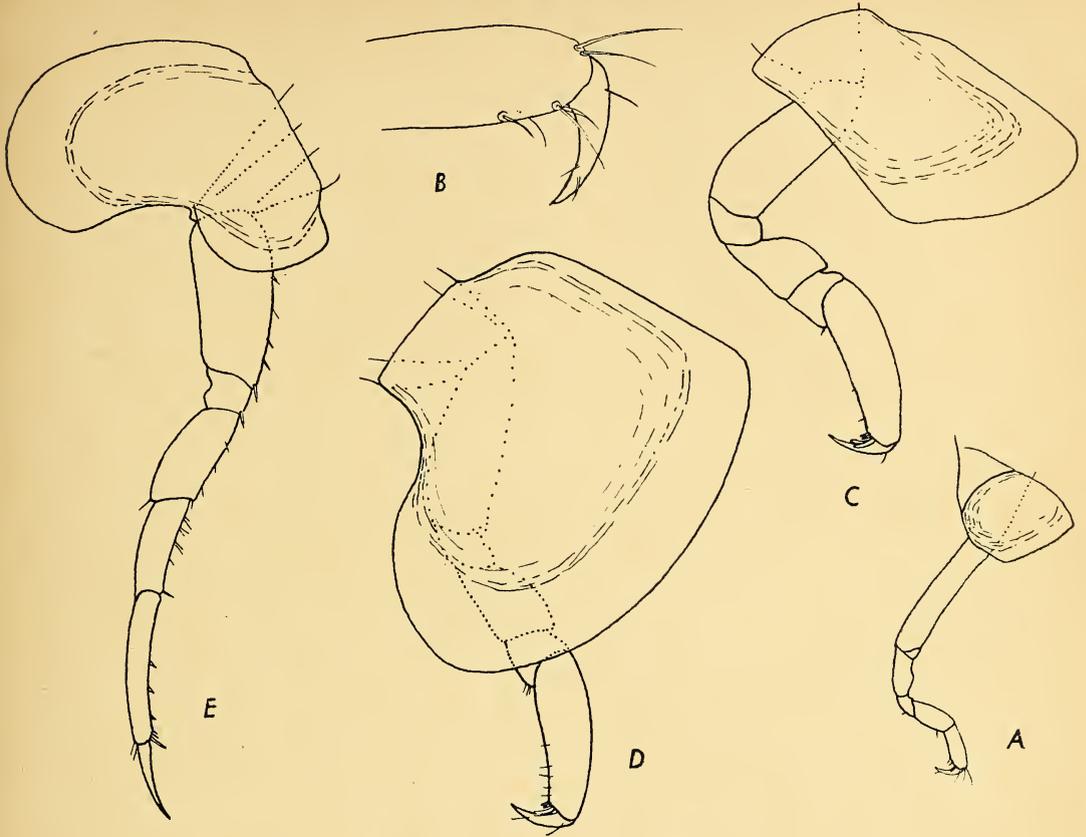
Tattersall says that the two specimens which he studied, measuring 11 mm., appeared to be males, but he does not state his reasons for so believing. The sex of all other recorded specimens has not been mentioned. The Bermuda specimens, the largest of which measures about 11 mm., do not show any sexual characters. They show neither male sexual organs nor marsupial plates. I am of the belief that Tattersall's specimens, and all other recorded specimens, were in a similar condition, and that the absence of marsupial plates led him to believe that his specimens were probably males.

***Crybelocyphocaris*, new genus.**

Head very short from front to back and very long from top to bottom. Antenna 1 without accessory flagellum. Mandible with degenerate 3-jointed palp, and without molar. Maxillipeds with inner and outer plates well developed, and possessing a 4-jointed palp. Gnathopod 1 simple. Gnathopod 2 normal. First, second, and third peraeopods stoutly built, sixth joint strongly spinose, dactyl strong and curved and closing against the spinose surface of the sixth joint. Fourth and fifth peraeopods normal, longer than



TEXT-FIG. 2. *Paracyphocaris praedator* Chevreux, male. A, antenna 1; B, gnathopod 1; C, gnathopod 2; D, peraeopod 1; E, peraeopod 2; F, sixth and seventh joints of peraeopod 2; G, peraeopod 3; H, peraeopod 4; I, peraeopod 5.



TEXT-FIG. 3. *Crybelocephalus megalurus* Tattersall. **A**, gnathopod 1; **B**, end of gnathopod 1; **C**, peraeopod 1; **D**, peraeopod 2; **E**, peraeopod 3.

the first three. Urosome segments long, second and third coalesced. First and second uropods normal. Uropod 3 with inner ramus greatly reduced. Telson tumid, not cleft.

Genotype, *Crybelocyphocaris tattersalli*.

***Crybelocyphocaris tattersalli*,**
new species.

Text-figs. 4, 5.

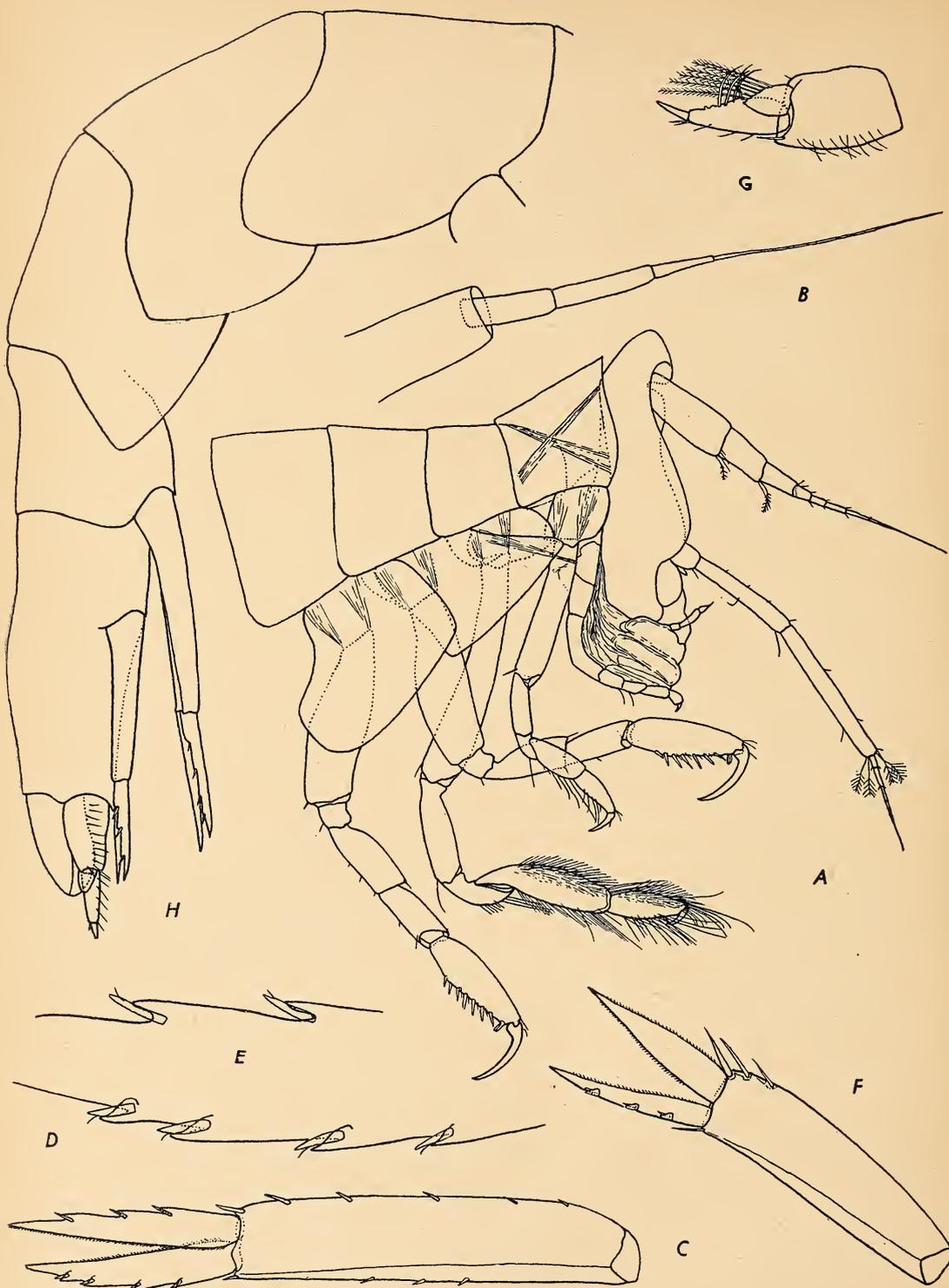
One specimen was taken at a depth of 600 fathoms.

Body with ventral surface bulging in the same manner as noted for *Paracyphocaris praedator*. Integument thin and weak and nearly transparent.

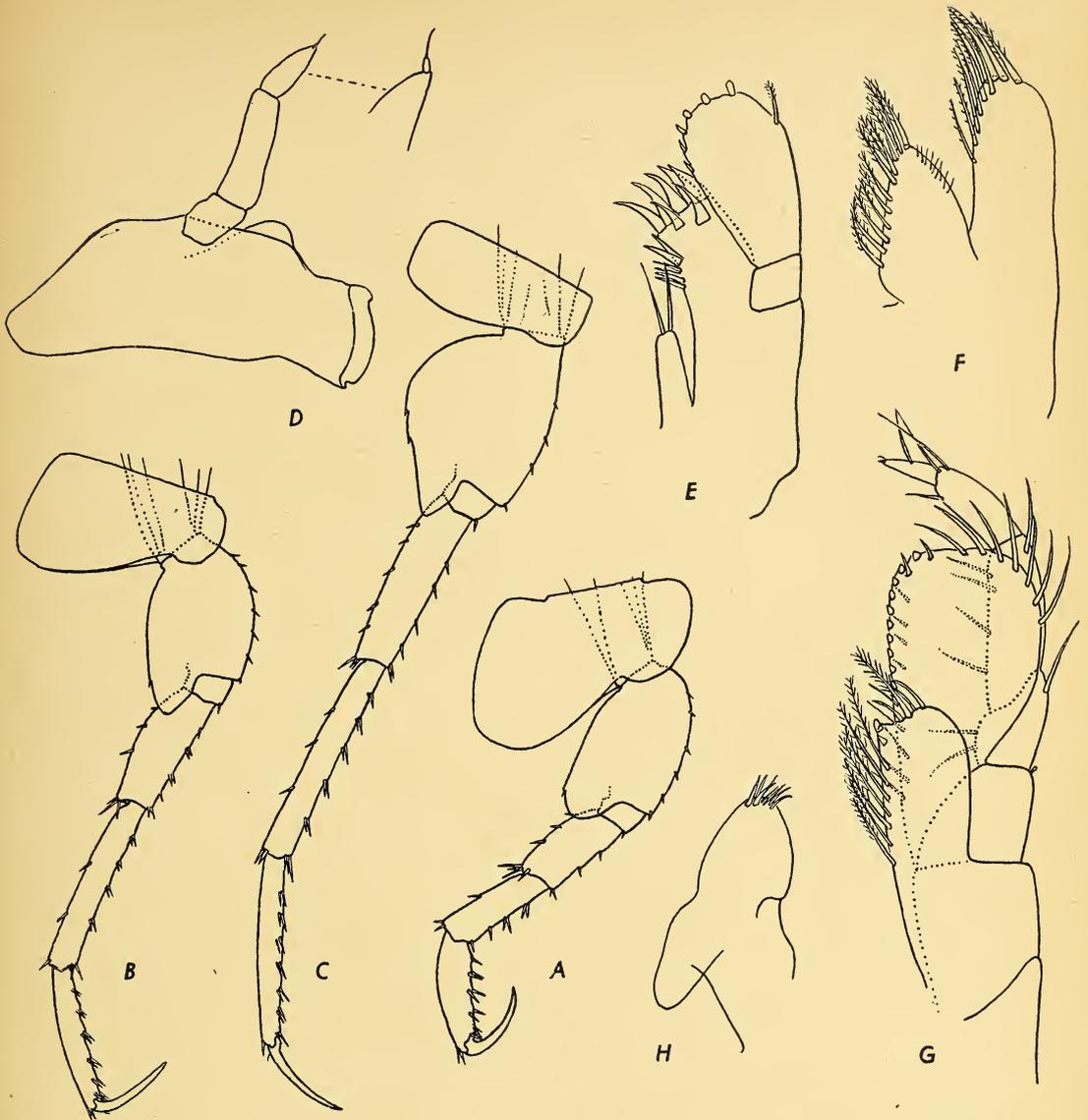
Head free, but probably capable of being withdrawn into the first body segment; front margin broadly lobed, without eyes; mouthparts very prominent. Antenna 1, flagellum about as long as the second and third peduncular joints combined, consisting of four joints, the last of which is long and slender and bears a long apical seta. Antenna 2, fifth joint longer than fourth, flagellum shorter than fifth peduncular joint and composed of

three joints, the last bearing a long apical seta.

Mandible with broad cutting-edge bearing a low tooth at upper end and an incision at the lower end; molar absent, but a low protuberance on the upper inner margin in front of the palp; palp 3-jointed, but weak and degenerate, third joint bearing apically a single spine which consists of an enlarged base carrying a slender seta. Maxilla 1, inner lobe elongate and bearing two apical setae; outer lobe armed on the upper margin with seven stout spine-teeth and on the inner margin with two stout spine-teeth and five or six slender spines; palp with second joint very broad distally and armed on the upper rounding margin with a plumose seta and six short teeth, the three distal ones being rounding and blunt. Maxilla 2, outer plate longer than inner; inner plate bearing on inner edge a row of submarginal plumose setae. Maxilliped, inner plate reaching to the end of the second joint of palp, bearing at the inner distal corner a low tooth below which on the outside is a short spine, and on the upper margin a



TEXT-FIG. 4. *Crybelocyphocaris tattersalli*, new gen. and new sp., male. **A**, anterior end of animal; **B**, end of antenna 2 enlarged; **C**, uropod 1; **D**, outer edge of outer ramus of uropod 1; **E**, inner edge of inner ramus of uropod 1; **F**, uropod 2; **G**, uropod 3; **H**, posterior end of animal.



TEXT-FIG. 5. *Crybelocyphocaris tattersalli*, new gen. and new sp., male. A, peraeopod 3; B, peraeopod 4; C, peraeopod 5; D, mandible; E, maxilla 1; F, maxilla 2; G, maxilliped; H, left half of lower lip.

long plumose seta and three short curved spines, inner margin bearing the usual row of plumose setae; outer plate very broad, inner margin armed on the upper half with very low, blunt teeth which do not project beyond the margin and a row of submarginal spinules on the outer surface; upper and outer margins armed with a row of seven long curved spines; palp rather weak, fourth joint short and straight, bearing a spine at the middle of the outer edge and a very short spinule and seta at the apex. Lower lip with rounding side lobes, but lacking inner lobes.

Gnathopod 1, fifth and sixth joints with

several setae on posterior margin, sixth joint slightly shorter than fifth and gradually narrowing distally, seventh joint rather strong and somewhat curved. Gnathopod 2 normal for the Lysianassidae; sixth joint much shorter than fifth; seventh joint considerably overlapping the short oblique palm. Peraeopod 1 slightly shorter than 2, but similar in structure; sixth joint strong and armed on posterior margin with a row of short, stout spines; seventh joint stout, curved, and closing against the spines of the sixth joint, forming an excellent clasping organ. Peraeopod 3 a little shorter than 2, sixth and seventh joints resembling those

of the two preceding peraeopods, but the spines of the sixth joint somewhat weaker. Peraeopod 4 longer than 3, but shorter than 5. The structure of these three peraeopods is clearly shown by Text-figs. 5a, b, c.

The metasome and urosome segments are noticeably elongate, and the former have rather bluntly rounding lower posterior angles. The second and third urosome segments are coalesced, forming one long joint. Uropod 1 not extending back as far as uropod 2, and uropod 2 not as far as uropod 3. Inner ramus of uropod 1 slightly the longer, and those of uropod 2 subequal. Uropod 3 with outer ramus slightly longer than peduncle and armed on inner margin with four stout curved spines; inner ramus half the length of the first joint of outer ramus, bearing a row of long plumose setae on inner margin, and apically acute. Telson very fleshy, extending back to about the middle of the first joint of outer ramus of uropod 3, base nearly as wide as last urosome segment, sides converging to the rather broadly rounding apex. Length about 11 or 12 mm. It is impossible to measure such flabby specimens accurately.

This strange deep-sea amphipod naturally joins the little group formed by *Paracyphocaris praedator*, *Metacyphocaris helgae* and *Crybelocephalus megalurus*. While it possesses many points of resemblance to these species, it nevertheless differs from them and from all other lysianassids by the coalescence of the second and third urosome segments. All four species have the short but very deep head, a very similar arrangement of the coxal plates, a simple first gnathopod, and the first three prehensile peraeopods. The antennae are quite similar in form, but *M. helgae* and *P. praedator* possess a small 1-jointed accessory flagellum, while *C. megalurus* and *C. tattersalli* are without an accessory flagellum. In *C. m.* the rami of the third uropods are subequal; in *P. p.* the inner ramus is about two-thirds the length of the outer; in *C. t.* it is about one-third the length of the outer; while in *M. h.* it is only about one-fifth the length of the outer. In *P. p.* the telson is deeply cleft; in *M. h.* it is slightly cleft, while in *C. m.* and *C. t.* it is not cleft.

Little is known about these peculiar amphipods. Of *M. h.* and *C. m.* only the male has been described, and of *P. p.* and *C. t.* the sex could not be determined, indicating that the specimens were immature. When mature specimens of both sexes of these four species have become known we shall be in a better position to judge of their relationship. It may be worthy of note that the first three peraeopods of the hyperiid *Microphasma agassizi* Woltereck bear a very close structural resemblance to those of this group of amphipods, which may merely mean that they have a similar function.

As this new genus combines characters possessed by some of the other genera, I have combined parts of their names to form a new genus, *Crybelocyphocaris*, with the idea of expressing this relationship.

FAMILY STEGOCEPHALIDAE.

Euandania gigantea (Stebbing).

Andania gigantea Stebbing, 1883, p. 206.

Andania gigantea Stebbing, 1888, p. 730, pl. 35.

Euandania gigantea Stebbing, 1899a, p. 206.

One specimen taken at a depth of 700 fathoms.

Distribution.—This species was described by Stebbing from off Marion Island, about 46° S., 45° E. Walker recorded an immature doubtful specimen 9 mm. in length from McMurdo Sound in the Antarctic. Barnard recorded a single specimen west of Cape Town (33°07' S., 4°30' E.). The present Bermuda record extends the range greatly northward.

Stebbing recorded two specimens, the larger of which measured about 50 mm. in the curved position in which it is figured, but would have measured considerably more if it had been straightened out. The smaller specimen measured about 40 mm. in the extended position. Barnard's specimen, a female, was 33 mm. in length. The present Bermuda specimen, which measures about 35 mm., is the fourth authentic specimen to be recorded.

The integument in the present specimen is very thin, soft and transparent, and the thorax, which is greatly distended, is filled with a colorless transparent liquid. The third uropods are perfect and agree with the description given by Barnard (1932, p. 80) for those of his specimen. The telson is very short and is cleft for about one-third of its length as figured by Stebbing.

Parandania boeckii (Stebbing).

Andania boeckii Stebbing, 1888, p. 735, pl. 36.

Stegocephalus boeckii Della Valle, 1893, p. 628, pl. 59, fig. 36.

Parandania boeckii Stebbing, 1899a, p. 206.

Seventeen specimens were taken at depths between 600 and 1,000 fathoms.

Distribution.—This species was described by Stebbing from off Pernambuco, Brazil (8° 37' S., 34° 28' W.). It has since been recorded from Baffin Bay (76° N., 62° W., Stephensen), southward through the Atlantic to the South Shetland Islands (Barnard). From the Indian Ocean it has been recorded by Walker (8° 16' S., 51° 26' E.), Schellenberg (4° 6' S., 73° 25' E.), and Barnard (Arabian Sea). It has not been recorded from the Pacific. The present records are the first for Bermuda.

Some of the females recorded by Barnard from Bouvet Island (52° 25' S., 9° 50' E.) measured 28 mm. in length and appear to be the largest specimens of this species yet recorded. The largest specimens taken at Bermuda are about 22 mm. Most of the specimens are rather firm and of a brownish color, but the integument of a few is quite soft and collapsible, as noted by Stephensen (1933, p. 22) for his Greenland specimens.

FAMILY PARDALISCIDAE.

Halice aculeata Chevreux.

Text-figs. 6, 7.

Halice aculeata Chevreux, 1912, p. 1, figs. 1-2.

Halice aculeata Chevreux, 1935, p. 88, pl. 13, figs. 5, 10.

Three specimens were taken at depths between 100 and 1,000 fathoms.

Distribution.—Chevreux described this species from a single male taken off the Atlantic coast of Morocco (32° 21' 30" N., 12° 31' W.).

Up to the present time the original male has been the only recorded specimen. The three Bermuda specimens are all females, and I have figured some of the appendages of one of them. These females measure 13 or 14 mm. in length, while Chevreux's male measured only 6.5 mm., which would seem to indicate that it was an immature specimen. The accessory flagellum of the first antenna is about three-fourths as long as the long first joint of the primary flagellum, and is composed of a long proximal joint and two short terminal joints. The fourth pereopod is longer than the fifth. All the appendages appear to be stouter than in the male, but this may be due to the larger size of the female. The present record extends the range of this little known species considerably westward.

FAMILY SYNOPIIDAE.

Synopia ultramarina Dana.

Text-fig. 8.

Synopia ultramarina Dana, 1852, p. 995, pl. 68, fig. 6, 7.

Synopia orientalis Kossmann, 1880, p. 137, pl. 15, figs. 11-13.

Synopia scheeleana Bovallius, 1886, p. 16, pl. 2, figs. 22-29.

Fifty specimens were taken at the surface.

Distribution.—Found in all tropical and subtropical seas. So far as I am able to ascertain, it has not heretofore been reported from Bermuda.

The usual length of this species is from 2 to 5 mm., but there are specimens in the U. S. National Museum taken at the Bahamas which measure 7 mm. The Bermuda specimens are about 4 mm.

Schellenberg (1926, p. 341, 342) regards

all the forms which have been described with a cleft telson as varieties of the original species *ultramarina*. The telson appears to be subject to considerable variation and I have figured this appendage of a specimen from Bermuda, in order to show one of these variations.

FAMILY CALLIOPIIDAE.

Stenopleura atlantica Stebbing.

Stenopleura atlantica Stebbing, 1888, p. 950, pl. 84.

Acanthozone atlantica Della Valle, 1893, p. 601, pl. 59, fig. 10.

Eight specimens were taken at depths between 200 and 900 fathoms.

Distribution.—Stebbing described this species from the tropical Atlantic. It has since been recorded from the Atlantic from 36° N. to 35° S. Walker recorded it from the western part of the Indian Ocean, and Schellenberg has recorded it from the southern part of that ocean. It has not heretofore been recorded from the Bermuda region.

The largest specimens recorded are 8 mm. in length. The Bermuda specimens measure from 5 to 5.5 mm.

FAMILY EUSIRIDAE.

Cleonardo microdactyla Stephensen.

Text-fig. 9.

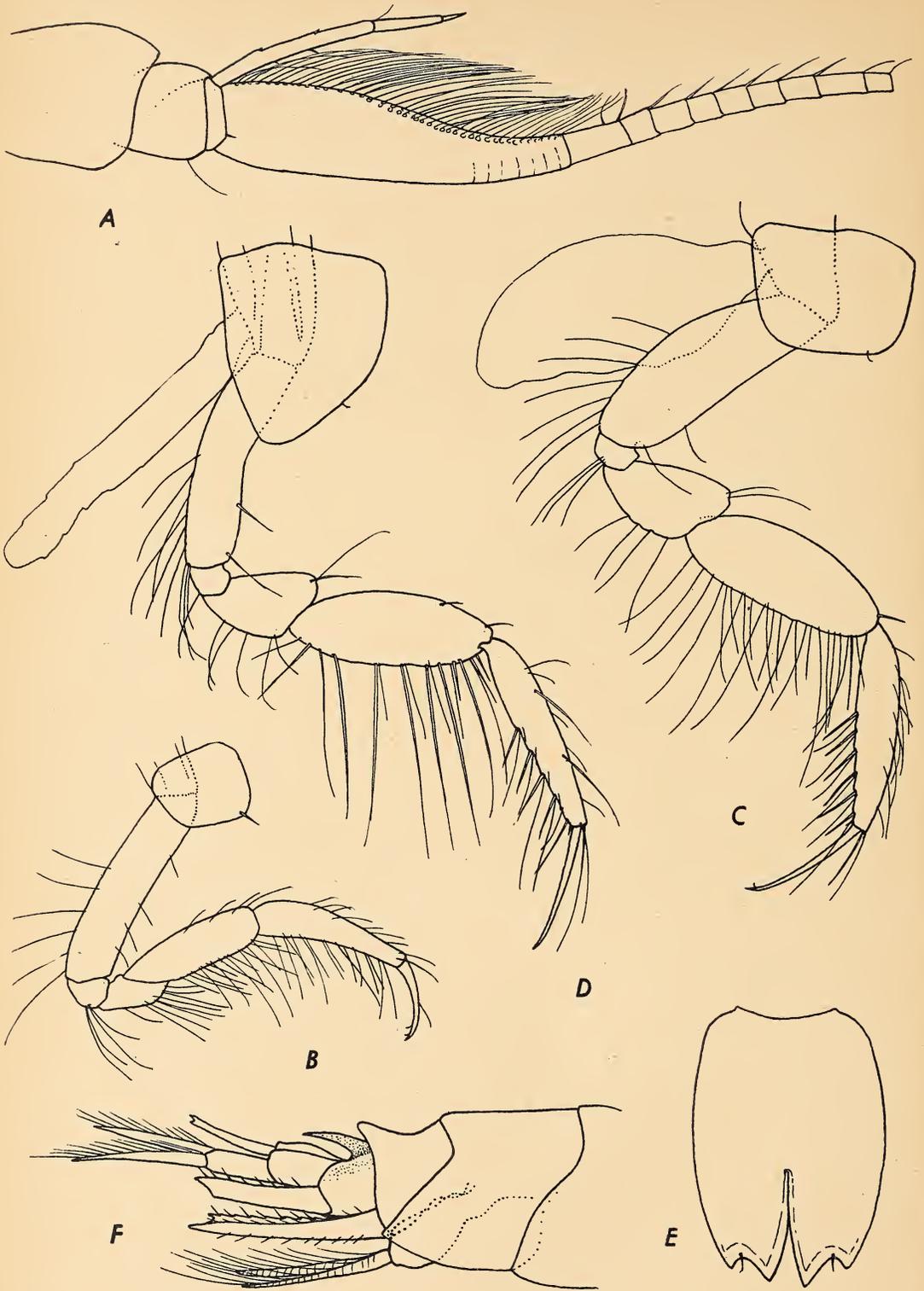
Cleonardo microdactylus Stephensen, 1912a, p. 90, figs. 3, 4.

Cleonardo microdactyla Stephensen, 1933, p. 40, fig. 19.

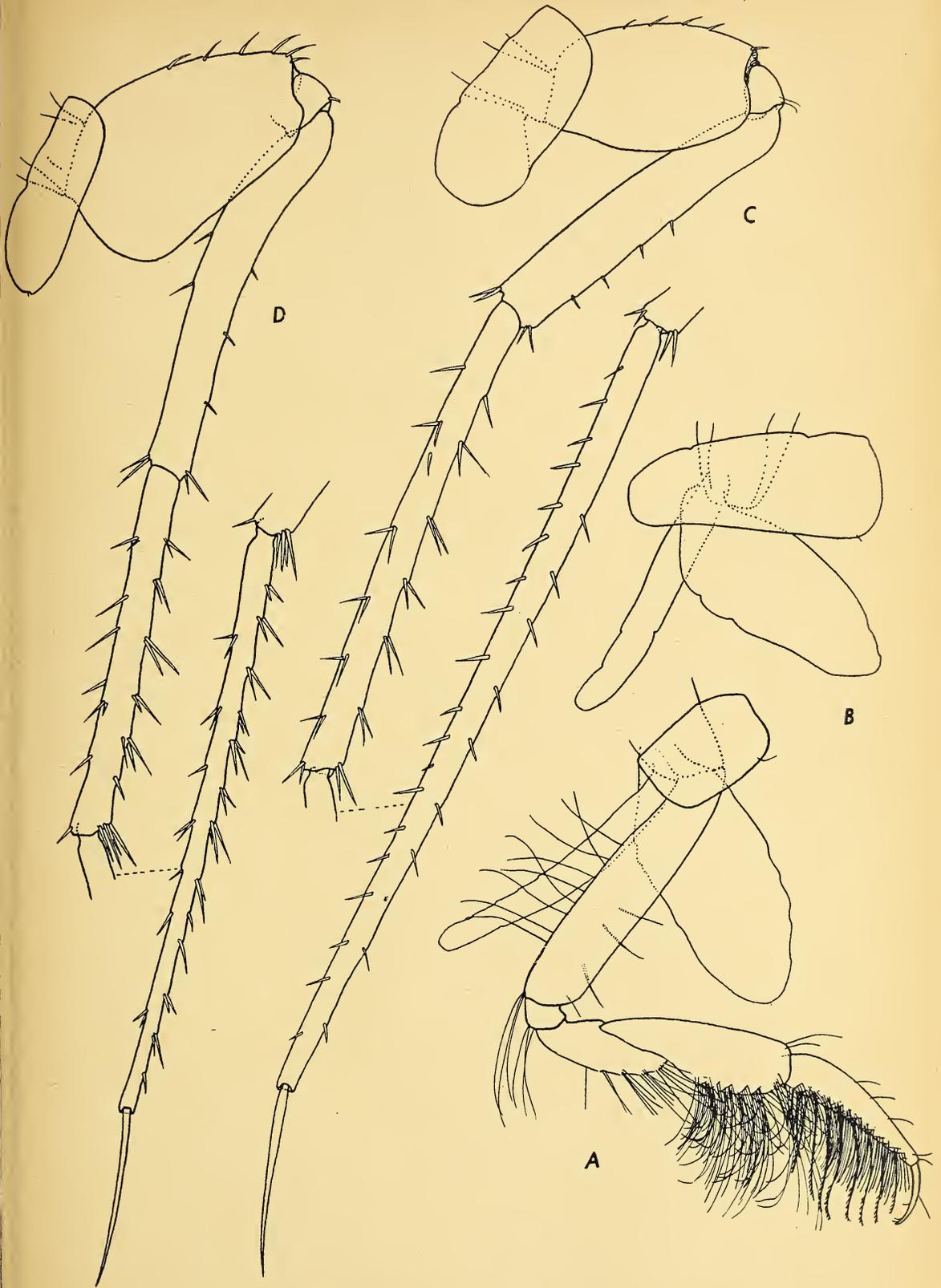
Three specimens were taken at depths between 600 and 800 fathoms.

Distribution.—This species was described by Stephensen from off the southwest coast of Greenland (64° 06' N., 55° 18' W.) from two females. In June, 1922, a single female was taken by the *Armauer Hansen* off the Bay of Biscay (47° 10' N., 18° 02' W.) and recorded by Pirlot in 1929. In 1933 Stephensen again recorded four specimens from off the southwest coast of Greenland and two small specimens from the waters south of Greenland. The three specimens from Bermuda extend the range of the species somewhat to the south and constitute the first records for the Western Atlantic.

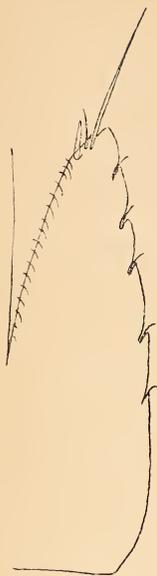
All the specimens of this species so far taken, of which the sex has been determined, are females. Stephensen believes that this species is most closely related to *C. longirostris* Chevreux, and this view is probably correct, but Chevreux's figures are so completely lacking in detail that a definite decision is impossible. *C. microdactyla* appears to be rather closely related also to *C. appendiculata* (Sars) and *C. longipes* Stebbing. Many of the apparent differences among the species of *Cleonardo* may be due to sex, size or individual variation, as Stephensen



TEXT-FIG. 6. *Halice aculeata* Chevreaux, female. **A**, antenna 1; **B**, gnathopod 1; **C**, pereopod 1; **D**, pereopod 2; **E**, telson; **F**, posterior end of animal.



TEXT-FIG. 7. *Halice aculeata* Chevreux, female. A, gnathopod 2; B, coxal plate of pereopod 3; C, pereopod 4; D, pereopod 5.



TEXT-FIG. 8. *Synopia ul-tramarina* Dana. Telson.

has suggested. Our acquaintance with this genus is so limited at present that it is scarcely possible to gauge the correct relation of the species which have been described. Of some of the species only one sex is known, which adds further to the difficulty.

The present specimens, which are all females, agree quite well with Stephensen's description and figures (1933, p. 40, fig. 19). I have figured some of the appendages showing details which have not heretofore been recorded.

The first antenna does not have an accessory flagellum. The third peduncular joint, however, is produced at the lower inside distal margin into a narrow lobe having somewhat the appearance of a small one-jointed flagellum, but it is not separated from the joint by an articulation. In my figure (Text-fig. 9b) the line which appears to separate this lobe from the third joint is the articulation between the third joint and the first flagellar joint and is on the outside, while the lobe is on the inside and has no articulation.

Gnathopod 1 bears a row of submarginal plumose setae on the inside front margin of the second joint. The defining angle of the palm is armed with three marginal spines, two of which are longer than the third, and submarginal to these on the inside surface is a row of five spines. The defining angle of the palm of gnathopod 2 is similarly armed except that the row on the inner surface contains four spines instead of five. Peraeopod 1 is not quite as long as peraeopod 2, but very much the same in general proportions. The fourth joint bears on both front and hind margins very long plumose setae. The dactyl is over

half the length of the sixth joint. The third, fourth and fifth peraeopods increase slightly in length consecutively and are very much alike in construction. The inner surface of the second joint bears a row of long plumose setae. The dactyl is a little less than half the length of the sixth joint. The third uropods reach very slightly beyond the apex of the telson, the inner ramus is longer than the outer, both are armed on their outer and inner margins with short spines, and all four margins bear extremely fine dentations which are discernible only by a high power of the microscope. The telson is very deeply cleft and is unarmed, but bears on the outer margins and the extremity of the cleft edges very fine dentations similar to those of the rami of the third uropods. The length of these mature females is about 7 mm. Stephensen gives 8 mm. for two of the females from the west coast of Greenland.

Eusirella elegans Chevreux.

Text-fig. 10.

Eusirella elegans Chevreux, 1908, p. 12, figs. 7, 8.

Eusirella valdiviae Schellenberg, 1926b, p. 228, fig. 19.

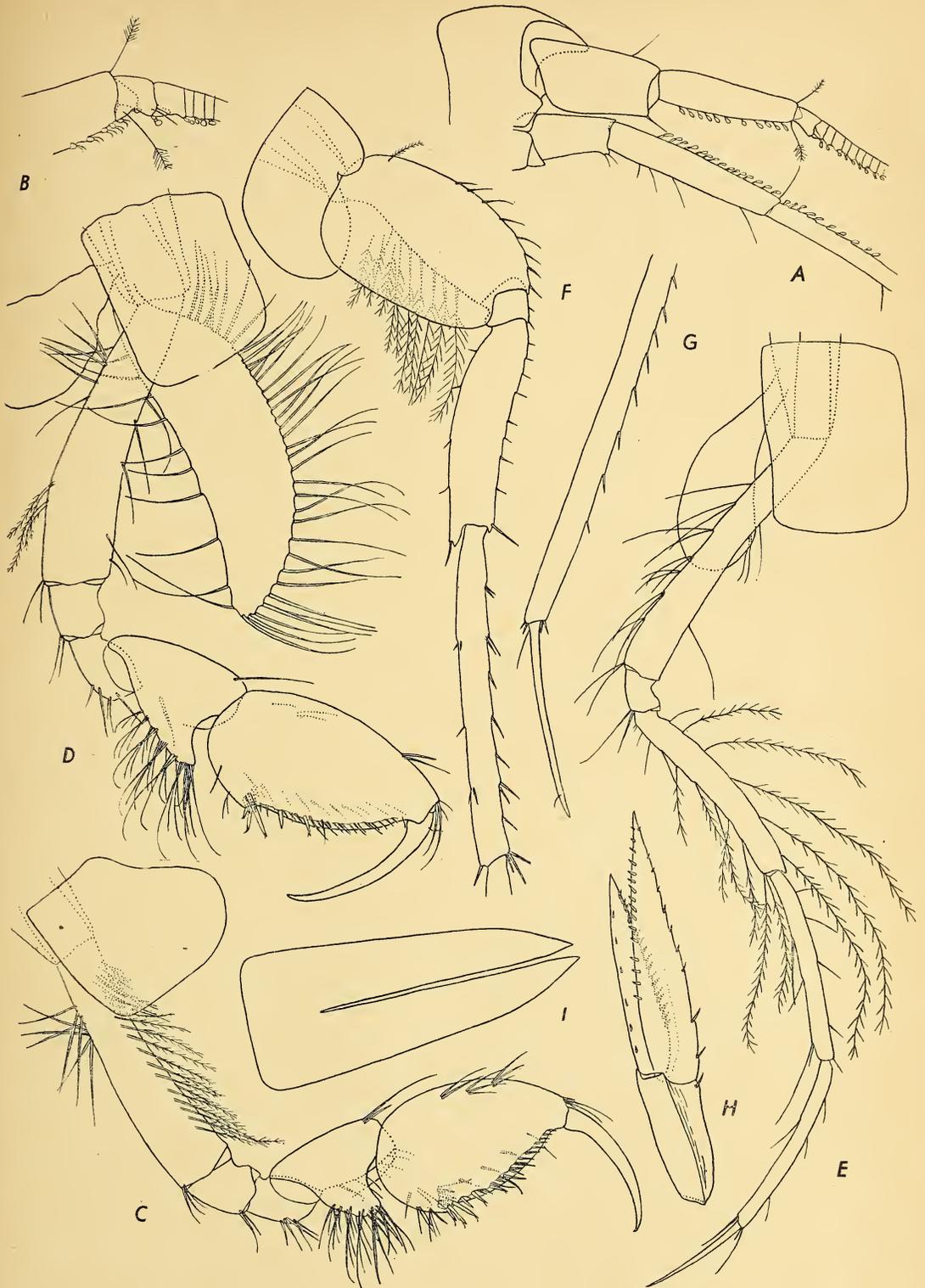
Gracilipes multicalceolus Thorsteinson, 1941, p. 85, pl. 7, figs. 71-77.

One specimen was taken at a depth of 1,000 fathoms.

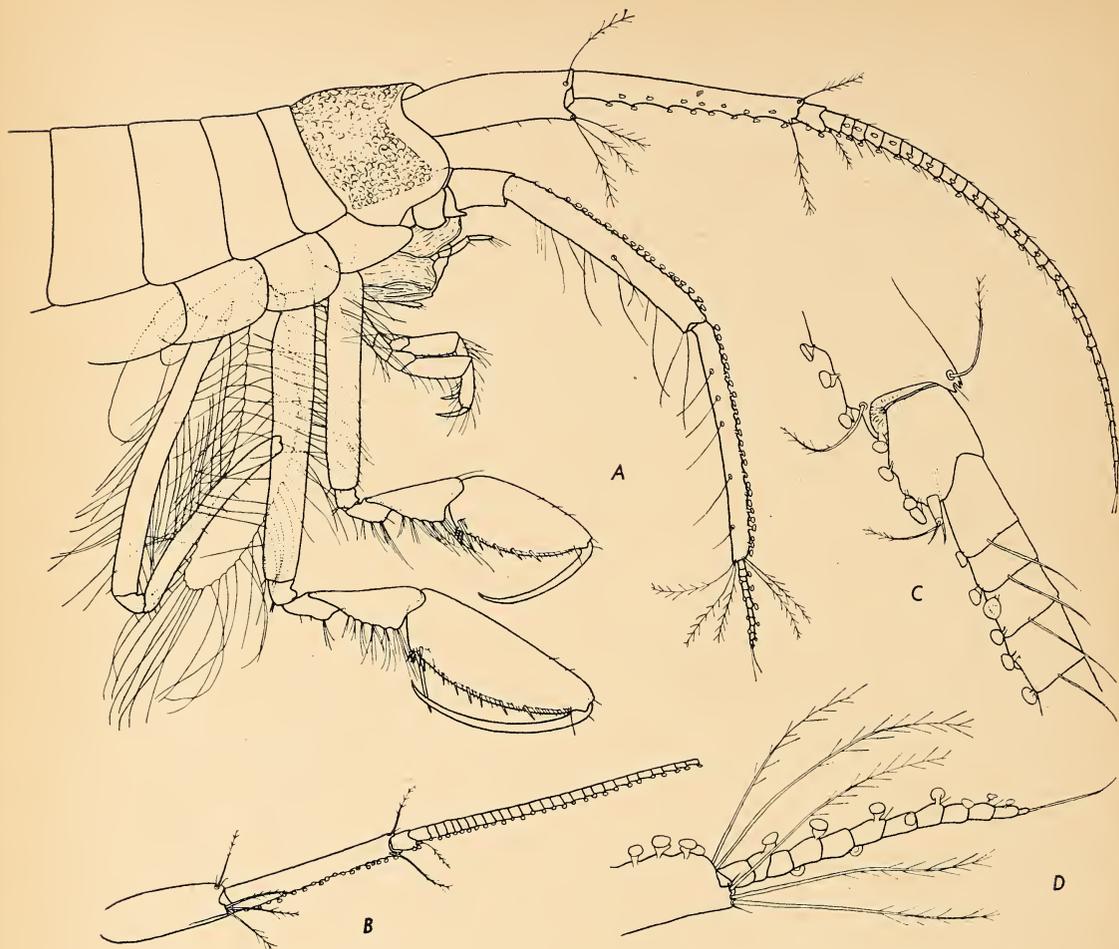
Distribution.—This species was described by Chevreux from the vicinity of the Azores (38°04' N., 26°07' W.). Schellenberg in 1926 described *E. valdiviae* from the South Atlantic (31°21' S., 9°46' E.). In 1932 Barnard also recorded it from the South Atlantic (33°53' S., 9°26' E.). Thorsteinson in 1941 recorded it from the Gulf of Alaska, North Pacific (*Gracilipes multicalceolus*). The present record is the first for the western North Atlantic.

The present specimen is a mature female measuring 10 mm. in length. Barnard believes that Chevreux's and Schellenberg's specimens represent the two sexes of the same species, the former the female and the latter the male. Both specimens are probably small and immature, measuring only about 5 mm.

The Bermuda specimen possesses the following characters: the eyes are rather poorly defined, but appear to be much as figured by Schellenberg for *E. valdiviae*. Antenna 1 is nearly as described by Barnard (1932, p. 194) for his Southeast Atlantic specimen, a male measuring 8.5 mm. The first peduncular joint bears the chisel-shaped tooth on the lower distal corner, but carries three plumose setae instead of two. The third joint bears a small, but distinct 1-jointed accessory flagellum. The primary flagellum is composed of about thirty joints. The



TEXT-FIG. 9. *Cleonardo microdactyla* Stephensen, female. **A**, head and antennae; **B**, antenna 1 greatly enlarged showing the small distal projection of third joint; **C**, gnathopod 1; **D**, gnathopod 2; **E**, pereopod 1; **F**, pereopod 4; **G**, sixth and seventh joints of pereopod 4; **H**, uropod 3; **I**, telson.



TEXT-FIG. 10. *Eusirella elegans* Chevreaux, female. **A**, anterior end of animal; **B**, antenna 1 showing under side; **C**, antenna 1 enlarged showing accessory flagellum; **D**, end of antenna 2 enlarged.

lower margin of the second and third peduncular joints and the flagellum bear calceoli. Antenna 2 is much as figured by Schellenberg for *E. valdiviae* (1926, p. 229, fig. 19), but the flagellum consists of twelve joints.

The gnathopods are rather long and slender, but not as slender as figured by Schellenberg, though much slenderer than figured by Chevreaux (1908, p. 13, fig. 7). The palms are very long, leaving only very short hind margins to the sixth joints, and are defined by blunt angles carrying groups of spines, one of the spines being much longer than the rest. The pereopods are all imperfect. The third pereopod lacks only the seventh joint and is proportionally about as figured by Schellenberg. The second joint of third, fourth and fifth pereopods is narrow and like Chevreaux's figures (1908, p. 14, fig. 8). The lower margins of

the metasome segments are broadly and evenly rounding and possess no angles. The uropods all reach back to the same point and are as characterized by Barnard, "rami sparsely spinose, with the margins very minutely serrulate." Telson reaching to the end of the peduncle of uropod 3, cleft nearly to its base, but the lobes separated only distally; the lobes apically acute, each with a very minute notch and setule as observed by Barnard.

Owing to the very close resemblance of the figures of *Gracilipes multicalceolus* to the figure of *E. valdiviae*, I believe them to be synonymous. Both represent the male, but there are a few discrepancies which may possibly be accounted for by the difference in maturity of the specimens. The gnathopods of *G. m.* are armed with a row of spines on the hind margin of the sixth joints, while in *E. valdiviae* these spines ap-

pear to be lacking, or at least are not shown in the figure. The antennae of *G. m.* are much more densely calceoliferous than those of *E. v.*, but this again may be due to the greater maturity of the former. Unfortunately, most of the figures which have been given of this genus are sadly lacking in detail, which greatly hinders the clarifying of the status of this species.

***Eusiropsis riisei* Stebbing.**

Eusiropsis riisei Stebbing, 1897, p. 39, pls. 13, 14.

Eight specimens were taken at depths between 300 and 800 fathoms.

Distribution.—This species was described by Stebbing from the tropical Atlantic. Walker in 1909 recorded it from the Seychelles. In 1926 Schellenberg recorded it again from the tropical Atlantic, and in 1929 he recorded it from the eastern tropical Pacific from specimens taken by the steamer *Albatross* in 1904 and 1905. Pirlot in 1934 recorded it from the East Indies, and Barnard in 1937 recorded it from the Arabian Sea.

A female from the eastern tropical Pacific measuring 13 mm., recorded by Schellenberg, appears to be the largest specimen so far brought to light. The Bermuda specimens measure between 8 and 10 mm. and the largest female carries eggs.

FAMILY TALITRIDAE.

***Hyale galatæae* Stebbing.**

Hyale galatæae Stebbing, 1899b, p. 402, pl. 31B.

One specimen was taken at a depth between the surface and 400 fathoms.

Distribution.—Stebbing described this species from specimens in the Copenhagen Museum which were taken at the following localities: Pacific, 37°32' N., 179°43' E.; 4°30' N., 137° E. Atlantic, one male from the Sargasso Sea; and one female, 26°20' N., 58°40' W., which is about the eastern edge of the Sargasso Sea. Chevreux records five specimens from 31°45'30" N., 42°42'30" W., and four specimens from 30° N., 42° W., which localities are also about the eastern edge of the Sargasso Sea. All the Atlantic specimens have been taken in the Sargasso Sea region, but the present specimen constitutes the first record for Bermuda.

Stebbing gives 4 mm. as the length of this species, and the present specimen, which is a male, is about this length.

Four hundred fathoms is given as the depth of the haul for net 1101, but this specimen must have been taken as the net came to the surface, as the species of *Hyale* are shallow water forms.

***Thoriella islandica* Stephensen.**

Text-fig. 11.

Thoriella islandica Stephensen, 1915, p. 39, fig. 23.

One specimen was taken at a depth of 900 fathoms.

Distribution.—This species was described by Stephensen from a single specimen taken by the *Thor* a few degrees south of Iceland (61°30' N., 17°08' W.), and was thought to be a female on account of the rather short cylindrical vesicles, considered to be underdeveloped marsupial plates, which accompanied the branchiae of the second to fifth thoracic appendages. A second immature female was recorded by Barnard from the Gulf of Oman in 1937.

Stephensen's specimen measured 19 mm. Barnard's specimen measured 18 mm. to end of telson and 22 mm. to end of first uropod. The Bermuda specimen measures 16 mm. in the curved position in which it is figured, but would undoubtedly measure 19 or 20 mm. if the animal were straightened out. Both Barnard's and the present specimen differ in a few details from the *Thor* specimen, but he nevertheless did not question the identity of his specimen, and I am not questioning the identity of the Bermuda specimen.

The antennae are considerably longer than in the *Thor* specimen, and are subequal in length. Both flagella are of about the same thickness, and are of the same thickness throughout their length. The flagellum of the first antenna consists of 20 joints and that of the second of 21 joints. The sixth joint of the second gnathopod bears a short dactyl which ends in a broad spine, as described by Stephensen, and which was lacking in Barnard's specimen. The first four coxal plates are slightly different from those figured by Stephensen. The first and second uropods, though of the same proportions, differ in detail from Stephensen's figures of these appendages. The outer ramus of these uropods is thick and cylindrical, ending rather abruptly in a small blunt point. The inner rami are slender and much shorter than the outer. The third uropods appear to be as described and figured by Stephensen.

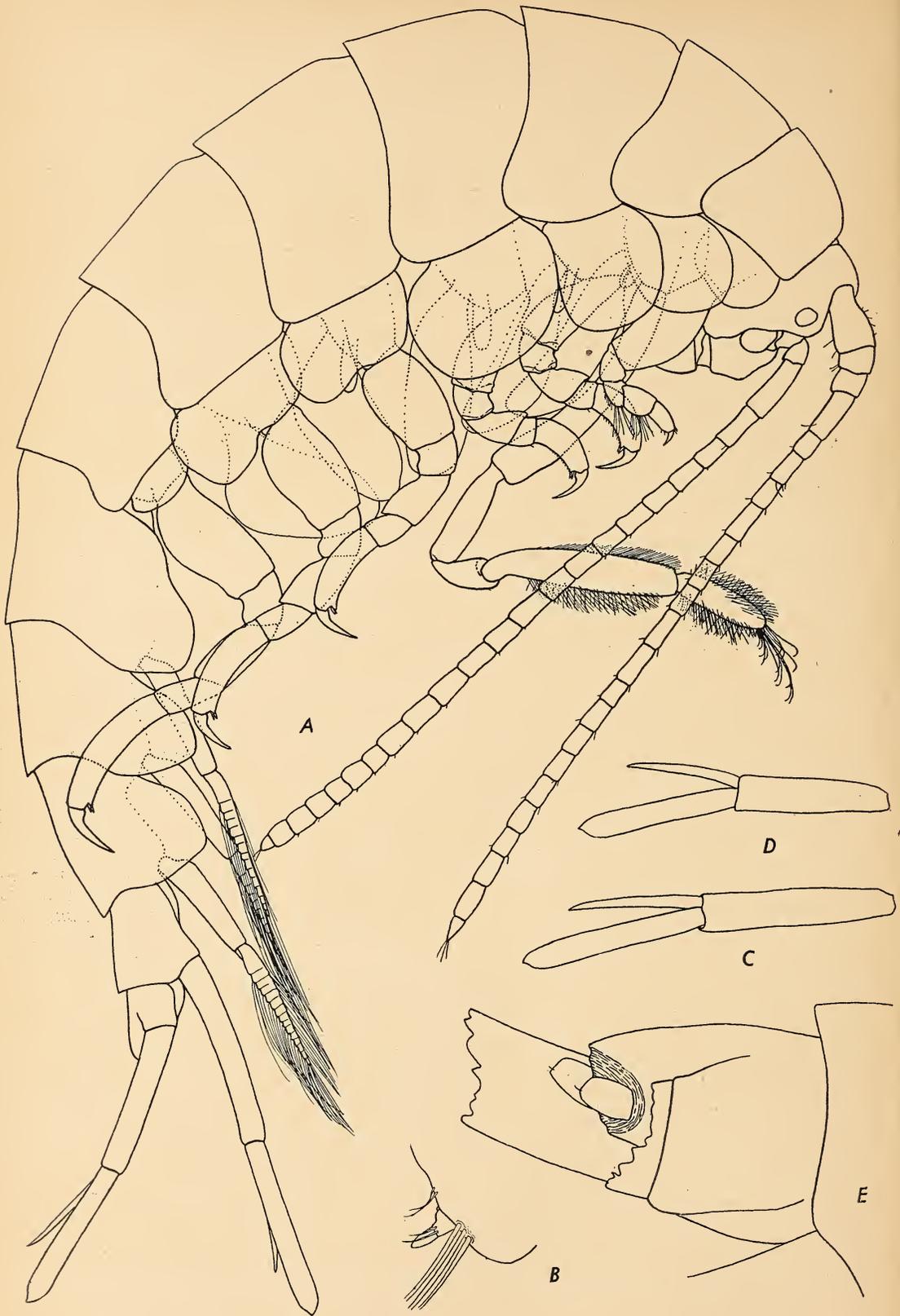
The present specimen is only the third recorded of this remarkably aberrant member of the family Talitridae.

FAMILY AMPITHOIDAE.

***Sunamphitoe pelagica* (Milne Edwards).**

Amphithoe pelagica Milne Edwards, 1830, p. 378.

Sunamphithoe hamulus + *S. conformata* Bate, 1862, p. 250, Pl. 43, fig. 5; p. 251, Pl. 43, fig. 6.



TEXT-FIG. 11. *Thoriella islandica* Stephensen, female. **A**, entire animal; **B**, end of sixth joint of gnathopod 2; **C**, uropod 1 from above; **D**, uropod 2 from above; **E**, end of urosome showing uropod 3.

Sunamphithoe conformata Sars, 1894, p. 585, pl. 208.

Sunamphithoe pelagica Chevreux, 1900, p. 102, pl. 11, fig. 4.

One specimen taken near the surface.

Distribution.—This species has been recorded from the warm and temperate areas of the North Atlantic. The present record is the first for Bermuda.

The single specimen from Bermuda is a small female, between 4 and 5 mm. in length, carrying one egg. The mandibular palp is absent and the specimen agrees in all characters with *S. pelagica*. Both Stebbing and Chilton have noted the close resemblance between this species and *Ampithoe femorata* (Kröyer). I have examined specimens from North Carolina, Tortugas and Brazil, which could be identified either as *Sunamphithoe pelagica* or *Ampithoe femorata*, depending upon the development of the mandibular palp. In some the palp is lacking and in others it is well developed, while many gradations between these extremes can be noted. In the genus *Ampithoe* there are a number of species, which, from the possession of several characters in common, seem naturally to form a homogeneous group. *S. pelagica* and *A. femorata* belong to this group, and it may be that eventually they will be considered variations of the same species.

S. pelagica usually measures between 5 and 8 mm. but Stebbing (1906, p. 645) gives 8 to 17 mm. as the length. The length of *S. hamulus* Bate, which Stebbing considers a synonym of *S. pelagica*, is given as 14/20 of an inch and this is equal to about 17 mm.

FAMILY HYPERIOPSIDAE.

Hyperiopis tridentata Barnard.

Text-figs. 12, 13.

Hyperiopis tridentata Barnard, 1937a, p. 147, fig. 4, ♀.

One specimen was taken at a depth of 1,000 fathoms.

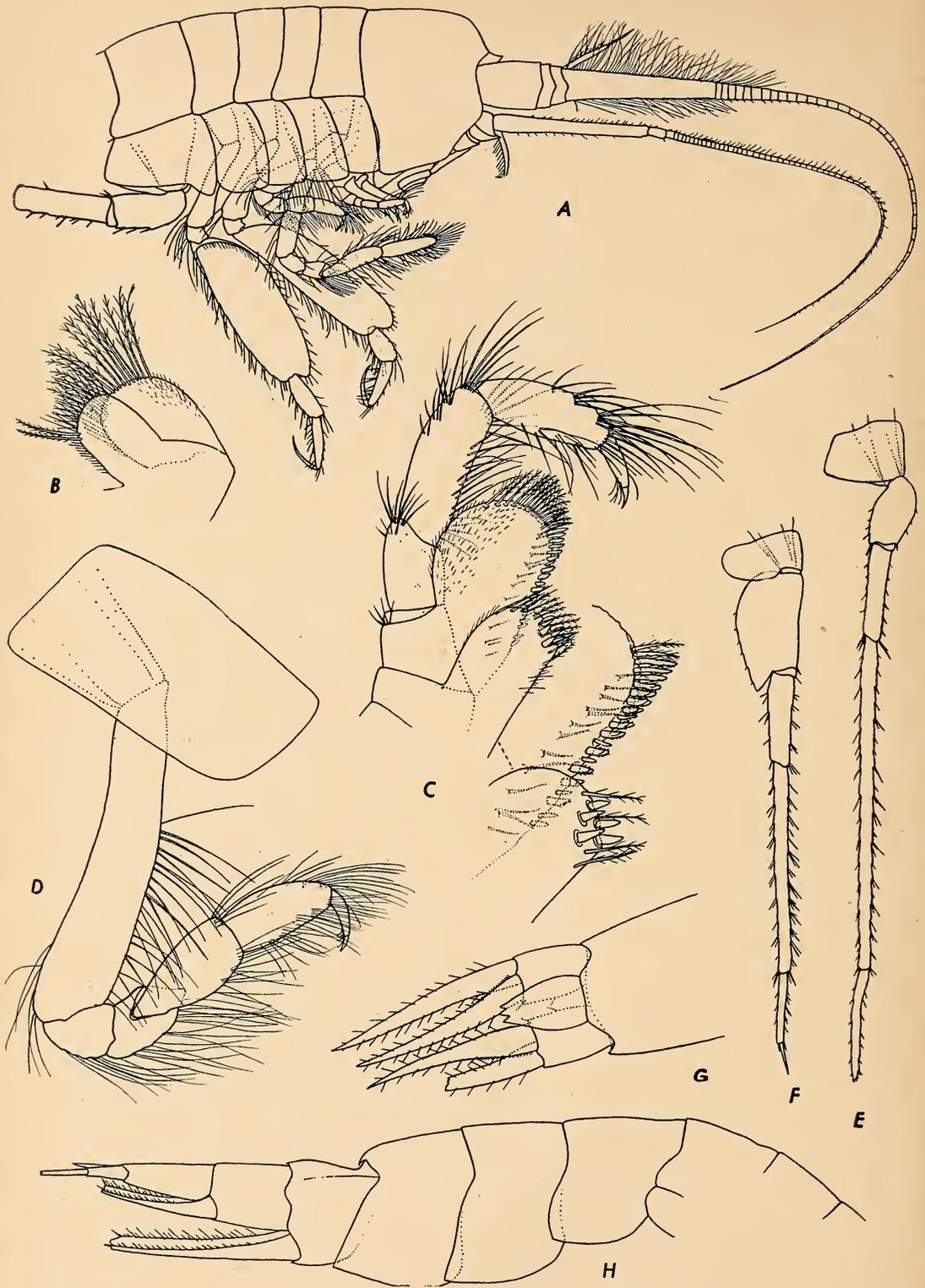
I have identified this specimen as *Hyperiopis tridentata* Barnard with some hesitancy, as I am unable to compare some of its characters with that species. Barnard describes only the first and second gnathopods and first peraeopod, which he says do not differ from those of *H. voringii* and resemble Stephensen's figures of that species (1934, p. 6, fig. 1, p1, p2, and p. 10, fig. 4, p3). Barnard does not mention peraeopod 5, which in the present specimen is quite different from that of either *H. voringii* Sars or *H. gibbosa* Pirlot. The hind margin of the second joint of this peraeopod is produced below into a conspicuous angular pointed lobe which is not the case with this joint in either *H. v.* or *H. g.* It would seem that if the fifth peraeopods were present in *H. tridentata* and the second joint bore this char-

acter, Barnard could scarcely have failed to have mentioned it.

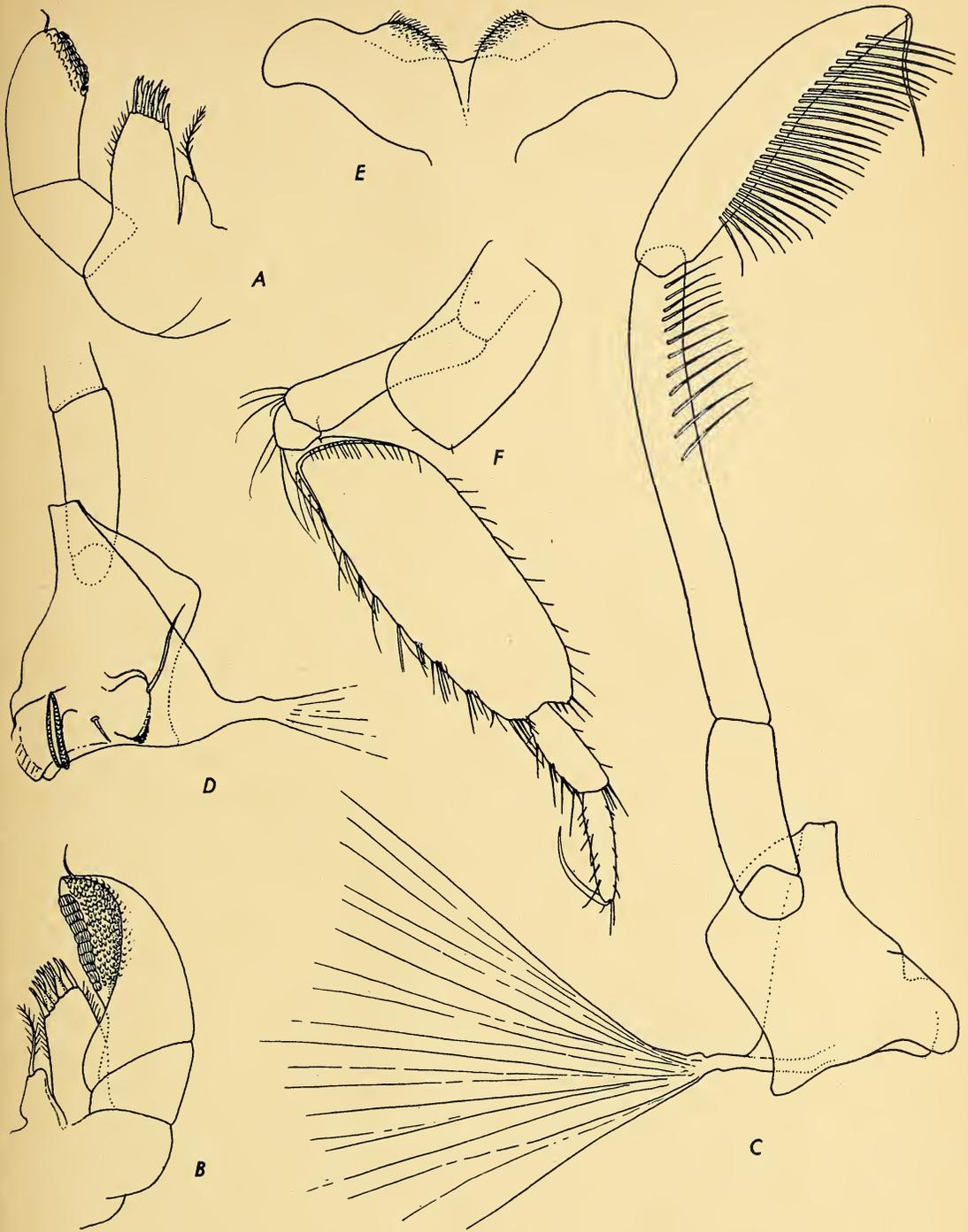
Barnard's specimen was a female 8 mm. in length. The Bermuda specimen measures about 16 mm. in length, and appears to be an immature female. There are no male sexual organs present, gnathopod 2 and peraeopods 1-5 bear large branchiae, and gnathopod 2 and peraeopods 1-3 bear small, cylindrical, undeveloped marsupial plates.

The head bears a short, broadly triangular rostrum. Eyes absent. Antenna 1, accessory flagellum about half the length of the first joint of primary flagellum and composed of one long and two short joints. Upper lip is unsymmetrical and is as figured by Stephensen for *H. voringii* (1934, p. 7, fig. 2). Right mandible with very broad, double-edged accessory plate; one spine in spine-row; molar long and narrow with a prominent seta at upper corner and a few short teeth at the lower corner; palp very long, first joint about one-third the length of the second, and third about three-fourths the length of the second. The first maxillae are not symmetrical, the right palp being very much stronger and more robust than the left. The armaments of the inner and outer plates and palp are as I have figured them, which is practically the same as described and figured by Stephensen for *H. voringii* (1934, p. 8, fig. 1). Maxilla 2, outer plate much wider than inner; the inner plate wider in proportion than is figured by Stephensen for *H. v.* (1934, p. 8, fig. 3). Maxillipeds, inner plate reaching to about the middle of outer plate and armed distally with plumose setae and five spine-teeth; outer plate rather wide, upper and outer margins forming a broadly rounding curve, inner margin armed with a row of closely set teeth, which are of a peculiar complicated structure, the outer surface of plate bearing a submarginal row of setae; palp shorter and stouter than is shown by Stephensen for *H. voringii* (1934, p. 7, fig. 2Mxp.), the second joint is very little longer than third, fourth joint bearing nail at base of which are several setules. Lower lip shallow, without inner lobes, lateral lobes very long, curved and bluntly rounding apically.

Gnathopod 1, second joint a little longer than the third to sixth joints combined, fifth joint a little longer and wider than sixth, seventh joint bearing nail at base of which are several setules. Gnathopod 2 much as figured by Stephensen for *H. v.* (1934, p. 6, fig. 1 p2), but perhaps proportionately a little longer and narrower. Peraeopods 1 and 2 much alike; fourth joint of peraeopod 1 produced distally into a rounding lobe; fourth joint of peraeopod 2 wider and forward lobe less pronounced than in peraeopod 1; the proximal end of this joint is reinforced by a stout chitinous ridge bearing a row of five setules. Peraeopods 3 to 5 slender. The second joint of peraeopod 3 is not ex-



TEXT-FIG. 12. *Hyperiopis tridentata* Barnard. A, anterior half of animal; B, maxilla 2; C, maxilliped; D, gnathopod 1; E, peraeopod 4; F, peraeopod 5; G, uropod 3 and telson; H, posterior half of animal.



TEXT-FIG. 13. *Hyperiopsis tridentata* Barnard. **A**, maxilla 1; **B**, maxilla 1, showing inside of palp; **C**, right mandible from outside; **D**, right mandible from inside; **E**, lower lip; **F**, peraeopod 2.

panded, and that of peraeopod 4 is very slightly expanded. Peraeopod 5 shorter than peraeopod 4, the second joint is well ex-

panded and its hind margin is produced below into a conspicuous angular lobe.

Metasome segment 1 is bluntly angular be-

low and segments 2 and 3 are sharply angular. The telson and uropods are as described and figured by Barnard (1937, p. 147, fig. 4). Telson extending beyond the peduncle of uropod 3, margins convex and converging to the narrow tridentate apex.

There are few records of the occurrence of this deep sea genus of amphipods. Sars in 1885 described the genus and the genotype, *H. voringii*, from the Arctic Ocean (72° N., 5° E.) and off the coast of Norway (64° N., 4° E.). In 1934 Stephensen redescribed and fully figured *H. voringii* from specimens in the Monaco collection which were taken in the Atlantic in 1898 (69°18¼' N., 12°09' E.). In 1906 Walker described the species *H. australis* taken by the *Discovery* in Antarctic waters. The status of this species, however, cannot be determined, as it is insufficiently described. Pirlet in 1934 described *H. gibbosa* taken by the *Siboga* Expedition in 1899, in the East Indies (0°17.6' S., 129°14.5' E.). In 1937 Barnard described *H. tridentata* taken in the North Arabian sea by the John Murray Expedition, in 1933. It is seen that the genus is widely distributed, but of the distribution of the species practically nothing is known. The present Bermuda record, however, indicates a rather wide range at least for the species *H. tridentata*.

Suborder 2. Hyperiidea.

FAMILY LANCEOLIDAE.

Lanceola pelagica Say.

Text-fig. 14.

Lanceola pelagica Say, 1818, p. 318.

Lanceola sayana Bovallius, 1885, p. 7, figs. 1, 1a and 1b.

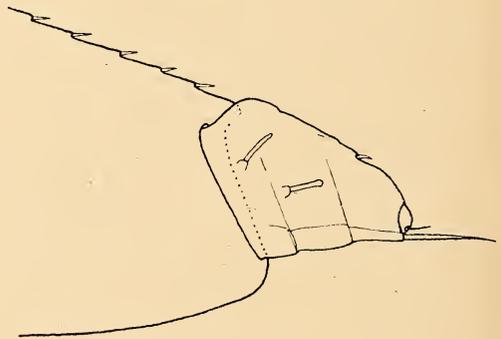
Lanceola sayana Bovallius, 1887a, p. 30, pl. 4, figs. 1-19; pl. 5, fig. 1.

Lanceola sayana var. *typica* + var. *longipes* Woltereck, 1909, p. 158.

Four specimens were taken at depths between 700 and 1,000 fathoms.

Distribution.—This species is widely distributed. Stephensen (1912, p. 612) records it 63° N., 54° W. in the southern part of Davis Strait. From the eastern North Atlantic there are numerous records. Woltereck records it from the South Atlantic (1927, p. 60, 35° S., 18° W.) and from the Antarctic Ocean (1927, p. 60, 64° S., 85° E.). Woltereck recorded it from the Eastern Pacific (1909, p. 159, *Albatross* Station 4604, off Nicaragua, and Station 4665, off Peru). Walker recorded it from the Indian Ocean (1909, p. 53). Barnard (1937, p. 178) recorded it from the Arabian Sea. Say (1818, p. 318) merely says that two specimens were found by Capt. Hamilton in the Gulf Stream. The specimens from Bermuda are the first recorded from these islands which lie on the outer edge of the Gulf Stream.

When Bovallius in 1885 (p. 3) definitely established the status of Say's genus *Lanceola* he carefully compared Say's description of the genus and the species *pelagica* with the description of a species of *Lanceola* which he was describing. As the only known species of *Lanceola* possessing the specific characters mentioned by both Say and Bovallius is *L. sayana*, I consider *sayana* to be a synonym of *pelagica*. Stebbing (1904, p. 29) says, "It is possible that Say's *L. pelagica* may be identical with the *L. sayana* of Bovallius, since the chief mark of distinction rests on a measurement which, at the date when Say wrote, was not likely to have been made with much exactness." Stephensen (1918, p. 9) places *pelagica* questionably as a synonym of *sayana*.



TEXT-FIG. 14. *Lanceola pelagica* Say, female. Inside view of the end of left antenna 1.

It is unfortunate after 57 years of recognition to have to discard Bovallius's name *sayana*, but if the law of priority is to be upheld it should be done. Say's specimen measured 1½ inches or about 32 mm. Bovallius gives the measurements as 30-42 mm. Stephensen (1918, p. 9, fig. 1) figures a male 27 mm. in length. The largest Bermuda specimen, which I believe to be an undeveloped female, measures 19 mm. I have figured the apex of antenna 1 which agrees very well with the figure given by Stephensen (1918, p. 9, fig. 1, A1 apex) except that the large antepenultimate joint appears to have a faint suggestion of segmentation, and the terminal seta of the narrow distal lower joint is much longer than is shown in his figure.

Lanceola loveni Bovallius.

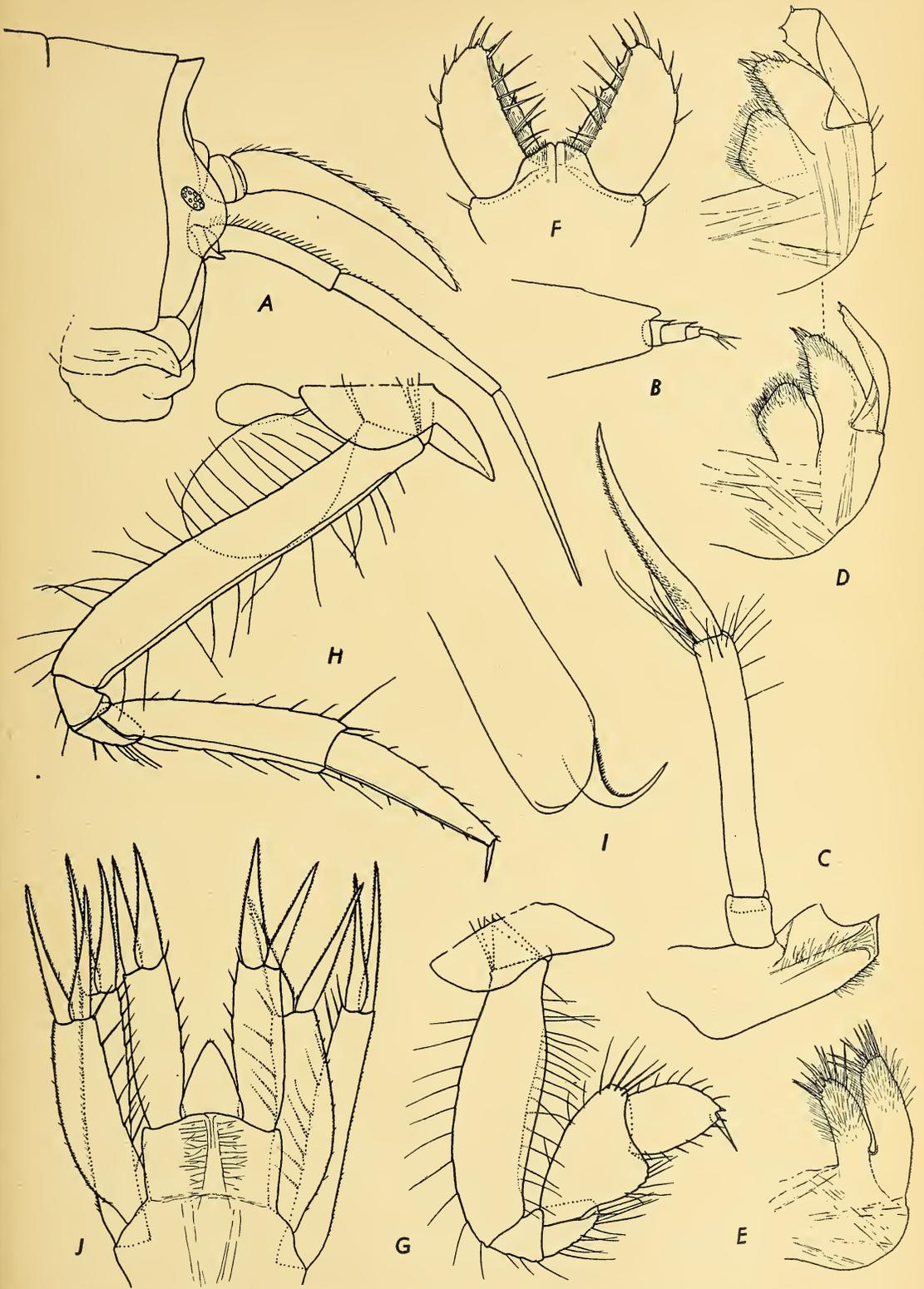
Text-figs. 15, 16 a-f.

Lanceola loveni Bovallius, 1885a, p. 6.

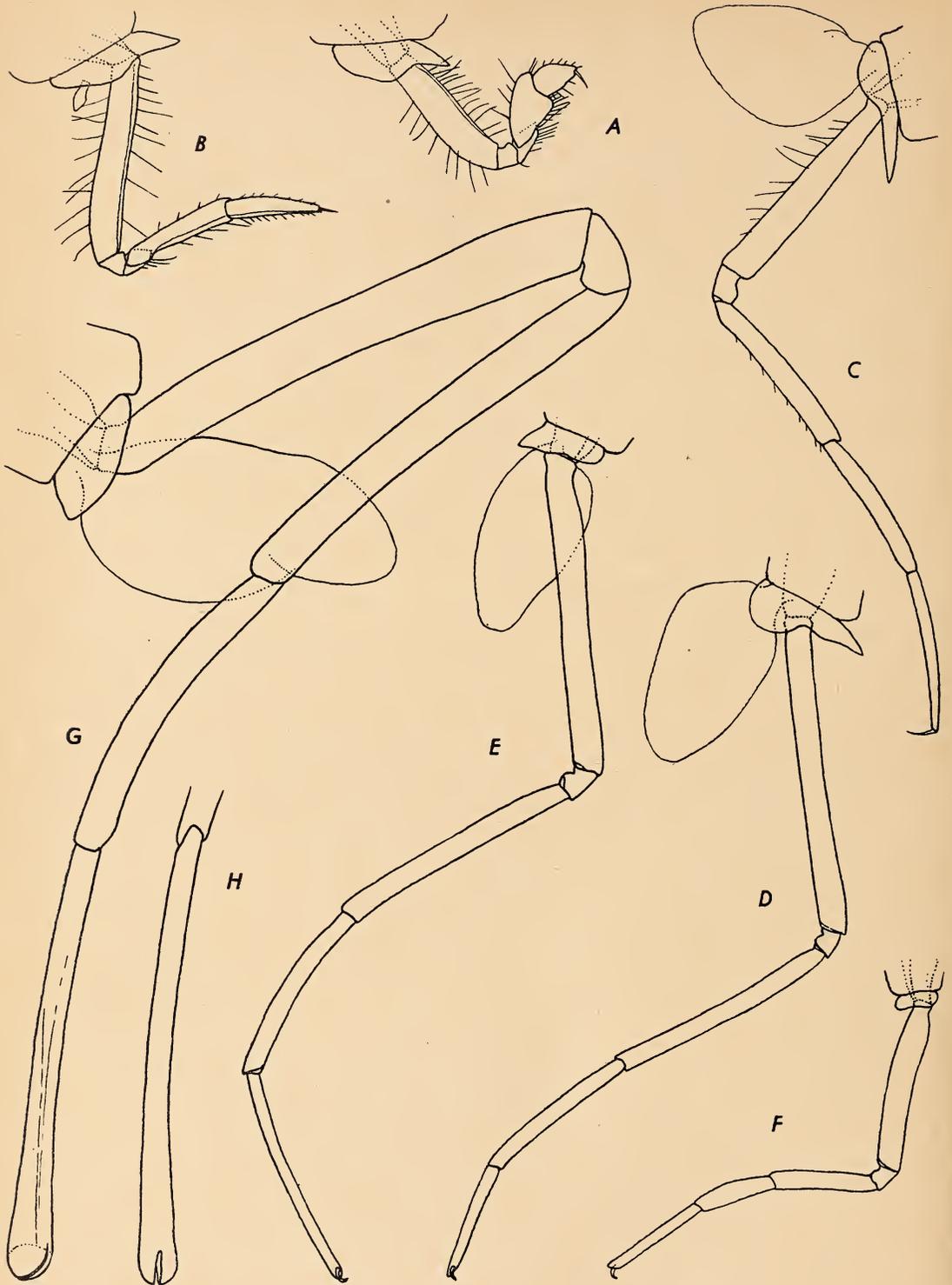
Lanceola loveni Bovallius, 1887a, p. 36, pl. 5, figs. 24-26; pl. 6, figs. 1-13.

Twenty-three specimens were taken at depths between 400 and 1,000 fathoms.

Distribution.—*Lanceola loveni* was described by Bovallius in 1885 from a single



TEXT-FIG. 15. *Lanceola loveni* Bovallius, male. **A**, head; **B**, end of antenna 1; **C**, mandible; **D**, maxilla 1; **E**, maxilla 2; **F**, maxillipeds; **G**, gnathopod 1; **H**, gnathopod 2; **I**, end of pereopod 4; **J**, uropods and telson.



TEXT-FIG. 16. *Lanceola loveni* Bovallius, male. A, gnathopod 1; B, gnathopod 2; C, pereopod 2; D, pereopod 3; E, pereopod 4; F, pereopod 5. *Lanceola loveni* var. *grossipes*, new var., female. G, pereopod 4; H, sixth joint of pereopod 4, front view.

specimen which was taken in the entrance to Davis Strait in 1843. The species has not appeared again until the present abundant material was procured at Bermuda by Dr. Beebe.

I have identified these specimens as *Lanceola loveni*, though they differ somewhat in detail from the description and figures given by Bovallius. The species was described from a single specimen, which, in my opinion, is always a more or less unsafe procedure, as there can be no certainty that the single specimen is a perfectly normal one. Variation in the relative length of the appendages appears to exist in the species of *Lanceola* and should be taken into consideration in their identification. The antennae and telson, as well as the peraeopods, are subject to relative variation in length, according to sex and size. The animals of this genus, and those of some of the other hyperiid genera, are inflated, bulky, transparent creatures, which with little handling become a limp misshapen mass of appendages, antennae, and integument. These facts naturally add to the difficulty of identifying these hyperiids.

The antennae are longer than shown by Bovallius (1887, pl. 6, fig. 1). The gnathopods resemble those figured by him, though they may be slightly longer. The peraeopods also resemble his figures except that peraeopod 3 (5 in his figures) is shorter in proportion to 4 (6 in his figures) than he has shown. Peraeopod 5 also is shorter in proportion to 4 than is shown by his figure. Peraeopod 4 has the broadly rounding apex to the sixth joint as Bovallius shows it. The uropods and telson agree with his figures. He states that the telson is less than half the length of the peduncle of the third pair of uropods and this statement holds good for the Bermuda specimens.

The largest female in the Bermuda collection measures about 21 mm., which is about the length of the type, which was a male. The largest male measures 15 mm. in length.

None of the females in the present collection possess fully developed marsupial plates and therefore do not appear to differ in appearance from the males.

***Lanceola loveni* var. *grossipes*,**
new variety.

Text-fig. 16 g, h.

Eight specimens were taken at depths between 600 and 1,000 fathoms.

This variety differs from the typical form only in the fourth and fifth peraeopods. The sixth joint of peraeopod 4 is distally thickened or expanded resembling a club. The joint is slit across the extremity for the reception of the strongly curved seventh joint when it is retracted. Peraeopod 5 appears to be only about one-third the length of peraeopod 4 which is about four-fifths the length of

the entire body. The length of the type female is 29 mm.

***Lanceola pacifica* Stebbing.**

Lanceola pacifica Stebbing, 1888, p. 1302, pls. 151, 152.

Lanceola pacifica var. *robusta* Woltereck, 1909, p. 160.

Fifteen specimens were taken at depths between 400 and 1,000 fathoms.

Distribution.—This species was described by Stebbing in 1888 from the western Pacific (35°41' N., 157°42' E.) from a single specimen which measured about 14 mm. (eleven-twentieths of an inch) in length. In 1904 Stebbing identified two specimens from the Bay of Biscay as this species, which were somewhat smaller than the type. Woltereck, in his meager description of his variety *robusta* from Albatross Station 4683, off southern Chile, gives no measurements, but in 1927, p. 64, he gives 27 mm. as the length of a female taken by the *Gauss* Expedition in the South Atlantic (0°46' N., 18°57' W.). Pirlet in 1929 recorded eight specimens taken by the *Armauer Hansen* in the vicinity of the Azores. Barnard in 1932 recorded fifteen specimens of *L. pacifica*, with which he included Woltereck's var. *robusta*, taken in the mid- and South Atlantic by the *Discovery*. His largest specimen, a female, measured 38 mm., while the largest in the present collection measures 30 mm. The specimens taken at Bermuda constitute the first records for this region.

***Lanceola serrata* Bovallius.**

Lanceola serrata Bovallius, 1885a, p. 7.

Lanceola serrata Bovallius, 1887a, p. 34, pl. 5, figs. 2-13.

Lanceola suhmi Stebbing, 1888, p. 1313, fig. 28.

Five specimens were taken at depths between 700 and 1,000 fathoms.

Distribution.—The most northern record is that given by Stephensen for specimens taken by the *Tjalfe* in Davis Strait (62°22' N., 55°48' W.). The most southern record is that of Barnard for specimens taken in the South Atlantic by the *Discovery* in 1926 (52°25' S., 9°50' E.). *L. serrata* has not been recorded outside of the Atlantic Ocean.

The present records are the first for Bermuda, but the specimens are all juvenile, the largest measuring about 16 mm. Bovallius gives 38 mm. as the length, but Barnard records a male from the South Atlantic 40 mm. in length.

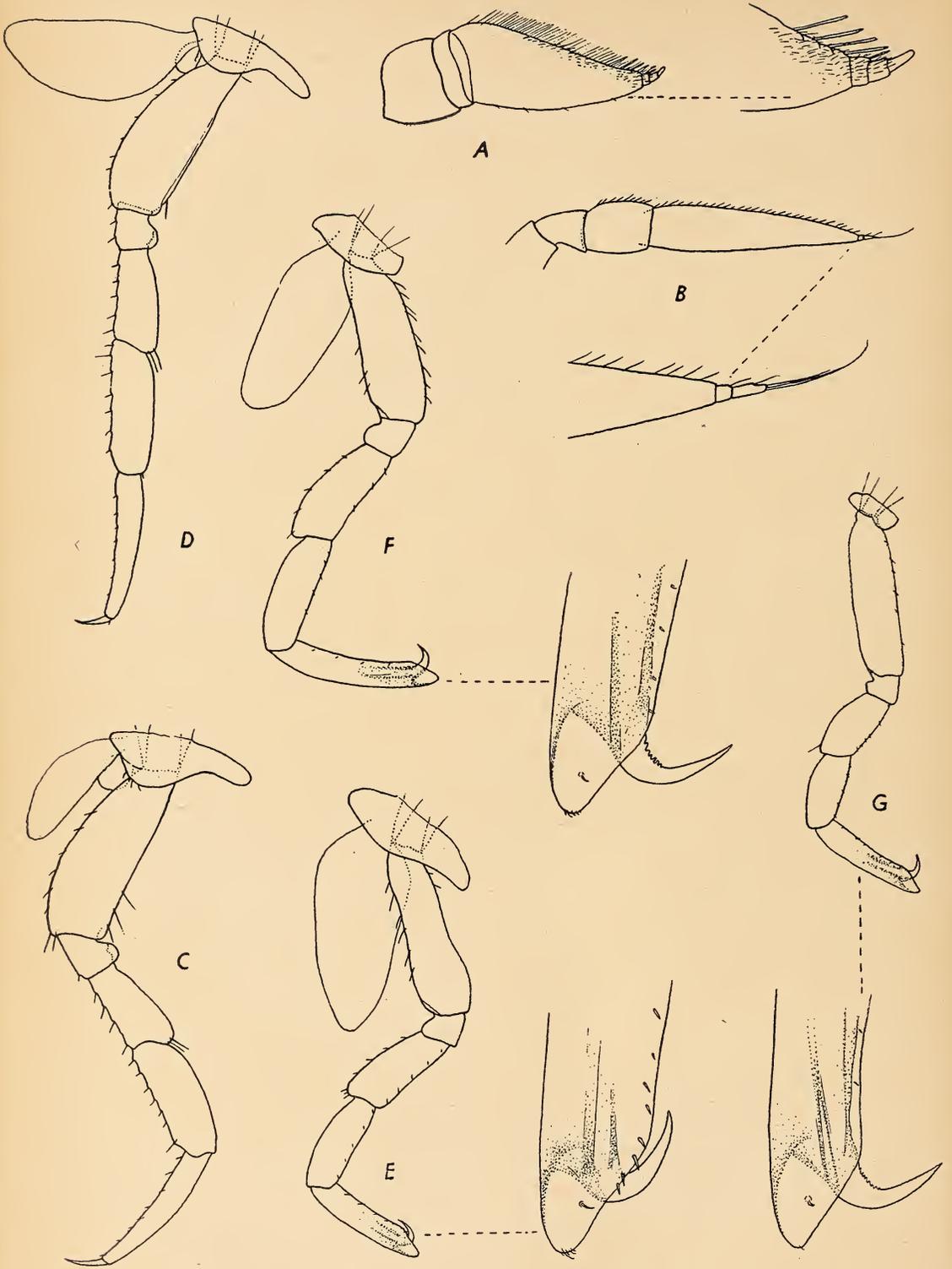
***Lanceola clausii* Bovallius.**

Text-figs. 17, 18.

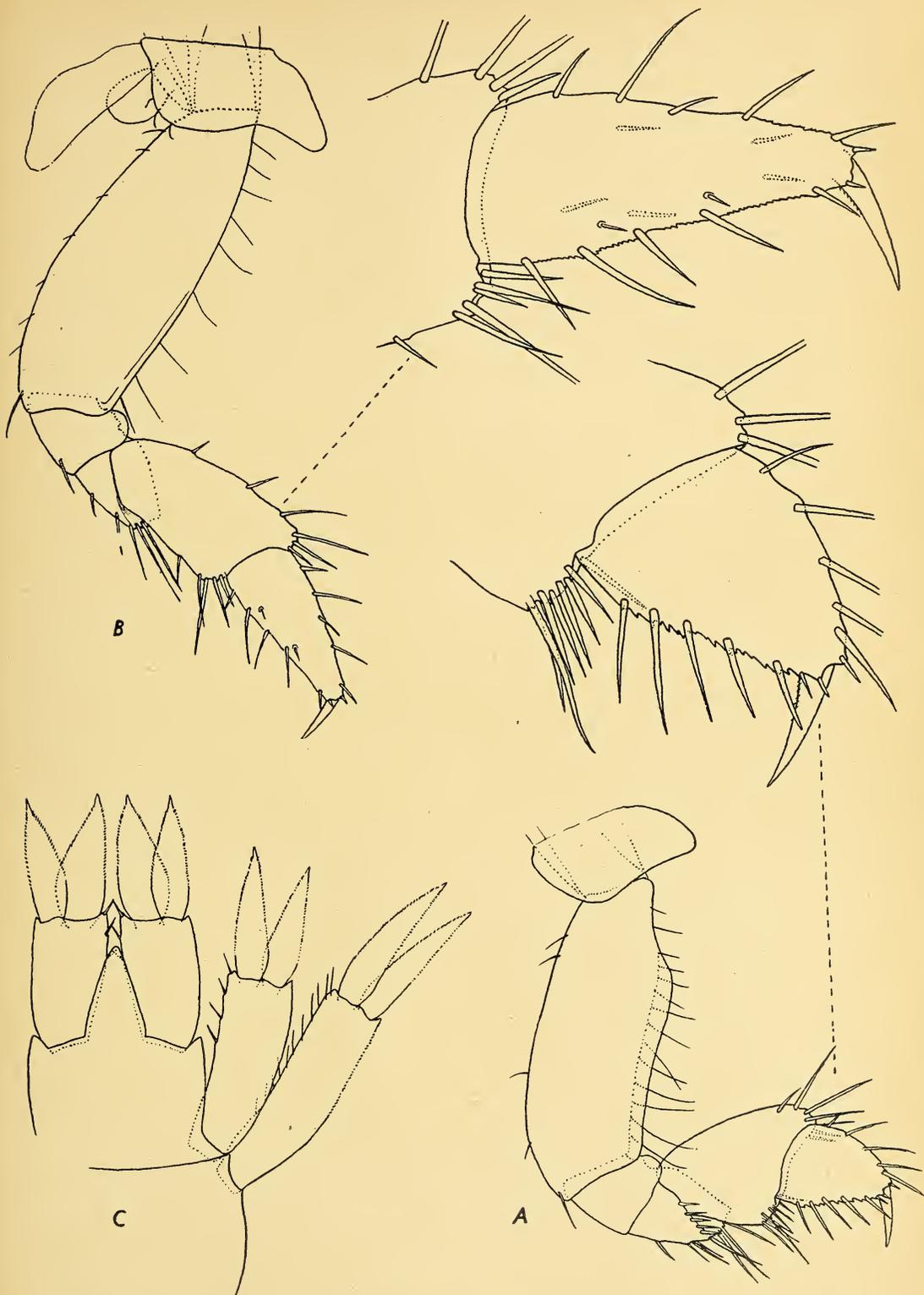
Lanceola clausii Bovallius, 1885a, p. 8.

Lanceola clausi Bovallius, 1887a, p. 40, pl. 6, figs. 14-23.

Lanceola clausi Sars, 1900, p. 15, pl. 1.



TEXT-FIG. 17. *Lanceola clausii* Bovallius, female. A, antenna 1; B, antenna 2; C, peraeopod 1; D, peraeopod 2; E, peraeopod 3; F, peraeopod 4; G, peraeopod 5.



TEXT-FIG. 18. *Lanceola clausii* Bovallius, female. A, gnathopod 1; B, gnathopod 2; C, uropods and telson.

Eight specimens were taken at depths between 700 and 1,000 fathoms.

Distribution.—This species was described by Bovallius from Baffin Bay (72° N.). Sars recorded it from 80° N., 134° E. and between 84° and 83° N., and between 25° and 11° E. Barnard records it from the Antarctic (71°41' S., 166°47' W.). Woltereck records it also from the Antarctic from specimens taken by the Deutsche Südpolar Exped. (65°3' S., 85°4' E.). This species has been taken in the Atlantic, and the Arctic and Antarctic Oceans but not in the Pacific. The present records are the first for Bermuda and also the first for the western North Atlantic.

Bovallius gives 20 mm. as the length of his specimen and Barnard records a specimen 19 mm. The specimens in the present collection are all immature, the largest measuring about 7 mm. None possess male sexual organs and some show partially developed marsupial plates. Although the specimens are immature they agree very well with the figures given by Bovallius and Sars. The peduncle of the first antenna is composed of three joints, the third, however, very short and rather difficult to observe. Second antenna with well-developed gland cone on second joint.

***Lanceola pirloti*, new species.**

Text-figs. 19, 20.

Six specimens were taken at depths between 700 and 1,000 fathoms.

Description of female.—Head very short and deep, upper front margin broadly angular and bent downward, but not at all projecting; side lobes rather bluntly angular with the small colorless oblique eye near the upper margin. Antenna 1 tumid and very broad horizontally, slightly longer than the second joint of gnathopod 1; the three peduncular joints plainly discernible, the first much the longest; the first flagellar joint very broad and fringed with sensory setae on inner margin, the three terminal joints short. Antenna 2 perhaps a little longer than antenna 1, first peduncular joint very large, second not in view except the gland cone, third short, fourth a little longer than the first three together and a little shorter than the fifth; flagellum about twice as long as fifth peduncular joint, the first joint very long and two terminal joints very short; inside margin of fourth and fifth peduncular joints and flagellum fringed with fine setae.

Gnathopod 1, coxal plate produced forward; second joint about two-thirds as wide as long; third and fourth joints short, fifth and sixth joints together nearly as long as second; fifth joint expanded distally and considerably wider than sixth; sixth joint shorter than fifth, with spines on upper and lower margins, palm slightly concave. Gnathopod 2 longer than 1, coxal plate produced

forward into a short lobe; second joint not expanded as much as that of gnathopod 1; fifth and sixth joints together about as long as the second; fifth joint moderately expanded distally and not much wider than sixth; sixth joint about equal in length to fifth, spines on upper and lower margins, palm slightly concave. The lower margins of the sixth joints of both gnathopods are serrate and the distal third of each is devoid of spines except for a rather small one near the distal end.

Peraeopods 1 and 2 short, stout, and much alike, coxal plate produced narrowly forward; second to fifth joints somewhat expanded; the fourth joint with the front margin strikingly convex. Peraeopods 3 to 5 not as stout as 1 or 2; peraeopod 4 the longest and 5 the shortest. In peraeopods 3 to 5 the distal extremity of the sixth joint which is produced beyond the dactyl is longer and not so obliquely truncate as is shown by Bovallius for *L. clausii* (1887, pl. 6, figs. 18-21). The dactyl of peraeopod 3 bears only a single small tooth on inner margin, but dactyl of peraeopods 4 and 5 bears several. The telson reaches beyond the middle of the peduncle of uropod 3. In uropod 3 the rami and the peduncle are subequal in length and the inner margin of the peduncle bears only a terminal spine. The female is about 13 mm. and the male about 11 mm. in length. The females appear to be immature, as only undeveloped marsupial plates are present. The body of the male is not so plump or distended as in the female, but the first antennae are noticeably broader and more tumid.

In general appearance this species is much like *L. clausii*, but there are characters which at once distinguish it from that species. The very broad second joint of gnathopod 1, the stout first and second peraeopods, and the relatively long fourth peraeopod are very striking.

***Megalanceola stephensi* (Chevreux).**

Text-fig. 21.

Lanceola stephensi Chevreux, 1920, p. 4, figs. 1-3.

Megalanceola terrae-novae Pirlot, 1935, p. 2, figs. 1-4 ♀.

Megalanceola stephensi Pirlot, 1939b, p. 9, pl. 1, figs. 1-4.

Eighteen specimens were taken at depths between 500 and 1,000 fathoms.

Distribution.—Pirlot, in 1935, p. 2, created the genus *Megalanceola* for a large female lanceolid which he named *Megalanceola terrae-novae*, and in 1939b, p. 9, he made his species a synonym of Chevreux's earlier species *Lanceola stephensi*, but retained the genus *Megalanceola* for it. Chevreux's specimen, a female 12 mm. in length, was



TEXT-FIG. 19. *Lanceola pirloti*, new species, female. **A**, gnathopod 1; **B**, sixth and seventh joints of gnathopod 1; **C**, gnathopod 2; **D** sixth and seventh joints of gnathopod 2; **E**, uropods and telson.



TEXT-FIG. 20. *Lanceola pirloti*, new species, female. **A**, antenna 1; **B**, end of antenna 1; **C**, antenna 2; **D**, mandible; **E**, maxilla 1; **F**, maxilla 2; **G**, maxillipeds; **H**, maxillipeds, side view; **I**, pereopod 1; **J**, pereopod 3; **K**, end of sixth joint of pereopod 3; **L**, pereopod 4; **M**, pereopod 5.

taken in the vicinity of the Azores (36°17' N., 28°53' W.), while Pirlot's specimen, a female 55 mm. in length, was taken at the Grand Bank of Newfoundland (43°26' N., 59°03' W.). In the present collection there are 1 male and 17 females. The largest specimen, a female, measures about 73 mm. in length, and the single male measures about 48 mm. in length and 14 mm. in width. Chevreux's specimen was undoubtedly very immature, but he thought it possible that it might be identical with the form cited by Stebbing as *Lanceola* species of his *Challenger* report (1888, p. 1308, fig. 27). The drawings accompanying Stebbing's remarks were made by Willemoes Suhm, and, though rather crude, leave little doubt that the specimen was the same as Chevreux's *Lanceola stephenseni*. The specimen was taken off the Banda Islands in the Banda Sea and, according to Stebbing, measured about 2 inches or about 50 mm. Stebbing says that the figure represents the specimen in a bent position, but this is apparently the normal position of the body, as all the specimens in the present collection have this position. The male, however, is not so much bent as the female. It is difficult to determine the best way of measuring an animal in this bent position, but I have measured from the farthest point in the bend of the body, which would usually be the dorsal surface of the second or third thoracic segment, straight across to the apex of the longest uropod. This distance in the largest specimen is about 73 mm.

The *Challenger* specimen, having been taken in the Banda Sea, indicates a very wide distribution for this species.

The eye in the present specimens is not conspicuous, but is of the same shape and size as figured by Willemoes Suhm and not oval, as figured by Chevreux. In the *Challenger* figure there is a very decided and abrupt narrowing of the proximal end of the second joint of peraeopods 1-5. In the Bermuda specimens, as in Chevreux's, this character is present only on peraeopods 3-5 and is most pronounced on peraeopod 3, where the angle is produced decidedly forward. Pirlot (Les Amphipodes de l'Expédition du Siboga; première partie, Les Amphipodes Hyperides, 1930, p. 3), thinks that Willemoes Suhm's figure probably represents *Lanceola sayana*, but in *L. sayana* the eye is small and placed higher up, and the fourth peraeopod is much longer than either the third or fifth. In *M. stephenseni* the eye is large and occupies the entire lateral angle which is placed much lower on the front margin of the head than in *L. sayana*. The fourth peraeopod in *M. stephenseni* is a little shorter than the third and only a little longer than the fifth.

***Metalanceola chevreuxi* Pirlot.**

Metalanceola chevreuxi Pirlot, 1931, p. 1, figs. 1-3.

Metalanceola chevreuxi Pirlot, 1939b, p. 13, figs. 6-8.

One specimen was taken at a depth of 1,000 fathoms.

Distribution.—The only specimen of this species heretofore recorded is the one described by Pirlot from west of the Madeira Islands (31° 06' 00" N., 24° 06' 45" W.).

Pirlot's specimen measured about 4 mm. from the front of the head to the bend of the abdomen. The present specimen measures about 8 mm. from the front of the head to the end of the uropods when the abdomen is in a straight line with the thorax, which would make it about the same size as his specimen. From the lack of marsupial plates Pirlot believed his specimen to be an immature male. The present specimen has partially developed marsupial plates on the second gnathopod and the first three peraeopods, and branchiae on the second, third and fourth peraeopods. These characters and the complete absence of male sexual appendages indicate that the specimen is an undeveloped female.

This specimen agrees exceedingly well with Pirlot's figures. The short stout legs with their large hook-like dactyls point, as Pirlot believed, to a parasitic mode of life. It is probably a very deep water species, as Pirlot's specimen came from a depth of 0-5,000 meters and the Bermuda specimen from 0-1,829 meters.

***Scypholanceola vanhoeffeni* Woltereck.**

Text-fig. 22.

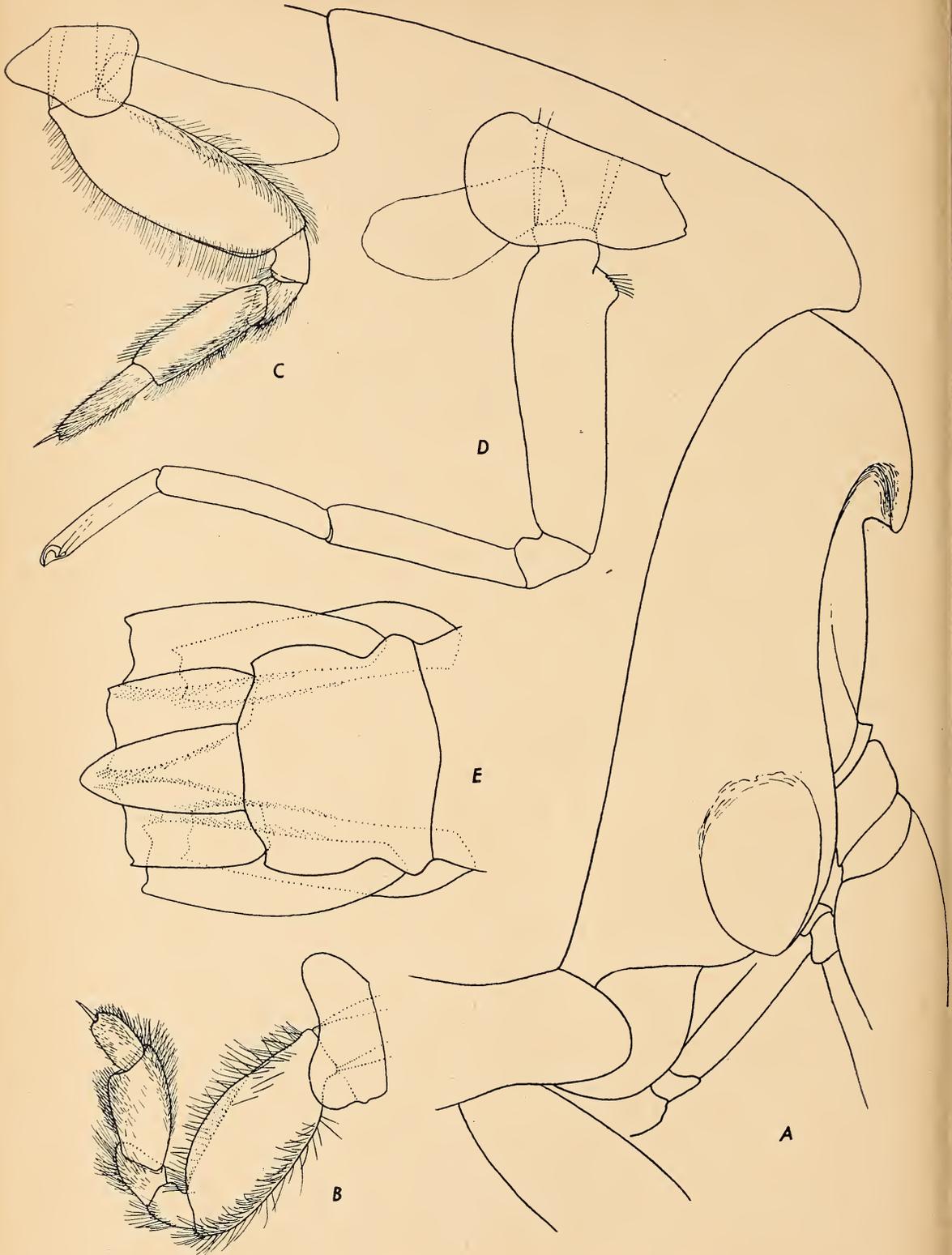
Scypholanceola vanhoeffeni Woltereck, 1909, p. 161, pl. 7, figs. 24a ♂, 24b ♀.

Scypholanceola vanhoeffeni Woltereck, 1927, p. 65, figs. 5a-b, 9.

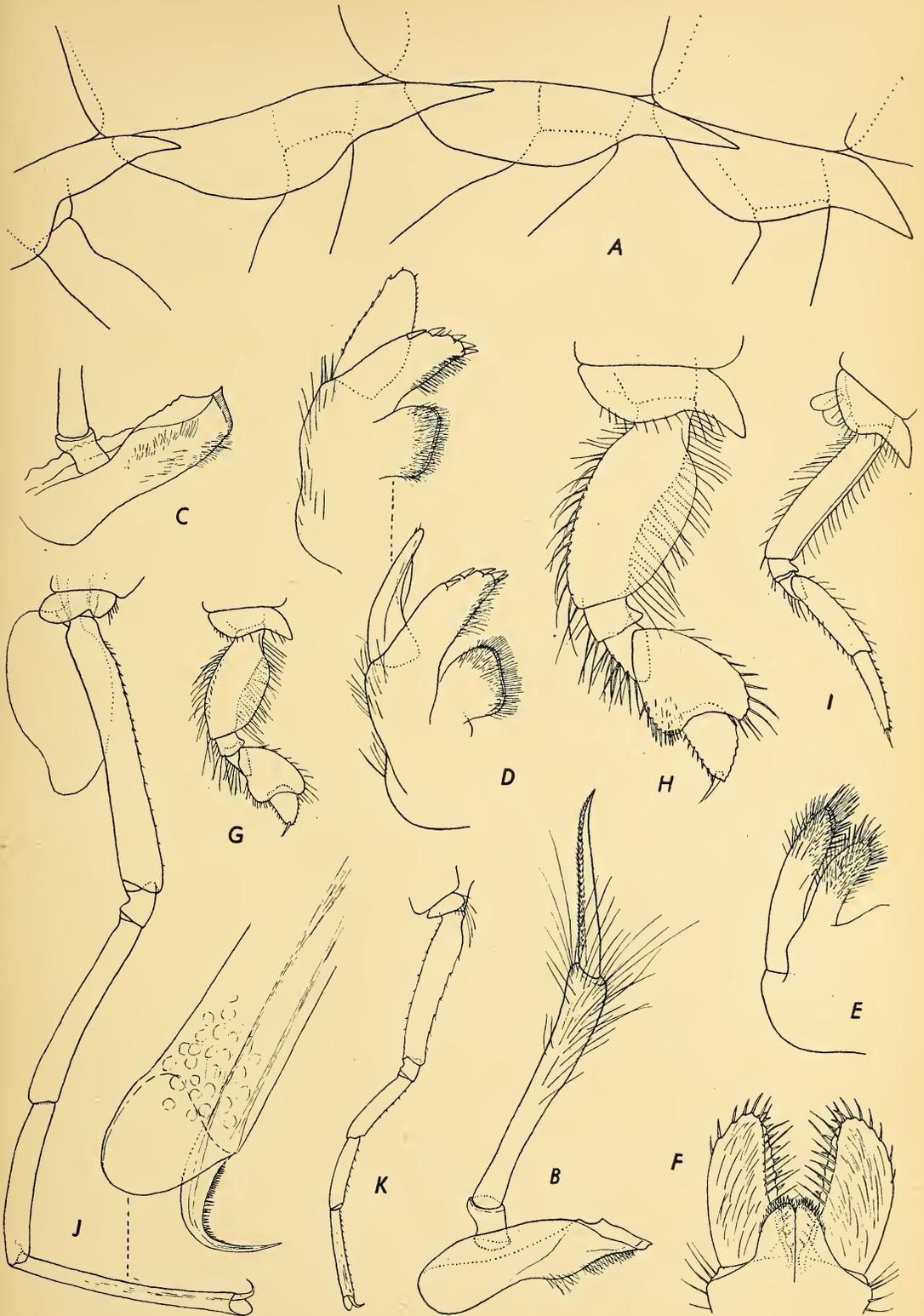
Forty-one specimens, male and female, were taken between 500 and 1,000 fathoms.

Distribution.—*Scypholanceola vanhoeffeni* was taken by the *Gauss* Expedition in the Antarctic (64° 29' S., 85° 27' E.) and the tropical Atlantic (12° 11' S., 6° 16' W.). By the *Valdivia* it was taken in the Indian Ocean (5° 42' S., 43° 36' E.). Barnard recorded it off Cape Point, Union of South Africa, in 1916, and in 1932 from the east mid-Atlantic and the Southeast Atlantic. The present specimens from Bermuda are the first from the western North Atlantic.

Woltereck (1927) and Barnard (1932) believed that *Scypholanceola richardi* Chevreux should be united with *vanhoeffeni*, and Barnard at the same time raised the question whether *Scypholanceola chuni* Woltereck should not also be regarded as a synonym of *vanhoeffeni*. Pirlot (1939b) regards *vanhoeffeni*, *chuni* and *richardi* as synonyms, but is doubtful about *Scypholanceola agassizi* Woltereck, which is insufficiently described. Until the status of *agassizi*, which was taken by the *Albatross* off Peru in



TEXT-FIG. 21. *Megalanceola stephenseni* (Chevreux), male, **A**, head; **B**, gnathopod 1; **C**, gnathopod 2; **D**, peraeopod 3; **E**, uropods and telson.



TEXT-FIG. 22. *Scypholanceola vanhoffeni* Woltereck, male. **A**, coxal plates 2-5; **B**, **C**, mandible; **D**, maxilla 1; **E**, maxilla 2; **F**, maxillipeds; **G**, **H**, gnathopod 1; **I**, gnathopod 2; **J**, peraeopod 4; **K**, peraeopod 5.

1904, can be determined, *vanhoeffeni* must be regarded as the type of the genus, as it is mentioned by Woltereck (1909) on page 161, whereas *chuni* is not mentioned until page 162, and, as Barnard has already observed (1932, p. 257), Woltereck's figure in his 1905 paper (p. 415, fig. 2) is clearly that of *vanhoeffeni*.

If *S. richardi* be accepted as a synonym of *S. vanhoeffeni* the range will be extended in the Atlantic to 46° north latitude.

The *Valdivia* obtained a female of *S. vanhoeffeni* 36 mm. in length from the Indian Ocean. The largest specimen in the present collection, a female, measures 41 mm. Woltereck (1927, p. 68) states that a female of *S. chuni* measuring 61 mm. is the largest lanceolid known. *S. vanhoeffeni* then becomes the largest lanceolid, as *S. chuni* is believed by Pirlot to be a synonym of it.

S. vanhoeffeni is easily recognized by the peculiar fold of the integument through the eye. The thorax is swollen, cylindrical, and filled with transparent liquid except for a large mass of purplish material, posterior to which is a smaller white mass. The head and the first two mesosome segments show a slight mid-dorsal angle which disappears on the following segments until the fifth where it begins to show again slightly, becoming more and more noticeable toward the first metasome segment where it ceases. The head is as figured by Woltereck (1909, pl. 7, fig. 24a, ♂, 24b ♀). I have figured the coxal plates, the mouth parts and some of the mesosome appendages. It will be seen that they agree very closely with the figures given by Chevreux (1920, pp. 9, 10, figs. 5, 6) for *S. richardi*.

The sexes appear to be very much alike, but the males can be distinguished from the immature females by the presence of the two tubercles on the ventral side of the seventh segment, which bear the external openings of the seminal ducts, though the ducts themselves have, in most specimens, disappeared entirely.

FAMILY MICROPHASMIIDAE.

Microphasma agassizi Woltereck.

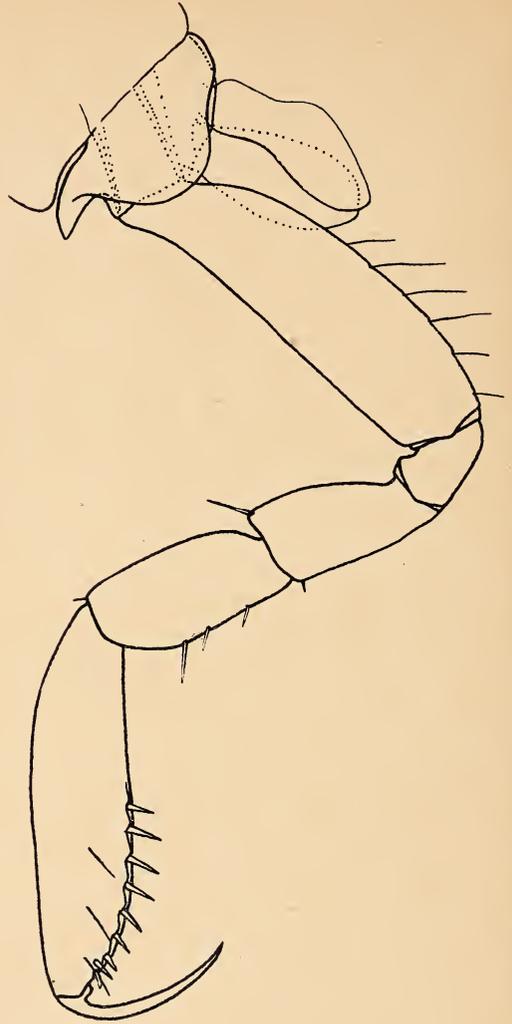
Text-fig. 23.

Microphasma agassizi Woltereck, 1909, p. 153, pl. 4, fig. 11.

Microphasma agassizi Stephensen and Pirlot, 1931, p. 539, figs. 15, 16.

Fifteen specimens, most females, were taken between 800 and 1,000 fathoms.

Distribution.—This genus and species were described by Woltereck from a single specimen taken by the steamer *Albatross* at Station 4663, off Peru. In 1929 Pirlot recorded a specimen which was taken by the *Armauer Hansen* off the Madeira Islands (30° 14' N., 19° 38' W.). In 1939 he recorded two specimens taken on the ex-



TEXT-FIG 23. *Microphasma agassizi* Woltereck. Pereopod 1.

peditions of the Prince of Monaco, 1904, 1905, in the vicinity of the Madeira Islands and the Azores, and one specimen taken on the expedition of 1910 in the Gulf of Gascony. Up to the present time these five specimens were all that had been recorded. Now the exploration of the waters at Bermuda by Dr. Beebe has brought from the ocean depths fifteen additional specimens of this rare hyperiid.

The males and females have very much the same appearance, but the males can be distinguished by the first antenna which is larger and thicker than in the female. The body in both sexes is tumid and very much arched as shown by Woltereck (1909, pl. 4, fig. 11). In the present specimens and in the specimen figured by Stephensen and Pirlot (1931, p. 542, fig. 16), the fifth joint of pereopods 1-3 (pereopods 3-5 of S. &

P.) is longer in proportion to the sixth joint than is shown in Woltereck's figure.

In the present collection the largest female measures 7 mm. from the end of the uropods to the farthest point of the arch of the body, and the male measures 6 mm.

FAMILY MIMONECTIDAE.

Mimonectes sphaericus Bovallius.

Text-fig. 24.

Mimonectes sphaericus Bovallius, 1885b, p. 11, pl. 2, fig. 12 ♀.

Mimonectes sphaericus Bovallius, 1889, p. 66, pl. 6, figs. 1-10 ♀.

Sphaeromimonectes valdiviae Woltereck, 1904, p. 621, fig. 1 ♀.

Sphaeromimonectes valdiviae pacifica Woltereck, 1909, p. 148, pl. 2, fig. 6 ♂, + *S. valdiviae*, pl. 2, fig. 7 ♀.

Sphaeromimonectes valdiviae Woltereck, 1927, p. 82, figs. 23 ♂ and ♀, 24b, 25b.

Mimonectes sphaericus Stephensen and Pirlot, 1931, p. 516, figs. 5, 6 ♀.

One specimen was taken at a depth of 600 fathoms.

Distribution.—The female described by Bovallius was 15 mm. in length and was taken in the Atlantic near the Canary Island, 28° N., 21° W. The female figured by Stephensen and Pirlot (1931, p. 517, figs. 5, 6) in the possession of the Copenhagen Museum is 17-18 mm. in length and was taken off the Bay of Biscay 46° N., 18° W. It has been recorded by Behning from Bering Sea. The present record is the first from the Bermuda region.

The single specimen in this collection is about 10 mm. in length and appears to be an immature male. The sexual organs are not developed, but the long first antennae and the undeveloped second antennae which extend just beyond the peduncles of the first antennae indicate that it is a male. Rudimentary marsupial plates are present as they are in the immature males of *M. gaussi*.

The male of *M. sphaericus* has not been described and I am of the opinion that the male of *Sphaeromimonectes valdiviae pacifica* Woltereck is the male of *M. sphaericus* Bovallius.

The present specimen bears a rather close resemblance to the figure of *Sphaeromimonectes valdiviae pacifica* ♂ Woltereck (1909, pl. 2, fig. 6), though the body is somewhat more arched anteriorly. His figure is rather diagrammatic and shows little detail; the gnathopods, therefore, may be more spinose than he has shown, or this may be a variable character. In the present specimen the second and sixth joints of the first gnathopod are three-sided, the top or front margin being flat and the two sides converging to the rounding lower or hind margin. This character is present also in the second gnathopod, but is not so strongly

developed. The relative lengths of the gnathopods and peraeopods and the proportions of the respective joints are very much the same in the present specimen as in the male of *S. valdiviae pacifica* figured by Woltereck, and as figured by Stephensen and Pirlot for the female of *M. sphaericus* (1931, p. 518, fig. 6).

The figures of the female of *S. valdiviae* given by Woltereck (1904, p. 623, fig. 1; 1909, pl. 2, fig. 7; 1927, p. 82, fig. 23a) appear not to differ materially from the figures of *M. sphaericus* given by Stephensen and Pirlot (1931, p. 517, fig. 5).

In the present specimen the first antennae are of the same proportions as figured by Woltereck for *S. valdiviae pacifica*. The long first antennary joint bears the armament of setae as shown by Woltereck and the three short terminal joints are as he has figured them. The second antennae are as figured by him, but are perhaps not quite so long. He states that the maxillipeds of *M. v. p.* possess a rudimentary palp. The outer plate of the left maxilliped in the present specimen bears a tubercle surmounted by a seta which appears to represent the rudimentary palp, but the right plate presents only a slight hump bearing a seta. Too much importance should not be placed on the proportions of a rudimentary organ, and it may well be that this rudimentary palp is not always present.

The gnathopods are as I have figured them. The proportions of the first gnathopod are practically as figured by Woltereck (1909, pl. 2, fig. 6) and they are also much as figured by Stephensen and Pirlot (1931, p. 518, fig. 6, pl. p2) for the female of *Mimonectes sphaericus*. The peraeopods are slender. Peraeopod 1 is slightly longer than peraeopod 2. Peraeopod 3 is the longest. Peraeopod 4 is shorter than either 1 or 3 and is the slenderest of all. Peraeopod 5 is a little shorter than 4 but stouter. The uropods and telson are as figured by S. & P. for *M. sphaericus* (1931, p. 517, fig. 5 uros.) except that the inner margins of the peduncles of all the uropods bear a few spines.

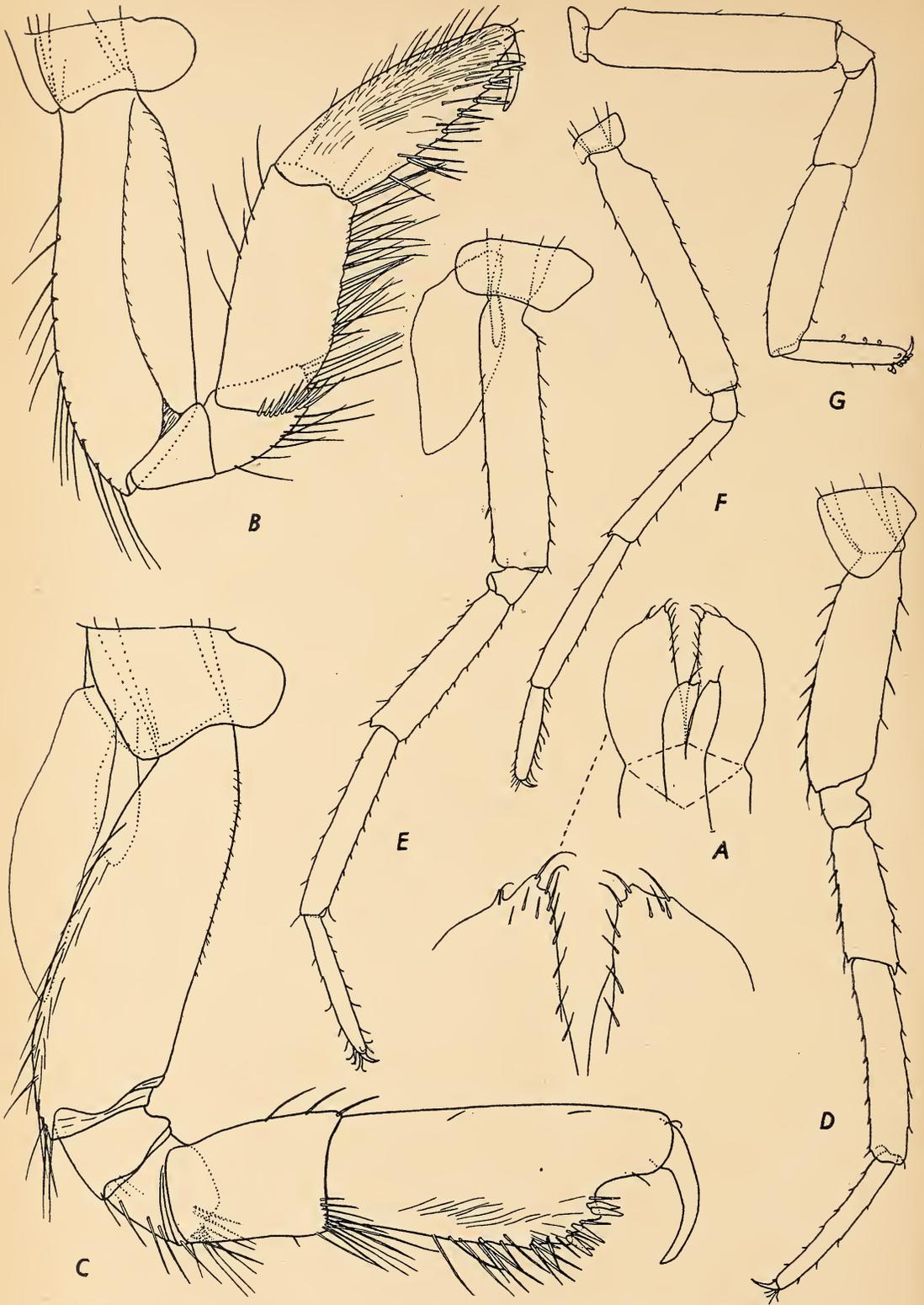
In the genus *Mimonectes*, where the degree of tumidity of the body varies with the development, the proportions of scarcely any two specimens are exactly alike. This, with the difference in appearance of the fully developed males and females, has, in my opinion, led to the describing of the males and females of the same species as different species, and also the females of the same species as different species.

Mimonectes loveni Bovallius.

Text-fig. 25.

Mimonectes loveni Bovallius, 1885b, p. 3, pl. 1, pl. 2, figs. 15-20, pl. 3.

Mimonectes loveni Bovallius, 1889, p. 60, pl. 5.



TEXT-FIG. 24. *Mimonectes sphaericus* Bovallius, male. **A**, maxillipeds; **B**, gnathopod 1, young; **C**, gnathopod 2, young; **D**, peraeopod 1; **E**, peraeopod 3; **F**, peraeopod 4; **G**, peraeopod 5.

Sphaeromimonectes cultricornis Woltereck, 1906, p. 868, fig. 5a.

Sphaeromimonectes cultricornis Woltereck, 1927, p. 83, figs. 25a, 26.

Parascina chevreuxi Pirlot, 1929a, p. 56.

Fifteen specimens were taken at depths between 500 and 1,000 fathoms.

Distribution.—This species has been recorded south of Iceland and down the eastern North Atlantic to the Azores and Madeira; in the South Atlantic it has been recorded from the Gulf of Guinea; in the Pacific it has been taken in the East Indies; and Barnard has reported it from the Arabian Sea. It is now recorded from Bermuda.

Pirlot (1939, p. 20) has made *Mimonectes chevreuxi* the male of *Mimonectes loveni* Bovallius. The Bermuda material contains both sexes. Most of the females range between 5 and 13 mm. in length and they do not exhibit the globular form shown by Bovallius (1885, pl. 1, fig. 1) but have much the appearance of the figure given by Woltereck of *Sphaeromimonectes diomedea* (1909, pl. 3, fig. 8). As the female increases in size to maturity, it gradually assumes

the spherical form shown by Bovallius, who states that the females measure from 18–28 mm. in length.

There is in the Bermuda material one large female about 24 mm. in length which is deflated and limp, but which undoubtedly originally had a spherical shape like the female figured by Bovallius. Another female about the same size shows very well the spherical shape.

In the immature females antenna 1 is about as long as the first two or three body segments combined, and antenna 2 is very short, not reaching to the end of the peduncle of antenna 1.

A male 13 mm. in length, which appears to be the largest male yet recorded, in shape and general appearance very much resembles Woltereck's figure of *Sphaeromimonectes diomedea*. The length to which the male grows or the form it finally assumes is not known, but the present specimen has the sexual organs well or perhaps fully developed, so it may be a fully developed specimen. Antenna 1 in this specimen is nearly as long as the mesosome and the inside surface is densely clothed with long, simple setae, which are longest proximally and gradually become shorter until at the apex they are very short.

The peraeopods appear to be proportionately somewhat longer in the male than in the female, and peraeopod 3 (peraeopod 5 of Stephensen and Pirlot) is noticeably stouter and longer than peraeopod 4 or 5.

Mimonectes gaussi (Woltereck).

Text-figs. 26, 27.

Sphaeromimonectes gaussi Woltereck, 1904, p. 627 (female).

Parascina fowleri Stebbing, 1904, p. 21, pl. 2B (immature).

Sphaeromimonectes gaussi Woltereck, 1906, p. 867, fig. 4 (female).

Sphaeromimonectes diomedea Woltereck, 1909, p. 148, pl. 3, fig. 8 (male).

Sphaeromimonectes gaussi Woltereck, 1927, p. 80, figs. 18–22 (female).

Mimonectes fowleri Stephensen and Pirlot, 1931, p. 519, figs. 13, 115, VII–X.

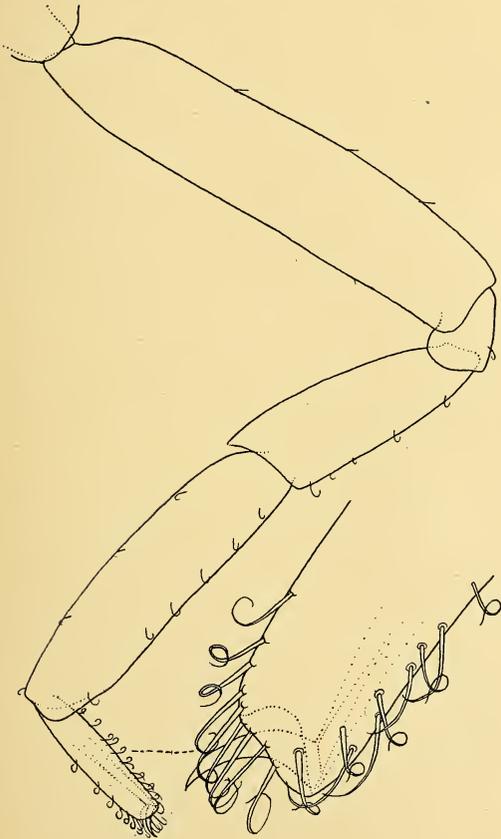
Mimonectes gaussi Stephensen and Pirlot, 1931, p. 531.

Mimonectes diomedea Stephensen and Pirlot, 1931, p. 531.

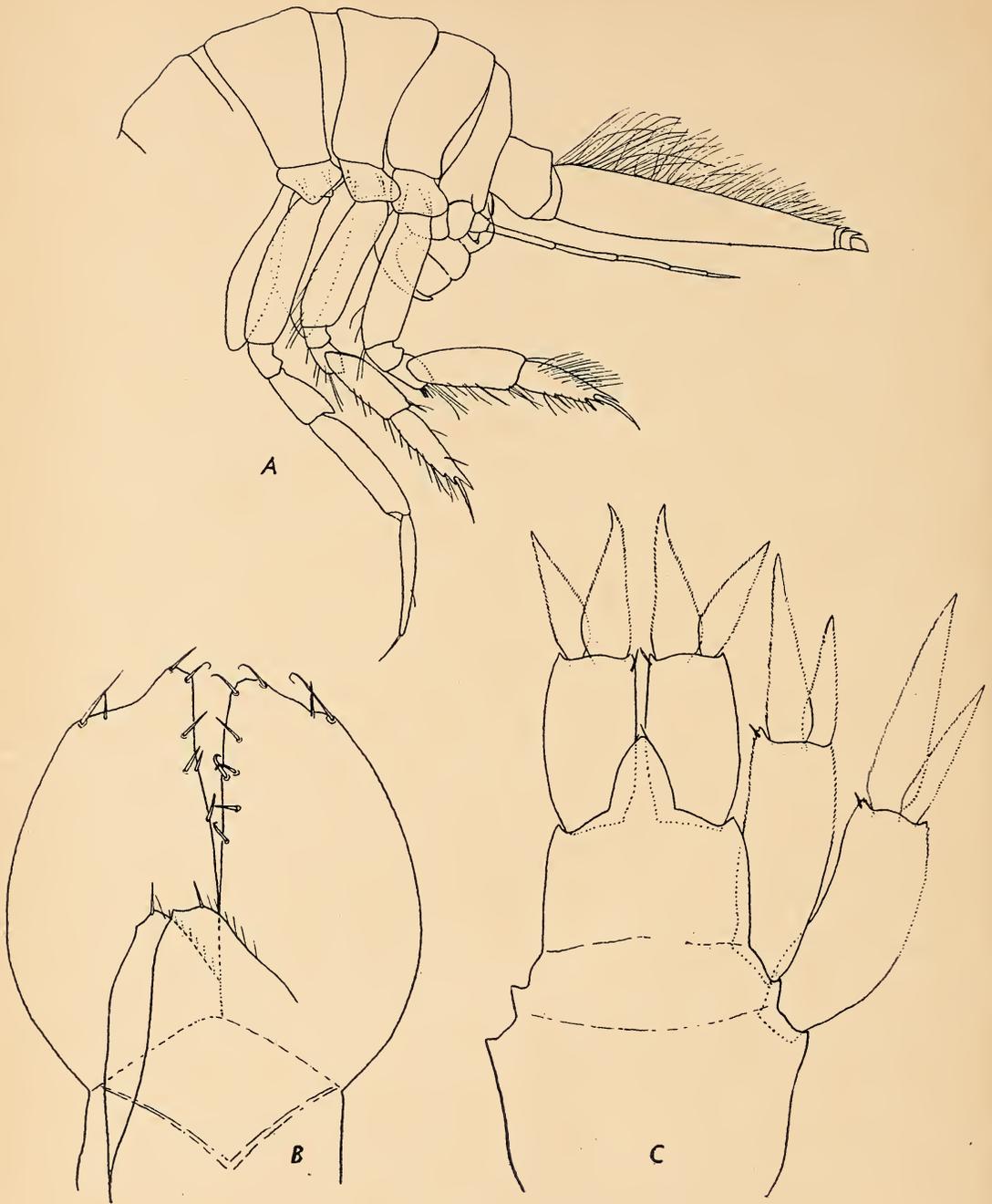
Twenty-nine specimens were taken at depths between 500 and 1,000 fathoms.

Distribution.—Davis Strait; south of Iceland; north of the Hebrides; Gulf of Gascony; coast of Portugal; Madeira Islands; southeast Atlantic (off South Africa, Barnard); off Peru (*S. diomedea*, Woltereck); and it is here recorded from Bermuda.

Sphaeromimonectes gaussi Woltereck described from the coast of Portugal, *Para-*



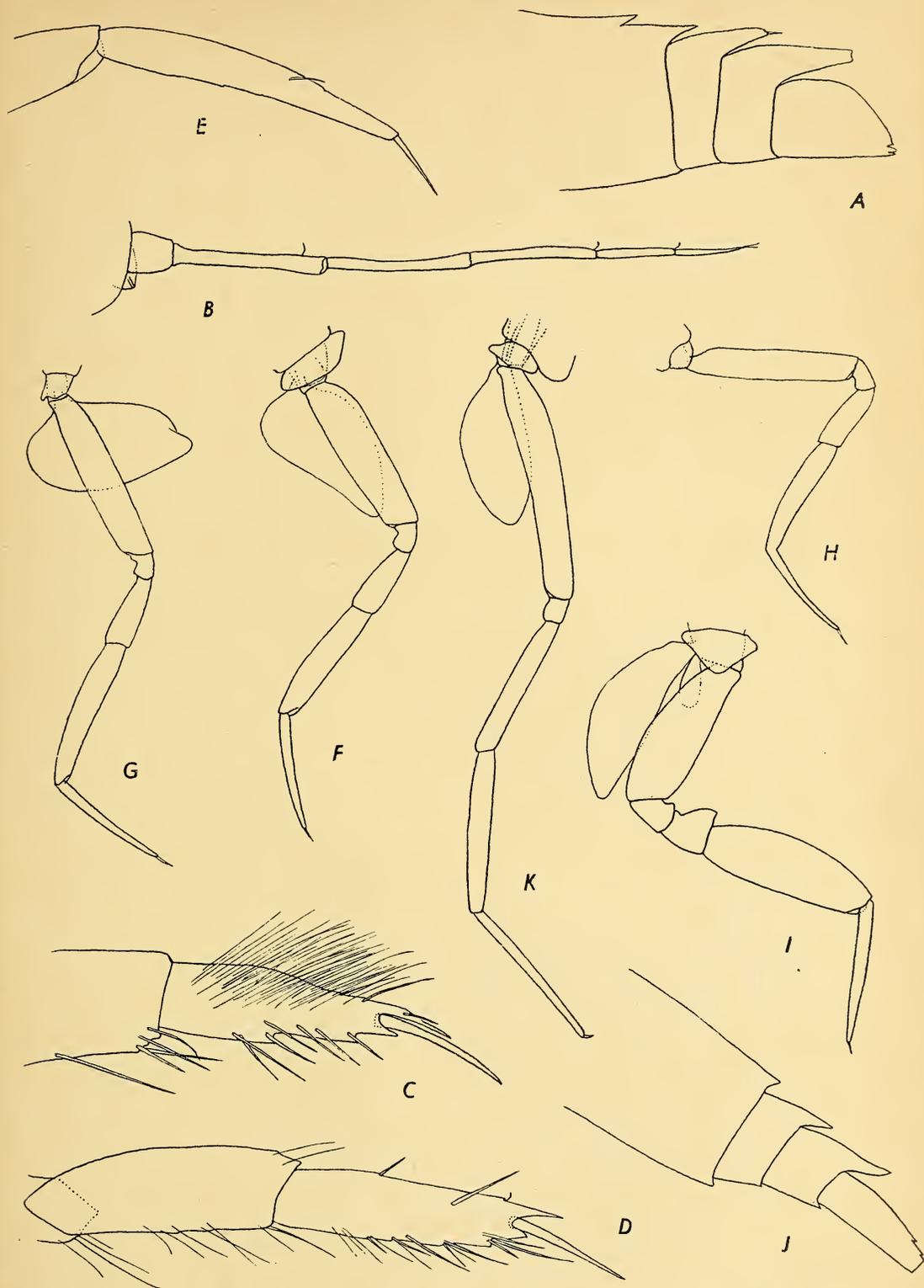
TEXT-FIG. 25. *Mimonectes loveni* Bovallius, female. Peraeopod 5.



TEXT-FIG. 26. *Mimonectes gaussi* (Woltereck), male. 9 mm. in length, **A**, anterior end of animal; **B**, maxillipeds; **C**, uropods and telson.

scina fowleri Stebbing described from the Gulf of Gascony, and *S. diomedea* Woltereck described from the coast of Peru appear to me to be one and the same species. As Woltereck's name has priority, the species will have to bear the name *Mimonectes gaussi*, as both *Sphaeromimonectes* and *Par-*

ascina are now regarded as synonyms of *Mimonectes* Bovallius. The original description of *S. gaussi* (1904, p. 629) is very short and superficial and is inadequate for identifying the species, but the figure of the original female given by Woltereck (1906, p. 867, fig. 4) is good and presents the



TEXT-FIG. 27. *Mimonectes gaussi* (Woltereck), male. 9 mm. in length, A, end of antenna 1; B, antenna 2; C, gnathopod 1; D, gnathopod 2; E, end of peraeopod 1; F, peraeopod 3; G, peraeopod 4; H, peraeopod 5; male, 6 mm. in length, I, peraeopod 1; male, 7.5 mm. in length, J, end of antenna 1; K, peraeopod 4.

specific characters very well. Woltereck's specimen was a fully developed female measuring 18 mm. in length, while the specimen of *Parascina fowleri* figured and described by Stebbing measured only 8 mm. from the apex of first antenna to the end of the uropods and was small and immature. The sex of Stebbing's specimen is not stated, probably for the reason that it is scarcely possible to distinguish the sex of small immature specimens.

Woltereck's figures of the peraeopods (1927, p. 81, fig. 20), while rather lacking in detail, show very distinctly the pointed apical processes of the sixth joint of the first and second gnathopods. Stephensen and Pirlot (1931, p. 531) noted several points of agreement between *M. gaussi* and *M. diomedae*, and between *M. diomedae* and *M. fowleri*, but they did not seem inclined to regard these three species as synonymous. Pirlot (1939, pp. 23, 24) makes *M. spandli* a questionable synonym of *Mimonectes gaussi*, but as the sixth joints of the gnathopods of *M. spandli* do not possess the characteristic apical processes of *M. gaussi*, I am retaining them as separate species, awaiting further evidence. Woltereck (1927, p. 81) states that in the female of *M. gaussi* the femora (second joints) of the peraeopods are broad, and Stephensen and Pirlot have figured the appendages of the female of *M. fowleri* (1931, p. 525, fig. 9) as possessing this character.

I have figured a male specimen 9 mm. in length from the front of the head to the end of the uropods, possessing fully developed sexual organs and second antennae two-thirds the length of the first antennae. This specimen appears to be fully developed, and the gnathopods and peraeopods are proportionately longer and slenderer than in the female and their second joints are very slightly expanded.

The characters of this species vary considerably with sex and size. The mature and fully grown females attain a greater size than the fully developed males and as the female reaches maturity the fore part of the mesosome becomes greatly arched and swollen. Young males with the sexual organs partially developed have also partially developed marsupial plates and closely resemble the young females. As the males become sexually mature the marsupial plates disappear and the second antennae reach about two-thirds the length of the first antennae. The second antennae in the young males may be very short or may extend beyond the short peduncle of the first antennae. The relative length of the joints of the gnathopods and peraeopods varies considerably with sex and size as I have shown in my figures. The males in this collection closely resemble the figure of *Sphaeromimonectes diomedae* given by Woltereck (1909,

pl. 3, fig. 8). He believed his specimen was a female, but the second antenna, which is only partially developed, and the slender second joints of the gnathopods and peraeopods clearly indicate that it was a male.

Mimonectes spandlii Stephensen and Pirlot.

Text-fig. 28.

Mimonectes steenstrupii Pirlot, 1929a (not Bovallius), p. 46, figs. 1-3.

Mimonectes spandlii Stephensen and Pirlot, 1931, p. 532, fig. 12.

Three specimens were taken at depths between 600 and 700 fathoms.

Distribution. — Stephensen and Pirlot give: temperate Atlantic, 38° 20' N., 9° 20' W.; 34° 41' N., 9° 30' W.

The type female described and figured by Pirlot (1929, p. 47, fig. 1), and Stephensen and Pirlot (1931, p. 533, fig. XII) was 7 mm. in length.

The present specimens are all females, one measuring 7 mm. and the others 15 mm. each. The larger specimens appear to have been quite globular in their natural condition, but are now deflated and much distorted. The first antennae are in general as figured by Pirlot (1929, p. 47, fig. 1a), but the first joint of the flagellum is thicker distally. The gland-cone of the second antenna and the joint upon which it is situated are very prominent, but the rest of the antenna is reduced to a minute knob and in one specimen is entirely lacking.

The gnathopods and peraeopods are short and rather stout and the dactyls are strong and curved. These Bermuda records extend the range of this species considerably westward in the Atlantic.

FAMILY MICROMIMONECTIDAE.

Mimonecteola beebei, new species.³

Text-figs. 29, 30

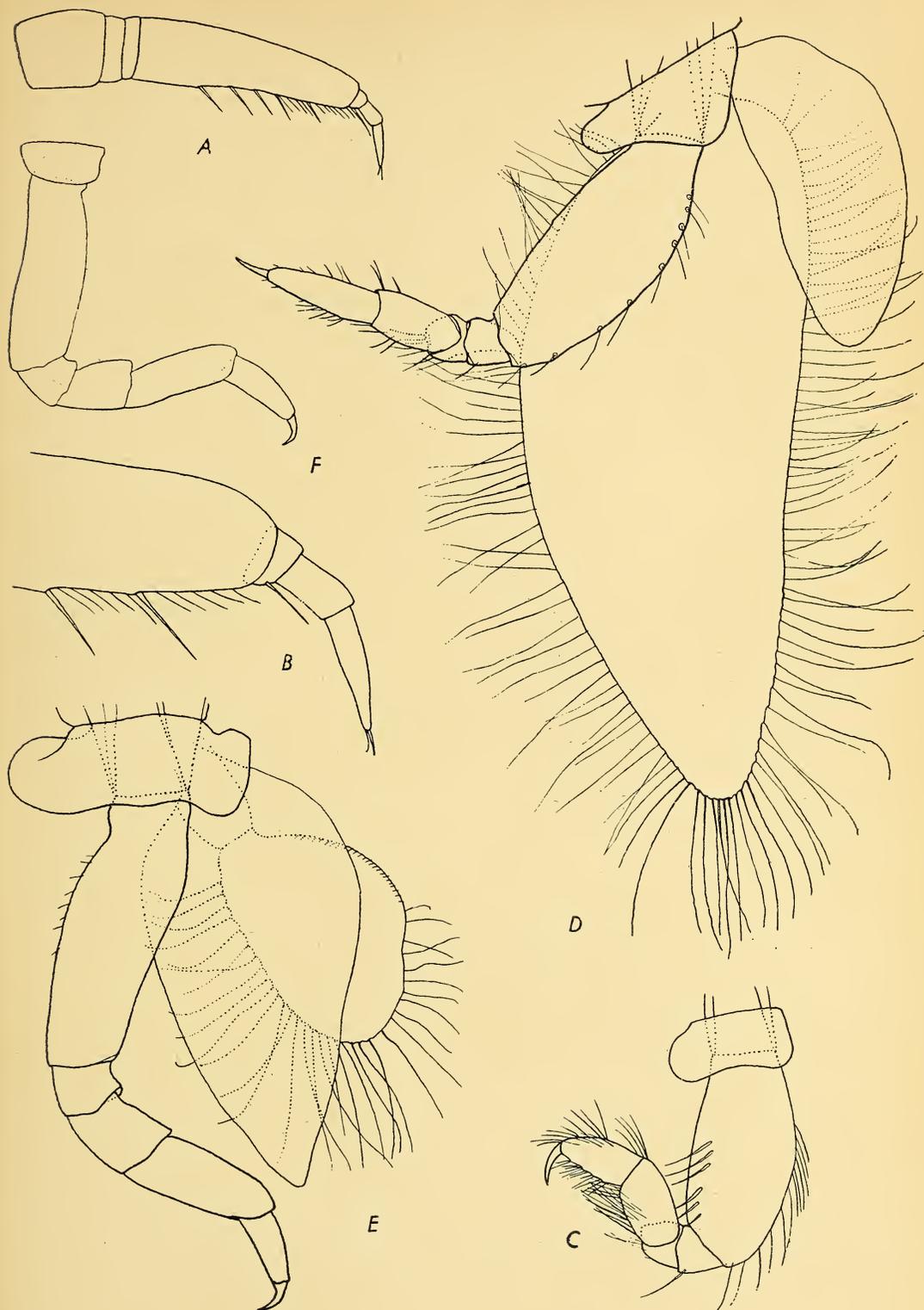
Two specimens, male and female, were taken at 1,000 fathoms.

Distribution of the genus.—*Mimonecteola* was founded by Woltereck in 1909 (p. 153) on the specimens taken by the steamer *Albatross* at Stations 4655 and 4717 off the coast of Peru in 1904 and 1905. In 1932 (p. 251) Barnard described *M. macronyx* from a specimen, questionably a female, taken by the R.S.S. *Discovery* in the east mid-Atlantic (2° 49' S., 9° 25' W.). The present record from Bermuda is the third of the occurrence of this deep sea genus.

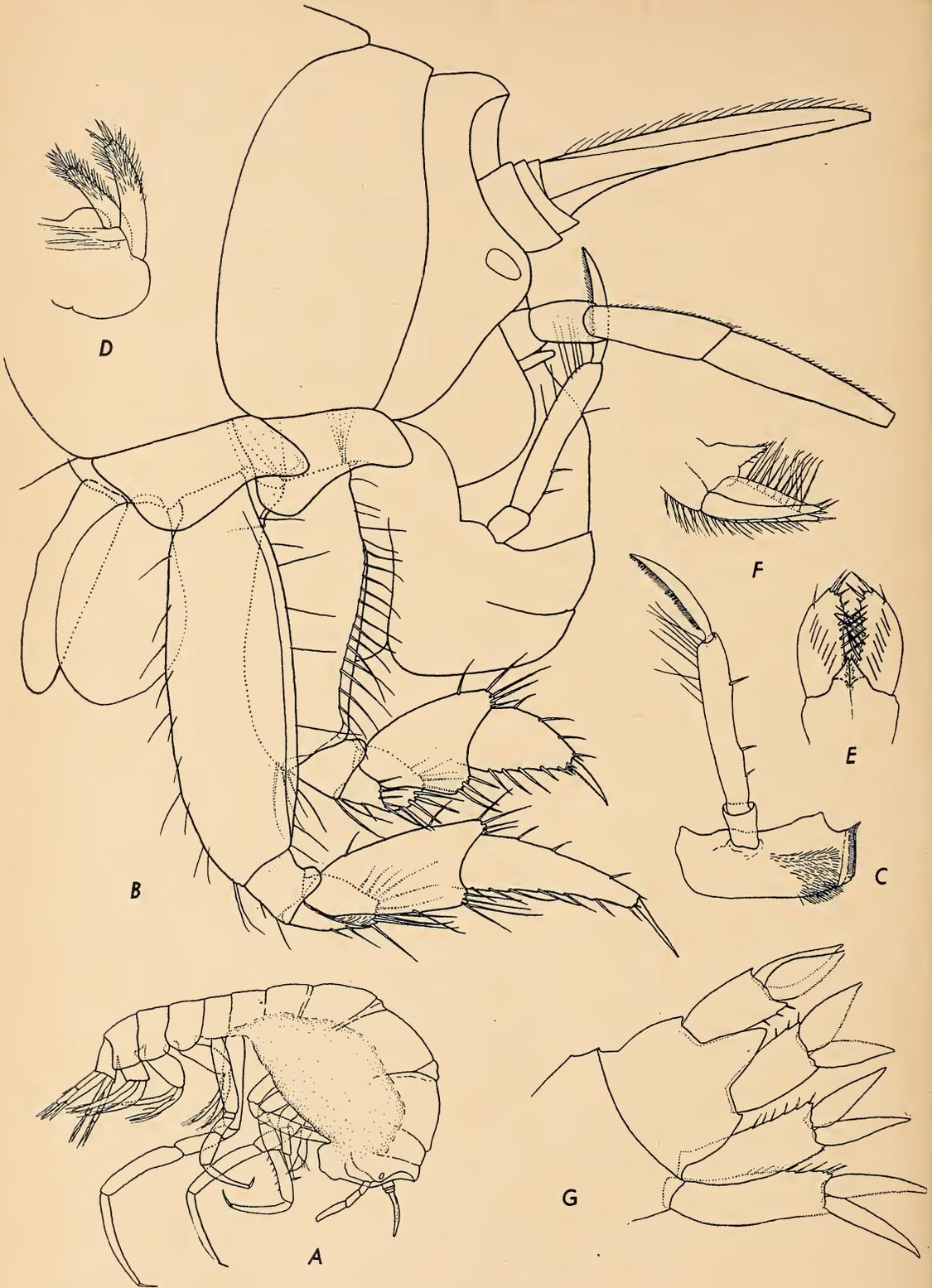
Mimonecteola diomedae Woltereck was dredged from 2,200 fathoms; *M. macronyx* Barnard from 800-1,000 (-0) m.; and the present species was taken at 1,000 fathoms.

Description of female. — Body much curved anteriorly. Head very short; ros-

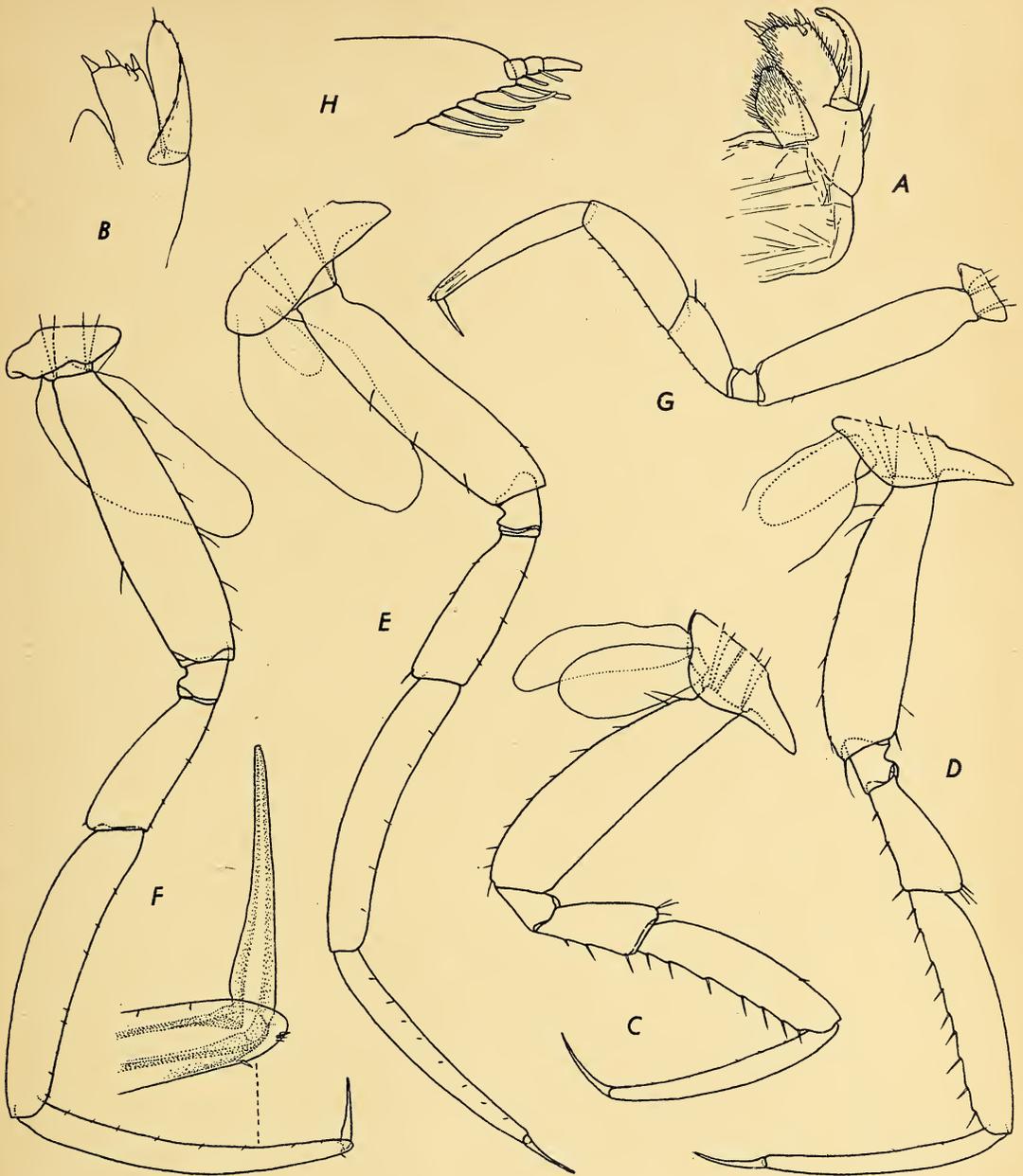
³ I take pleasure in naming this species in honor of Dr. William Beebe, the director of the Bermuda Oceanographic Expeditions.



TEXT-FIG. 28. *Mimonectes spandlii* Stephensen and Pirlot, female. **A**, antenna 1; **B**, end of antenna 1; **C**, gnathopod 1; **D**, gnathopod 2; **E**, pereopod 3; **F**, pereopod 5.



TEXT-FIG. 29. *Mimonecteola beebey*, new species, female. **A**, entire animal; **B**, anterior end of animal; **C**, mandible; **D**, maxilla 2; **E**, maxillipeds; **F**, maxillipeds, side view; **G**, uropods and telson.



TEXT-FIG. 30. *Mimonecteola beebey*, new species, female. A, B, maxilla 1; C, peraeopod 1; D, peraeopod 2; E, peraeopod 3; F, peraeopod 4; G, peraeopod 5. Male, H, end of antenna 1, top view.

trum very slightly produced and forming a very wide, obtuse angle viewed from above; side-lobes evenly rounding, rather prominent and bearing the small oval, indistinct, whitish eye. Antenna 1 strong, and rather broad viewed from above; peduncle short and composed of three joints; flagellum consisting of one very long, stout joint and probably several very short, slender joints,

which in this female specimen are missing, inside margin bearing a row of long setae. Antenna 2, first joint very large, second joint represented from the side only by the prominent gland-cone, third joint reaching to about the end of the gland-cone, fourth joint about half the length of the fifth; only the long first joint of the flagellum is present, the apex being transversely truncate

giving the impression that some terminal joints are missing; the upper margin of the fifth peduncular joint and the flagellum bear a row of very fine setae.

Mandible without molar, but in its place a mat of fine setae on inside surface, cutting-edge smooth except for a small sharp projection at the upper corner; palp very well developed, second joint one and one-half times the length of the third and bearing a few setae on the distal third of the inner margin and two or three spines on outer margin, third joint much slenderer than the second, tapering to a sharp apex and bearing a row of very fine, closely set spinules on inner margin. Maxilla 1, inner plate obliquely truncate and densely clothed in fine setae; outer plate rectangular and bearing four simple spine-teeth on the slightly oblique end; palp apparently consisting of one inwardly curving joint with rounding apex, and bearing on the apex and outer margin nine or ten very short spinules. Maxilla 2, inner plate narrower than outer, both densely setose and armed apically with a few spines. Maxillipeds of the *Lanceola* type, inner lobes conspicuous and conical.

Gnathopod 1, second joint moderately expanded with outer front margin bearing setae, fifth joint expanded distally, sixth joint a little shorter than fifth, converging distally and bearing spines on upper and lower margins, seventh joint very slightly curved. Gnathopod 2 longer than 1, second joint moderately expanded, fifth joint little expanded distally, sixth joint about equal in length to fifth but narrower, bearing spines on upper and lower margins and converging distally, seventh joint straight. Peraeopods 1 and 2 much alike, but 2 the longer, their coxal plates produced sharply forward, seventh joint long and slender and about one-third the length of the sixth joint. Peraeopods 3 to 5 much alike, the fourth being the longest, the fifth about three-fourths the length of the fourth, and all three bearing rather long, slightly curved seventh joints about one-fourth the length of the sixth joint.

Metasome segment 3 with lower lateral hind margin produced slightly backward. Uropod 3, peduncle equal in length to the rami, which are subequal. Telson over half the length of the peduncle of uropod 3, sides slightly convex and converging to the narrow, rounding apex. Length of female 11 mm.

Male.—The male specimen, the type, is 9 mm. in length and slenderer than the female. Antenna 1 bears three slender terminal joints, the two proximal of which are the shortest and bear a distal seta. The third or last of these joints ends abruptly, giving the impression that one or more terminal joints

are missing. Antenna 2 is like that of the female, and appears also to have lost the terminal joints of the flagellum. The type is in the American Museum of Natural History.

All the specimens of this genus so far taken have come from great depths, and all are of nearly the same size; *M. diomedae* about 9 mm., *M. macronyx* 9 mm., and the present species, *M. beebei*, 9 and 11 mm. All have been taken in tropical or sub-tropical waters; the first from just south of the equator in the Pacific, the second from the Atlantic just south of the equator, and the present species from the Bermuda waters.

FAMILY SCINIDAE.

Scina crassicornis (Fabricius).

Astacus crassicornis Fabricius, 1775, p. 415.

Tyro atlantica Bovallius, 1885a, p. 14.

Tyro sarsi Bovallius, 1887a, p. 9, pl. 1, figs. 1-17; pl. 2, figs. 1-10.

Tyro atlantica Bovallius, 1887a, p. 13, pl. 2, figs. 11-18.

Scina crassicornis Stebbing, 1904, p. 24 (literature & synonymy).

Scina crassicornis Wagler, 1926, p. 324, figs. 2, 3 (literature and synonymy).

Seventy-three specimens were taken at depths between 300 and 1,400 fathoms.

Distribution.—This species has been recorded from North, mid-, and South Atlantic; Mediterranean; South Pacific (New Zealand, Barnard, 1930); and Indian Ocean. Davis Strait (64° N., 55° W., Stephensen, 1923) appears to be the most northern record and 65° 57' S., 88° 58' E. (Wagler, 1927) the most southern. It has been recorded from the Gulf of Maine (Bigelow), but not heretofore from the Bermuda region.

Barnard (1932, p. 258) records females 21 mm. in length from the east mid-Atlantic, but the largest specimens (females) in the present collection measure 15 mm.

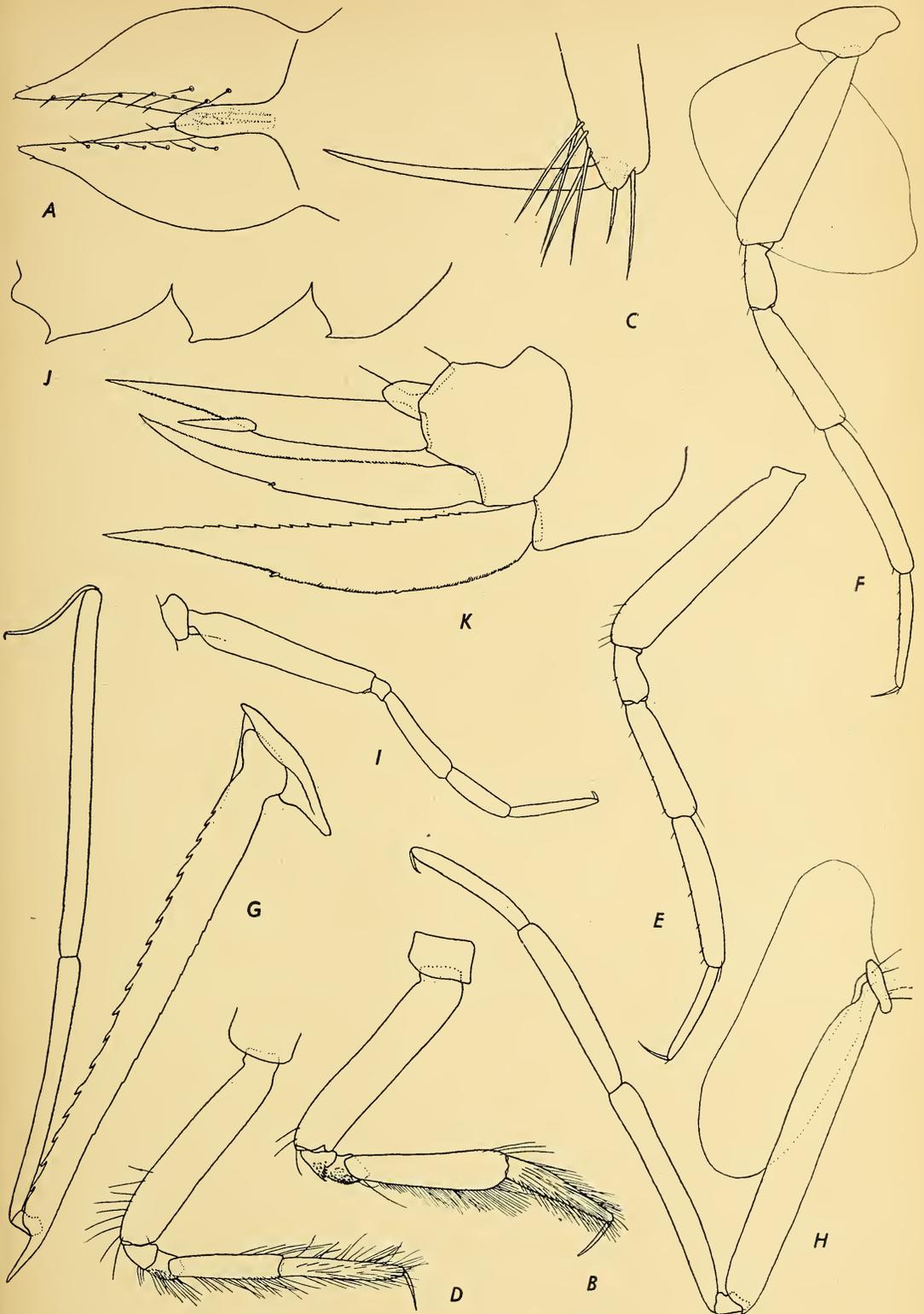
In many of the Bermuda specimens the relative proportions of the joints of the third peraeopod are more like those given by Bovallius for *Tyro sarsi* (= *S. crassicornis* Fabr.) (1887, p. 1; pl. 2, figs. 1-10) than those given by Wagler (1926, p. 326, fig. 2a). Barnard (1932, p. 258) has noted discrepancies in the proportions of the joints of the fourth peraeopod in some of the females which he examined.

Scina crassicornis var. *bermudensis*, new variety.

Text-fig. 31.

Fifty specimens were taken at depths between 300 and 1,000 fathoms.

These specimens appear to me to be a variety of *Scina crassicornis*. In peraeopod 3 the fourth joint is a little more than two-



TEXT-FIG. 31. *Scina crassicornis* var. *bermudensis* new var., male. **A**, maxillipeds; **B**, gnathopod 1; **C**, end of gnathopod 1; **D**, gnathopod 2; **E**, pereopod 1; **F**, pereopod 2; **G**, pereopod 3; **H**, pereopod 4; **I**, pereopod 5; **J**, metasome segments; **K**, uropods and telson.

thirds as long as the fifth, and in peraeopod 4 the fourth, fifth and sixth joints are consecutively shorter. The seventh joint of peraeopod 4 is short and curved, as figured by Bovallius (1887, pl. 1, figs. 1, 2) and not long and straight, as figured by Wagler (1926, p. 326, fig. 2a). The relative proportions of the joints of the last three peraeopods in *S. crassicornis* appear to be quite variable, so it is possible that the two forms may grade into each other. The largest specimen, a female, measures 23 mm. from front to head to the end of uropod 3.

***Scina curvidactyla* Chevreux.**

Scina curvidactyla Chevreux, 1914, p. 3, fig. 2.

Scina curvidactyla Wagler, 1926, p. 328, fig. 4.

Fifty-one specimens were taken at depths between 300 and 1,000 fathoms.

Distribution.—This species has been recorded from the North, tropical, and South Atlantic; Mediterranean; South Pacific (New Zealand, Barnard, 1930, p. 401); and Indian Ocean. It has been taken in the eastern part of the North Atlantic, but has not heretofore been recorded from the western part.

Barnard (1932, p. 259), recorded a female from the Southeast Atlantic measuring 20 mm. which he said was the largest specimen recorded up to that time. Among the Bermuda material is a female, with fully developed marsupial plates, measuring 23 mm. from front to head to end of the third uropods. In the Bermuda specimens the dactyl of the fourth peraeopods is not as stout as figured by Wagler (1926, p. 329, fig. 4a), but is very short, slender, and much curved, agreeing with the observations made by Barnard (1932, p. 259).

***Scina borealis* (Sars).**

Clydonia borealis Sars, 1882, p. 77, pl. 3, figs. 1, 1a, b.

Tyro clausii Bovallius, 1885a, p. 14.

Tyro borealis Bovallius, 1887a, p. 16.

Tyro clausi Bovallius, 1887a, p. 18, pl. 2, figs. 19-28.

Tyro clausi Bovallius, 1887b, p. 552, pl. 40, figs. 1-3.

Scina borealis Sars, 1890, p. 20, pl. 8.

Scina borealis Wagler, 1926, p. 337, figs. 9-11.

One specimen was taken at a depth of 800 fathoms.

Distribution.—This widely distributed species has been recorded from the North Atlantic (63° N., 26° W. and the Lofoten Islands); eastern North Atlantic; South Atlantic down to the Agulhas Current; North Pacific (Okhotsk Sea, Bering Sea, Behning),

Strait of Georgia and Gulf of Alaska (Thorsteinson); South Pacific (New Zealand, Barnard); East Indies (Pilot); Indian Ocean (Walker and Wagler); and the Mediterranean. It was taken in the Arctic Ocean by the Norwegian North Polar Expedition (80° N., 134° E., Sars), and in the Antarctic by the British Antarctic Expedition (71° 49' S., 167° 32' W., Barnard). The present record is the first for the western North Atlantic.

***Scina incerta* Chevreux.**

Scina incerta Chevreux, 1900, p. 123, pl. 14, figs. 9 and 12.

Scina incerta Wagler, 1926, p. 331, figs. 5-7.

Twenty-eight specimens were taken at depths between 700 and 1,000 fathoms.

Distribution.—North Atlantic (47° N., 22° W., Chevreux); tropical and South Atlantic (down to 35° S., Wagler and Barnard); tropical waters of the Indian Ocean (Wagler). It has not heretofore been recorded from the western part of the North Atlantic.

Chevreux gives for the length of the type 8.5 mm., but Wagler gives 21-22 mm. as the length of his largest specimens. The largest specimens in Bermuda are 13 and 14 mm. in length. It would seem, therefore, that the species was described from a rather small, immature specimen.

***Scina excisa* Wagler.**

Scina excisa Wagler, 1926, p. 398, fig. 39.

Scina excisa Wagler, 1927, p. 103, fig. 9.

One male specimen was taken at a depth of 200 fathoms.

Distribution.—Wagler in 1926, recorded this species from the Gulf of Guinea and the Agulhas Bank in the South Atlantic, and from the Indian Ocean. In 1927 he recorded it from 21° N., 32° W. in the Atlantic, and from 64° S. in the Antarctic. The present record extends the range somewhat northward, and considerably westward.

***Scina spinosa* Vosseler.**

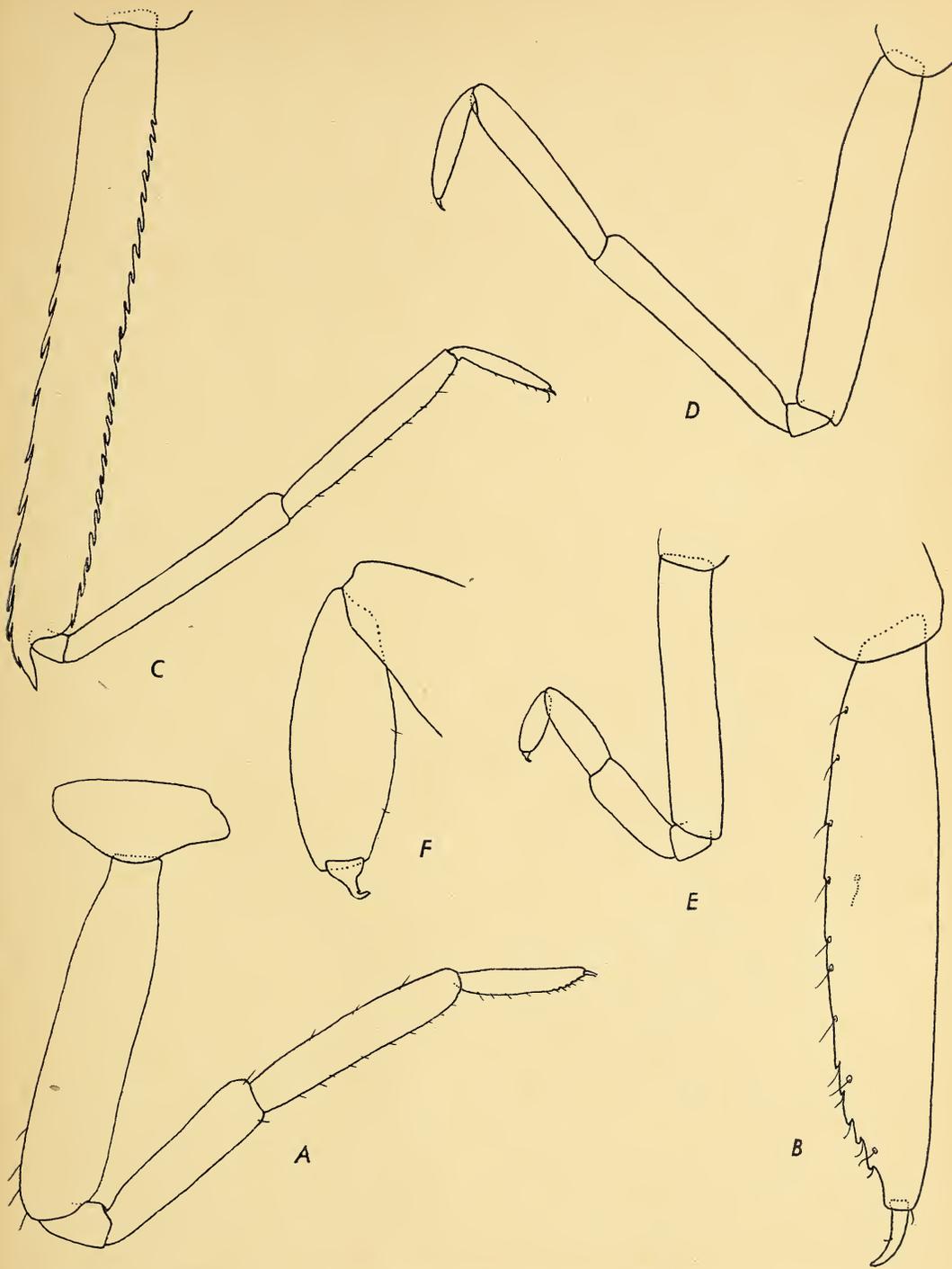
Text-fig. 32.

Scina spinosa Vosseler, 1901, p. 108, pl. 10, figs. 11-15.

Scina spinosa spinosa Wagler, 1926, p. 350, figs. 13c, 15a-e.

Seven female specimens were taken at depths between 800 and 1,000 fathoms.

Distribution.—This species was described by Vosseler from the Atlantic from the South Equatorial Current, and in 1926 it was recorded by Wagler from the Benguela Current (about 31° S.); from south of Bouvet Island (about 55° S.); and from the South Equatorial Current in the Indian Ocean. The present Bermuda records are the first for the North Atlantic.



TEXT-FIG. 32. *Scina spinosa* Vosseler. **A**, peraeopod 1, right; **B**, sixth and seventh joints of peraeopod 1; **C**, peraeopod 3, left; **D**, peraeopod 4, right; **E**, peraeopod 5, right; **F**, sixth and seventh joints of peraeopod 5.

Wagler records two varieties of *spinosa*, the typical form *spinosa spinosa* and a new variety *spinosa affinis*. The specimen from

which my figures were made is a 12 mm. female, with fully developed marsupial plates. The relative proportions of the joints

of the peraeopods do not agree with those of either Vosseler's or Wagler's figures. The third, fourth and fifth joints of peraeopod 3 combined are noticeably shorter than the second joint, whereas in the figures of Vosseler and Wagler they are longer than the second joint. The sixth joint is less than half the length of the fifth, but in Vosseler's and Wagler's figures it is over half the length of the fifth. In the smaller, immature females the proportions of the third peraeopod are closer to those given by Vosseler and Wagler. The serrations on the second joint of peraeopod 3 are more like those figured by Wagler (fig. 15a) than those of Vosseler (pl. 10, fig. 12). The sixth joint of peraeopod 1 is more like Wagler's figure (fig. 13d) of *S. s. affinis* than that of *S. s. spinosa* (fig. 13c).

The proportions and characters of the peraeopods appear to vary considerably in this species, so that it is not possible to assign the present specimens to either of the varieties given by Wagler as they partake of the characters of each.

***Scina vosseleri* Tattersall.**

Scina vosseleri Tattersall, 1906, p. 7, pl. 1, figs. 1-8.

Scina vosseleri Wagler, 1926, p. 416, figs. 48, 49.

Four specimens, male and female, were taken at depths between 500 and 1,000 fathoms.

Distribution.—This species was described from the North Atlantic (53° N., 15° W.). It has since been recorded as far south as 31° S., 9° E., and in the Indian Ocean, 29° S., 89° E. and 26° S., 93° E. The present records are the first for the Bermuda area.

Wagler records a female measuring 15 mm. from front of head to end of third uropods. The usual length appears to be from 6 to 10 mm. The largest specimen from Bermuda, a female, measures about 12 mm.

***Scina marginata* (Bovallius).**

Tyro marginata Bovallius, 1885a, p. 15.

Tyro marginata Bovallius, 1887a, p. 21, pl. 3, figs. 18-33.

Scina marginata Stebbing, 1888, p. 1272.

Scina marginata Chevreux, 1900, p. 122, pl. 14, fig. 8, pl. 15, fig. 1.

Scina marginata Wagler 1926, p. 361, figs. 19-21.

One female specimen taken at a depth of 300 fathoms.

Distribution.—This species was described from the Mediterranean by Bovallius. It has been recorded by Walker (1903, p. 231) from 52° N., 15° W., and by Wagler from 19° 1' S., 20° W. Stephensen recorded it from the Mediterranean (1918, p. 27), and Barnard has recorded it from the northern

Arabian Sea (1937, p. 181). The present record is the first for Bermuda.

Bovallius gives 6 mm. as the length of his specimen, but Wagler has recorded a specimen measuring 9 mm. in length. The Bermuda specimen, a female, is about 8 mm. in length.

***Scina submarginata* Tattersall.**

Scina submarginata Tattersall, 1906, p. 12.

Scina latipes Stephensen, 1918, p. 32, fig. 7.

Scina submarginata Wagler, 1926, p. 367, figs. 22-24 (literature and synonymy).

One female specimen was taken at a depth of 800 fathoms.

Distribution.—Tattersall described this species from the North Atlantic (53° N., 15° W.). Stephensen has recorded it (*Scina latipes*) from 36° 53' N., 7° 26' W. Wagler records it from the vicinity of the Cape Verde Islands; off the mouth of the Kongo; and from 55° 57' S. In the Indian Ocean he records it from the warm and temperate waters. Barnard has recorded it from the South Atlantic (32° 45' S., 8° 47' W.). It has not heretofore been recorded from the Bermuda area.

Tattersall's specimen measured 4.5 mm. Stephensen gives 7 mm. as the length of *S. latipes*. Wagler's largest specimen measured 8.5 mm. The specimen from Bermuda, a female, is about 6 mm. in length.

Chevreux (1919, p. 13) has made *submarginata* a synonym of *marginata*, but I am following Wagler and giving them both specific rank for the present.

***Scina tullbergi* (Bovallius).**

Tyro tullbergi Bovallius, 1885a, p. 15.

Tyro tullbergi Bovallius, 1887a, p. 23, pl. 3, figs. 1-9.

Tyro tullbergi Bovallius, 1887b, p. 552, pl. 40, figs. 4-10.

Tyro pacifica Bovallius, 1887a, p. 25, pl. 3, figs. 10-17.

Scina concors Stebbing, 1895, p. 360, pl. 53B.

Scina tullbergi Wagler, 1926, p. 384, figs. 34, 35.

One male specimen was taken at a depth of 200 fathoms.

Distribution.—North, tropical and South Atlantic; Pacific (Coral Sea, Barnard, 1931) (Nicaragua, Bovallius, 1887); Indian Ocean (Wagler, 1926); and Mediterranean. It is new to the Bermuda area.

Bovallius gives 4 mm. as the length of the species. Wagler gives 6 mm., including the antennae. Barnard gives 3 mm. as the length of the male which he examined. Stebbing gives 5 mm. (*S. concors*). The Bermuda specimen, a male, measures about 3.5 mm. exclusive of the antennae.

***Scina stenops* Stebbing.**

Scina stenops Stebbing, 1895, p. 354, pl. 52a.

Scina chuni Garbowski, 1896, p. 71, pl. 1, fig. 1; pl. 8, figs. 110-114; pl. 9, figs. 115-124.

Scina stenops Wagler, 1926, p. 419, fig. 50.

One male specimen was taken at a depth of 400 fathoms.

Distribution.—North Atlantic to 46° N. (Chevreux, 1935, p. 158, Station 1639); tropical Atlantic; South Atlantic down to Agulhas Bank (Wagler, 1926, p. 422); Indian Ocean (Wagler, 1926, p. 422), and Mediterranean (Garbowski, 1896). The present record is the first for Bermuda.

The female which Stebbing figured measured about 7 mm., and the present specimen, which is a male, measures about 5 mm. These measurements are from the front of the head to the end of the third uropods. Stebbing gives half an inch as the length, which is about 13 mm., but his measurement includes the antennae. Wagler gives 15.5 mm. as the length of the largest males taken by the Deepsea Expedition and his measurement also includes the antennae.

***Acanthoscina acanthodes* (Stebbing).**

Scina acanthodes Stebbing, 1895, p. 352, pl. 51.

Acanthoscina serrata Vosseler, 1900, p. 675, figs. 1-4.

Acanthoscina acanthodes Chevreux, 1905e, p. 1.

Acanthoscina acanthodes Wagler, 1926, p. 426, figs. 51, 52.

One male specimen was taken at a depth of 100 fathoms.

Distribution.—In the Atlantic it has been recorded from 61° N. (Stephensen) to 28° S. (Wagler). In the Indian Ocean it has been recorded from the tropical waters. The present record is the first for the Bermuda area.

Wagler gives 6.3 mm. for the length of his largest specimen, a female.

FAMILY CYSTISOMATIDAE.***Cystisoma magna* (Woltereck).**

Thaumtops magna Woltereck, 1903, p. 455, fig. 2.

Thaumtops magna Spandl, 1927, p. 171, figs. 8, 9a-d.

Fifteen specimens, male and female, were taken at depths between 200 and 1,000 fathoms.

Distribution.—This species of *Cystisoma* has been recorded from the Indian Ocean and the South Atlantic. The present records are the first for the North Atlantic.

Carcinologists have found it difficult to discover reliable characters for determining the species of the genus *Cystisoma*. All characters apparently vary considerably

with sex and age. Stebbing, for instance, says on page 1334 of his *Challenger* report, "It is conceivable that by a diligent counting and comparing of the teeth on various parts of the animal (*Cystisoma spinosum*) and comparative measurements of the limbs, one might make a species of every specimen; on the other hand, among specimens from so many parts of the world some specific variation might be expected, difficult as it is to seize any character which can be regarded as at once so salient and so constant as certainly to warrant the establishment of any new species." Stephensen in his report on the hyperiids of the Danish Oceanographic Expeditions, 1908-1910 (1918, pp. 56-59) has discussed the problem of characterizing the species of this genus and has given a key based on the fusion of the mesosome segments, the length of the antenna, the number of ventral spines and the breadth of the first free joint of the last peraeopod.

Barnard in his *Discovery* report (1932, p. 268) says, "Of this genus it may well be said that we describe specimens, not species. There are some ten or eleven nominal species, but the latest writers agree on the difficulty of finding suitable diagnostic characters to define the species." He has given a list of the species arranged according to the ascending number of mandibular and ventral spines, and has also given a list of nine species which he believes may perhaps be defined, and three species which he believes insufficiently described.

I have identified five large females and three smaller males as *C. magna* because their diagnostic characters proclaim them to be that species according to the schemes of Stephensen and Barnard mentioned above. Three of these females are about 90 mm. in length and the other two smaller. In these specimens the usual number of mandibular spines is two. Occasionally there are two on one side and three on the other. In two of the large females there are two large spines and one small proximal spine on each side. Of the five large females two have five ventral spines on each side, two have five on one side and four on the other, and one has five on one side and six on the other. In the three males the number of spines is constant, there being two mandibular spines on each side and five ventral spines on each side. The females all have the expanded chelate sixth joint in the last pair of peraeopods, and the antennae are short. The uropods are as figured by Spandl (1927, p. 172, fig. 9d). The first two mesosome segments are fused.

There are six specimens, the largest 80 mm., of which I am not sure of the sex.

Beside the specimens which I have identified as *C. magna*, there are four which are too small and immature for identification specifically.

I should mention, perhaps, that in the Bermuda specimens of *C. magna* the number of marginal spines is greater than is shown in Woltereck's fine photograph (1903, pl. 2, fig. 2). In the photograph there are ten spines, but in the Bermuda specimens the number varies between fifteen and eighteen, the number rarely being the same on both sides. How important this character is for diagnosis I do not know.

Woltereck's figure of *C. magna* referred to above is from a retouched photograph which is stated to be natural size, and if this be correct the specimen would measure about 120 mm.

FAMILY VIBILIIDAE.

Vibilia cultripes Vosseler.

Text-fig. 33.

Vibilia cultripes Vosseler, 1901, p. 121, pl. 11, figs. 6-18.

Vibilia cultripes Chevreux and Fage, 1925, p. 388, fig. 392.

Six specimens, male and female, were taken at depths between 300 and 900 fathoms.

Distribution.—This species was described from the South Equatorial Current in the Atlantic from a single specimen. It has since been recorded from the North Atlantic; Mediterranean; Southwest Atlantic; Indian Ocean; and Pacific. In the North Atlantic, it has not, heretofore, been recorded as far west as Bermuda. Vosseler's specimen, which was a female, measured 12 mm. The female which I have figured measures about 13.5 mm. from front of head to end of uropods.

Vibilia viatrix Bovallius.

Text-fig 34.

Vibilia viatrix Bovallius, 1887a, p. 63, pl. 9, figs. 1-13.

Vibilia californica Holmes, 1908, p. 490, figs. 1, 2.

Vibilia viatrix Chevreux and Fage, 1925, p. 385, fig. 390.

Eighty-six specimens were taken between the surface and 1,000 fathoms.

Distribution.—Bovallius gives for the distribution of this species North and South Atlantic, the Pacific and Indian Oceans. It was recorded from the Mediterranean by Stephensen. Holmes recorded it from the coast of southern California under the name *Vibilia californica*. The present records are the first for the Bermuda region.

FAMILY PARAPHRONIMIDAE.

Paraphronima crassipes Claus.

Paraphronima crassipes Claus, 1879b, pp. 65, 66, pl. 1, figs. 6-9, pl. 2, fig. 10.

Paraphronima clypeata Bovallius, 1885a, p. 11, fig. 2.

Paraphronima pectinata Bovallius, 1887c, p. 13.

Paraphronima crassipes Bovallius, 1889, p. 30, pl. 2, figs. 11-15.

Paraphronima clypeata Bovallius, 1889, p. 33, pl. 2, fig. 16-40.

Paraphronima crassipes Chevreux and Fage, 1925, p. 390, figs. 393, 394.

Four specimens, male and female, were taken at depths between 200 and 800 fathoms.

Distribution.—North and South Atlantic; South Pacific (Australia); Indian Ocean (Barnard, 1937); Mediterranean (Stephensen, 1924). The present records are the first for the Bermuda region.

Bovallius gives as the length of this species 5-8 mm. for the male and 6-9 for the female, but for *P. clypeata*, which is now considered a synonym of *P. crassipes*, he gives a maximum of 16 mm. for the female. Barnard, however, records a female from the South Atlantic (39° S., 17° E.) which measures 17 mm. in length. The largest specimen from Bermuda measures only about 7 mm.

FAMILY ANCHYLOMERIDAE.

Anchylomera blossevillii M. Edw.

Anchylomera blossevillii Milne Edwards, 1830, p. 394.

Anchylomera blossevillii Stebbing, 1888, p. 1433, pl. 177 (literature).

Anchylomera blossevillii Chevreux and Fage, 1925, p. 414, fig. 410.

Five specimens were taken at depths between 25 and 800 fathoms.

Distribution.—A widely distributed species, having been recorded from the North and South Atlantic; North and South Pacific; Indian Ocean; and the Mediterranean. It has been recorded as occurring off the coast of Newfoundland, and it has been reported a few degrees northeast of Bermuda, but not heretofore immediately south of the Islands.

Primno macropa Guérin.

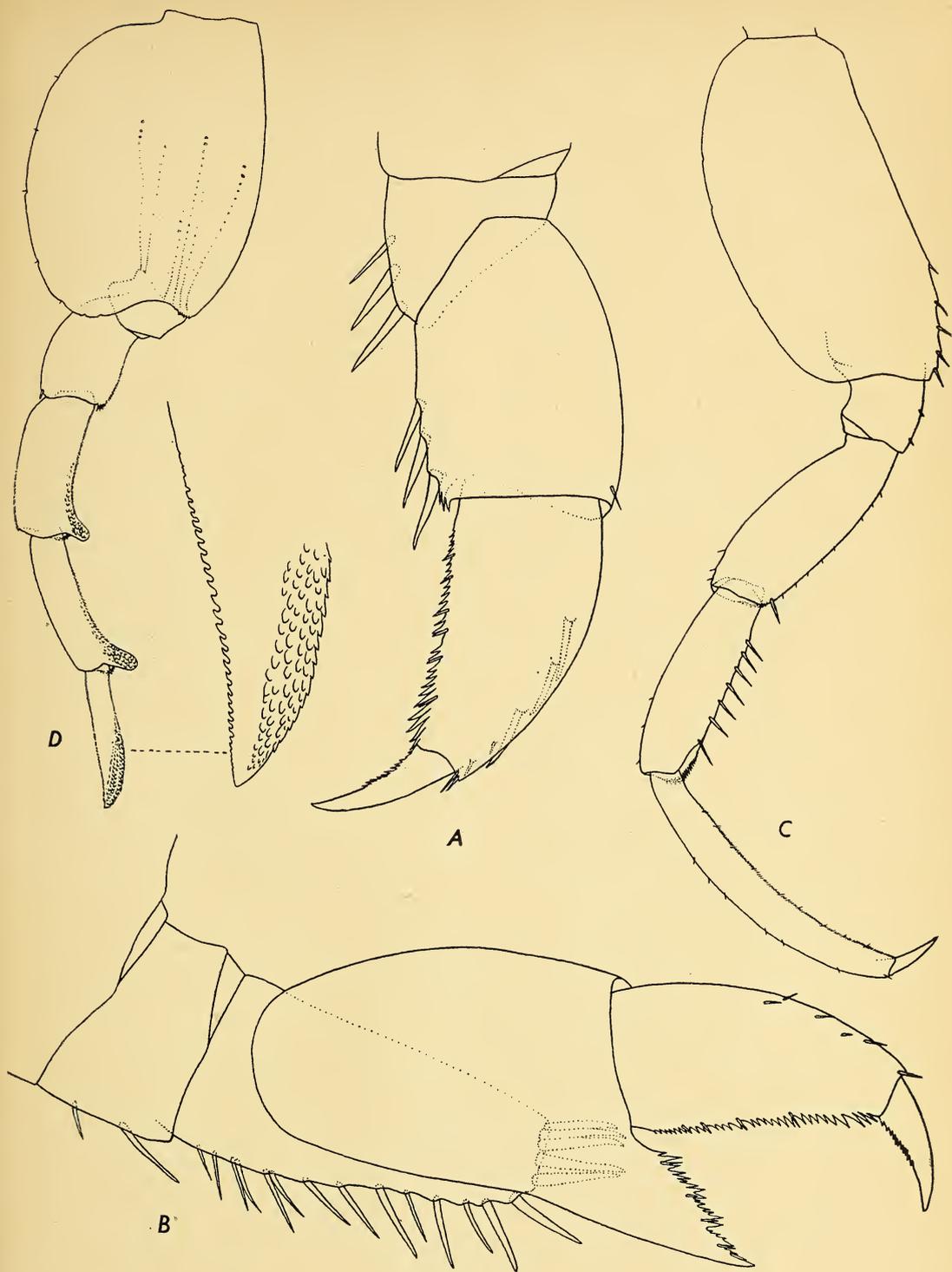
Primno macropa Guérin, 1836, p. 4, pl. 17, figs. 1a-f.

Euprimno macropa Bovallius, 1889, p. 400, pl. 27, figs. 23-40, pl. 28, figs. 1-2.

Euprimno macropa Chevreux and Fage, 1925, p. 416, fig. 411.

Three hundred and sixty specimens were taken at depths between the surface and 1,000 fathoms.

Distribution.—North and South Atlantic; North and South Pacific; Indian Ocean; Antarctic (66° S., 89° E., Spandl); and Mediterranean. This is a very common and widely distributed hyperiid, but it has not



TEXT-FIG. 33. *Vibilia cultripipes* Vosseler, female. A, gnathopod 1; B, gnathopod 2; C, peraeopod 4; D peraeopod 5.

heretofore been recorded from Bermuda. It is of medium size, measuring between 5 and 12 mm.

***Phrosina semilunata* Risso.**

Phrosina semilunata Risso, 1822, p. 245.

Phrosina semilunata Stebbing, 1888, p. 1425, pl. 176.

Phrosina pacifica Stebbing, 1888, p. 1430.

Phrosina australis Stebbing, 1888, p. 1431.

Phrosina semilunata Chevreux and Fage, 1925, p. 413, fig. 409.

Nine specimens were taken at depths between 50 and 1,000 fathoms.

Distribution.—A cosmopolitan species which has been recorded from the North and South Atlantic; North and South Pacific; Indian Ocean; Mediterranean; and the Antarctic (Spandl, 1927, p. 168, 65°16' S., 80°28' E.).

The present records are the first for the Bermuda Islands, but the species was taken by the *Challenger* (35°18' N., 51°42' W.) about 700 miles northeast of the islands. The length of the animal ranges between 8-30 mm. The largest specimens in the present collection are about 17 mm. in length.

FAMILY PHRONIMIDAE.

***Phronima sedentaria* (Forskål).**

Cancer sedentaria Forskål, 1775, p. XXI and 95.

Phronima sedentaria Latreille, 1803, p. 291.

Phronima sedentaria Stebbing, 1888, p. 1357, pl. 162B.

Phronima sedentaria Bovallius, 1889, p. 354, pl. 16, figs. 1-3 (literature).

Sixty-three specimens were taken at depths between 100 and 1,000 fathoms.

Distribution.—North and South Atlantic; North and South Pacific; Indian Ocean; Mediterranean.

This species has been recorded from both the east and west coasts of the United States, but the present records are the first for Bermuda.

Bovallius gives as the length of this species 10-36 mm. In regard to the house in which the species of *Phronima* live, he says (1889, p. 365), "It seems beyond doubt that it in most cases consists of the tests of *Tunicata* and *Siphonophora*, which have been attacked, and adapted for its purpose, by the *Phronima* itself."

***Phronima atlantica* Guérin.**

Phronima atlantica Guérin, 1836, p. 7, pl. 18, fig. 1.

Phronima atlantica Vosseler, 1901, p. 21, pl. 2, figs. 1-10 (literature).

Twelve specimens were taken at depths between 25 and 1,400 fathoms.

Distribution.—North and South Atlantic;

North and South Pacific; Indian Ocean; Mediterranean; Antarctic (65° S., 88° E., Mogk). It has not heretofore been recorded from Bermuda.

***Phronima atlantica*, var. *solitaria* Guérin.**

Phronima solitaria Guérin, 1836, p. 21.

Phronima solitaria Bovallius, 1889, p. 372, pl. 16, figs. 4-7.

Phronima atlantica var. *solitaria* Vosseler, 1901, p. 23, pl. 2, fig. 5.

Four specimens were taken at depths between 25 and 900 fathoms.

Distribution.—North and South Atlantic; North Pacific; Indian Ocean; Mediterranean. The present records are the first for Bermuda.

***Phronima colletti* Bovallius.**

Phronima colletti Bovallius, 1887c, p. 25.

Phronima colletti Bovallius, 1889, p. 378, pl. 16, figs. 27-47.

Phronima colletti Vosseler, 1901, p. 32, pl. 3, figs. 8-10, pl. 4, figs. 1-3.

Twelve specimens were taken at depths between 50 and 1,000 fathoms.

Distribution.—North and South Atlantic; Indian Ocean; and Mediterranean. The present records are the first for Bermuda.

***Phronima pacifica* Streets.**

Phronima pacifica Streets, 1877, p. 128.

Phronima pacifica Bovallius, 1889, p. 382, pl. 15, figs. 48-50.

Phronima pacifica Vosseler, 1901, p. 29, pl. 3, figs. 4-7.

Eight specimens were taken at depths between 50 and 1,000 fathoms.

Distribution.—North and South Atlantic; North and South Pacific; Indian Ocean; Mediterranean. It has not heretofore been recorded from Bermuda.

***Phronima stebbingii* Vosseler.**

Phronima stebbingii Vosseler, 1900, p. 402.

Phronima stebbingii Vosseler, 1901, p. 36, pl. 4, figs. 4-10.

Six specimens were taken at depths between 300 and 1,000 fathoms.

Distribution.—Tropical and subtropical Atlantic and Pacific (Bovallius); vicinity of Sierra Leone (Stebbing); equatorial Atlantic (Vosseler); South Atlantic (Stewart); Mediterranean (Chevreux). The present records are the first for Bermuda.

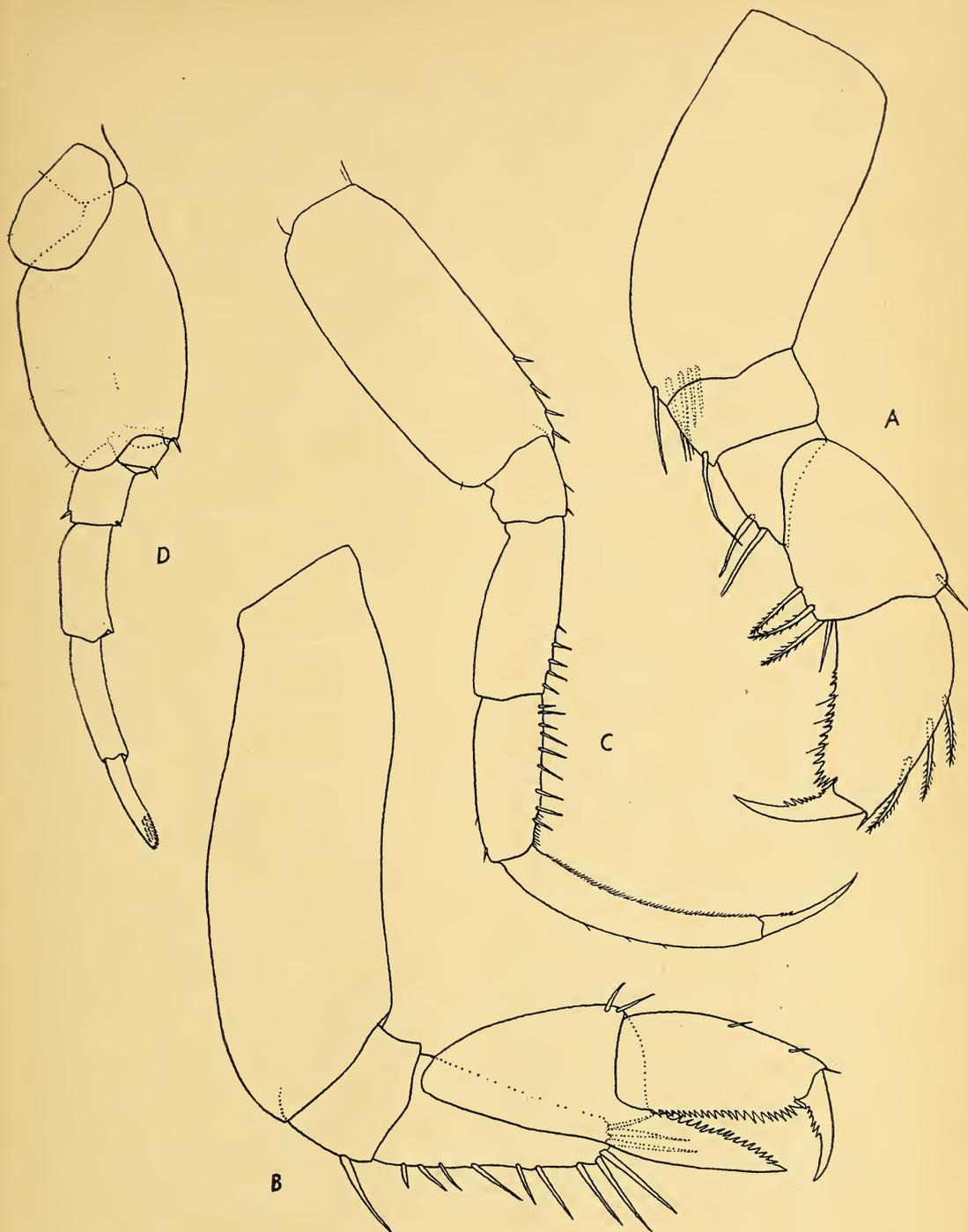
***Phronimella elongata* (Claus).**

Phronimella elongata Claus, 1862a, p. 193, pl. 19, figs. 2, 3, & 7.

Phronimella elongata Claus, 1871, p. 149.

Anchylonyx hamatus Streets, 1877, p. 131.

Phronimella elongata Claus, 1879b, p. 63, pl. 2, fig. 15, pl. 4, fig. 26.



TEXT-FIG. 34. *Vibilia viatrix* Bovallius, male. **A**, gnathopod 1; **B**, gnathopod 2; **C**, peraeopod 4; **D**, peraeopod 5.

Phronimella elongata and *filiformis* Boval-
lius 1887c, p. 26.

Phronimella hippocephala Giles, 1887, p. 217,
pl. 3, fig. 3.

Five specimens were taken at depths be-
tween 500 and 1,000 fathoms.

Distribution.—North, mid- and South At-
lantic; Mediterranean; North Pacific

(Streets, 34° N.); South Pacific (Streets, 30° S.); New Zealand (Barnard, 1932); Indian Ocean; East Indies (Stebbing, 1888); Antarctic (Mogk, 63° S., 82° E.). The present records are the first for the Bermuda area.

Dr. Stephensen says that the size of adult males is as a rule from 8 to 10 mm., very rarely 11 or 12 mm., and that the adult female is as a rule 16 mm. or very rarely 17 to 19 mm. The largest specimens in the Bermuda collection are about 11 mm.

FAMILY HYPERIIDAE.

Hyperia bengalensis (Giles).

Lestrigonus bengalensis Giles, 1887, p. 224, pl. 6, figs. 1-10; pl. 7, figs. 1-9.

Hyperia promontorii Stebbing, 1888, p. 1385, pl. 166B.

Hyperia disschystus Stebbing, 1888, p. 1388, pl. 167.

Hyperia schizogeneios Stebbing, 1888, p. 1391, pl. 168.

Hyperia zebui Stebbing, 1888, p. 1394.

Hyperia latissima Bovallius, 1889, p. 229, pl. 11, figs. 26-36.

Hyperia thoracica Bovallius, 1889, p. 233, pl. 11, figs. 37-41.

Hyperia gilesi Bovallius, 1889, p. 236.

Themistella steenstrupi Bovallius, 1889, p. 313, pl. 13, figs. 47-60.

Hyperia macrophthalma Vosseler, 1901, p. 70, pl. 6, figs. 16-25.

Hyperia hydrocephala Vosseler, 1901, p. 74, pl. 6, figs. 26-28; pl. 7, figs. 1-5.

Hyperia bengalensis Pirlot, 1939b, p. 35 (literature).

Two specimens, male and female, were taken at depths of 50 and 800 fathoms.

Hyperia bengalensis was described from the Bay of Bengal. It has since been recorded under different names from the North and South Atlantic; Mediterranean; Arabian Sea; and South Pacific (off Cape Howe, Australia).

The specimen from Net 1340 is a fully developed male measuring 4 mm. in length, and the specimen from 1331 is a female about half the size of the male. Pirlot (1939, p. 35) has given the complete synonymy for this species. The present records are the first for the Bermuda region.

Hyperia spinigera Bovallius.

Text-fig. 35.

Hyperia spinigera Bovallius, 1889, p. 191, pl. X, figs. 33-39.

Eleven specimens, male and female, were taken at depths between 500 and 900 fathoms.

Distribution.—This species has been recorded from Spitzbergen; off the northern

coast of Norway; the Labrador Current; west coast of Ireland; south coast of England; East mid-Atlantic; South Georgia; and Friday Harbor, Washington (collected from a medusa). The present records are the first for the Bermuda region.

This species appears to be very close to, if not identical with, *Hyperia galba* (Montagu). Barnard (1932, p. 274) concluded from evidence presented by the specimens which he examined that they were distinct, as Tattersall (1906, p. 22) had previously concluded from his studies of specimens taken off the coast of Ireland. I have figured the gnathopods, metasome and uropods of a male measuring about 16 mm., which, from the characters of the gnathopods and uropods, appears to be *Hyperia spinigera*. Tattersall states that the posterolateral angles of the third metasome segment are sharply pointed in *H. galba* and rounding in *H. spinigera*. In most of the Bermuda specimens the epimera of the metasome are very tumid and do not show clearly the lower and posterior margins, but in the specimen figured they were quite clearly defined. The third epimeron has a broadly rounding lower and posterior margin with a slight, pointed angle about the center of the curve. The gnathopods appear to resemble very closely the figures given by Bovallius (1889, pl. X, figs. 34-35).

Barnard (1932, p. 274) is of the opinion that *Hyperia antarctica* Spandl is synonymous with *H. spinigera* Bovallius.

The largest male in the present collection measures about 16 mm., and the females somewhat less.

Hyperioides longipes Chevreux.

Hyperioides longipes Chevreux, 1900, p. 143, pl. 17, fig. 2.

Hyperia sibaginis Vosseler, 1901, p. 60, pl. 7, figs. 6-20.

Hyperioides longipes Chevreux and Fage, 1925, p. 407, fig. 405.

Four specimens were taken at depths between 300 and 700 fathoms.

Distribution.—North Atlantic; tropical Atlantic; South Atlantic (37½° S.); East Indies; New Zealand (51° S., Barnard); Gulf of Aden; Mediterranean. It is new to the Bermuda region.

Hyperioides longipes is a small but widely distributed species, attaining a length of 5-6 mm. The Bermuda specimens, both male and female, are about 5 mm. in length.

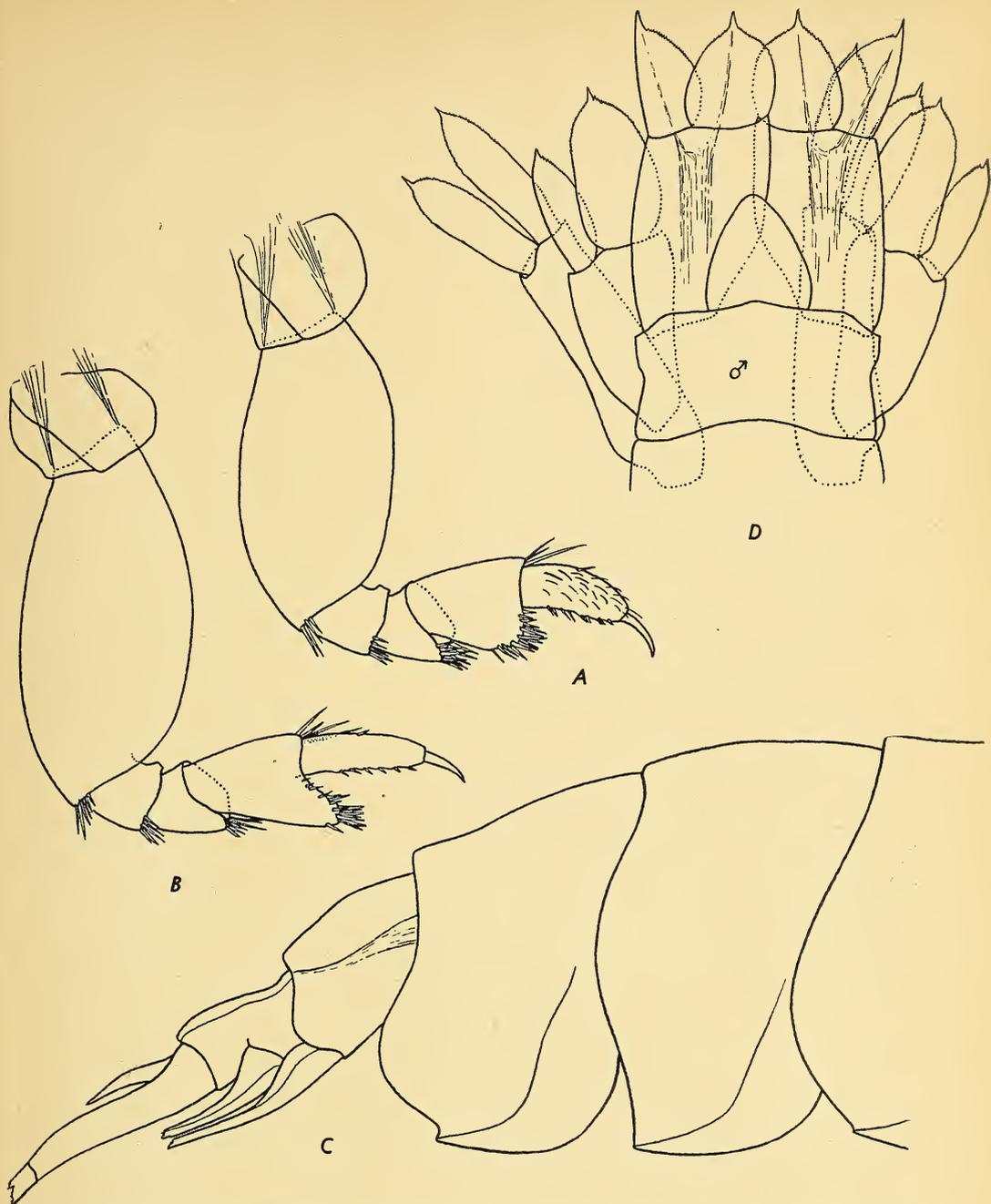
Iulopsis mirabilis Bovallius.

Text-figs. 36, 37.

Iulopsis mirabilis Bovallius, 1887c, p. 18.

Euiulopsis mirabilis Bovallius, 1889, p. 125, pl. 8, figs. 19-33.

Euiulopsis mirabilis Spandl, 1927, p. 159, figs. 4 l-m.



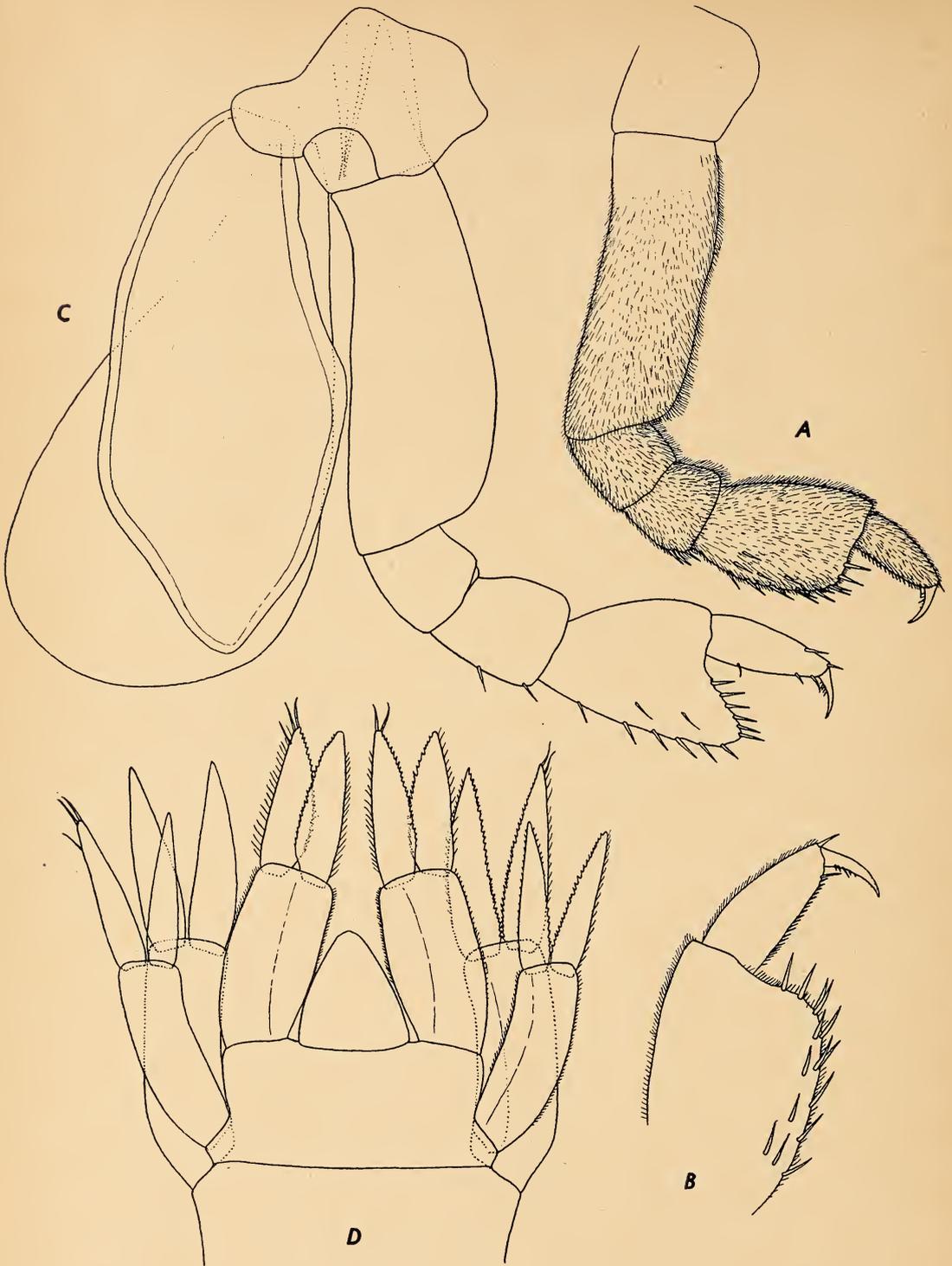
TEXT-FIG. 35. *Hyperia spinigera* Bovallius, male. **A**, gnathopod 1; **B**, gnathopod 2; **C**, metasome and urosome; **D**, uropods and telson.

Two female specimens were taken at depths of 700 and 800 fathoms.

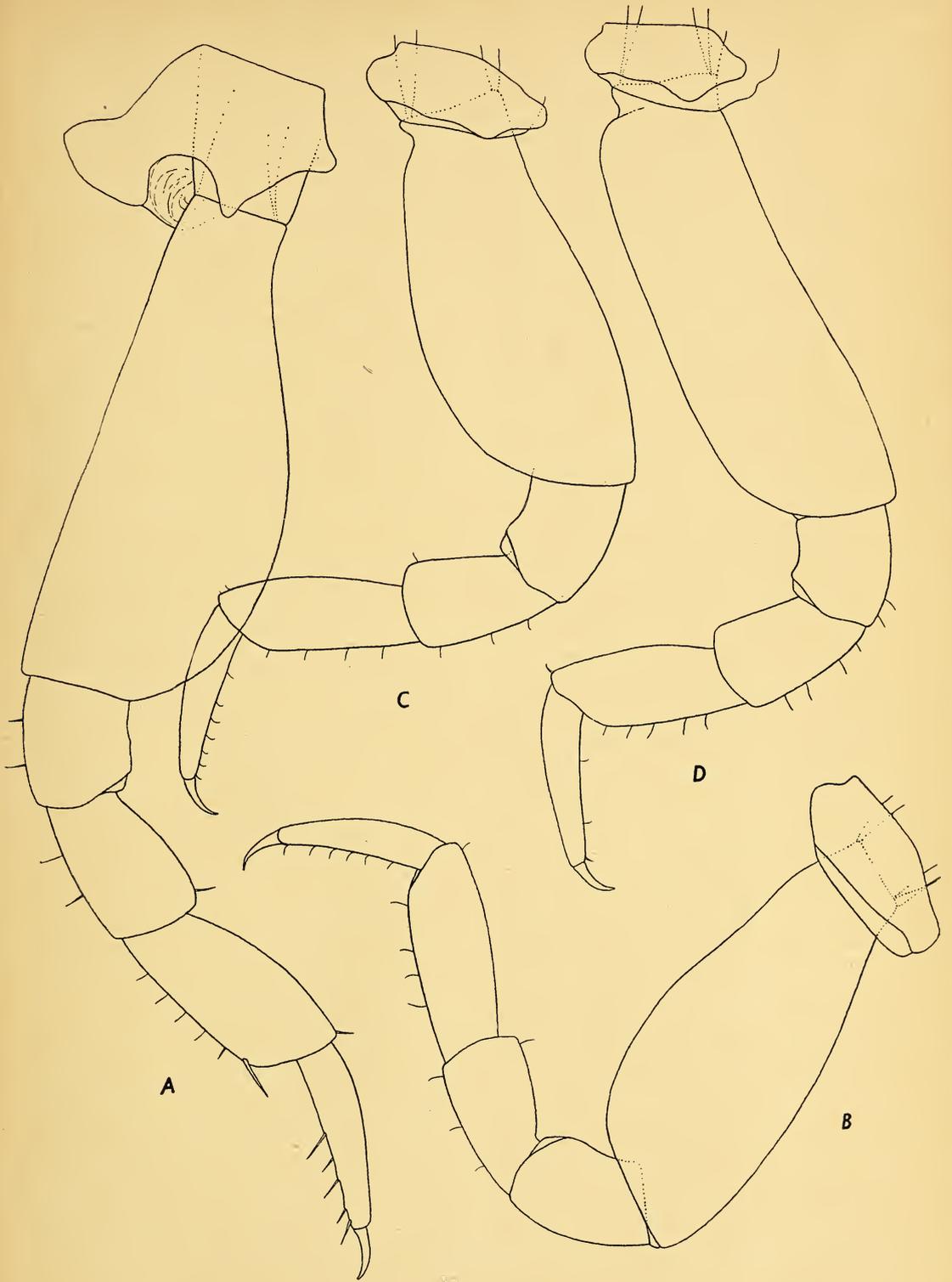
Distribution.—Bovallius described this species from the Bay of Panama in 1887, and it has not been recorded since until the two specimens of the present collection were procured at Bermuda.

Bovallius described *Iulopis loveni* from

the North Atlantic, but the present specimens do not appear to belong to that species. In most characters they agree very well with the figures given by Bovallius for *I. mirabilis*, as I have shown by my figures. Spandl (1927, p. 160) has figured the first and second gnathopods of a specimen of *I. mirabilis* which was identified by Bovallius



TEXT-FIG. 36. *Iulopsis mirabilis* Bovallius, female. **A**, gnathopod 1; **B**, end of gnathopod 1, enlarged; **C**, gnathopod 2; **D**, uropods and telson.



TEXT-FIG. 37. *Iulopis mirabilis* Bovallius, female. **A**, peraeopod 1; **B**, peraeopod 3; **C**, peraeopod 4; **D**, peraeopod 5.

and my figures of these gnathopods agree very well with his figures except that mine are somewhat stouter. Spandl, however, accidentally transposed the letters *l* and *m* on his figures. Bovallius figures a male, but Spandl does not state the sex or the size of the specimen from which his figures were made. It is possible that the appendages of the female are somewhat stouter than those of the male.

Bovallius states that the telson is narrower than the peduncle of the last pair of uropods and that it is considerably shorter than half the peduncle of the last pair of uropoda, but longer than half the last coalesced urol segment. These statements do not agree with the Bermuda specimens, where the telson is over half the length of the peduncles of the third pair of uropoda and also wider than these peduncles. The telson is not only longer than half the coalesced urol segment but is fully equal in length to it. Several of the rami of the uropods are tipped with two or three slender setae, and it is probable that all were so armed, but that they have been lost from most of the rami. The female figured measures between 5 and 6 mm., carries young in the marsupial pouch, and is covered with a very fine, dense, velvety pubescence. The second female appears also to be fully developed and measures a little over 6 mm.

As both *Iulopis loveni* and *I. mirabilis* have now been recorded from the North Atlantic, and taking into consideration the few specimens of this genus which have come to light, our lack of knowledge of the sex variations, and the apparent variability of at least some of the characters, it seems possible that these two species may prove to be synonymous.

I agree with Barnard (1930, p. 418) that there is no valid reason for altering the original spelling of the genus *Iulopis* to *Eriulopis* and that therefore the original name must be used.

Phronimopsis spinifera Claus.

Phronimopsis spinifer Claus, 1879b, p. 64, pl. 1, figs. 1-3.

Phronimopsis sarsii Bovallius, 1887c, p. 23.

Phronimopsis tenella Stebbing, 1888, p. 1374, pl. 164.

Phronimopsis sarsii Bovallius, 1889, p. 320, pl. 14, figs. 1-29.

Phronimopsis spinifera Bovallius, 1889, p. 326, pl. 14, figs. 30-35.

Phronimopsis tumida Vester, 1900, p. 9, pl. 1-2.

Phronimopsis spinifera Chevreux and Fage, 1925, p. 408, fig. 406.

Five specimens were taken at depths between 100 and 900 fathoms.

Distribution. — *Phronimopsis spinifera*

has been recorded from the warm and temperate regions of the Atlantic, Pacific, and Indian Oceans, and the Mediterranean and Red Seas. It has not heretofore been recorded from the Bermuda region.

Several species of this genus have been described as shown by the synonymy, but these are all considered by the foremost authorities to be synonyms of *S. spinifera*.

This is a small species measuring between 3 and 4 mm. The present specimens are about 3.5 mm.

FAMILY LYCAEOPSIDAE.

***Lycaeopsis neglecta* Pirlot.**

Lycaeopsis zamboange Chevreux, 1913, p. 22, fig. 9 ♀.

Lycaeopsis neglecta Pirlot, 1929a, p. 144, fig. 8.

One specimen was taken at a depth of 100 fathoms.

Distribution.—Mediterranean; North Atlantic. This specimen from Bermuda constitutes the first record for the western part of the North Atlantic.

Chevreux identified and figured specimens from the Mediterranean as *Lycaeopsis zamboange* Stebbing. Pirlot in 1929 gave these specimens the new name, *Lycaeopsis neglecta*, as Chevreux's specimens were not *L. zamboange*. The *Armauer Hansen* took 19 specimens of this species in the eastern part of the North Atlantic (31° - 35° N., Pirlot). The Scientific Expeditions of the Prince of Monaco in the eastern part of the North Atlantic took 5 females in 1885 and 6 females and 1 young male in 1911.

This is a very small species, measuring between 2 and 4 mm. The present specimen is about 3.5 mm.

***Brachyscelus crusculum* Bate.**

Brachyscelus crusculum Bate, 1861, p. 7, pl. 2, figs. 1-2.

Brachyscelus crusculum Bate, 1862, p. 310, pl. 1, fig. 6.

Thamyris mediterranea Claus, 1887, p. 60, pl. 16, figs. 11-18.

Seven specimens were taken at depths between the surface and 900 fathoms.

Distribution.—North and South Atlantic; North Pacific; East Indies; Indian Ocean; and Mediterranean. These are the initial records of this species for Bermuda.

The largest female of the present collection measures 14 mm. and the largest male 10.5 mm.

***Brachyscelus globiceps* (Claus).**

Thamyris globiceps Claus, 1879a, p. 182.

Thamyris globiceps Claus, 1887, p. 59, pl. 16, figs. 1-2, 4-10.

Brachyscelus globiceps Stephensen, 1925, p. 176, fig. 65.

Five specimens were taken at depths between 25 and 900 fathoms.

Distribution.—Mediterranean; Zanzibar (Claus); Portuguese West Africa (Barnard); Arabian Sea (Barnard); Great Barrier Reef, Australia (Barnard). These present records from Bermuda are the first for the North Atlantic.

The largest specimen in the collection measures 6.5 mm.

***Brachyscelus macrocephalus* Stephensen.**

Brachyscelus macrocephalus Stephensen, 1925, p. 177, fig. 66.

One specimen was taken at a depth of 100 fathoms.

Distribution.—This species was described by Dr. Stephensen from specimens taken by the *Thor* in the Mediterranean. The present record is the second of the occurrence of the species and the first of its occurrence outside the Mediterranean.

The Bermuda specimen, a female, though slightly larger than the specimens taken by the *Thor*, agrees very well with Dr. Stephensen's description and figures. This female measures 6 mm. in length, while the largest of the *Thor* specimens was 5 mm.

***Lycaea pulex* Marion.**

Lycaea pulex Marion, 1874, p. 13, pl. 2, fig. 2.

Lycaea similis and *robusta* Claus, 1879a, pp. 185-186.

Lycaea similis Claus, 1887, p. 63, pl. 18, figs. 8-14.

Lycaea robusta Claus, 1887, p. 63, pl. 19, figs. 2-10.

Amphipronoe longicornuta Giles, 1887, p. 220, pl. 5.

Lycaea vincentii and *pulex* Stebbing, 1888, p. 1563, pl. 99; p. 1567.

Lycaea bovallii Chevreux, 1900, p. 157, pl. 18, fig. 3.

Lycaea gracilis Spandl, 1924b, p. 30, fig. 6.
Lycaea bajensis Shoemaker, 1925, p. 46, figs. 16, 17.

Lycaea pulex and *bovallioides* Stephensen, 1925, p. 167; p. 169, fig. 63.

Sixteen specimens were taken between the surface and 1,000 fathoms.

Distribution.—North and South Atlantic; North and South Pacific; Indian Ocean; and Mediterranean. The present records are the first for Bermuda.

Previous authors have considered *similis*, *robusta*, *longicornuta*, *gracilis* and *bajensis* to be synonyms of *pulex*. I believe that *vincentii*, *bovallii* and *bovallioides* should be added to this list. *L. pulex* is a very variable species and all of the species which are now considered synonyms appear to have been founded on variations of *pulex*.

The species *ochracea* Dana, *stebbingi* Bovallius and *pauli* Stebbing are not sufficiently described or figured for recognition.

***Lycaea serrata* Claus.**

Text-figs. 38, 39.

Lycaea serrata Claus, 1879a, p. 185.

Lycaea serrata Claus, 1887, p. 63, pl. 18, figs. 15-20.

Three specimens were taken at depths between 200 and 900 fathoms.

Distribution.—This species was described by Claus from the Bay of Bengal from the male. In 1910 the *Thor* took five males in the Mediterranean (Stephensen 1925, p. 168). The present specimens, two males and a female, from Bermuda are first to be recorded from the Atlantic.

The female of this species has not heretofore been recorded, and, as it does not bear a very close resemblance to the male, I have figured it and given a short description.

Head very large and covered by the eyes except for a narrow median area. Body very much swollen with the mesosome very high and broad. Mesosome somewhat broader than long, with the segments elevated and some of them separated by a membranous depression. Metasome very much narrower than the mesosome, and each segment ending dorsally in a blunt posterior projection. The first five coxal plates produced forward.

Gnathopods 1 and 2 much like those of the male, but the second joint apparently more expanded. Peraeopods 1 and 2 much like those of the male; sixth joint somewhat expanded, but narrowing rather abruptly distally; seventh joint short and blunt. Peraeopod 3 the longest; second joint little expanded; fourth and fifth joints normal, not expanded as in the male; sixth and seventh joints like those of peraeopods 1 and 2. Peraeopod 4 like that of the male with second joint expanded. Peraeopod 5 as in the male, except that perhaps the third to sixth joints are more degenerate, the seventh joint being entirely absent. Uropods and telson as in the male. Length of ovigerous female 10.5 mm. Male 8 mm.

***Tryphana malmii* Boeck.**

Tryphana malmii Boeck, 1870, p. 9.

Tryphana malmii Boeck, 1872, p. 92, pl. 1, fig. 3.

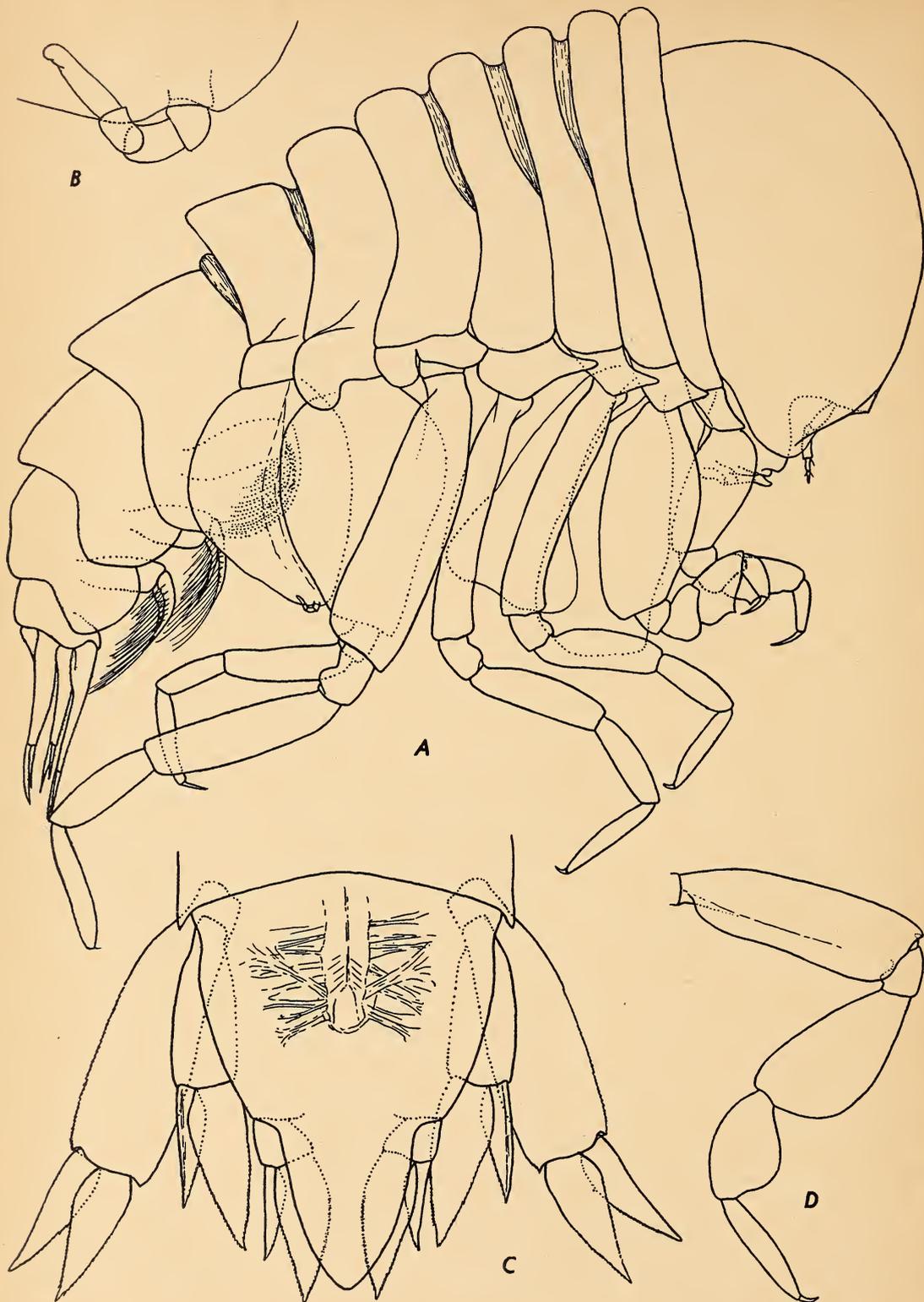
Tryphana boeckii Stebbing, 1888, p. 1539, pl. 194.

Tryphaena malmi Sars, 1895, p. 17, pl. 7.

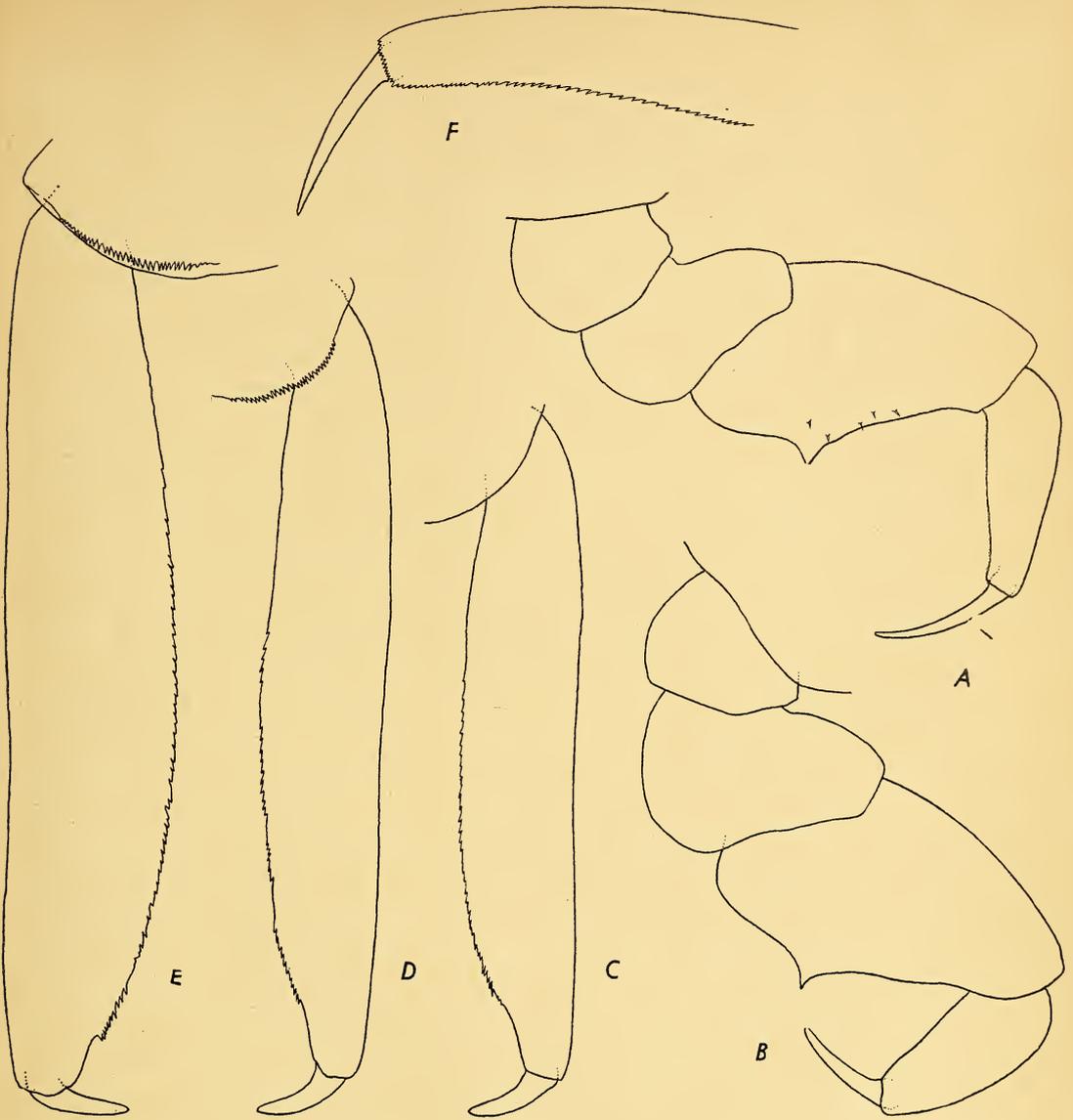
Twelve specimens were taken at depths of 100 and 300 fathoms.

Distribution.—*Tryphana malmii* was not known outside the North Atlantic until Barnard recorded it from New Zealand in 1930. The present Bermuda records are the first for the western part of the North Atlantic.

This species attains a length of 4 or 5 mm. The largest specimen from Bermuda is about 4 mm.



TEXT-FIG. 38. *Lycaea serrata* Claus, female. **A**, entire animal; **B**, end of peraeopod 5; **C**, uropods and telson; male, **D**, peraeopod 3.



TEXT-FIG. 39. *Lycaea serrata* Claus, female. **A**, gnathopod 1; **B**, gnathopod 2; **C**, peraeopod 1; **D**, peraeopod 2; **E**, peraeopod 3; **F**, peraeopod 4.

FAMILY PRONOIDAE.

Eupronoë maculata Claus.

Eupronoë maculata Claus, 1879a, p. 174 (28).

Eupronoë maculata Claus, 1887, p. 52, pl. 13, figs. 1-6.

Eupronoë inscripta Stebbing, 1888, p. 1510, pl. 187.

Six specimens were taken at depths of 50 and 1,000 fathoms.

Distribution.—North and South Atlantic; North and South Pacific; Indian Ocean; and

Mediterranean. The present records are the first for Bermuda.

The largest specimen in the Bermuda material is about 7.5 mm.

Eupronoë minuta Claus.

Eupronoë minuta Claus, 1879a, p. 174 (28).

Eupronoë minuta Claus, 1887, p. 53, pl. 14, figs. 7-12.

Eupronoë minuta Chevreux and Fage, 1925, p. 425, fig. 417.

Nineteen specimens were taken at depths between 100 and 1,000 fathoms.

Distribution.—North Atlantic; Mediterranean; Indian Ocean (Stebbing, *Challenger Rep.*, p. 1516, 40° 3' S., 132° 58' W.); East Indies; New Zealand; Pacific (37° 37' N., 163° 26' W., *pacifica*, Stebbing, *Challenger Rep.* p. 1513). It is new to the North Atlantic.

Eupronoë minuta reaches a length of 4.5 or 5 mm. The Bermuda specimens are about 3.5 mm. Barnard regards *E. pacifica* Stebbing as a young male of *E. minuta*. He is probably correct in believing it synonymous with *E. m.*, but Stebbing's specimen measured about one-fifth of an inch, which is about equal to 5 mm. Barnard's male of *minuta* measured only 4.5 mm., so it would seem that the specimen of *pacifica* was not likely juvenile.

Parapronoë crustulum Claus.

Text-figs. 40, 41.

Parapronoë crustulum Claus, 1879a, p. 177 (31).

Parapronoë atlantica Bovallius, 1887a, p. 42.

Parapronoë crustulum Claus, 1887, p. 55, pl. 15.

Parapronoë crustulum Stebbing, 1888, p. 1530, pl. 193A.

Parapronoë campbelli Stebbing, 1888, p. 1522, pl. 189.

Parapronoë clausi Stebbing, 1888, p. 1526, pl. 190.

Parapronoë clausoides Stebbing, 1888, p. 1229, pl. 191.

Parapronoë similis, *stebbingi*, and *crustulum* Spandl, 1927, p. 219, fig. 38; p. 220, fig. 39; p. 221, fig. 40.

Nineteen specimens were taken at depths between 100 and 1,000 fathoms.

Distribution.—*Parapronoë crustulum* has, under its several synonyms, been recorded from the North and South Atlantic; North Pacific; South Pacific (New Zealand, Australia and East Indies); and the Indian Ocean. The present records are the first from Bermuda.

Many species of *Parapronoë* have been described, but recent authors regard a number of them as synonyms of the earlier species *crustulum*. The last to be added to this list of synonyms is *campbelli* Stebbing, which is regarded by Pirlot as only an immature form of *crustulum* (1939, p. 52).

P. crustulum reaches a length of 20 mm., and the specimens from Bermuda range between 10 and 19 mm.

I have figured a female measuring 19 mm. which appears to be the form described and figured by Stebbing as *clausoides*. Barnard has figured the second joint of the fourth peraeopod of the same form (1932, fig. 165). The distal lobe on the fourth joint of this peraeopod is of about the same proportionate length as shown in

Stebbing's figure (1888, p. 191). The serrations on the distal front margin of the second joint of the fourth peraeopod are a very variable character; in the specimen figured they are very prominent, but in others they are small and obscure, while in still others they are absent altogether. The serrations on the gnathopods also appear to be quite variable. The hind margin of the fifth joint of gnathopod 1 bears very fine serrations distally.

All the specimens bear two small terminal joints on the fifth peraeopods. The uropods and telson are variable in character, but more or less conform to the pattern figured by Stebbing for *clausoides* rather than to that figured by him for *crustulum*.

Sympronoë parva (Claus).

Parapronoë parva Claus, 1879a, p. 177 (31).

Parapronoë parva Claus, 1887, p. 55, pl. 14, figs. 13-18.

Sympronoë parva Stebbing, 1888, p. 1533, pl. 192.

Sympronoë parva and *parva* var. *7-articulata* Stephensen, 1925, p. 162, figs. 59, 60.

Sympronoë anomala Shoemaker, 1925, p. 42, figs. 14, 15.

Sympronoë parva and *parva septemarticulata* Pirlot, 1930, p. 32; 33.

Forty-four specimens were taken at depths between the surface and 500 fathoms.

Distribution.—North and tropical Atlantic; North Pacific; East Indies; Indian Ocean; Mediterranean. It has not heretofore been recorded from Bermuda.

This is a rather small species, measuring about 6 or 7 mm.

FAMILY OXYCEPHALIDAE.

***Oxycephalus piscator* Milne-Edwards.**

Text-figs. 42, 43.

Oxycephalus piscatoris Milne-Edwards, 1830, p. 396.

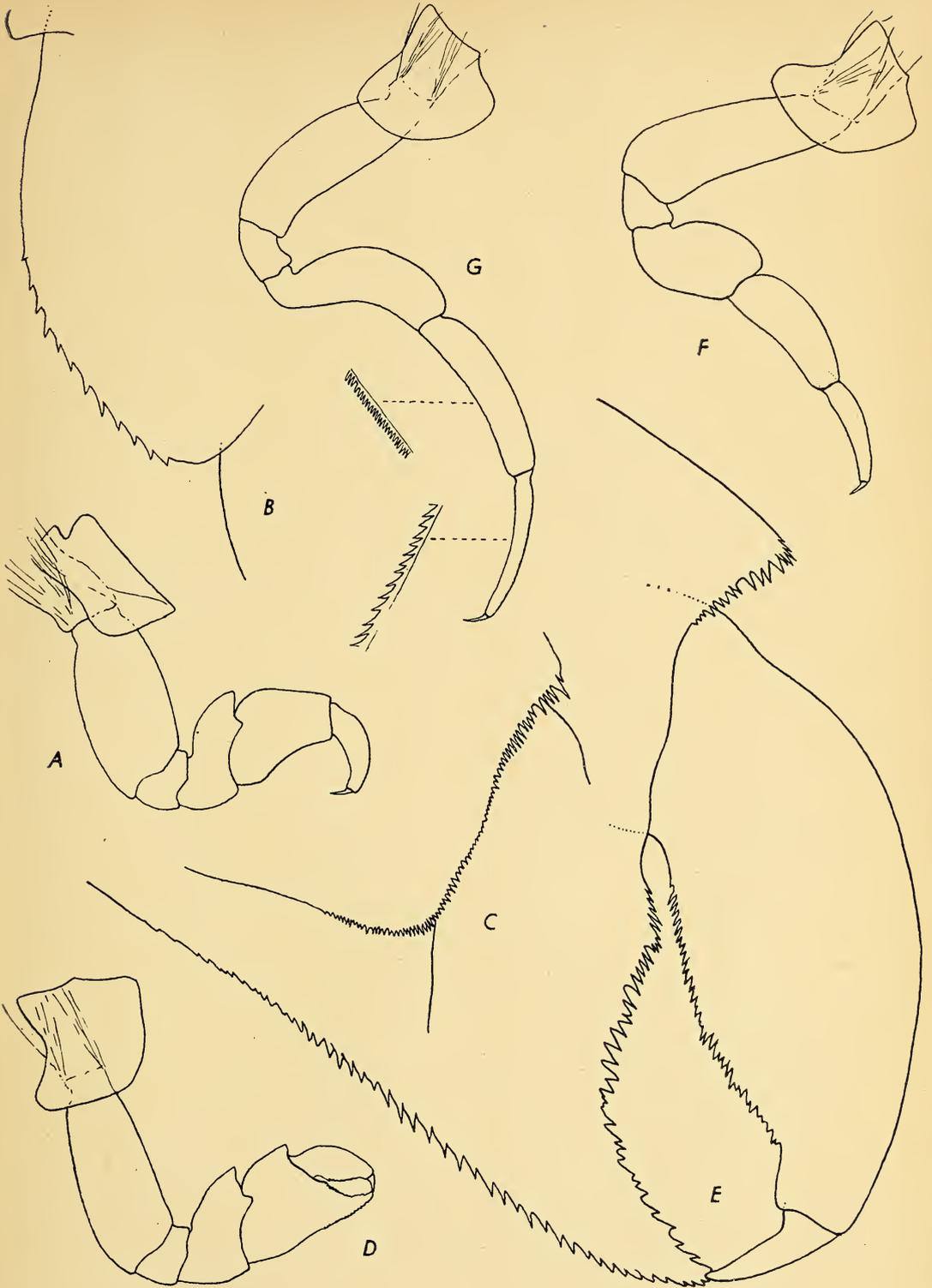
Oxycephalus piscator Bovallius, 1890, p. 56, pl. 1, figs. 8-16, text-figs. 33, 35, 36, 37, 41, 42, 66, 68, 69, 75 (literature and synonymy).

Oxycephalus piscator Spandl, 1927, p. 180, fig. 13.

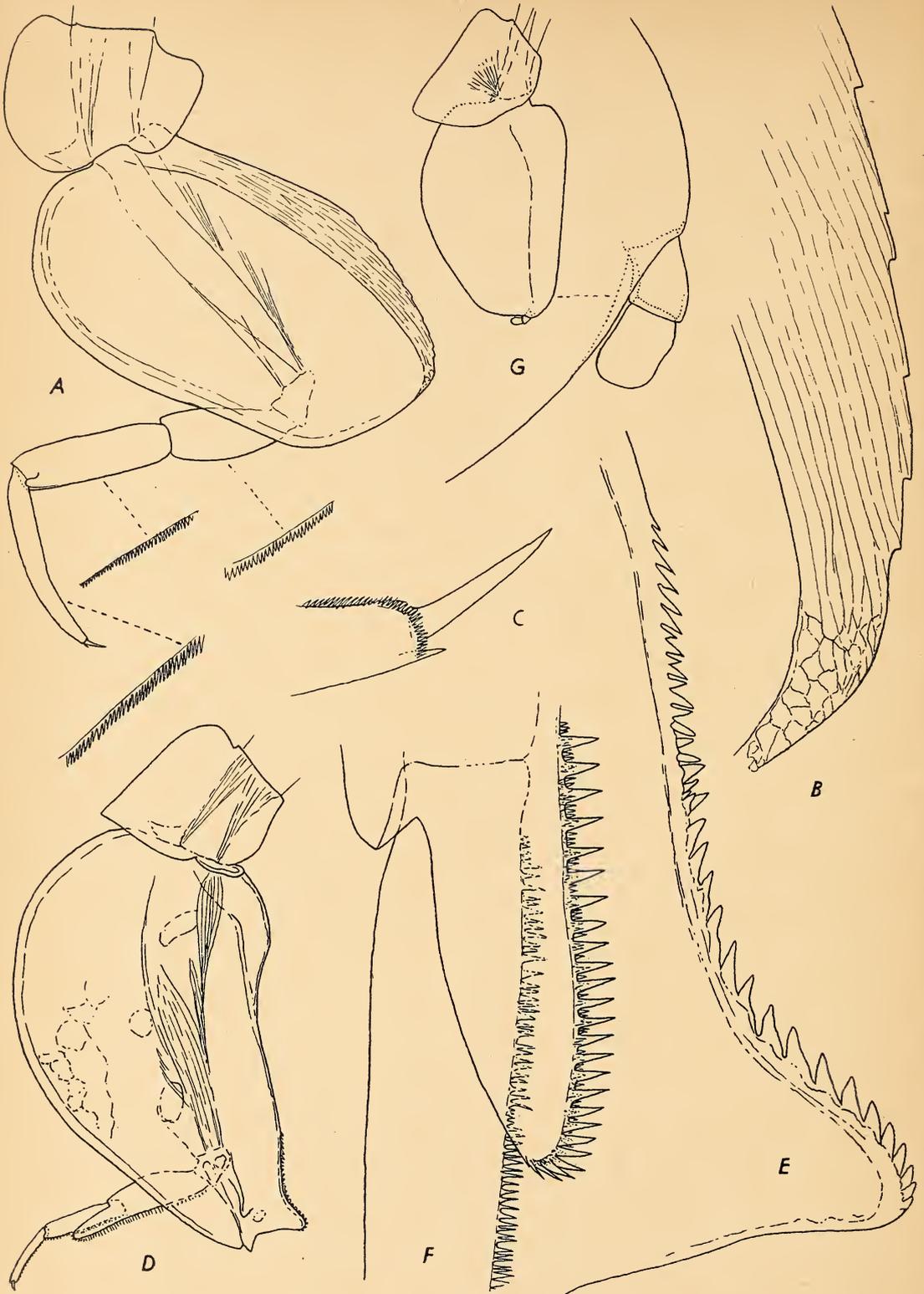
One specimen, a female, was taken at a depth of 800 fathoms.

Distribution.—North Atlantic (41° N., Chevreux), tropical Atlantic, and South Atlantic; subtropical and tropical Pacific; New Zealand (Barnard); Indian Ocean; and Mediterranean.

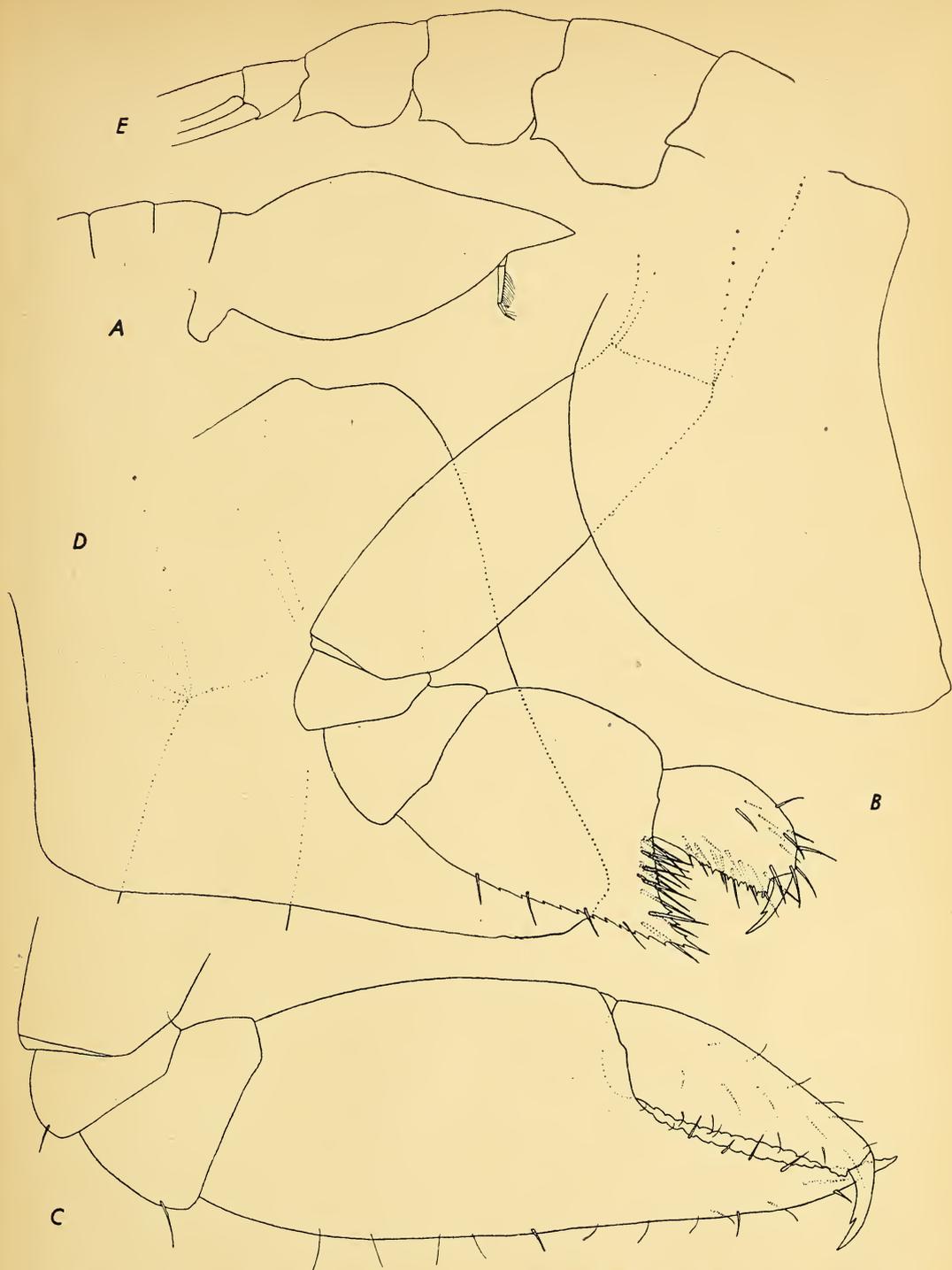
I have identified this single female as *Oxycephalus piscator* M.-E., as it appears to agree in most characters with the description given by Bovallius (1890, p. 64). As the figures given by different authors do not



TEXT-FIG. 40. *Parapronoë crustulum* Claus. **A**, gnathopod 1; **B**, hind margin of fourth joint of gnathopod 1; **C**, serrate distal margin of fifth joint of gnathopod 1; **D**, gnathopod 2; **E**, end of gnathopod 2 enlarged; **F**, pereaeopod 1; **G**, pereaeopod 2.



TEXT-FIG. 41. *Parapronoë crustulum* Claus. **A**, peraeopod 3; **B**, lower front margin of second joint of peraeopod 3; **C**, sixth and seventh joints of peraeopod 3; **D**, peraeopod 4; **E**, lower front margin of second joint of peraeopod 4; **F**, lower front margin of fourth joint, and upper front margin of fifth joint of peraeopod 4; **G**, peraeopod 5.

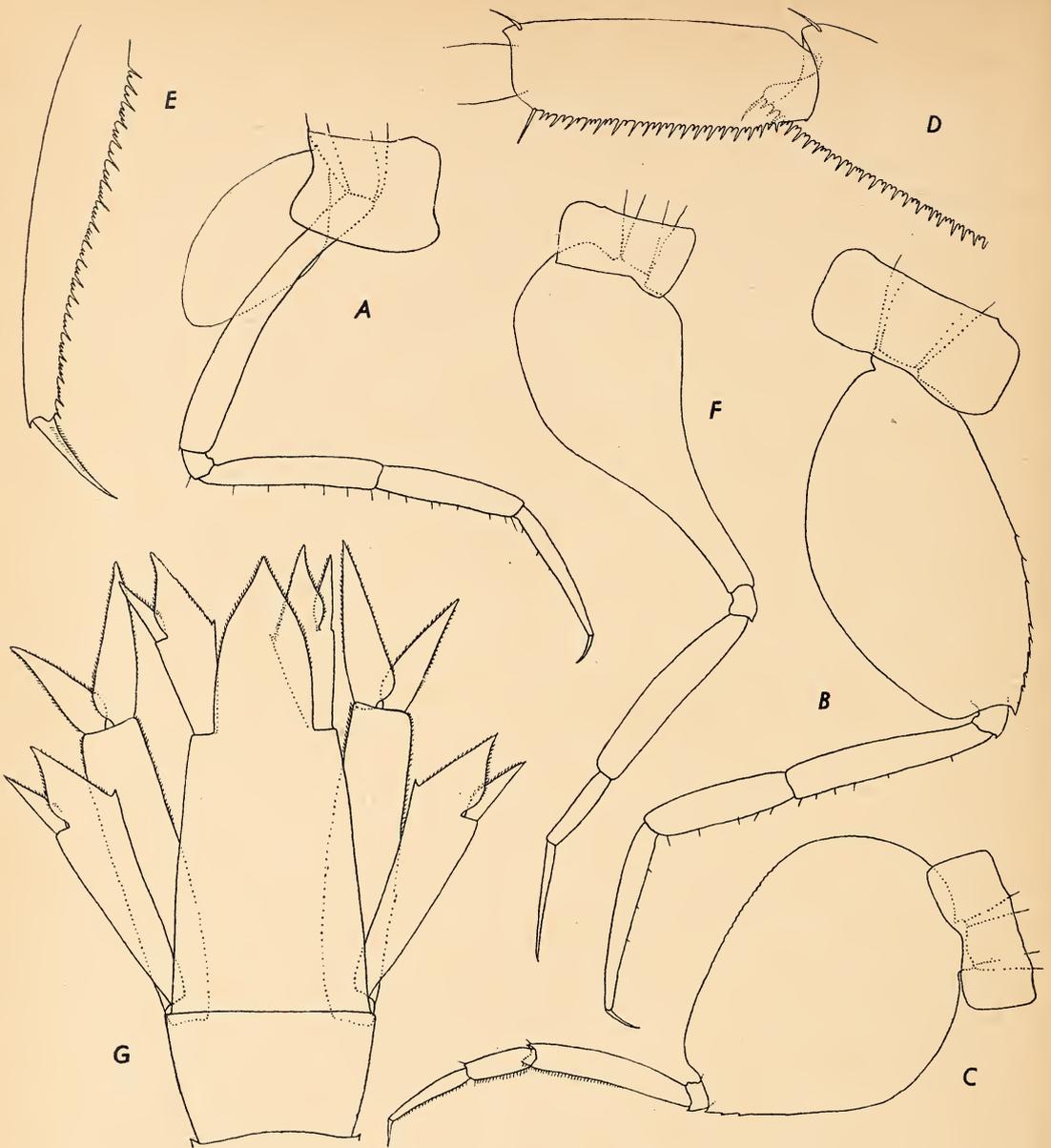


TEXT-FIG. 42. *Oxycephalus piscator* M. Edw., female. **A**, head; **B**, gnathopod 1; **C**, gnathopod 2; **D**, coxal plate 2; **E**, metasome.

agree in some characters, I have figured the present female with the hope that it may help to clear up some of these difficulties.

The head is deeper from top to bottom than is shown by Claus or Bovallius. The

first gnathopods do not have the slight projecting keel at the distal corner of the upper margin of the fifth joint as figured by Spandl (1927, p. 180, fig. 13a). Bovallius mentions a slight keel in his description,



TEXT-FIG. 43. *Oxycephalus piscator* M. Edw., female. **A**, peraeopod 1; **B**, peraeopod 3; **C**, peraeopod 4; **D**, fourth and fifth joints of peraeopod 4; **E**, sixth and seventh joints of peraeopod 4; **F**, peraeopod 5; **G**, uropods and telson.

but does not show it in his figure (1890, pl. 1, fig. 11) which, however, is of the male. In the second gnathopod the fifth joint appears to be proportionately longer than in either the figures of Bovallius or Spandl. The second joint of the fourth peraeopod is proportionately wider than is figured by Claus or Bovallius. Bovallius does not state that the sixth joint of this peraeopod, as well as the fourth and fifth, is serrate, but the present specimen is thus armed, and Spandl has figured this joint as being serrate. The

greatest discrepancy, perhaps, lies in the fifth or last peraeopod. In the present specimen the second joint of this peraeopod is expanded above and quickly narrows down until the distal third is no wider than the following joints. This sudden narrowing does not occur in Bovallius's figure (1890, pl. 1, fig. 14), or in the figure of Spandl (1927, p. 180, fig. 13d). This peraeopod, however, in many of the hyperiids appears to be undergoing degeneration so that too much dependence cannot be placed upon it as a reliable character.

The first three metasome segments do not agree with the figures of either Claus or Bovallius. They approach somewhat those of the figure of a young male given by Bovallius (1890, pl. 1, fig. 9), but are quite unlike those of the figure of the female given by Claus (*O. similis*, 1887, pl. 23, fig. 9) (Bovallius 1890, pl. 1, fig. 10). The description of these three segments given by Bovallius does not agree with Claus's figure. I have figured the metasome of the Bermuda specimen so that the characters of the first three segments may be clearly seen.

Bovallius says that the peduncle of the first uropod is a little longer than the inner ramus, but in the present specimen it is nearly twice as long. In the figure given by Bovallius (1890, p. 39, fig. 75) the peduncle of the second uropod is considerably less than twice the length of the inner ramus, but in the Bermuda specimen it is over twice the length of the inner ramus.

The length of this species is given by Bovallius as 14-20 mm., but Stephensen records a female 25 mm. and Barnard a male 27 mm. The female from Bermuda measures about 17 mm.

Oxycephalus clausi Bovallius.

Oxycephalus piscator Claus, 1887, p. 69, pl. 22, figs. 1-9, pl. 23, figs. 1-8.

Oxycephalus clausi Bovallius, 1887c, p. 35.

Oxycephalus clausi Stebbing, 1888, p. 1583, pl. 202.

Oxycephalus clausi Bovallius, 1890, p. 60, pl. 1, figs. 19-24; pl. 2, fig. 1; p. 21, fig. 4; p. 22, figs. 7 and 8, p. 25, fig. 22; p. 33, fig. 54; p. 36, fig. 65.

Oxycephalus clausii, erythraeus, and *manicini* Cecchini, 1929, p. 5-7, pl. 1-3.

Twenty specimens were taken at depths between 25 and 1,000 fathoms.

Distribution.—This is a very widely distributed species, having been recorded from the North, tropical and South Atlantic; North, tropical and South Pacific; Indian Ocean; and Mediterranean. It has not heretofore been recorded from the Bermuda region, but there are specimens in the National Museum taken by the steamer *Albatross* at Station 2096 (39° 22' 20" N., 70° 52' 20" W.) and by the steamer *Grampus* at Station 10218 (40° 06' N., 68° 06' W.).

The largest females from Bermuda measure about 30 mm., but Barnard records a female from the Southeast Atlantic which measured 36 mm. The males are smaller than the females.

Calamorrhynchus pellucidus Streets.

Calamorrhynchus pellucidus Streets, 1878, p. 285, fig. 5.

Calamorrhynchus rigidus Stebbing, 1888, p. 1600, pl. 206.

Calamorrhynchus pellucidus Bovallius, 1890, p. 73, pl. 2, figs. 14, 15.

Twelve specimens were taken at depths between 50 and 1,000 fathoms.

Distribution.—North and South Atlantic; North Pacific; East Indies; Indian Ocean; and Mediterranean.

Many authors have suspected the identity of *C. pellucidus* and *C. rigidus*, but Pirlot (1938, p. 371) made them synonymous and I believe he was correct in so doing. The distinctions between these two species are all based on more or less variable characters. The length of *pellucidus* was given as 12 mm., while that of *rigidus* was given as nine-tenths of an inch or 23 mm. Stephensen records a female with ova measuring 18 mm. from the North Atlantic (31° 23' N.). The largest female in the present collection is 15 mm., and these specimens constitute the first record of the occurrence of this species in the Bermuda region.

Cranocephalus scleroticus (Streets).

Text-fig. 44.

Oxycephalus scleroticus Streets, 1878, p. 281, pl. II, fig. 3, 3a-c.

Oxycephalus typhoides Claus, 1879a, p. 195.

Oxycephalus typhoides Claus, 1887, p. 72, pl. 24, figs. 11-14.

Cranocephalus goësi Bovallius, 1890, p. 95, pl. IV, figs. 7-9; p. 21, fig. 5; p. 32, fig. 53; p. 38, fig. 72 (male adult).

Stebbingella sclerotica Bovallius, 1890, *Ibid.*, p. 98, pl. IV, figs. 13-16.

Stebbingella typhoides Bovallius, 1890, *Ibid.*, p. 100, pl. IV, figs. 10-12; p. 27, fig. 30.

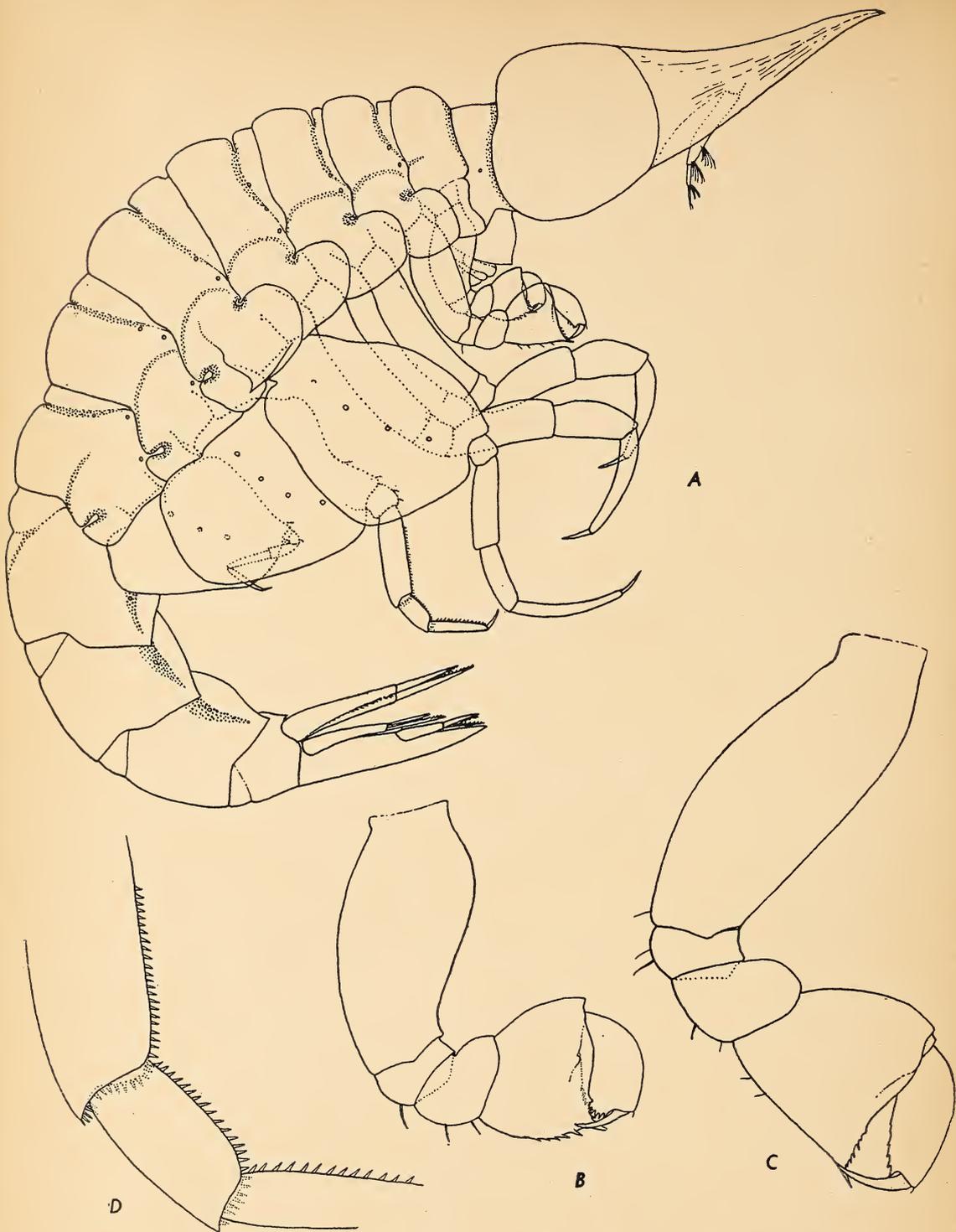
Stebbingella théeli Bovallius, 1890, *Ibid.*, p. 101, pl. V, figs. 1-4; p. 21, fig. 3; p. 35, fig. 60.

Stebbingella typhoides? Stephensen, 1925, p. 199, fig. 76.

One specimen, a female, was taken at a depth of 600 fathoms.

Distribution.—This species was described from the North Pacific between the Hawaiian Islands and Lower California. *Oxycephalus typhoides* was described from Zanzibar and the Mediterranean. *Cranocephalus goësi* was described from the tropical regions of the Atlantic. *Stebbingella théeli* came from the Indian Ocean. Stephensen recorded *Stebbingella typhoides* from the North Atlantic (32° 10' N., 17° 20' W.) and the Mediterranean. Spandl's record was from the South Atlantic (19° S., 20° W.). Pirlot in 1929 recorded *S. typhoides* from off the coast of Portugal. In 1938, Pirlot recorded *Cranocephalus typhoides* from the Sulu Archipelago; and in 1939 he recorded it from Angola. The present record is the first from the western North Atlantic.

Oxycephalus typhoides Claus, *Cranocephalus goësi* Bovallius, and *Stebbingella théeli* Bovallius all appear to me to be synonyms of



TEXT-FIG. 44. *Cranocephalus scleroticus* (Streets), female. **A**, entire animal; **B**, gnathopod 1; **C**, gnathopod 2; **D**, fourth, fifth, and sixth joints of pereopod 4.

Oxycephalus scleroticus Streets. Streets's figures, though very small, show many characters quite correctly. None of the figures of the early authors shows much

detail, so that much is left to be supplied by the imagination. But it appears to me that the figures of the above mentioned species given by their authors have enough

in common to be considered as one and the same species.

Stephensen says of *Stebbingella typhoides* (1925, p. 199), "The epimeral plates of pereopods 1 and 2 seem to be totally coalesced with the corresponding body segments, the three hindermost of which, however, send out a free wing in a posterior direction." In the Bermuda female, as my figure shows, coxal-plate 1 appears to be free, while plates 2-7 are coalesced with their respective body segments. Though all traces of the sutures have disappeared, their original positions are clearly indicated by the deep indentations on the front and hind margins of the body segments. The conspicuous backward-pointing tooth is present on the fifth segment. The metasome, urosome, uropods and telson are as figured by Bovallius for the male of *Stebbingella thééli* (1890, pl. V, fig. 4.).

Bovallius gives 15-21 mm. as the length of *Stebbingella thééli*, while the female from Bermuda is between 9 and 10 mm., which is a trifle longer than the specimens of *S. typhoides* examined by Stephensen, but is about the same as given by Streets for *O. scleroticus*. Notwithstanding the discrepancy in size, my female and the figure of the male of *S. thééli* given by Bovallius (1890, pl. V, fig. 1) show similar characters, except those distinguishing the sexes. Stephensen's figures of *S. typhoides* (1925, p. 200, fig. 76) show practically the same characters. I have carefully figured the Bermuda female so as to clearly show its characters, which may be readily compared with the figures of Streets, Claus and Bovallius. Claus's figure of *O. typhoides* (1887, pl. 24, fig. 11) is so lamentably lacking in detail that one has to rely chiefly on the general form of the animal for comparison.

Pirlet believes that *Oxycephalus bulbosus* Streets may also be synonymous with *S. typhoides*, but Streets's figures of the head and second gnathopod are so different from those of the species under discussion that I cannot accept his view.

***Glossocephalus milne-edwardsi* Bovallius.**

Text-fig. 45.

Glossocephalus milne-edwardsi Bovallius, 1887c, p. 35.

Glossocephalus spiniger Bovallius, 1887c, p. 35.

Elsia indica Giles, 1888, p. 250, pl. 6, figs. 2-4.

Glossocephalus milne-edwardsi Bovallius, 1890, p. 106, pl. 5; p. 22, fig. 6, 6a; p. 38, fig. 71.

Glossocephalus spiniger Bovallius, 1890, p. 108, pl. 5, figs. 6-9; p. 26, fig. 26; p. 29, fig. 43.

Glossocephalus adriaticus Steuer, 1911b, p. 682, pl. 3.

Two specimens, male and female, were taken at depths of 100 and 200 fathoms.

Distribution.—North and South Atlantic; South Pacific; Indian Ocean; Mediterranean; and Red Sea. The present records are the first for the Bermuda region.

As seen from the synonymy, this widely distributed species has been described under several specific names, but they are all now considered synonyms of the original *G. milne-edwardsi*. I have figured the female and some parts of the male in order to show wherein they differ from the previously published figures of this species. The sexes appear to bear a close resemblance to each other, even in the shape of the head. The head of the male figured by Bovallius (1890, pl. 5, fig. 5) is quite different from the head of the male which I have figured. His male measured 17 mm. while mine measures about 11 mm., and this difference in size and maturity may account for the difference in shape of the heads of the two males. The head of both the male and female in side view is produced to a sharp angle and not rounded as Bovallius shows for the female of *G. spiniger* (1890, pl. 5, fig. 6). The lower posterior angles of the three metasome segments in the male are produced and similar to those of the female, and not rounding as shown by Bovallius in his figure of *G. milne-edwardsi* (1890, pl. 5, fig. 5).

***Leptocotis tenuirostris* (Claus).**

Oxycephalus tenuirostris Claus, 1871, p. 155.

Leptocotis spinifera Streets, 1878, p. 283, pl. 2, fig. 4.

Oxycephalus tenuirostris Claus, 1887, p. 71, pl. 24, fig. 2.

Leptocotis tenuirostris Bovallius, 1887c, p. 38.

Leptocotis ambobus Stebbing, 1888, p. 1594, pl. 205.

Dorycephalus lindstromi Bovallius, 1890, p. 76, pl. 2, figs. 16-18; pl. 3, fig. 1, and p. 27, fig. 31; p. 29, figs. 39, 44; p. 33, fig. 56; p. 38, fig. 73; p. 39, fig. 77.

Leptocotis tenuirostris Stephensen, 1925, p. 191, fig. 74 (literature).

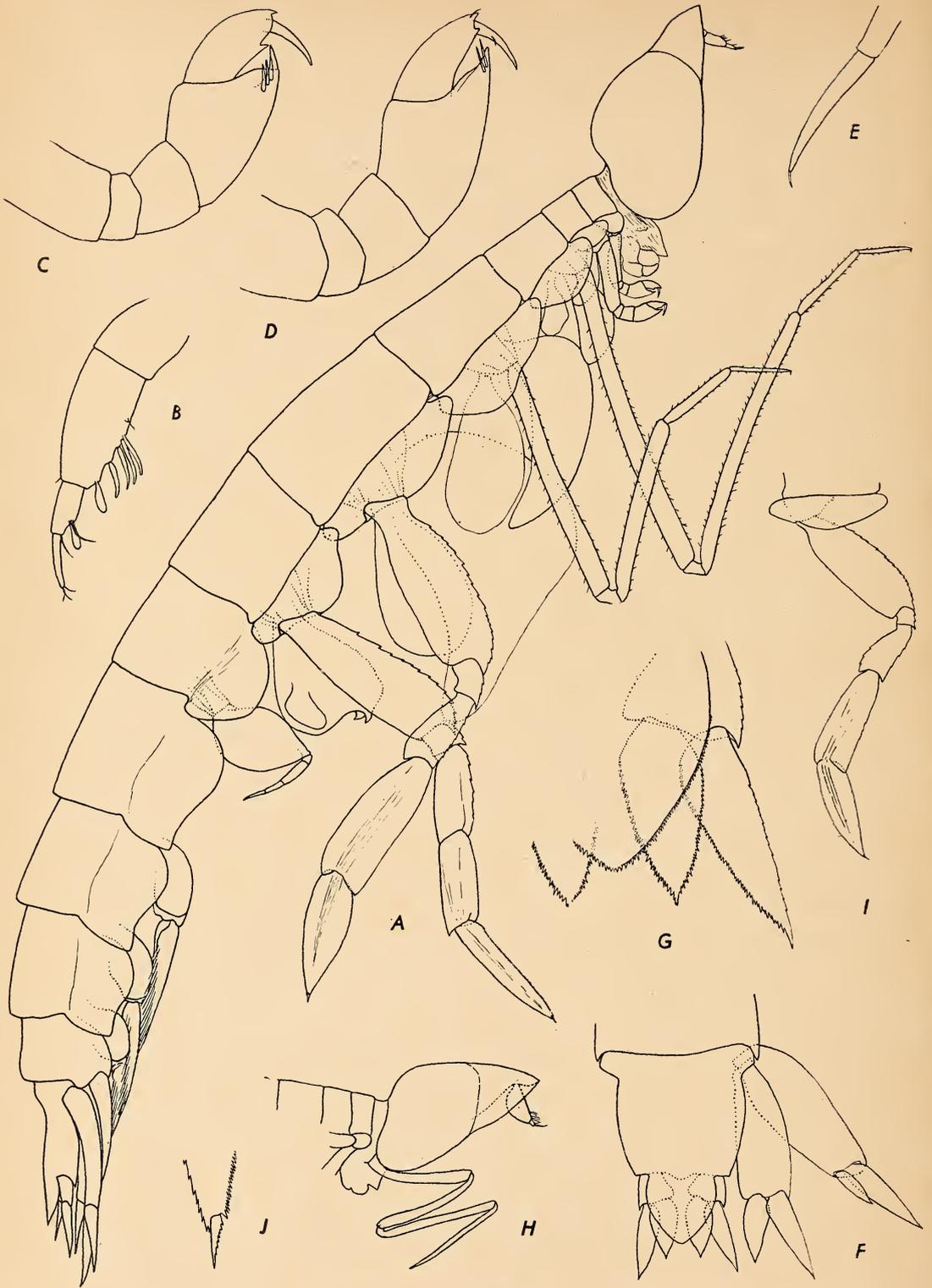
Dorycephalus ambobus Spandl, 1927, p. 203, fig. 28a-c.

Two male specimens were taken at depths of 100 and 900 fathoms.

Distribution.—This is a widely distributed species, having been recorded from the North and South Atlantic; Pacific; East Indian region; and Indian Ocean.

The measurements of *L. tenuirostris* have been given as 10-13 mm. The present specimens, which are both males, measure about 8 mm.

The Bermuda specimens agree very well with Claus's figure (1887, pl. 24, fig. 2) except in the first and second metasome seg-



TEXT-FIG. 45. *Glossocephalus milne-edwardsii* Bovallius, female 14 mm. in length. **A**, entire animal; **B**, antenna 1; **C**, gnathopod 1; **D**, gnathopod 2; **E**, end of peraeopod 5; **F**, uropods and telson; **G**, uropod 3 and telson greatly enlarged; male, **H**, head; **I**, peraeopod 4; **J**, end of sixth joint of peraeopod 4 showing the small seventh joint.

ments, the lower hind corners of which are bluntly angular and not broadly rounding. The third metasome segment is sharply and narrowly produced as in Claus's figure.

***Streetsia challengeri* Stebbing.**

Streetsia challengeri Stebbing, 1888, p. 1603, pl. 207.

Streetsia washingtoni Senna, 1902, p. 15, pl. 2.

Streetsia challengeri Stephensen, 1925, p. 194, fig. 75 (and literature).

Fifteen specimens were taken at depths between 50 and 900 fathoms.

Distribution.—This species was described by Stebbing from northeast of the Hawaiian Islands (35° N., 150° E.). It has since been recorded from the North and South Atlantic; South Pacific; Indian Ocean; Arabian Sea; and the Mediterranean. It has not heretofore been recorded from the Bermuda region.

This is a large, handsome species, Stebbing giving the length as a little over an inch. Barnard, however, records a specimen from the mid-Atlantic measuring 44 mm. The specimens of the present collection are all females, the largest measuring about 27 mm.

***Streetsia porcella* (Claus).**

Oxycephalus porcellus Claus, 1879a, p. 48.

Oxycephalus porcellus Claus, 1887, p. 72, pl. 24, figs. 7-9.

Oxycephalus porcellus Stebbing, 1888, p. 1587 (spec. A), pl. 203.

Streetsia porcella Bovallius, 1890, p. 83, pl. 4, figs. 4-6.

Five specimens were taken at depths from 50 to 1,000 fathoms.

Distribution.—*Streetsia porcella* was described by Claus from Zanzibar. It has since been recorded from the North and South Atlantic; Mediterranean; Sea of Japan (Stephensen, 1925, p. 194); New Zealand; and the Arabian Sea. The present records are the first for the Bermuda region.

Stephensen recorded a female from the Mediterranean 18 mm. in length which appears to be the largest so far taken. The largest specimens from Bermuda are about 14 mm. in length.

***Rhabdosoma whitei* Bate.**

Rhabdosoma whitei Spence Bate, 1862, p. 345, pl. 54, fig. 7.

Xiphocephalus whitei Walker, 1909b, p. 55.

Rhabdosoma whitei Stephensen, 1925, p. 207 (and literature).

Rhabdosoma whitei Spandl, 1927, p. 208, fig. 31.

One specimen was taken at a depth of 50 fathoms.

Distribution.—This species has been recorded from the North and South Atlantic; North and South Pacific; the Indian Ocean; and the Mediterranean. The present records are the first for the Bermuda region.

This is a large species. Stephensen records a male from the Northeast Atlantic measuring 53 mm. and a female from the same region 45 mm. The single specimen, a male, in the present collection, measures 55 mm., which appears to be the largest so far recorded.

***Rhabdosoma brevicaudatum* Stebbing.**

Rhabdosoma brevicaudatum Stebbing, 1888, p. 1612, pl. 208.

Rhabdosoma brevicaudatum Stephensen, 1925, p. 205, figs. 79, 80.

Four female specimens were taken at the surface and at 25 fathoms.

Distribution.—This species was described by Stebbing from a single female taken by the *Challenger* off the west coast of Africa (10° 55' N., 17° 46' W.). It has since been recorded from the Northeast Atlantic and the Mediterranean. It has not heretofore been recorded from the Bermuda region.

Stebbing's specimen measured in an outstretched position four-fifths of an inch, but the rostrum was not entire. A female recorded by Barnard measured 23 mm. with the tip of the rostrum broken off. A female with a perfect rostrum from Bermuda measures in an outstretched position 32 mm. Dr. Stephensen records a young male from the *Thor* material, and says that as far as he knew a mature male has never been taken.

FAMILY PLATYSCELIDAE.

***Platyscelus armatus* var. *inermis* (Claus).**

Text-fig. 46.

Eutyphis armatus Claus, 1879a, p. 156 (10).

Eutyphis armatus Claus, 1887, p. 36, pl. 2, fig. 3-15.

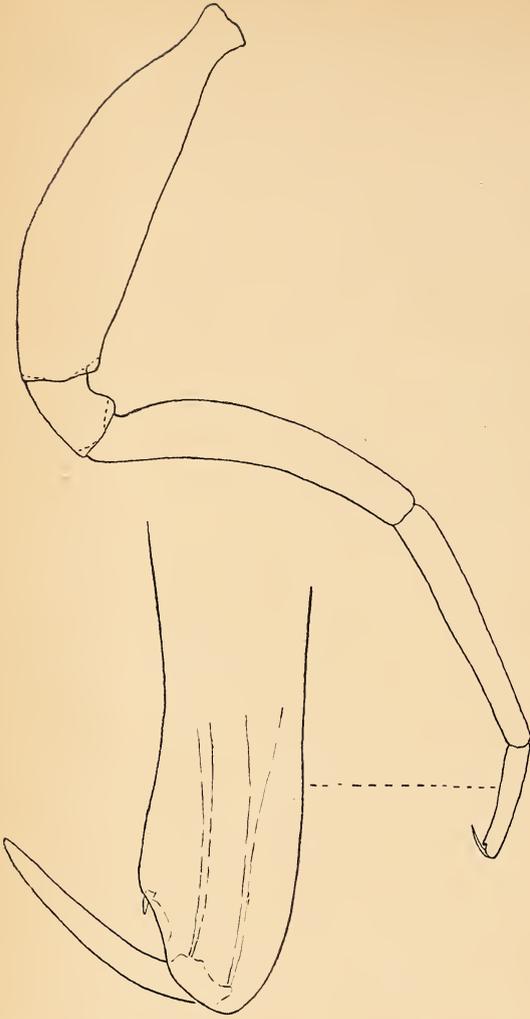
Eutyphis inermis Claus, 1887, p. 37.

Seven specimens, male and female, were taken at depths between 100 and 1,000 fathoms.

Distribution.—North and South Atlantic; North Pacific; South Pacific (Coast of Chile, Claus); Indian Ocean. The present records are the first for the western North Atlantic.

The females from Bermuda measure 15 mm. and the males about 10 mm., which seem to be the largest specimens of the variety *inermis* yet recorded.

The first and second pereopods of *armatus* are quite different from those of *ovoides*. The sixth joint is less than half as long as the fifth and is slightly subchelate, having a very short oblique palm defined by a spine; the second joint is very little expanded.



TEXT-FIG. 46. *Platyscelus armatus* var. *inermis* (Claus). Pereopod 1.

***Platyscelus ovoides* (Claus).**

Text-figs. 47, 48.

Eutyphhis ovoides Claus, 1879a, p. 155 (9).

Eutyphhis globosus Claus, 1879a, p. 159 (12).

Eutyphhis ovoides Claus, 1887, p. 35, pl. 1, pl. 2, figs. 1, 2; pl. 3, figs. 1-3.

Eutyphhis globosus Claus, 1887, p. 38, pl. 3, figs. 4, 15-19.

Thirteen specimens were taken from the surface to 800 fathoms.

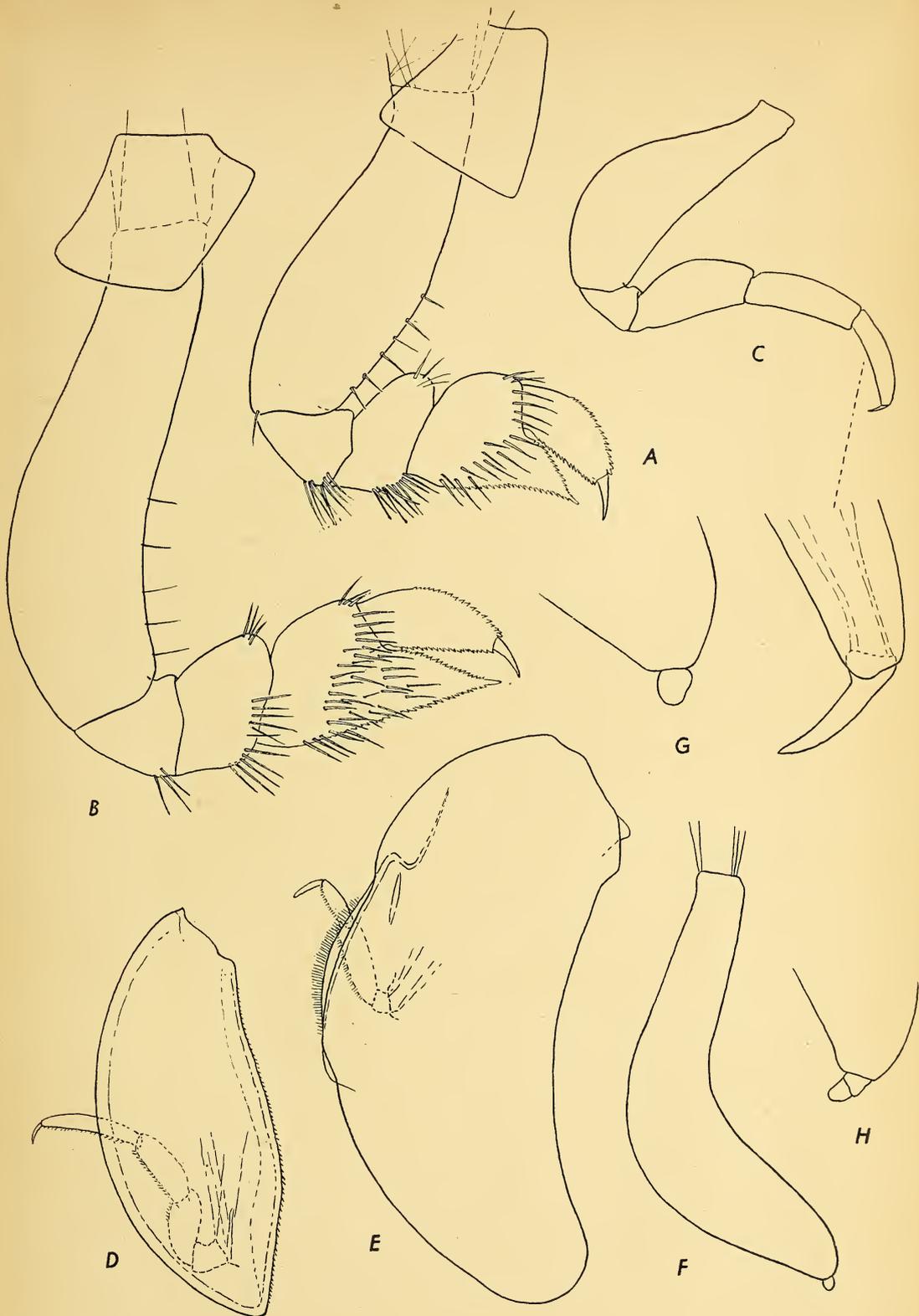
Distribution.—North and South Atlantic; Mediterranean; North Pacific; South Pacific (*intermedius*); Indian Ocean. The present records are the first for the western North Atlantic.

Platyscelus ovoides reaches a length of 20 mm. The present collection contains both male and female specimens measuring from 5-17 mm. All but the three smallest speci-

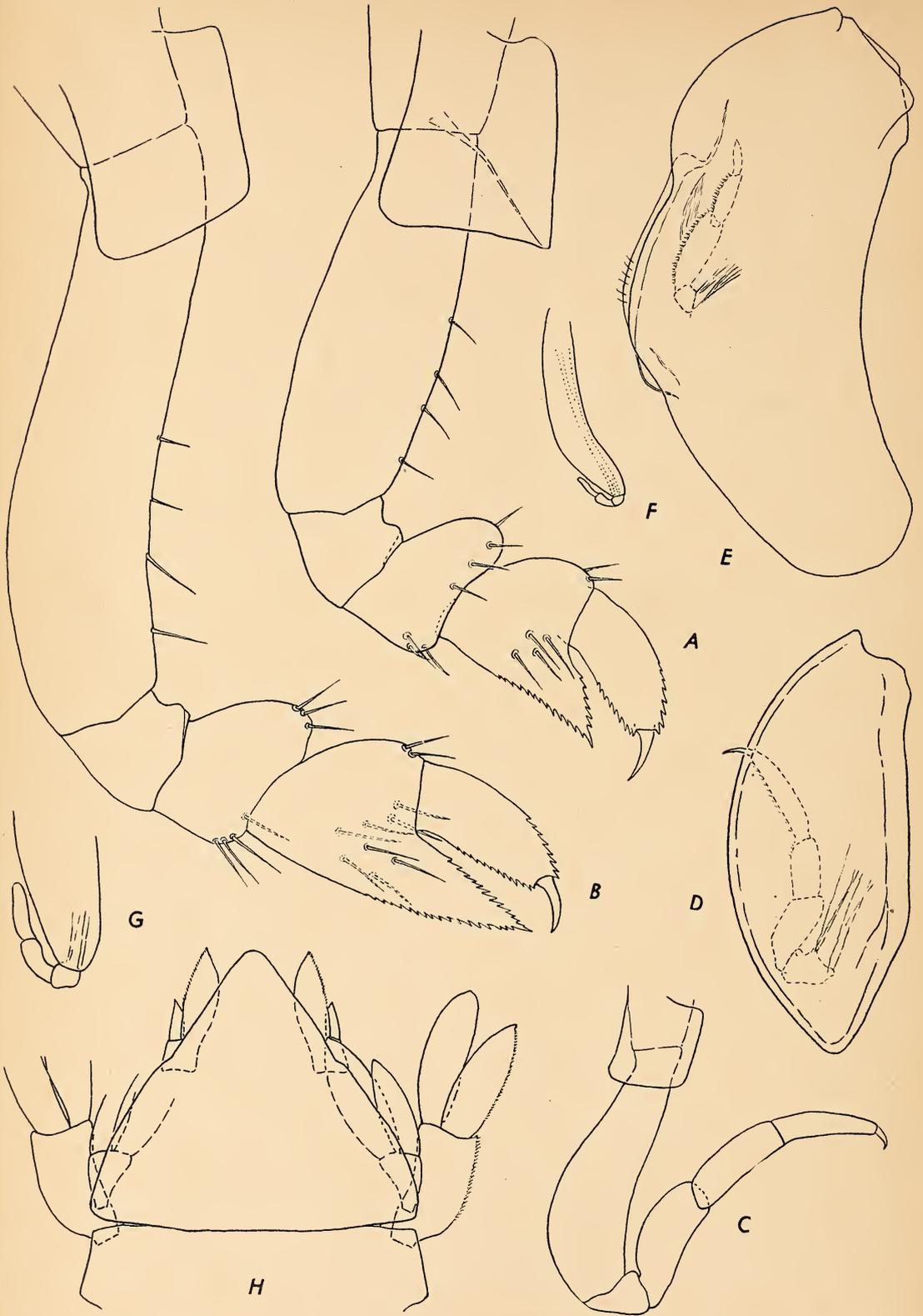
mens, measuring 5-7 mm., are typical *P. ovoides*. These three smallest specimens appear to be what Claus described and figured as *P. globosus*, which undoubtedly is only the small immature stage of *P. ovoides*. The fifth pereopod (seventh of Claus) in *ovoides* is reduced to a narrow curved second joint bearing apically a very small atrophied joint. The fifth pereopod in *globosus* is represented by Claus as having a narrow curved second joint bearing apically three short degenerate joints. I have figured the gnathopods and pereopods of both *ovoides* and *globosus* in order to show that the slight differences existing between them can be readily accounted for by the differences in size and maturity. The female of *ovoides* I have figured is 12 mm. in length and the specimen of *globosus* is 5 mm. In *ovoides* the serrations on the fifth and sixth joints of the first and second gnathopods are more numerous; in the third pereopod the serrations extend from the distal portion of the fourth joint to the sixth joint; in the fourth pereopod the second joint is a little narrower distally and the fringe of setae on the hind margin is much denser.

The female of *ovoides* I have figured carries young, which agree with the young specimen figured by Claus (1887, pl. 2, fig. 1). As will be seen from his figure, the pereopods all possess seven joints and are quite normal in appearance. As the animal grows, a considerable change takes place in the pereopods, but the greatest alteration occurs in the third, fourth and fifth pairs. The second joint of the third and fourth pereopods become greatly enlarged and the succeeding joints become greatly reduced, moving from their apical position to the inner surface of the joint. In the fourth pereopod the alterations are greater than in the third, the third to sixth joints undergoing greater reduction and the seventh joint becoming lost. The fifth pereopod suffers the greatest change, becoming finally a short, narrow lamellar appendage bearing a very small apical knob-like third joint. In this pereopod the terminal joints appear to be lost gradually. The very young possess the normal number of seven. Specimens 5-7 mm. possess a comparatively long narrow second joint and three succeeding reduced and useless joints, the sixth and seventh having been lost. The next largest specimen in the collection, a male measuring about 8.5 mm., has lost the fifth, sixth and seventh joints, leaving only the very greatly reduced third and fourth joints forming a knob-like appendage to the second. Larger specimens possess only a single-jointed knob-like appendage to the second joint.

These facts, in conjunction with the great similarity in the other characters of *ovoides* and *globosus*, leave no doubt that they are



TEXT-FIG. 47. *Platyscelus ovoides* (Claus), female 12 mm. in length. **A**, gnathopod 1; **B**, gnathopod 2; **C**, peraeopod 1; **D**, peraeopod 3; **E**, peraeopod 4; **F**, peraeopod 5; **G**, end of peraeopod 5 greatly enlarged; **H**, end of peraeopod 5 of a male 8.5 mm. in length.



TEXT-FIG. 48. *Platyscelus ovoides* (Claus), immature specimen 5 mm. in length. **A**, gnathopod 1; **B**, gnathopod 2; **C**, peraeopod 1; **D**, peraeopod 3; **E**, peraeopod 4; **F**, peraeopod 5; **G**, end of peraeopod 5 enlarged; **H**, uropods and telson. (The young of this species was described by Claus as *Eutyphis globosus*.)

synonymous. Comparatively few specimens of *globosus* have been recorded, probably for the reason that they have been identified as the young of *ovoides*. The *Thor* took 53 specimens of *globosus* measuring from 5-7 mm. in the Mediterranean, and one in the Atlantic near by. Dr. Stephensen presumed that they were all females, but the specimens were undoubtedly the young of *ovoides* which were too immature to be sexually determined. Claus gives the sexes of *ovoides* but does not mention the sex of *globosus*, evidently for the reason that his specimen was immature and the sex could not be determined.

The uropods and telson are the same in both *ovoides* and *globosus* except that the rami are somewhat narrower in *globosus*, as they likewise are in *Platyscelus*, sp. jun. Stephensen (1925, fig. 84, Us-T). These specimens, *Platyscelus*, sp. jun., measuring 2.5 mm., from the Mediterranean, are undoubtedly the very young of *P. ovoides*, which still possess the seven joints to the fifth peraeopod (1925, fig. 84, p. 7).

The species, *P. intermedius*, described by Thomson from New Zealand in 1879 is probably the same as *P. ovoides* Claus, but the species was not figured and the description is not sufficient for the determination of the species.

***Platyscelus serratulus* Stebbing.**

Eutyphis serratus Claus, 1879a, p. 157 (11).

Eutyphis serratus Claus, 1887, p. 37, pl. 3, figs. 5-14.

Platyscelus serratulus Stebbing, 1888, p. 1470.

Platyscelus serratulus Chevreux and Fage, 1925, p. 422, fig. 414.

Platyscelus dubius Shoemaker, 1925, p. 51, figs. 20, 21.

One specimen was taken at a depth of 800 fathoms.

Distribution.—North Atlantic; South Atlantic; North Pacific (*dubius*); South Pacific; Indian Ocean; Red Sea; Mediterranean. The present records are the first for Bermuda.

Platyscelus serratulus reaches a length of 6 mm. The single specimen, a male, taken at Bermuda is about 5 mm. in length.

***Amphithyrus bispinosus* Claus.**

Amphithyrus bispinosus Claus, 1879a, p. 161 (15).

Amphithyrus bispinosus Claus, 1887, p. 41, pl. 6, figs. 4-16.

One specimen was taken at a depth of 300 fathoms.

Distribution.—North and tropical Atlantic; Mediterranean; East Indies; New Zealand; Arabian Sea; Bay of Bengal; Hong-kong-Shanghai (Stephensen). It is new to the Bermuda area.

This is a small species measuring about 3 mm.

***Amphithyrus similis* Claus.**

Amphithyrus similis Claus, 1879a, p. 162 (16).

Amphithyrus similis Claus, 1887, p. 42, pl. 7, figs. 10-12.

Five specimens were taken at depths between 100 and 1,000 fathoms.

Distribution.—North Atlantic; Mediterranean; Red Sea. The present records are the first for the western North Atlantic.

This species measures about 3 mm. in length, which is the size of the largest specimens in the Bermuda material.

***Tetrathyrus forcipatus* Claus.**

Tetrathyrus forcipatus Claus, 1879a, p. 160 (14).

Tetrathyrus forcipatus Claus, 1887, p. 40, pl. 5, figs. 10-13, pl. 6, figs. 1-3.

Tetrathyrus sancti-josephi Shoemaker, 1925, p. 54, figs. 22-24.

Tetrathyrus forcipatus Chevreux and Fage, 1925, p. 422, fig. 415.

Two specimens were taken at depths of 25 and 800 fathoms.

Distribution.—North, tropical and South Atlantic; Mediterranean; Red Sea; Northern Arabian Sea; East Indies; New Zealand; and North Pacific (California, *T. sancti-josephi*). It is new to the Bermuda region.

This species measures from 3 to 4.5 mm.

***Hemityphis rapax* (Milne-Edwards).**

Typhis rapax Milne Edwards, 1830, p. 395.

Typhis rapax Milne Edwards, 1840, p. 97.

Dithyrus tenuimanus and *crustulum* Bovalius, 1887c, p. 46.

Schizoscelus rapax Bovallius, 1887c, p. 44.

Hemityphis tenuimanus Claus, 1887, p. 38, pl. 4, figs. 1-13.

Hemityphis crustulatus Claus, 1887, p. 39, pl. 4, figs. 14-22.

Hemityphis rapax Pirlot, 1930, p. 37 (literature).

One specimen was taken at a depth of 50 fathoms.

Distribution.—North and South Atlantic; Mediterranean; New Zealand; East Indies; Indian Ocean; Arabian Sea. It has not heretofore been recorded from the western North Atlantic.

Hemityphis rapax is a small species measuring about 5 mm. in length. The single specimen of the present collection, which is a male, is about 4.5 mm.

***Paratyphis maculatus* Claus.**

Paratyphis maculatus Claus, 1879a, p. 160 (14).

Paratyphis maculatus Claus, 1887, p. 39, pl. 5, figs. 1-9.

?*Paratyphis parvus* Claus, 1887, p. 40.

Two male specimens were taken at depths of 400 and 600 fathoms.

Distribution.—North and South Atlantic; East Indies; Gulf of Aden. It is new to the Bermuda region.

This species ranges from 2 to 4 mm. in length. The specimens from Bermuda (both males) are about 3.5 mm.

These two males agree with Claus's figures (1887, pl. 5, figs. 1-9) and bear the five brownish-red spots on the side of the metasome. It appears that several of the subsequent species of *Paratyphis* are distinguished by very flimsy character modifications and no doubt sooner or later will be made synonyms of *maculatus*, in which category *parvus* has already been doubtfully placed. In some of the genera of hyperiids remarkable modifications have taken place both in the body and appendages. Under such circumstances it is perhaps not to be expected that the same appendage of every individual of a species should undergo precisely the same amount of modification. Some authors have been inclined to regard slight differences in a character as of too great significance, and in some instances species have been founded on such slight modifications. Such discrepancies should, by all means, be noted, but it would seem advisable to place such specimens in the species with which they so nearly agree, if, by a slight stretch of the imagination, this could be done. This would tend to lessen the existing confusion in some of the genera and would curtail the mounting list of synonyms.

FAMILY THYROPIDAE.

Parascelus edwardsii Claus.

Parascelus edwardsii Claus, 1879a, p. 164 (18).

Parascelus edwardsii Claus, 1887, p. 46, pl. 10, figs. 1-11.

Parascelus zebu Stebbing, 1888, p. 1496, pl. 185.

Two specimens were taken, one at the surface and one at 100 fathoms.

Distribution.—North Atlantic; tropical Atlantic; Mediterranean; Red Sea; East Indies; South Pacific; North Pacific. The present specimens are the first taken in the western part of the North Atlantic.

The male and female recorded by Barnard from the South Pacific measured 6 and 5 mm. respectively. The specimens recorded by Stephensen from the Mediterranean and Atlantic measured from 3 to 6 mm. Those which I have recorded from Bermuda are about 4 mm.

Parascelus typhoides Claus.

Parascelus typhoides Claus, 1879a, p. 165 (19).

Parascelus typhoides Claus, 1887, p. 46, pl. 9, figs. 12-16, pl. 10, figs. 12-13.

One specimen was taken at a depth of 600 fathoms.

Distribution.—North and South Atlantic; Mediterranean; Red Sea. It is new to the western North Atlantic.

The single specimen (a female) taken by the *Thor* measured 6.5 mm. (Stephensen). The ovigerous female recorded by Barnard measured 5 mm. The Bermuda specimen, a male, is about 3.5 mm.

Thyropus sphaeroma (Claus).

Tanyscelus sphaeroma Claus, 1879a, p. 163 (17).

Tanyscelus sphaeroma Claus, 1887, p. 45, pl. 8, figs. 1-11.

Thyropus sphaeroma Bovallius, 1887c, p. 43.

Thyropus danae Stebbing, 1888, p. 1492, pl. 210C.

Thyropus sphaeroma Spandl, 1927, p. 259, figs. 53, 54; p. 284, fig. 63.

One specimen was taken at a depth of 300 fathoms.

Distribution.—North Atlantic; South Atlantic (36° S., 51° W., Barnard); East Indies; Indian Ocean; Northern Arabian Sea. The present record is the first from the western North Atlantic. Barnard has recorded males measuring 7 mm. in length. The Bermuda specimen, a female, is about 6 mm.

Thyropus diaphanus, the genotype, described by Dana from the tropical Atlantic (4° S., 21° W.), differs from *T. sphaeroma* principally in the third uropods, the rami of which he says are subequal, and are so shown by his figures. He gives the length as one-quarter inch, which is a little over 6 mm. It is possible that Dana's observation on this character may not be correct, and that *diaphanus* and *sphaeroma* may be synonymous.

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18.

The *Meliponidae* (Stingless Bees) of Caripito, Northeastern Venezuela.¹

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[This is a contribution from the Forty-third or Third Venezuelan Expedition of the Department of Tropical Research of the New York Zoological Society made under the direction of Dr. William Beebe. The expedition was sponsored by grants from the Committee for Inter-American Artistic and Intellectual Relations and from four trustees of the Zoological Society, George C. Clark, Childs Frick, Laurence S. Rockefeller and Herbert Satterlee, and by invaluable assistance from the Standard Oil Companies of New Jersey and Venezuela.]

The following stingless bees were collected in Caripito, State of Monagas, Venezuela, during a seven months' stay from February to September, 1942. It is interesting to note that of the six forms taken, one species and two subspecies were not taken by the Department in British Guiana approximately 400 miles away.²

The author's thanks go to Mr. Herbert F. Schwartz of The American Museum of Natural History for his identification of the specimens.

Melipona fasciata lateralis variety *kangarumensis* Cockerell.

Three females captured on March 24. Their nest was within a termite's nest. The species ranges south through the Guianas and Brazil.

¹ Contribution No. 730, Department of Tropical Research, New York Zoological Society.

² See Herbert F. Schwartz, "The Stingless Bees (*Meliponidae*) of British Guiana and Some Related Forms," *Bull. Amer. Mus. Nat. Hist.*, Vol. LXXIV, Art. VII, pp. 437-508, (1938).

Melipona fasciata trinitatis Cockerell.

Two specimens, both workers, taken on May 12 and June 13. Described from Trinidad. This is the first record from the South American mainland.

Trigona (Trigona) amalthea (Oliver).

One worker captured on March 3. This species has a very wide distribution, being found from Mexico to Argentina.

Trigona (Trigona) hyalinata variety *branneri* Cockerell.

One female collected on March 3. This species has been reported from Brazil, Peru, Guianas and Venezuela.

Trigona (Trigona) trinidadensis trinidadensis (Provancher).

Twelve workers captured on the following dates: February 28, March 15, May 15, July 1 (3 specimens), August 19 (2), August 25 and August 30 (3). Widely distributed in South America although we did not collect it at Kartabo, British Guiana.

Trigona (Tetragona) nigra variety *paupera* (Provancher).

Three workers captured on the following dates: April 14, April 15 and May 2. The last specimen was taken from a nest in the laboratory roof. This variety has been reported from Colombia.

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