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The Sphingidae (Moths) of Kartabo, Brit[ish Guiana] and Caripito, Venezuela[1]

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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,

[1] Contribution 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 (*Boletin de la Sociedad Venezolana 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 (*Boletin 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; Caripto, 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 northeastern part of South America. Hitherto,

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

Protoparce franciscae 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-Shäffer).

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 (*Boletin 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.

Amplypterus 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.

Amplypterus 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 Amerca.

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 phorbas (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 (*Boletin de la Sociedad Venezolana de Ciencias Naturales*, Tomo IV, No. 32, p. 305, Caracas, 1938) at Caripito 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, unque.

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]

WILLIAM BEEBE.

Director, Department of Tropical Research, New York Zoological Society

(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.

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[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.

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 (*Boletin de la Sociedad Venezolana de Ciencias Naturales*, Tomo IV, No. 32, p. 305, Caracas, 1938) at Caripito 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, unque. 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]

WILLIAM BEEBE.

Director, Department of Tropical Research, New York Zoological Society

(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.

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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 artifically 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 waggling 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, black-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.

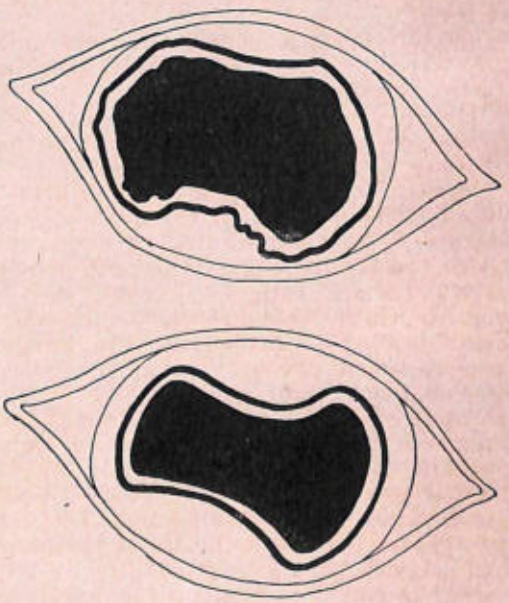
Specimen No. 182: Dorsally the head is yellow olive green, the mid-back between shoulders the same, merging posteriorly into golden brown on the rump. The tail is raw umber with a few black spots. Face pale cinnamon buff. The black lateral stripe extends down the tail as a series of black spots, which 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.

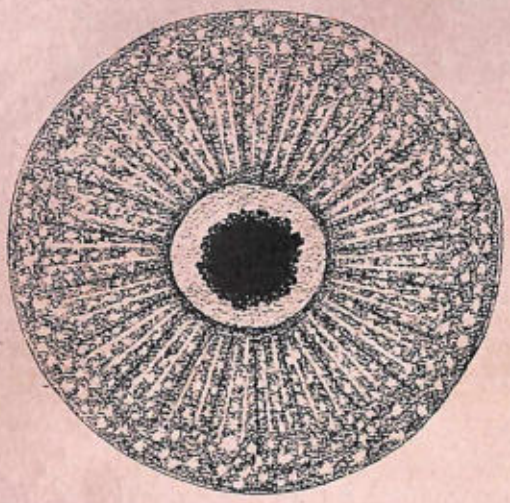
Iris and Pupil: A very distinctive character of ameivas of all ages and both sexes is the shape of the pupil, or perhaps more correctly, of the iris. The iris is golden, finely vermiculated with reddish and black flecks. In lizards of medium and large size there is a wide, conspicuous pupil frame of 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. × 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.

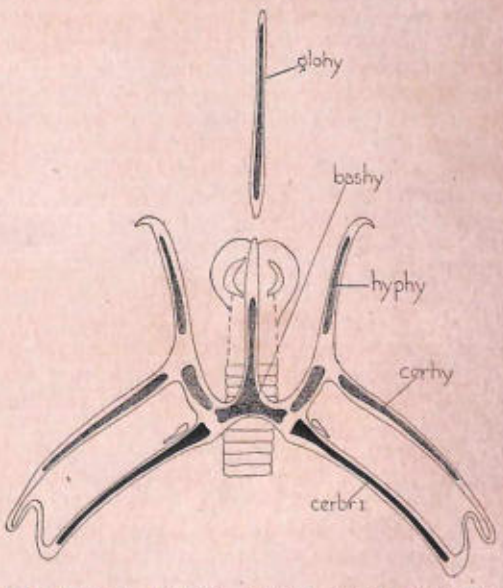
The fundus oculi of *Cnemidophorus* and *Kentropyx* are indistinguishable from that of *Ameiva.*

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 guinaensis* 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 common 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 tapeworms 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).

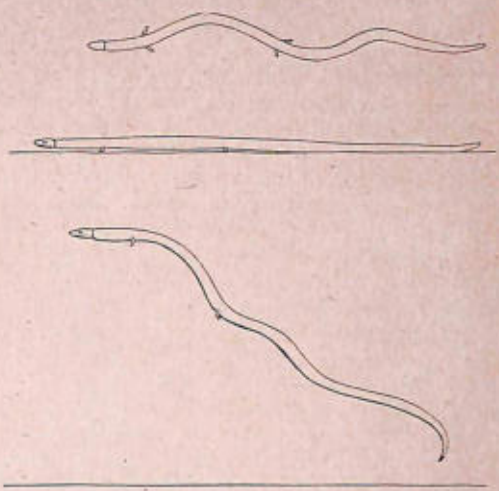
When touched or alarmed at the approach of a hand it often whirled the front half of its body about in a snake-like fashion and started off in a new direction, and in a wholly different method of progression. This was serpentine, the body moving in successive lateral waves, the legs dangling uselessly, 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. × .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.

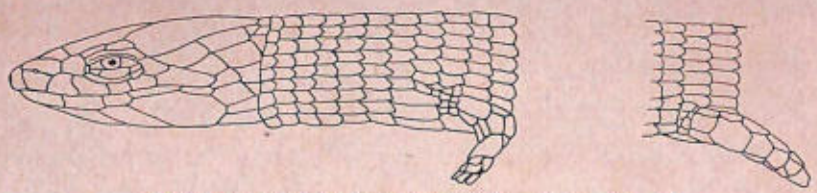
Food: In the stomach of No. 3130 was a small grub, many microlepidopteran scales and numerous fine particles of quartz. No. 3131 had eaten four ants and two sowbugs. A third *Bachia* had eaten two grubs and three termites.

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

Percentages of Length				
Body	*Tail*	*Legs*	*Weight*	
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. × 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.

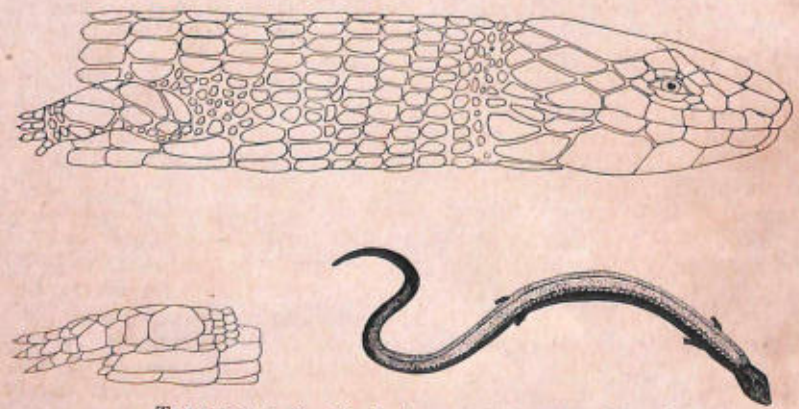
Color in Life: Chestnut brown above with a wide band down the back of dull cinnamon gray stippled with chestnut, fading into solid chestnut toward tail. A narrow stripe of chestnut down center of dorsal band. The band is edged on each side with a linear series of arrowheads of pale olive buff. Inner 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 adjacence 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.

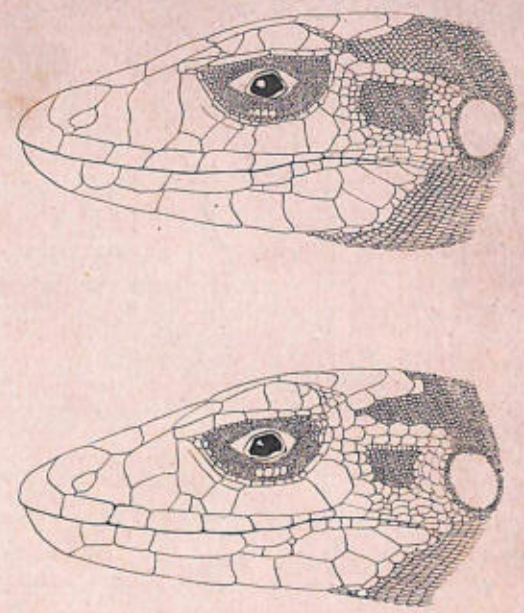
Detachment, loss and subsequent regeneration of the tail is as effective in *Cnemidophorous* as in other related lizards. Usually if shot, or if the creature is grasped awkwardly in the hand, the tail breaks off and if free, goes through a period of violent activity, wriggling about and snapping clear 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.

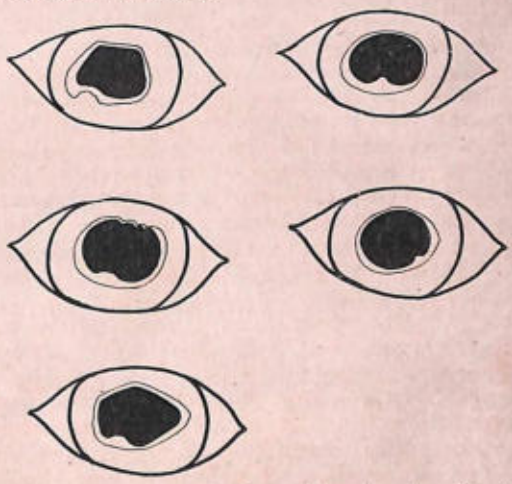
Cat. No.	2972		2986		2956		2968	
Sex	Male, juv.		Male, br.		Male, br.		Female, br.	
Total Length	148		290		280		197	
Head	12.5	8.4%	27	9.3%	26	9.3%	18	9.1%
Snout to Vent	43	29%	89	30.7%	85	30.4%	67	34.9%
Tail	105	71%	201	69.3%	195	69.6%	128	65.1%
Eye Diameter	2	1.3%	3.5	1.2%	3.8	1.4%	2.9	1.5%
Fore Limb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



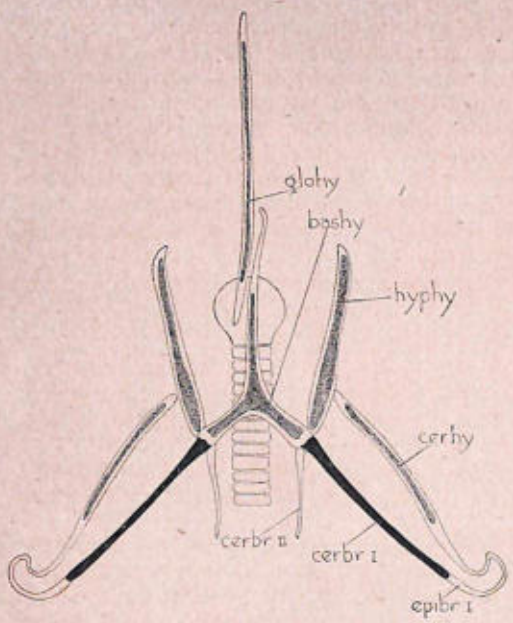
TEXT-FIG. 8. *Cnemidophorus lemniscatus*. Pupil outlines of the eyes of five individuals, showing variation in shape. × 4.

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. × 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 gular fold, upper labials, sub-occulars 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

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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 débris 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.

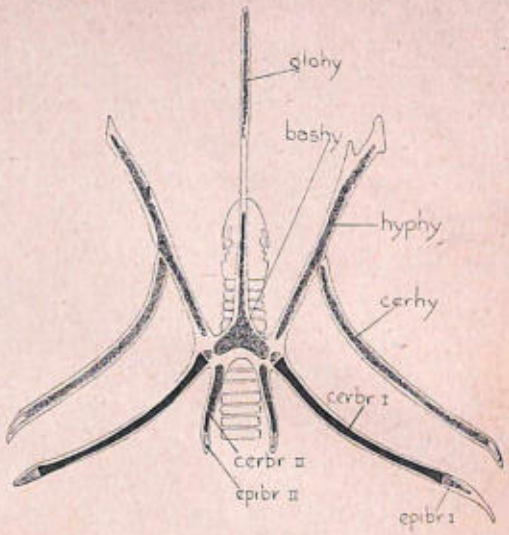
Occurrence: A rare lizard, of which I have notes on only five specimens at Kartabo and none at Caripito. It lives in holes in the banks of jungle streams and rivers and is a swimming lizard.

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 pupilar 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 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 outward 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.



TEXT-FIG. 11. *Neusticurus rudis*. Hyoid of adult. × 4.

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 poecilid 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.

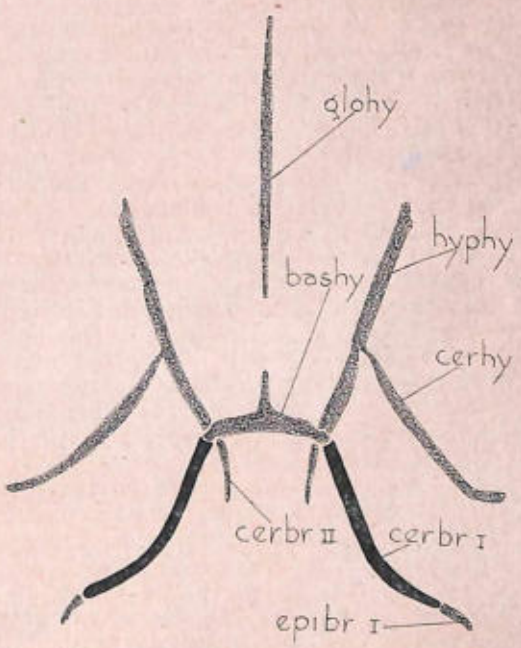
Measurements and Color in Life: Specimen No. 30,110, Caripito, May 18, 1942, Color Plate 1577. Total length (renewed tail) 115 mm., head and body 50, tail 65 mm. Body above in general black, with two lines of creamy white, and tail brilliant cobalt blue. The two upper white lines extend around the tip 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. × 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 increase 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 Ridgeway'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 chartreuse 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.

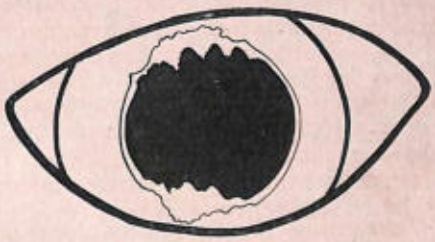
Male breeding, No. 2961, length 730 mm., June 16, 1924. Black above. Head scales edged with yellowish-green. Sides of snout mottled with olive and dark gray. A dark line backward over tympanum. Ten very faint cross bands on body, faintest on lower back, composed of small, scale markings which become 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).

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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 material. The shell was soft and leathery and wherever freed of débris 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 débris or down one or two feet in the ground, and also in the nests of attas and other ants.

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.)

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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 débris or down one or two feet in the ground, and also in the nests of attas and other ants.

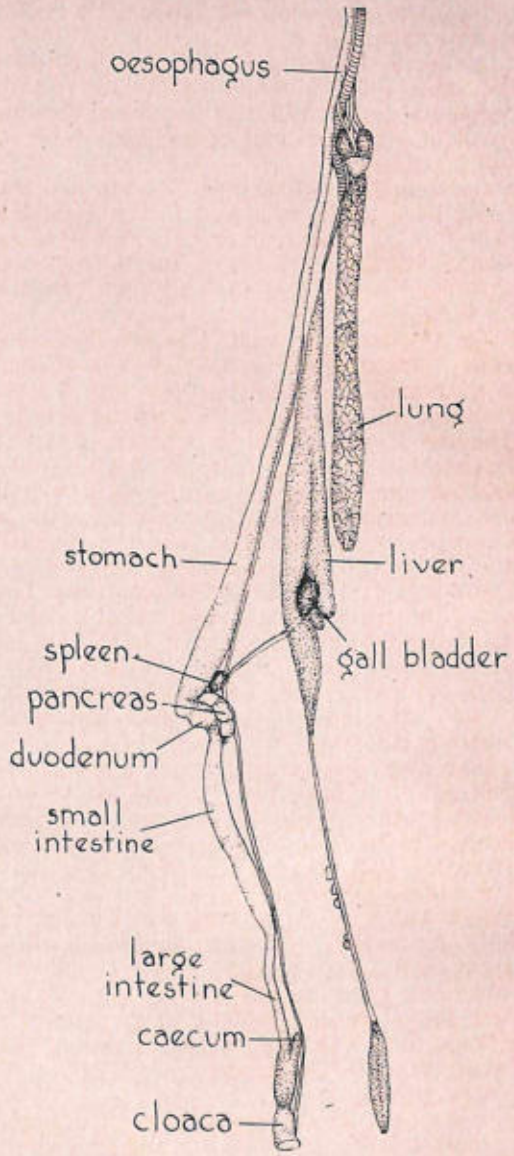
They are legless, snake- or worm-like lizards, growing to two feet in length, thick bodied, cylindrical, with minute eyes, equal ended, and are dark brown above, shading to creamy white beneath.

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 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.



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

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 pyloris. 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 (Akawai 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 dominately brown with many irregular lines and flecks of ivory white, many extending clear across. Below same, with colors reversed, many extending across.

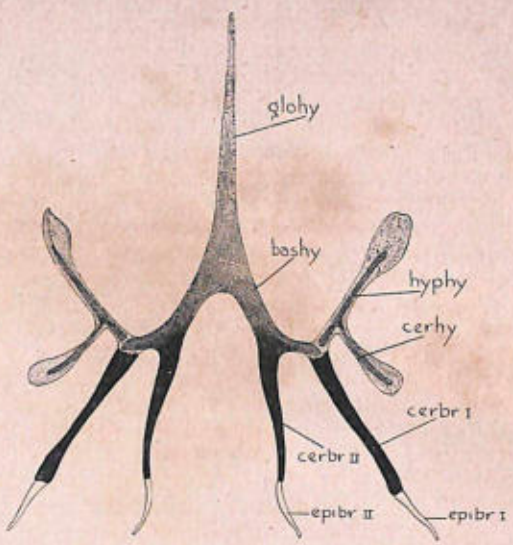
Specimen No. 30,194, Caripito, length 180 mm. Head back to fourth annulus, chin and throat immaculate. Above blackish-brown, with many flecks and short lines. Below white, unspotted. Dorsal black visible as short lateral lines here and there, crossing mid-ventral only four times under tail.

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. × 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

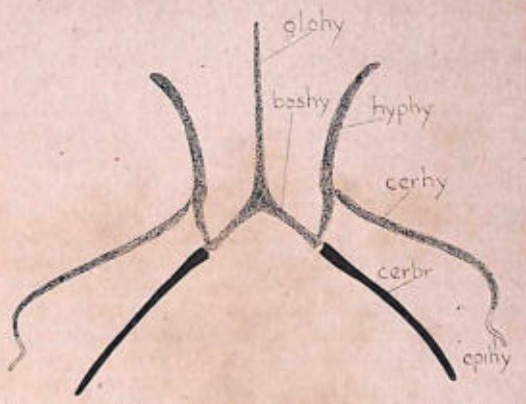
protectively colored that they are probably more common than observations would indicate. They are terrestrial inhabitants of the jungle floor. Characteristically their scales are smooth and flat. Above they are olive with a bronze sheen and a broad, dark brown lateral band extends from snout to tail, 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 basihyals is 2 mm. long. From the anterior side of the tip of the basihyals spring the hypohyals, 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.



TEXT-FIG. 16. *Mabuya m. mabouya*. Hyoid of adult. × 4.5.

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 *Phyllobates* 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. × .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, × 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. × .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. × 4.5. Brown above, salmon red below.

Fig. 6. *Kentropyx calcaratus*, head of adult, showing irregular iris. × 4. Sepia brown above, lilac below, iris scarlet.

PLATE III.

Fig. 7. *Leposoma percarinatum*, adult, specimen 2965. × 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 next. × .8.

Fig. 11. Full-grown embryo tegu in shell, and a tegu just hatched. × .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. × 2.

Fig. 15. *Amphisbaena fuliginosa*, dorsal view, and head of a second individual, showing asymmetry of pattern. × .3. Black and white.

Fig. 16. *Mabuya m. mabouya*, head of adult. Nat. size. Bronze above, lateral bands black with alternating bands of pink.

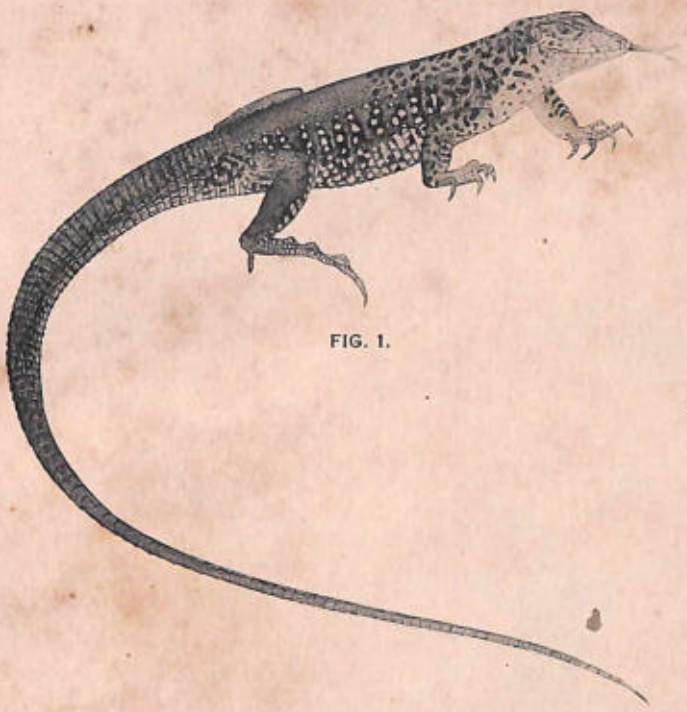


FIG. 1.

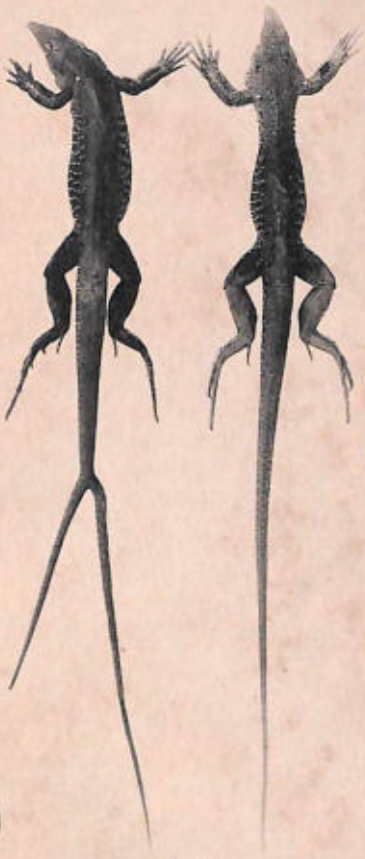


FIG. 2.

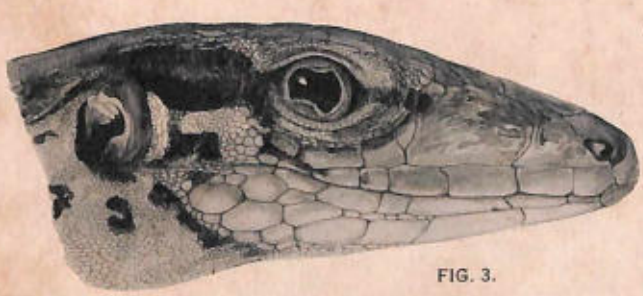


FIG. 3.

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

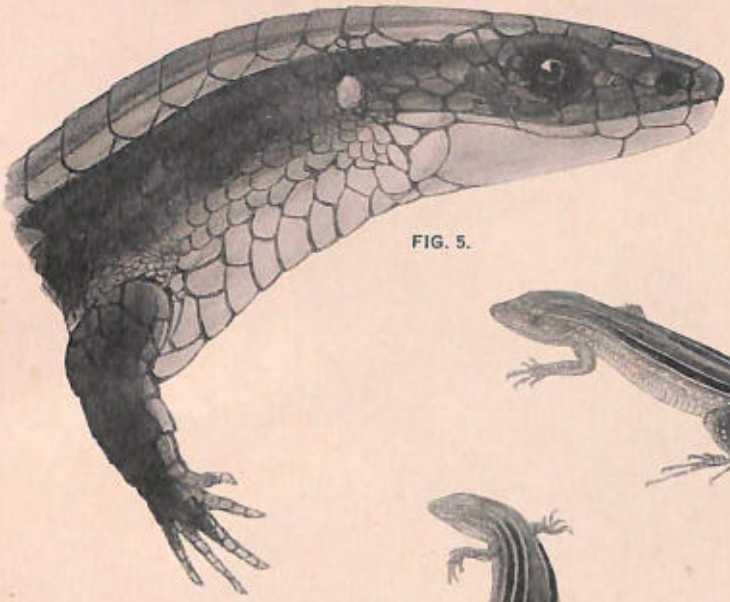


FIG. 5.

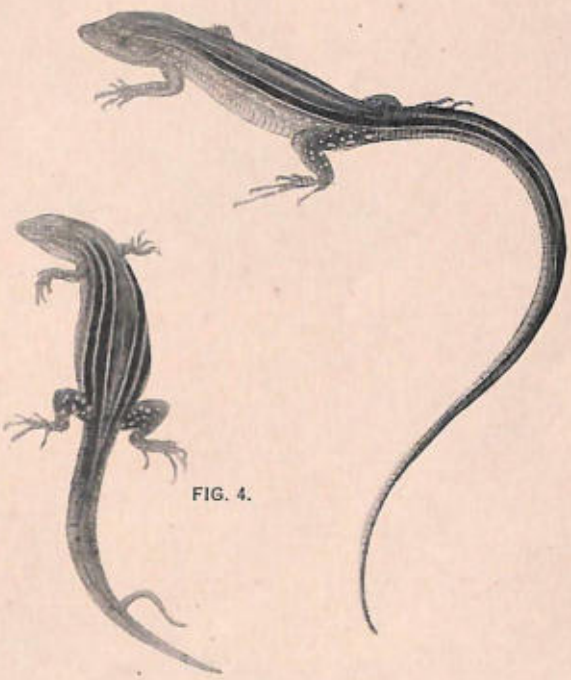


FIG. 4.

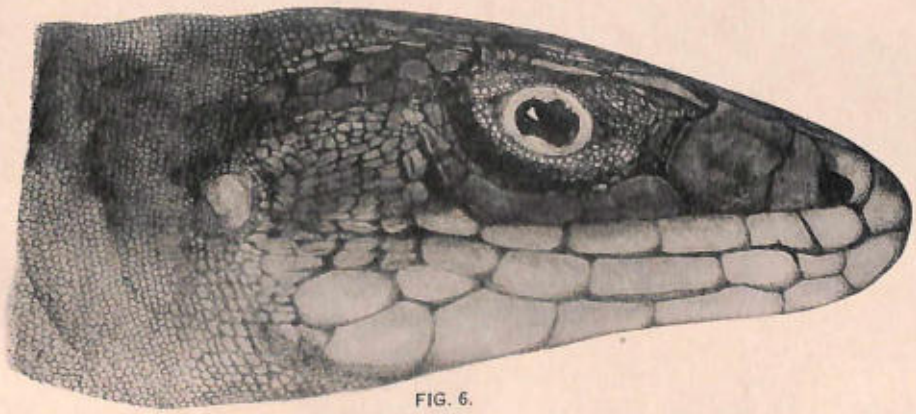


FIG. 6.

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

FIG. 7.

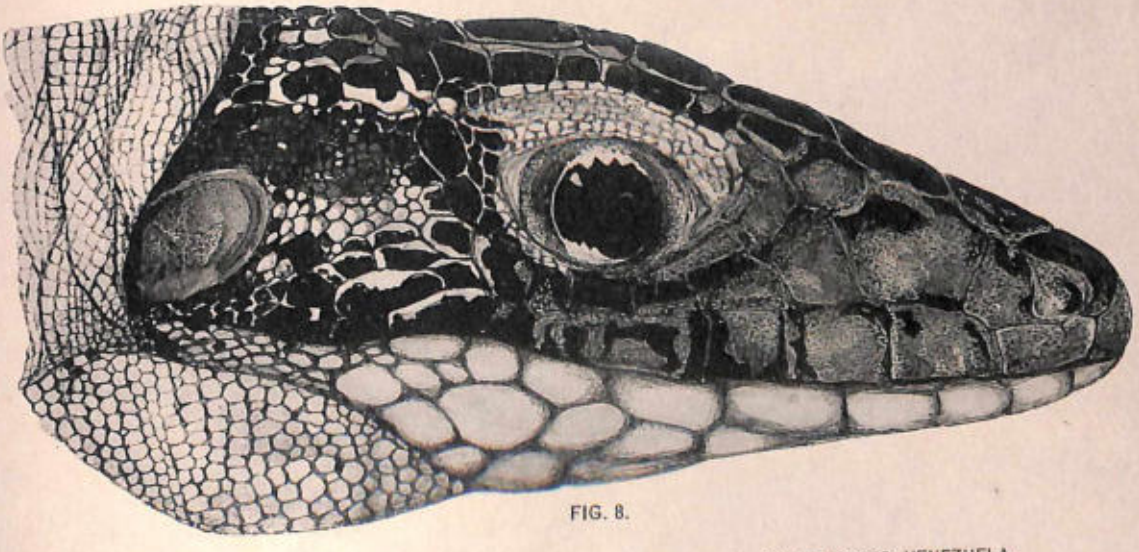


FIG. 8.

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

FIG. 7.

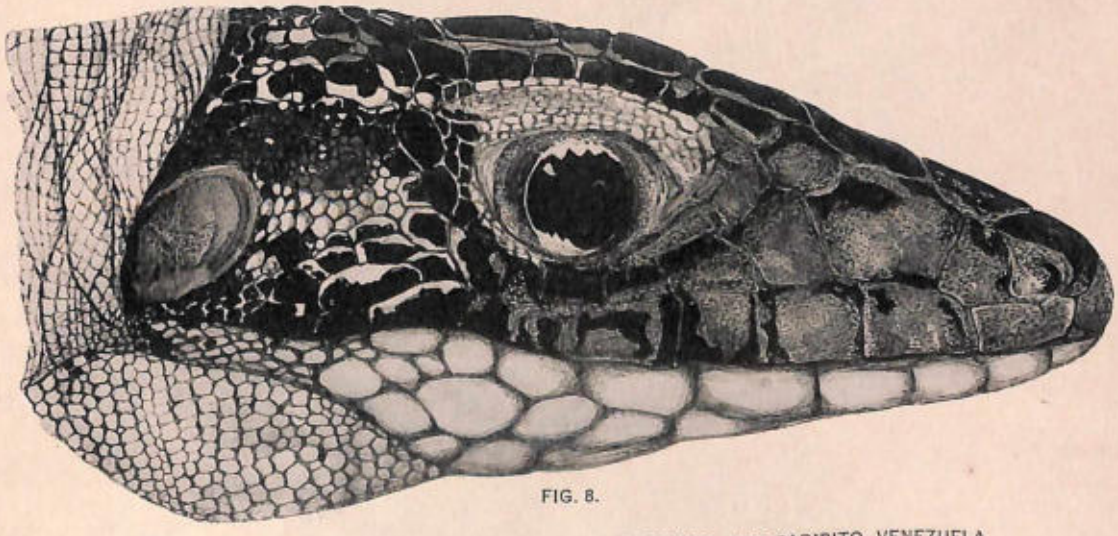


FIG. 8.

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

FIG. 9.

FIG. 10.

FIG. 11.

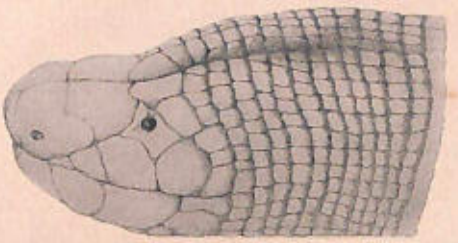


FIG. 12.

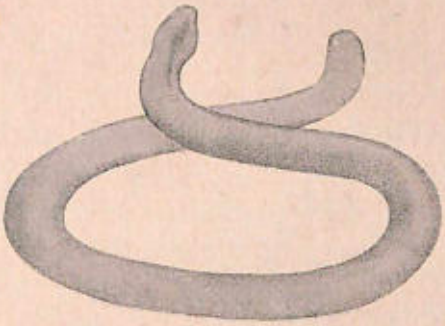


FIG. 13.

FIG. 15.

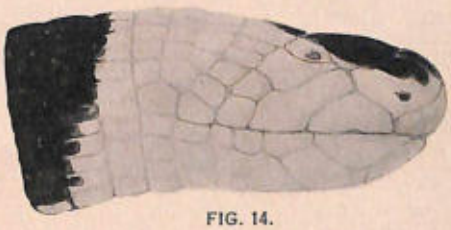


FIG. 14.

FIG. 16.

FIELD NOTES ON THE LIZARDS OF KARTABO, BRITISH GUIANA, AND CARIPITO, VENEZUELA.
PART 4. TEIIDAE, AMPHISBAENIDAE AND SCINCIDAE.

3.

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

JOCELYN CRANE.
Research Zoologist, Department of Tropical Research, 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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Parnaeus smaragdus sp. nov. 40

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).

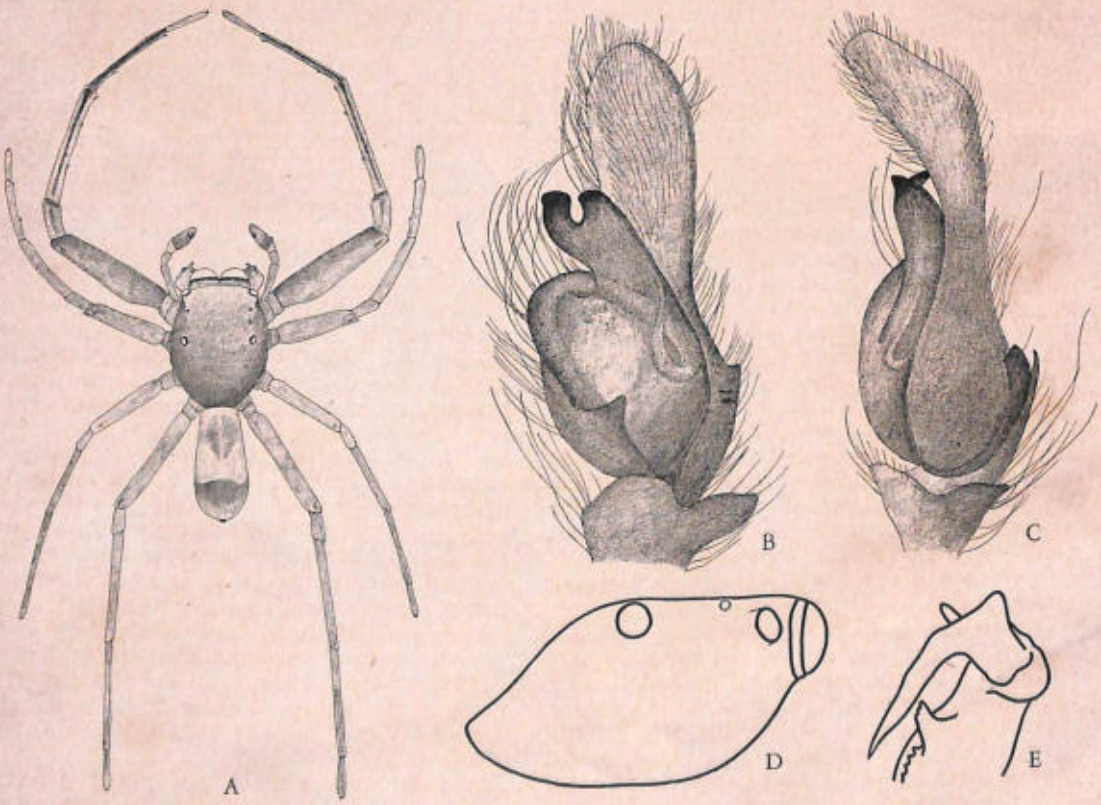
Scopocira carinata sp. nov.

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 *dentichelis* 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 *histrio.*

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, Bartica District, British Guiana.

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

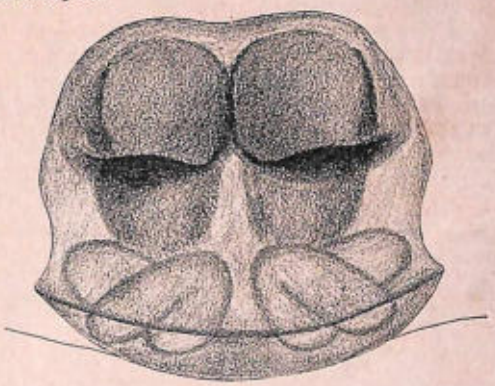
Thiodina pallida (Koch, 1846).

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 decline; 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.

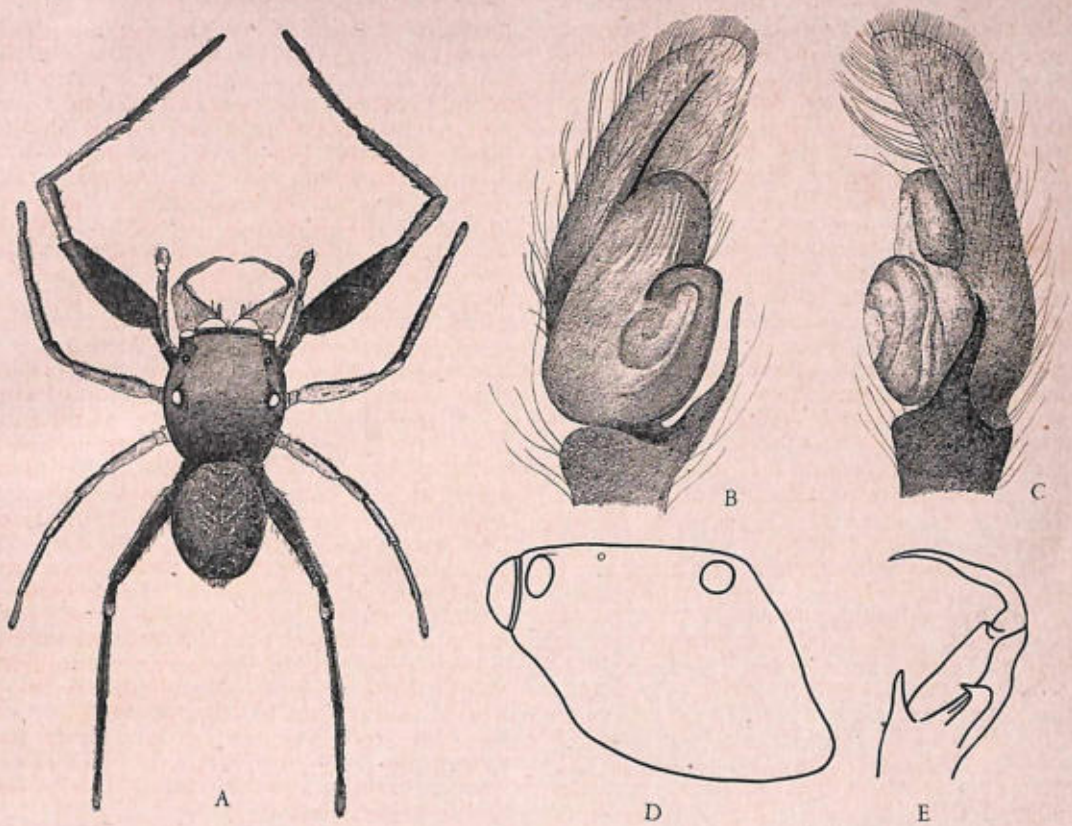
Material: The 17 specimens were distributed as follows: Kartabo, Bartica District, British Guiana: 1917: Sept., 1 juv. ♀ (Cat. No. 1717), 1 imm. ♀ (No. 1741). 1920: 1 juv. ♀ (No. 2030); Nov. 1-6, 1 imm. ♀ (No. 201493); 1 ♀ (No. 201639). 1921: 1 ♀ (No. 21313). 1924: Mar. 29, 1 ♀ (24328); Date?, 1 ♀, breeding, (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, Bartica 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. ccccIviii, fig. 1211.

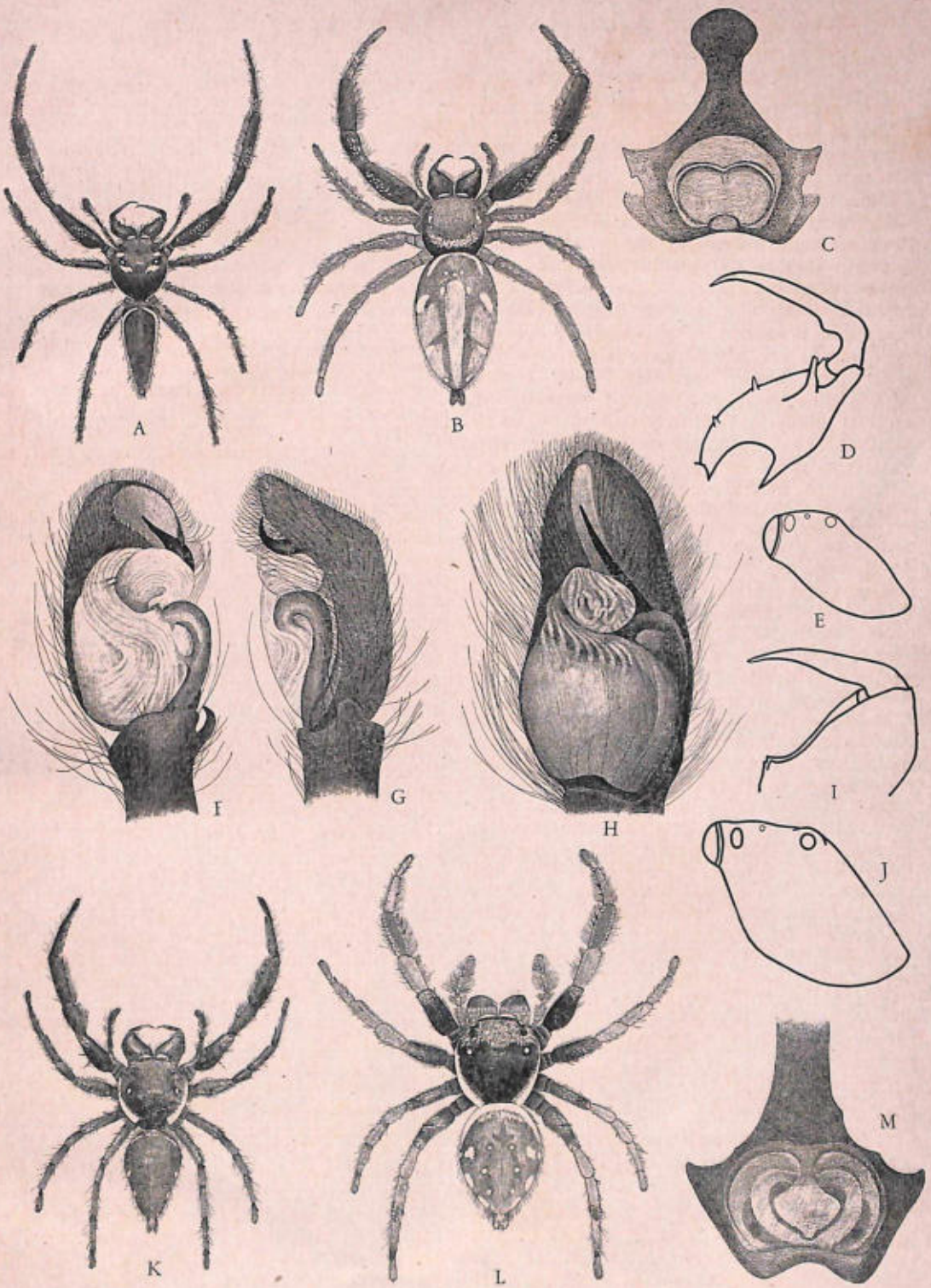
Parnaeus cyanidens, Peckham, 1896, p. 38, pl. iii, fig. 2; id., 1900, p. 301; F. Cambridge, 1901, p. 288, pl. xxvii, figs. 12, 13.

Dendryphantes 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.

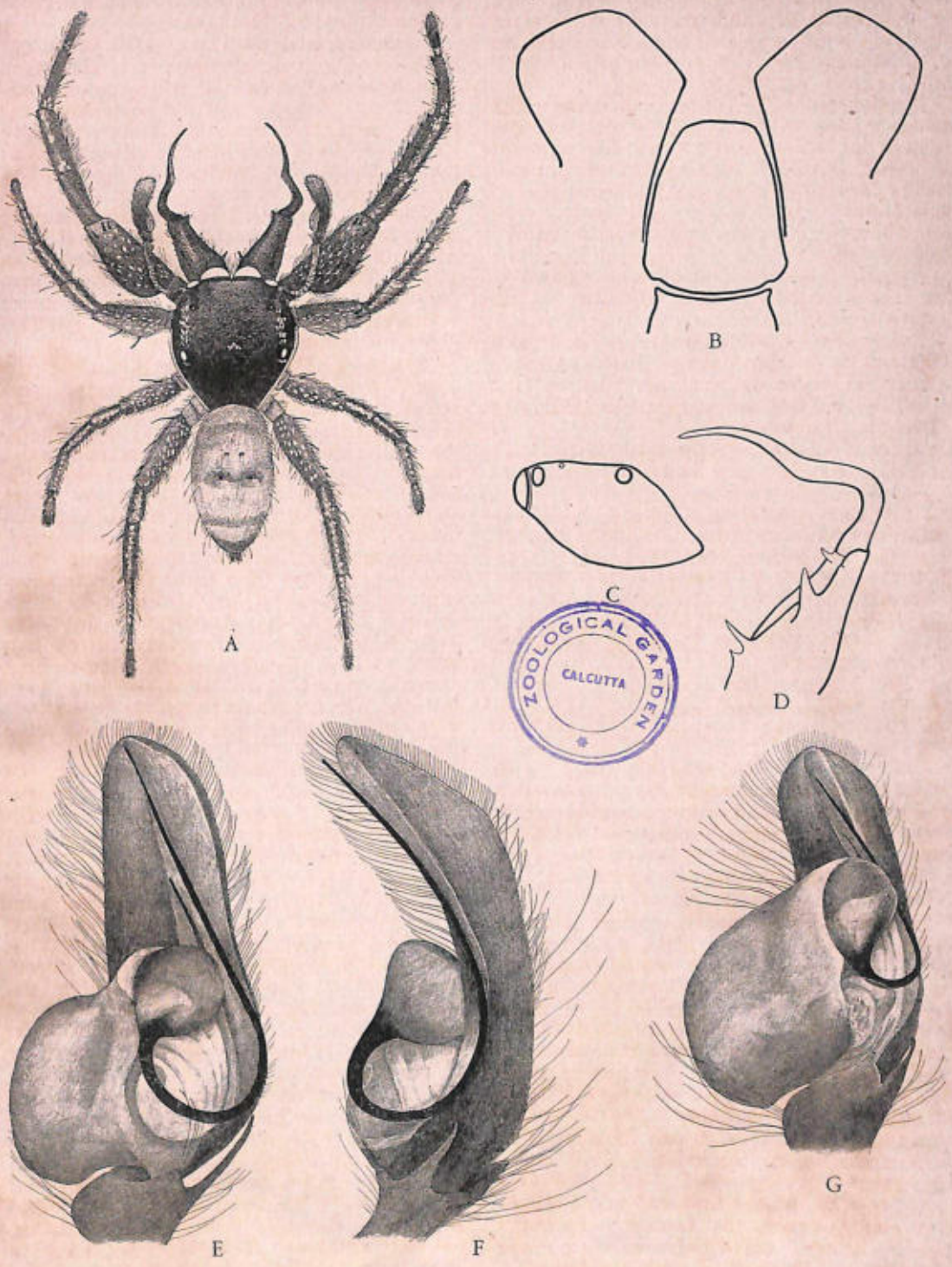
In detail: Adult male paratype: Integument of cephalothorax black with narrow marginal band of white scales extending posteriorly from slightly behind vertical from median eyes; a large patch of white scales on each side between small and posterior eyes; a pair of smaller patches behind posterior eyes; 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-



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TEXT-FIG. 5. *Parnaeus 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. mantchuricum*) 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 superspecies, 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. mantchuricum* 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

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).

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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. mantchuricum*) 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 superspecies, 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.

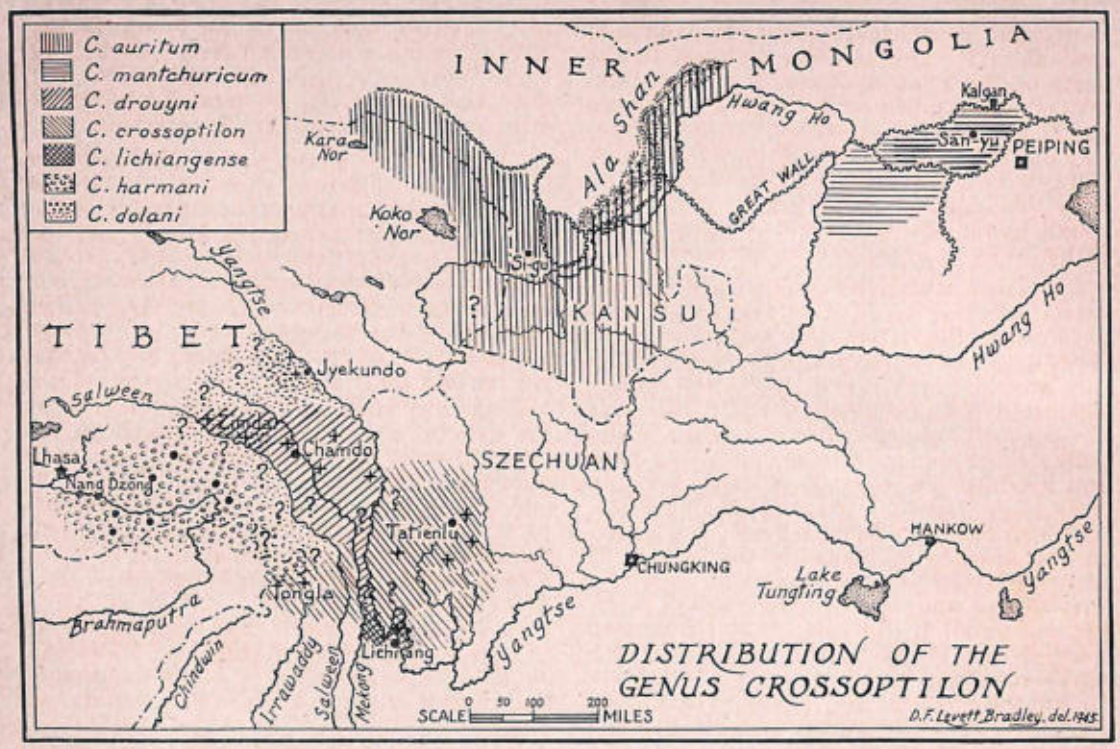
In life, the aspect of *C. crossoptilon* is strikingly different from that of the other two species, as are its voice and actions.

The distribution of the species *crossoptilon* is still incompletely recorded. Unlike *C. mantchuricum* 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 Thorrold 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. Forrest, 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.

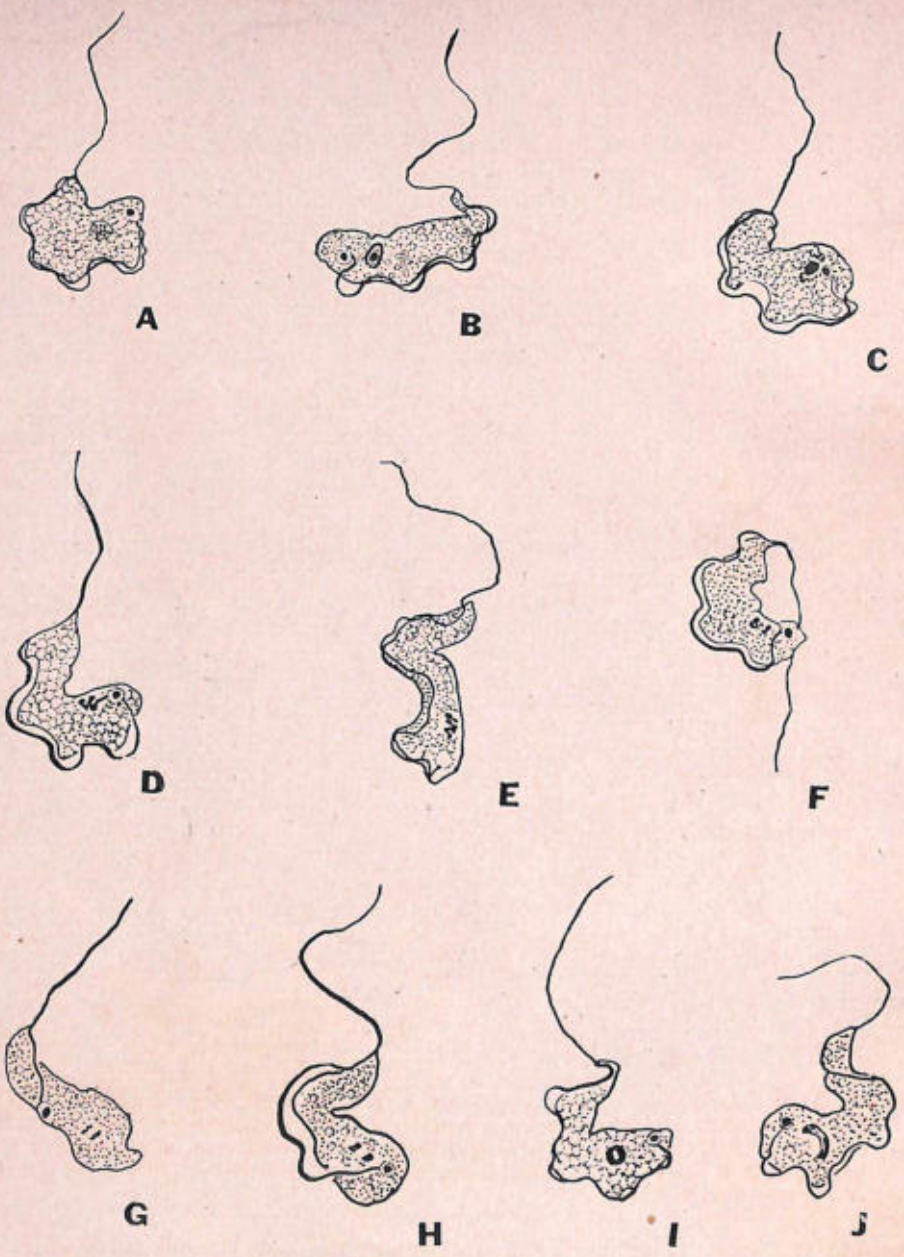
(Text-figure 1 A-J).

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. × 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 35 μ in length and about 2.3 μ in width.

The flagellate (Fig. C) from *Hyla cruci-fer* 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 10.8 μ.

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

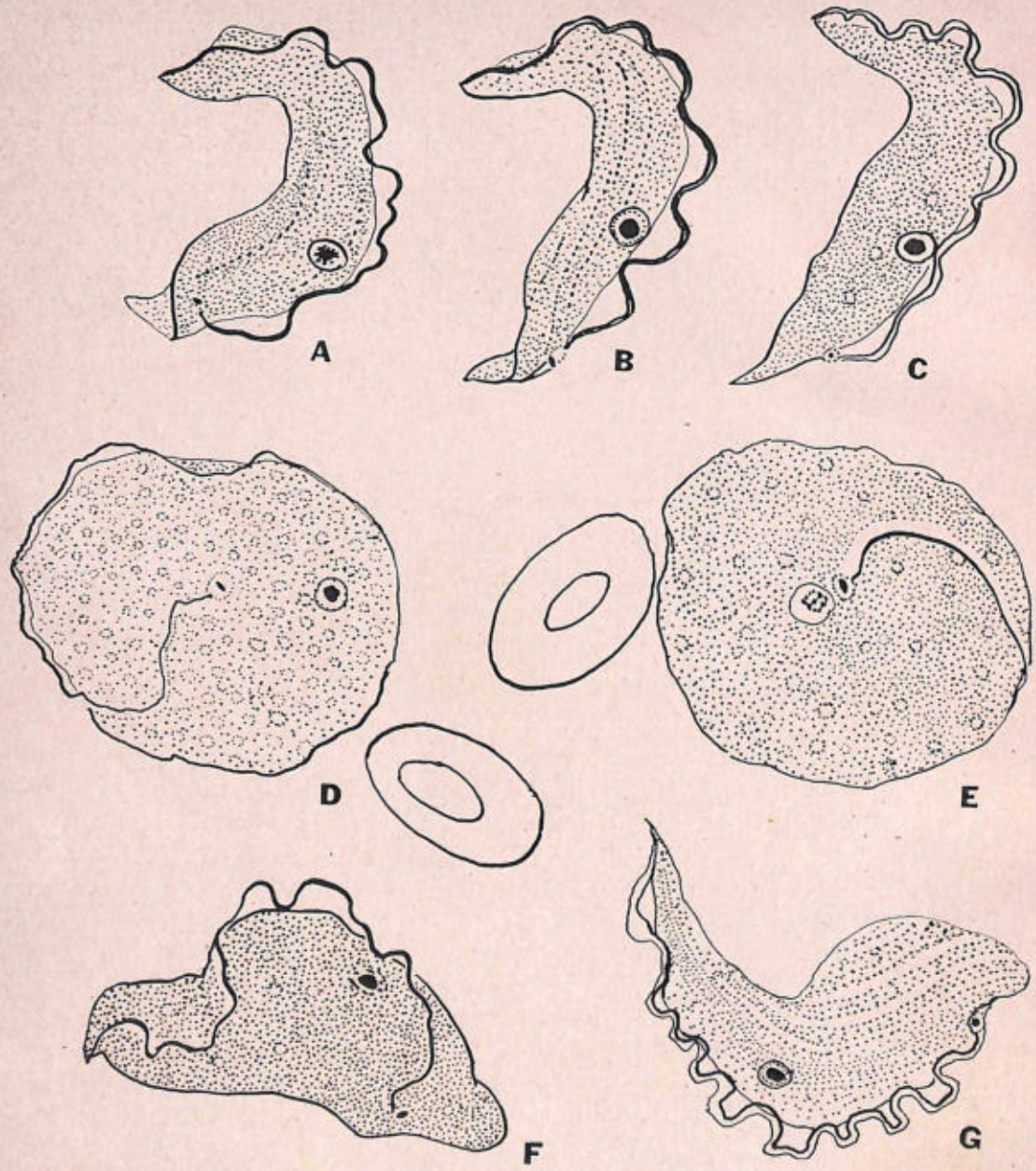
TEXT-FIG. 2. **A.** *Trypanosoma* sp. from *Rana pipiens*. **B & C.** *Trypanosoma* spp. from *Hyla versicolor* and *H. crucifer*, respectively. **D-F.** *Trypanosoma* sp. from *Hyla andersoni*. Note position of parabasal body and development of undulating membrane. Fig. **E** shows a crithidia form, indicating that the infection in this host is a recent one. × 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. Sergent (1904) reported from *Rana pipiens* by several investigators (see Kudo, 1922; Fantham, Porter & Richardson, 1942).

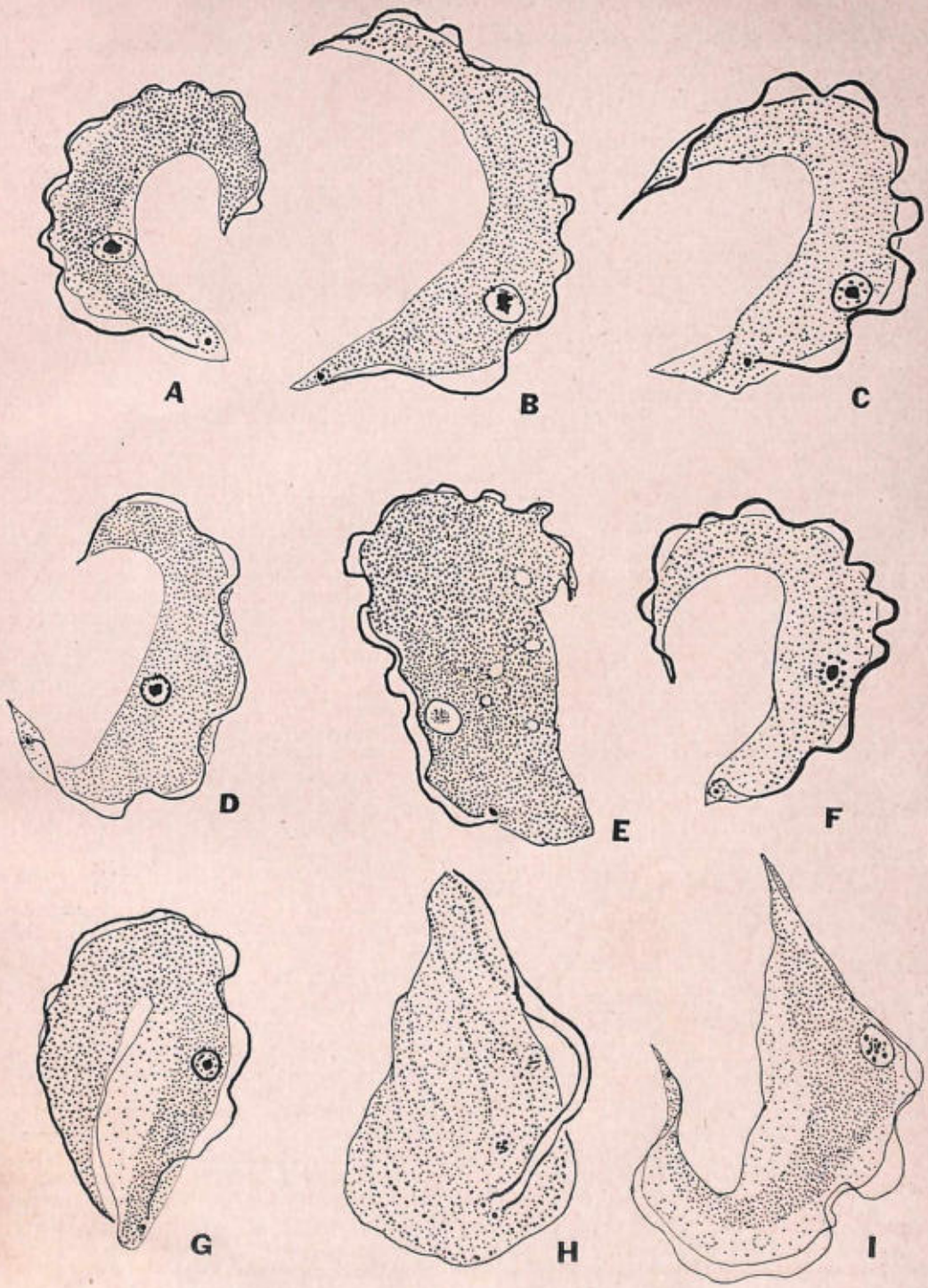


TEXT-FIG. 3. *Trypanosoma rotatorium* (Mayer) from *Rana clamitans*. Note the highly polymorphic nature of this trypanosome. Figs. **A-C**; **F & G**. Typical forms. Figs. **D** and **E** rounded dividing forms. Note the juxtaposition of nucleus and parabasal in the flagellate in Fig. **E**. × 1200.

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 × 10-25 μ and the latter 48-50 × 45 μ. 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. × 1200.

They measure 51-85 × 12-19 μ. 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
Acris gryllus (Le Conte)	*T. grylli*	Nigrelli	1944
Ambystoma maculatus (Shaw)	Negative	Nigrelli	Present paper
Ambystoma opacum (Gravenhorst)	Negative	Nigrelli	Present paper
Ambystoma tigrinum (Green)	Negative	Nigrelli	Present paper
Ambystoma tigrinum (Green)	Negative	Roudabush & Coatney	1937
Bufo americanus Holbrook	*T. lavalia*	Fantham, Porter & Richardson	1942
Bufo americanus Holbrook	*T. gaumontis*	Fantham, Porter & Richardson	1942
Bufo americanus Holbrook	*T. montrealis*	Fantham, Porter & Richardson	1942
Bufo fowleri (Hinckley)	*T. rotatorium*	Brandt	1936
Bufo woodhousii Girard	Negative	Roudabush & Coatney	1937
Cryptobranchus alleganiensis (Daudin)	*T. cryptobranchi*	Roudabush & Coatney	1937
Desmognathus fuscus (Rafinesque)	Negative	Nigrelli	Present paper
Desmognathus fuscus (Rafinesque)	Negative	Hegner	1921
Hyla andersoni Baird	*Trypanosoma* sp.	Nigrelli	Present paper
Hyla cinera (Schneider)	Negative	Nigrelli	Present paper
Hyla crucifer Wied	*T. rotatorium*	Brandt	1936
Hyla crucifer Wied	*Trypanosoma* sp.	Nigrelli	Present paper
Hyla femoralis Latreille	Negative	Nigrelli	Present paper
Hyla squirella Latreille	Negative	Nigrelli	Present paper
Hyla versicolor (Le Conte)	*Trypanosoma* sp.	Nigrelli	Present paper
Necturus maculosus (Rafinesque)	*Trypanosoma* sp.	Hegner	1921
Necturus maculosus (Rafinesque)	*Trypanosoma* sp.	Roudabush & Coatney	1937
Necturus maculosus (Rafinesque)	*Trypanosoma* sp.	Nigrelli	Present paper
Plethodon cinereus (Green)	*Trypanosoma* sp.	Hegner	1921
Plethodon glutinosus (Green)	*Trypanosoma* sp.	Hegner	1921
Pseudacris brimleyi (Brandt & Walker)	*T. rotatorium*	Brandt	1936
Pseudotriton rubra (Latreille)	Negative	Nigrelli	Present paper
Rana catesbeiana Shaw	*T. rotatorium*	Brandt	1936
Rana catesbeiana Shaw	*T. rotatorium*	Fantham, et al	1942
Rana catesbeiana Shaw	*T. rotatorium*	Nigrelli	Present paper
Rana catesbeiana Shaw	*T. inopinatum*	Fantham, et al	1942
Rana catesbeiana Shaw	*Trypanosoma* sp.	Hegner	1920[1]
Rana clamitans Latreille	*T. clamatae*	Stebbins	1907
Rana clamitans Latreille	*T. parvum*	Kudo	1922
Rana clamitans Latreille	*T. rotatorium*	Kudo	1922
Rana clamitans Latreille	*T. rotatorium*	Fantham, et al	1942
Rana clamitans Latreille	*T. rotatorium*	Nigrelli	Present paper
Rana clamitans Latreille	*Trypanosoma* sp.[2]	Stebbins	1907
Rana clamitans Latreille	*Trypanosoma* sp.	Hegner	1920
Rana palustris Le Conte	Negative	Nigrelli	Present paper
Rana pipiens Schreber	*T. rotatorium*	Kudo	1922
Rana pipiens Schreber	*T. rotatorium*	Packchanian	1934
Rana pipiens Schreber	*T. rotatorium*	Fantham, et al	1942
Rana pipiens Schreber	*T. inopinatum*	Fantham, et al	1942
Rana pipiens Schreber	*Trypanosoma* sp.	Nigrelli	Present paper
Rana sphenocephala (Cope)	*T. rotatorium*	Brandt	1936
Rana sylvatica Le Conte	Negative	Fantham, et al	1942
Rana sylvatica Le Conte	Negative	Nigrelli	Present paper
Rana virgatipes Cope	Negative	Nigrelli	Present paper
Scaphiopus holbrooki (Harlan)	Negative	Brandt	1936
Spelerpes (*Eurycea*) *bislineatus* (Green)	Negative	Hegner	1921
Triturus viridescens (Rafinesque)	*T. diemyctyli*	Tobey	1906
Triturus viridescens (Rafinesque)	*T. diemyctyli*	Hegner	1921
Triturus viridescens (Rafinesque)	*T. diemyctyli*	Nigrelli	1929
Triturus viridescens (Rafinesque)	*T. diemyctyli*	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. *T. rotatorium* (Mayer, 1843)				
Fantham, et al (1942)	47.4-72.6	3.0-26.7	.....	Very short
Nigrelli (present paper)				
From adult *R. clamitans*				
Elongate forms	51-80	10-25	67.7×17.2	None or very short
Round forms	48-50	43-45	44×49	None or very short
From adult *R. catesbeiana*	51-85	12-19	67.7×12.8	None or very short
2. *T. inopinatum* Sergent & Sergent (1904)				
Original Measurements	16.5-21	1.5-2.2	.....	1-6
Kudo (1939)				
Slender forms	12-20	.....	.....	.....
Larger Forms	30-35	.....	.....	.....
Fantham, et al (1942)	.....	.....	.....	1.5-2.5
3. *T. diemyctyli* Tobey (1906)				
Hegner (1921)	38.1-75.3	1.9-4.4	56×2.89	.....
Nigrelli (1929)				
Broad forms	63.5-79.4	5.2-9.0	71×8.2	Very long
Slender forms	38-57	1.9-4.5	53×3.8	
4. *T. clamatae* Stebbins (1907)				
Slender forms	21	2.5-2.8	.....	12-13
Larger forms	27.56-47	16.78-28.51	.....	5.96-14.79
5. *T. parvum* Kudo (1922)	11-14	1.2-1.9	.....	5-15
6. *T. cryptobranchi* Roudabush & Coatney (1936)	46.8-77.4	1.8-5.84	60.87×3.51	31.61
7. *T. lavalia* Fantham, Porter, & Richardson (1942)	31.1-35.5	3.9-4.4	.....	1.5-2.6
8. *T. gaumontis* Fantham, Porter & Richardson (1942)				
Group I	15-15.8	1.3-1.85	.....	None
Group II	19.7-20.7	1.5-1.85	.....	None
9. *T. montrealis* Fantham, Porter & Richardson (1942)	45-68	1.8-6	44-45	3-5.5
10. *T. grylli* 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 of 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. diemctyli* 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 (crithidia) 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. Packchanian (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 experiments 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* Sergent & Sergent (1904), *T. neveu-lemairei* 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. sphenocephala* 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 Salinetia 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*. × 3200.

FIG. 1.

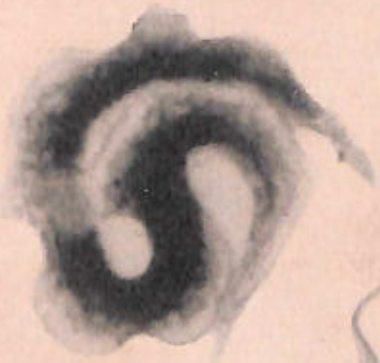


FIG. 2.

FIG. 3.

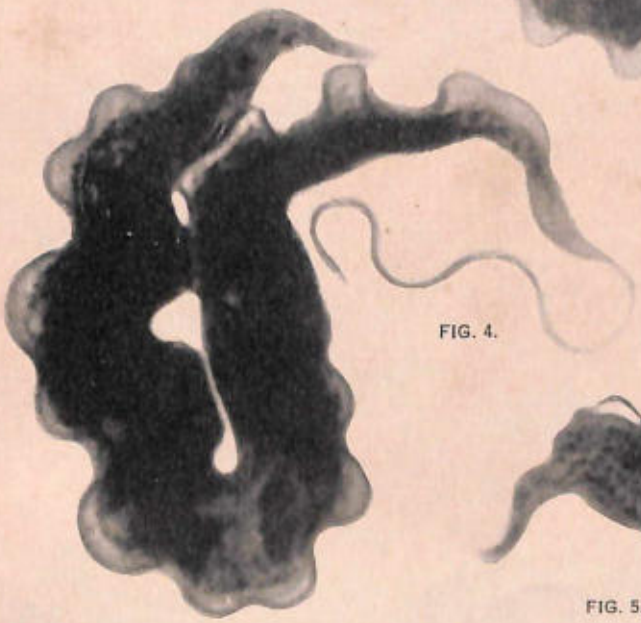


FIG. 4.

FIG. 5.

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

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 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

[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.

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

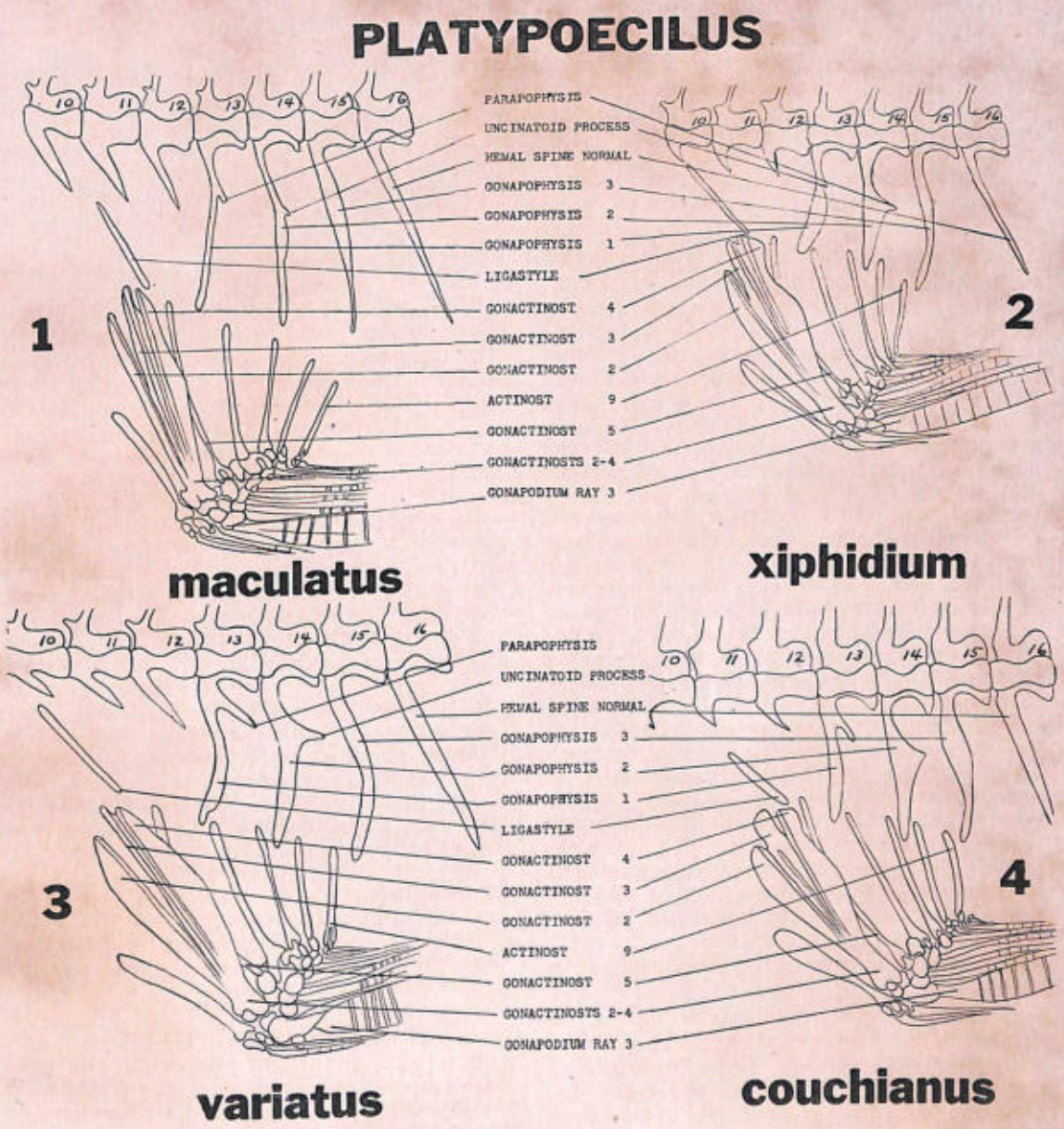
Generic Distinctions.

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*.



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 Platypoecilus 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.

Species of Platypoecilus	*Length of gonapophyses*	*Length of uncini*	*Spread of uncini tips*	*Width of gonapophyses*	
	A	B	C	D	
maculatus	2.53	0.97	1.00	0.53	
variatus	1.93	0.97	1.33	0.40	
xiphidium	2.56	1.13	0.73	0.72	
couchianus	2.07	0.97	1.13	0.40	
	$\frac{A}{A}$	$\frac{B}{A}$	$\frac{C}{A}$	$\frac{D}{A}$	$\frac{c}{d}$
	a	b	c	d	
maculatus	1.00	0.38	0.39	0.21	1.9
variatus	1.00	0.50	0.53	0.21	2.5
xiphidium	1.00	0.45	0.28	0.28	1.0
couchianus	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.

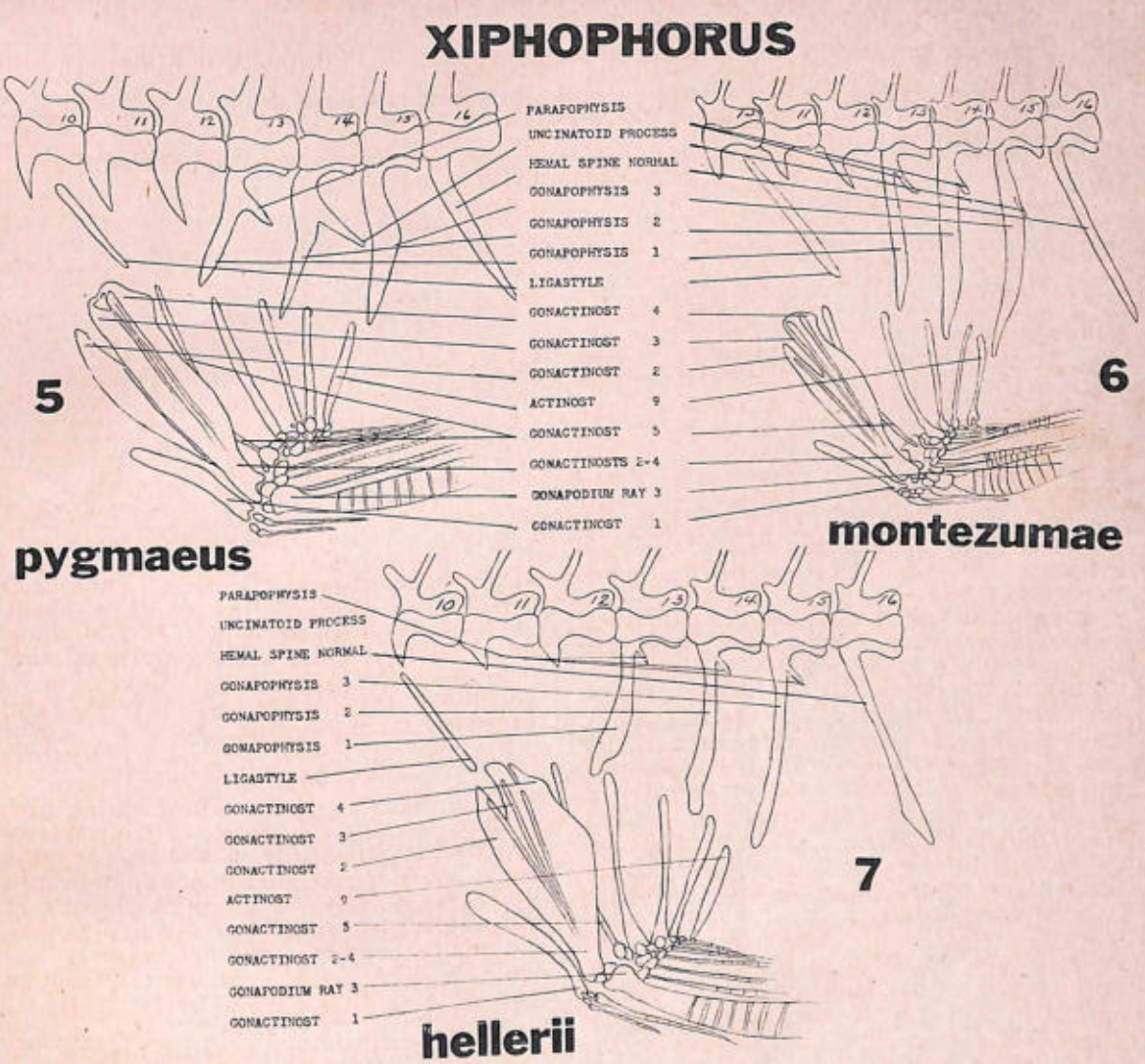
SPECIFIC DISTINCTIONS IN *Xiphophorus.*

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.



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

ANOMALIES IN THE ELEMENTS OF THE GONOPODIAL 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.

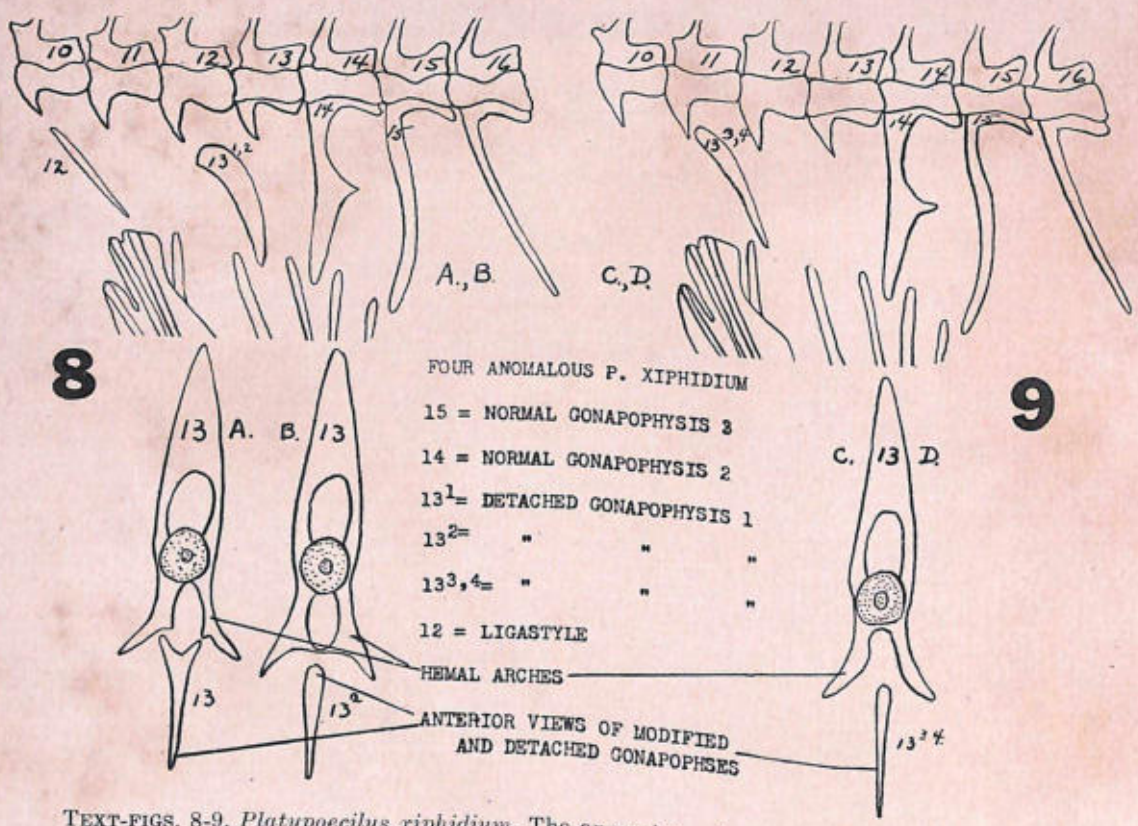
P. xiphidium.

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 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 Phillipi (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*. Phillipi 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
P. maculatus	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"
P. variatus	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"
P. xiphidium	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
P. couchianus	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 4 "collar" small
X. pygmaeus	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 4 "collar" pronounced
X. montezumae	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
X. hellerii	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 4 "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 noticed a "skeletstab" 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 "skeletstab" 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 (*Knochenstuchen*) 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.

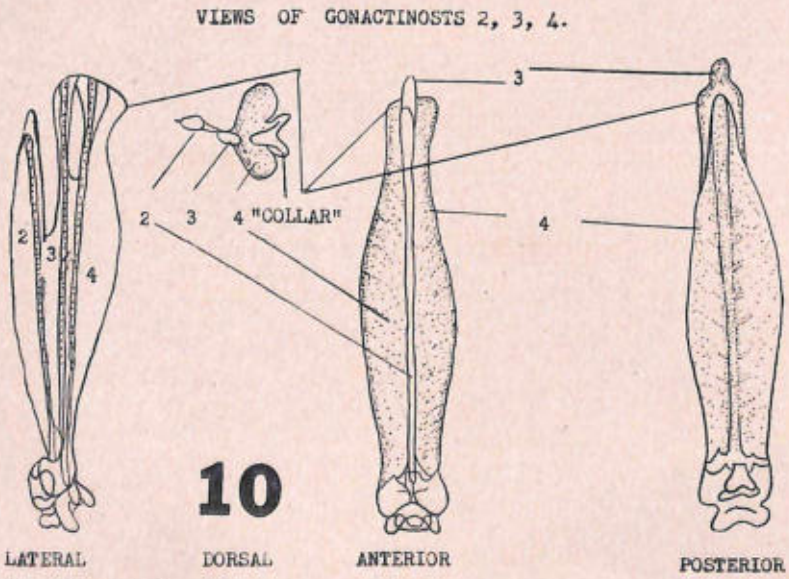
Sexual Dimorphism Expressed in Hemal Spines.

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 *Mollienisia* 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 *Platypoecilus 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 *Mollienisia* 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.

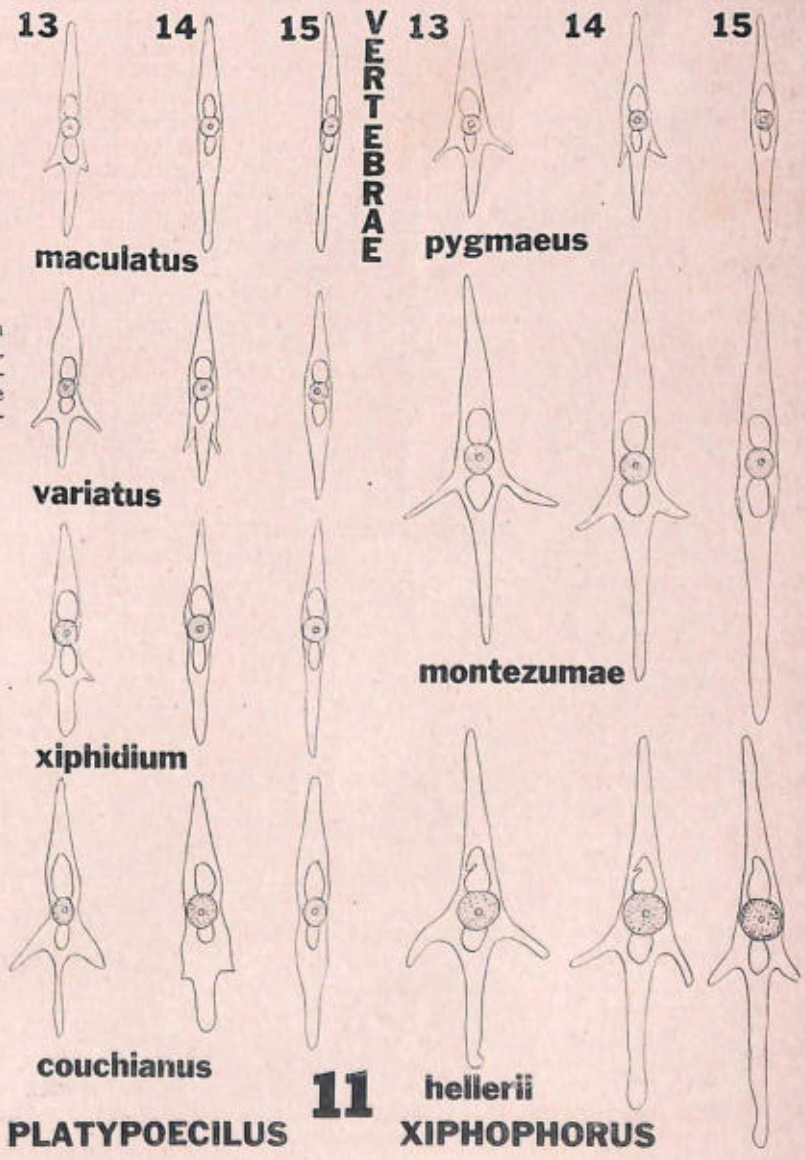
ial elements and modification of the caudal fin in *P. maculatus*, may be induced in females by the synthetic steroid pregneninolone. Scott (1944) reported hormonal effects on the *Lebistes* suspensorium.

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 redescriptions of *Furcipenis 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. Xiphophorin Vertebrae: 13, 14, and 15. Anterior views of disarticulated vertebrae to show the first, second and third gonapophyses.

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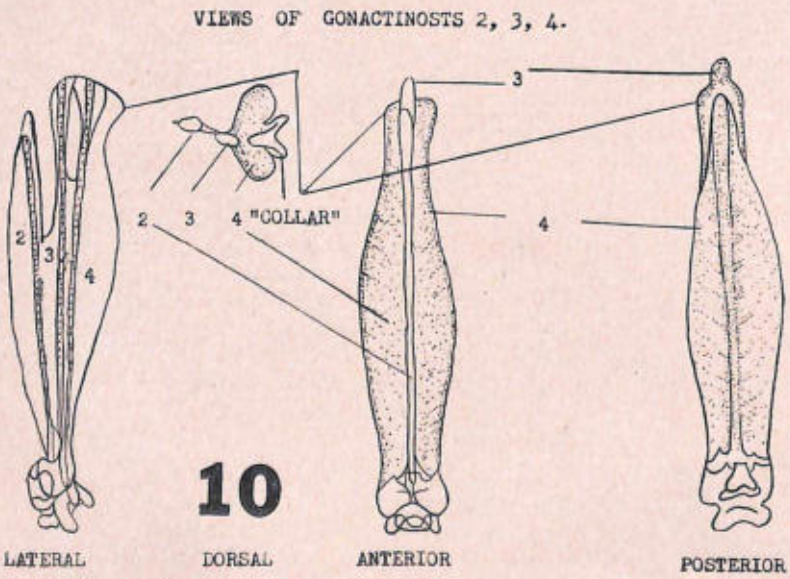

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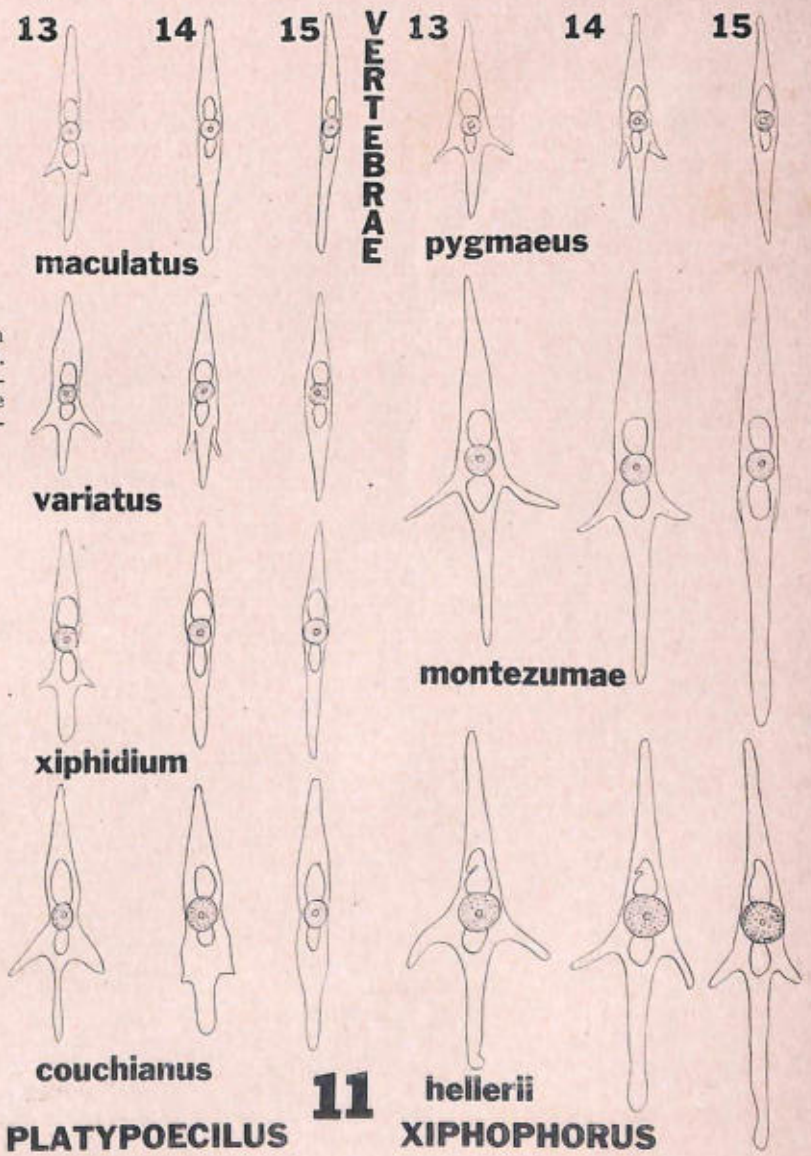

TEXT-FIG. 11. Xiphophorin Vertebrae: 13, 14, and 15. Anterior views of disarticulated vertebrae to show the first, second and third gonapophyses.

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
P. maculatus	8	11	1	1	2	11	15	14.9	26	25.9
	1	11	1	1	2	10	14		25	
P. variatus	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	
P. xiphidium	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	
P. couchianus	9	11	1	1	2	12	16	16.2	27	27.2
	2	11	1	1	2	13	17		28	
X. pygmaeus	11	11	1	1	2	12	16	15.9	27	26.9
	1	11	1	1	2	11	15		26	
X. montezumae	10	11	1	2	1	13	17	17.0	28	28.0
X. hellerii	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 *Platypoecilus*, 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-Platypoecilus* group be placed under a single genus.

Undoubtedly both Regan and Langer were influenced in making their decisions concerning the closeness of *Xiphophorus* to *Platypoecilus* 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 Terrarienkünde* and *Wochenschrift für Aquarien und Terrarienkünde*. 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 vertebrae 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 Tetraodontidae.

Viviparous cyprinodonts have rib-bearing caudal vertebrae: *Flexipenis* 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 xiphorphorin 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 regularen Hämapophysen zu den Übergangshamapopnysen, zu den Gonapopnysen ohne Rippe, zu denen mit Rippe, zu den Rumpfwirbeln nur mit Hämalkanal, zu den typischen Rumpfwirbeln des ♂		(Erste Zahl = Wirbel ohne Rippen zweite Zahl = Wirbel mit Rippen, D = Differenz) ♂	
Platypoecilus maculatus	(2 mal)	10:0:3:1:0:12=26		14:15 = 29
	(1 mal)	11:0:3:1:0:14=29	D.3	13:13 = 26
				13:15 = 28
Xiphophorus strigatus		13:0:0:3: 12=28		13:15 = 28
	x1	14:0:0:2:0:12=28		14:14 = 28
	x(vor x1)	14:0:0:3:?:11=28		15:13 = 28
	x(vor x1)	15:0:0:3:0:10=28	D.2	15:15 = 30
	x(vor x1)	13:0:1:2:?:12=28		18:11 = 29
	x(vor x1)	14:0:1:2:?:13=30		16:13 = 29
	x(vor x1)	15:0:1:2:?:12=30		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 and 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 *Platypoecuus 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. blennius*, 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 (*Furcipenis* 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 forth 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 swordtail 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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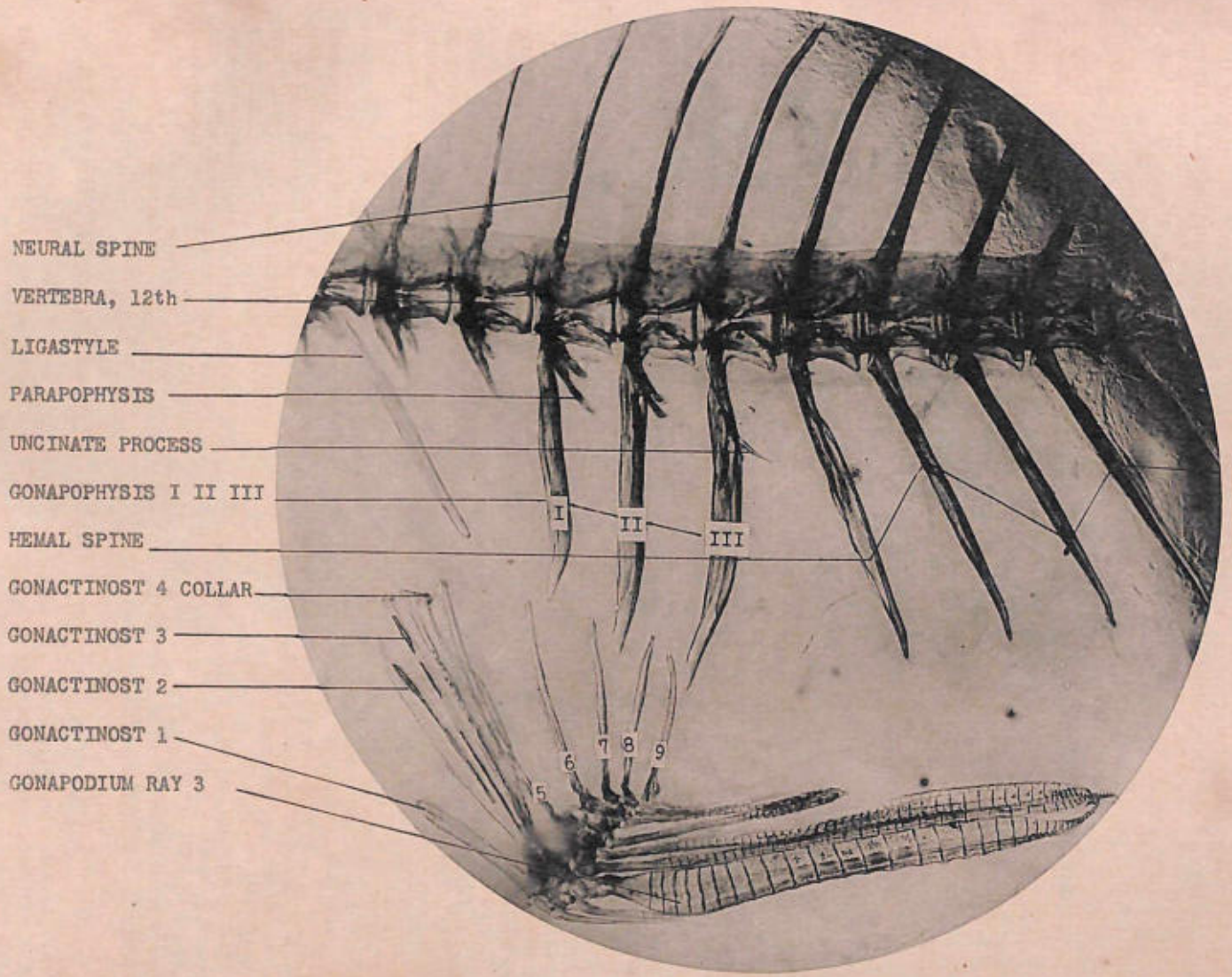
EXPLANATION OF THE PLATE.

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 another specimen on June 29. These specimens were captured at Kartabo in different years.

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 Saturniidés. Mém. Mus. Nation. Hist. Nat.*, N.S., Tome 3, pp. 288-289, 1936). It seems unlikely that 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 of a somewhat lighter chestnut-brown and in 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 was described from Merida, Venezuela. I conclude 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 it 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-Méneville).

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.

One specimen taken at Kartabo on June 4 and another on December 1. Judging by the literature, the range of this species is restricted to British Guiana.

Automeris pictus Conte.

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

Automeris pyrrhomelas Walker.

Three specimens taken at Kartabo on December 11. Although this species occurs from Colombia to Bolivia and Brazil, this is the first record from British Guiana.

Automeris surinamensis Kirby.

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

Hylesia canitia (Cramer).

Six specimens taken at Kartabo on the following dates: February 1, May 29, June 16, June 20, July 19 and July 24. The species is known from Venezuela and the Guianas.

Hylesia indurata Dyar.

Four specimens captured at Kartabo on the following dates: May 29, June 2, June 26, and 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 collected in Trinidad and the Guianas.

Hylesia ochrifex Dyar.

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

Hylesia praeda Dognin.

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

Hylesia sp.?

One Kartabo specimen very badly rubbed and undeterminable.

Hylesia sp.?

Two specimens from Caripito, apparently the same species, badly rubbed and undeterminable.

Lonomia achelous (Cramer).

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

Dirphia eumedide (Cramer).

Two specimens taken at Kartabo, one on March 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 record 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 record 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 Guianas.

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 specimens 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 captures 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), captured 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_1 and Cu_1. The proximal and distal margins of the band converge below vein Cu_2, 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_3 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_4 and R_5 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_3, 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 aedoeagus 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_2, 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 Guyabal, 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 occuring 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 postmedian 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.

Harpe[2] 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.

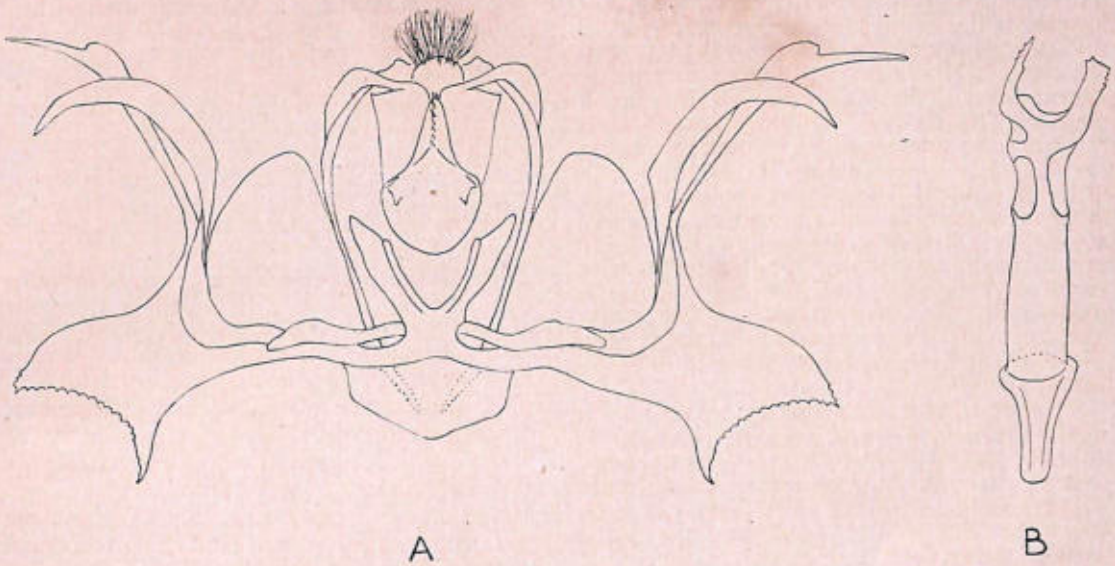
(Pl. I, Fig. 4; Text-figs. 2C, D).

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 McDonnough: On the Nomenclature of the Male Genitalia in Lepidoptera. *Canad. Ent.*, Vol. XLIII, p. 188, 1911.

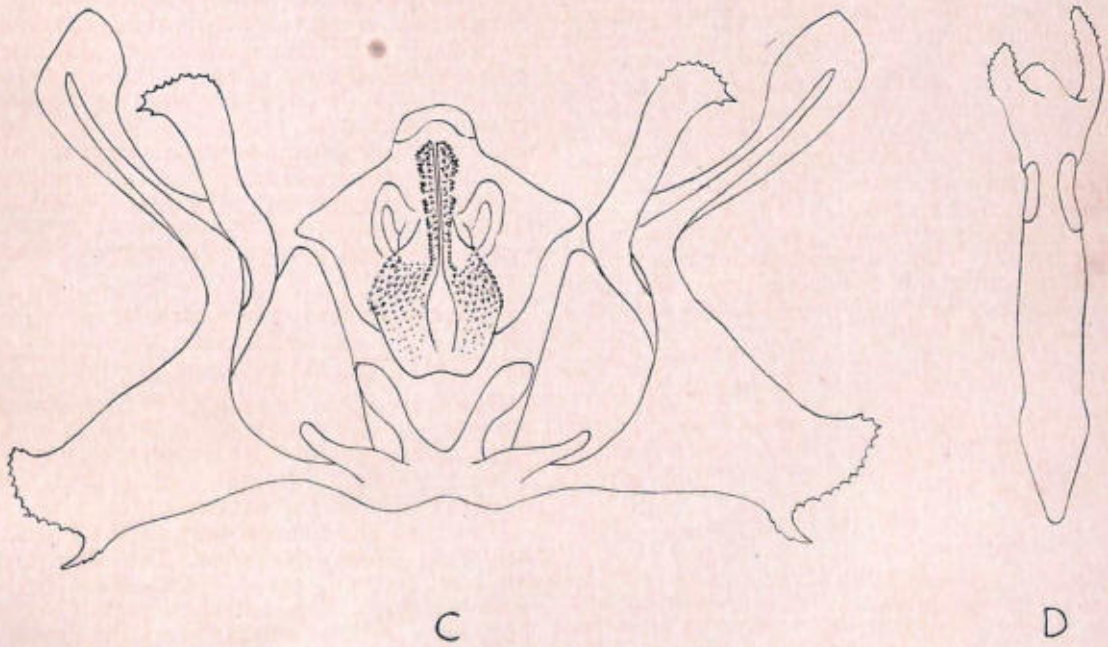


TEXT-FIG. 1. **A,** *Syssphinx comstocki.* Paratype: Cat. No. 42485. Caudal view of the ♂ genital organs with the claspers spread and aedeagus omitted. The uncus has been bent downward. **B,** aedeagus.

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 fuscus 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 hing 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, Amazons 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 subochreata 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.

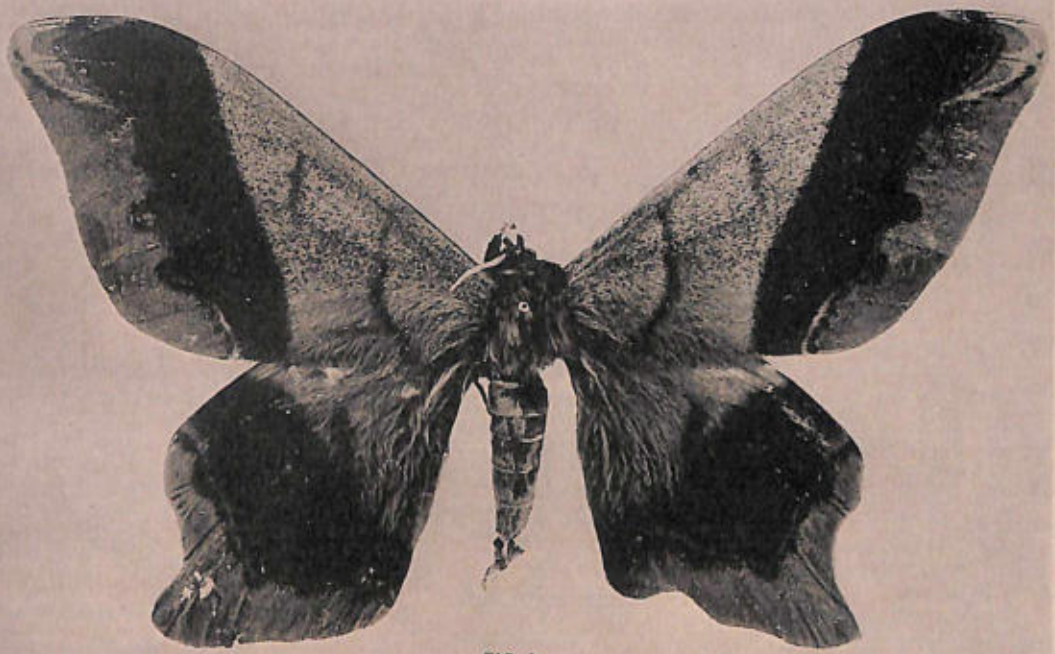


FIG. 1.

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.]

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[1] Contribution No. 708, Department of Tropical Research, New York Zoological Society.

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.

[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.

[4] *Carollia perspicillata* (Linnaeus).

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

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 lips; 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 *bimaculatus*.

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 *Hoplias* 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 unitaeniatus (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 Carine, 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 alta Eigenmann.

One specimen, No. 30,010, length 51 mm., mud-hole, March 21.

Crenicichla macropthalmus 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 light 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 linds 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 membraneous 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).

One large male, not breeding, well down in the mud, full activity. Length 122 mm., mud-hole, May 6.

REPTILIA.

Family Mydidae.

Geoemyda punctularis (Daudin).

Two 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. × 1.3.

Fig. 3. *Farlowella acus*, side view of head. × 6.

PLATE II.

Fig. 4. *Farlowella acus*, ventral view of mouth a few minutes after death. × 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. × 1.3.

FIG. 1.

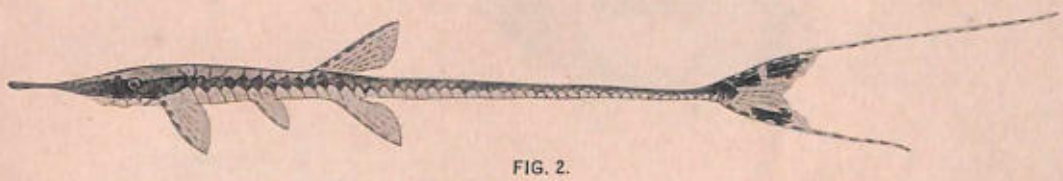

FIG. 2.

FIG. 3.

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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(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.

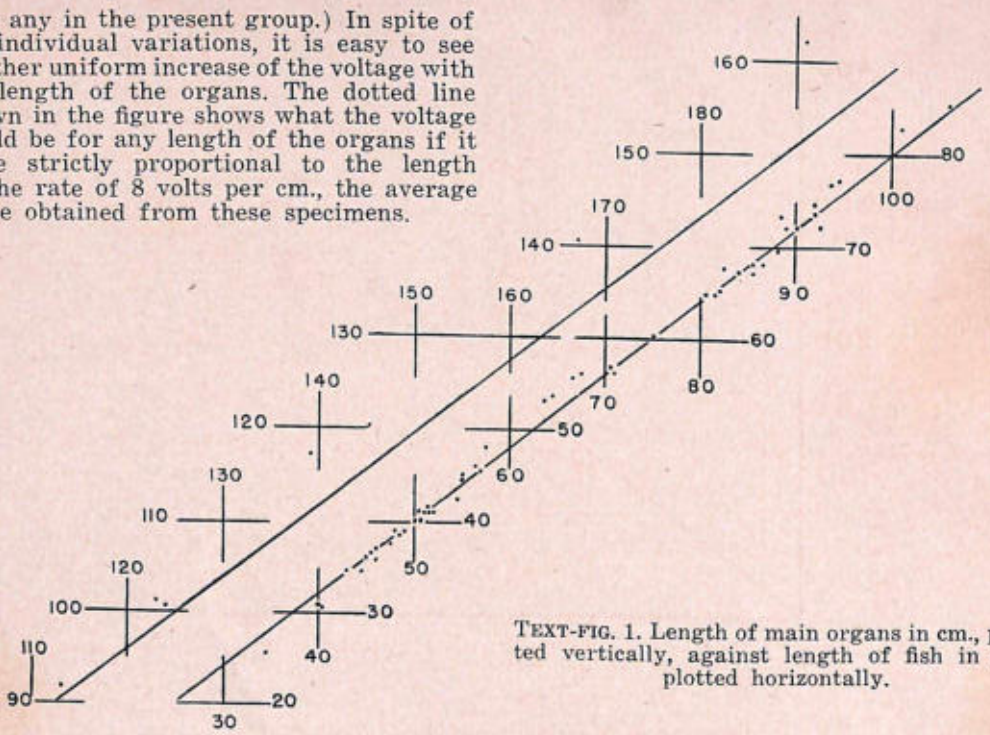
Some of the measurements were made in October, 1944, and the rest in January, 1945. The fish employed at the earlier dates were not kept segregated afterwards, and it is therefore likely that some of them were among those measured at the later date. This is not a disadvantage, however, since a good deal 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.



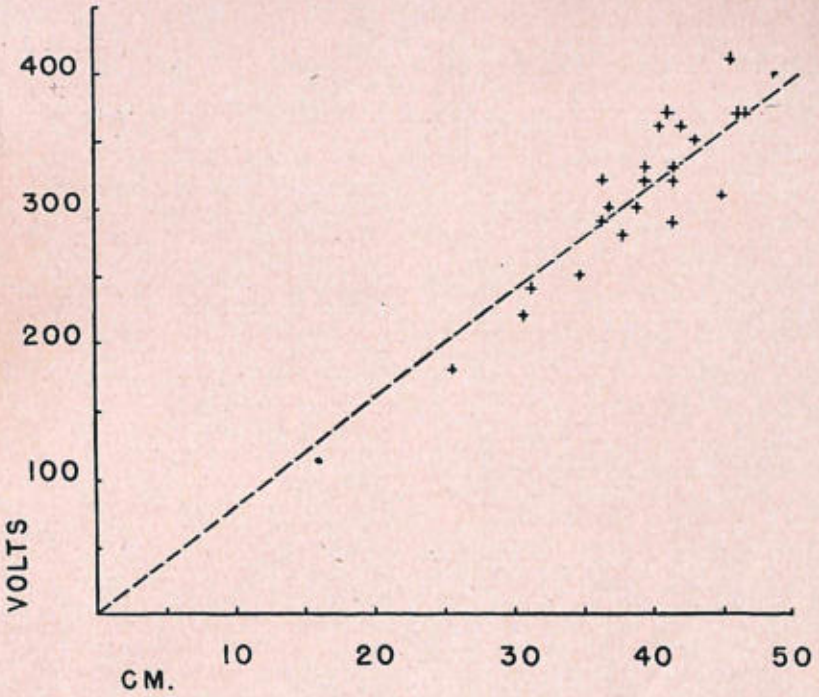
TEXT-FIG. 1. Length of main organs in cm., plotted vertically, against length of fish in cm., plotted horizontally.

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.

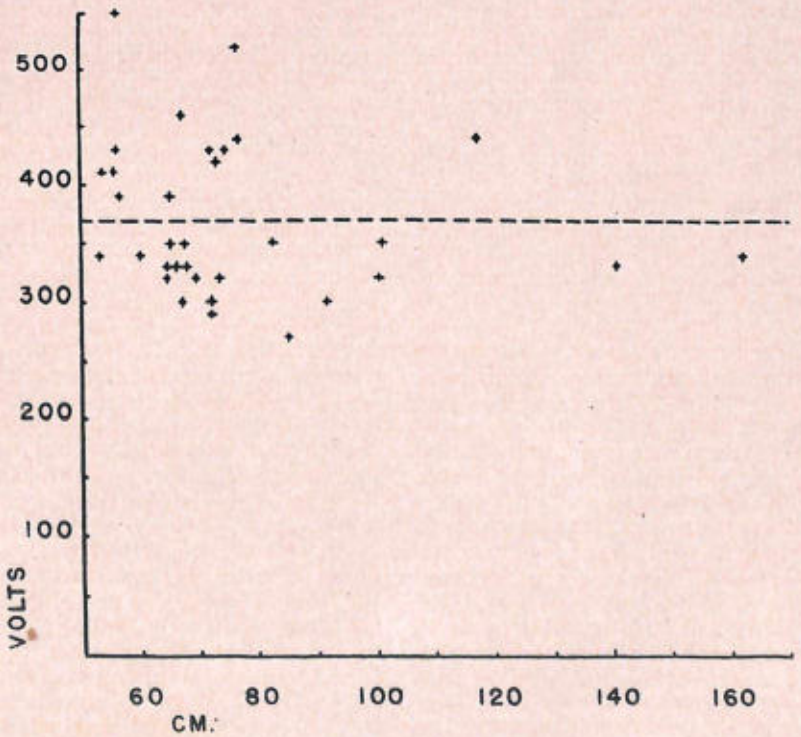
Though this is the most extensive comparison of the lengths and voltages of electric eels which we have been able to make, we have observed over a number of years that the voltages of large fish bore to those of small fish a ratio less than the ratio of their lengths. At one time we ventured the opinion 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.

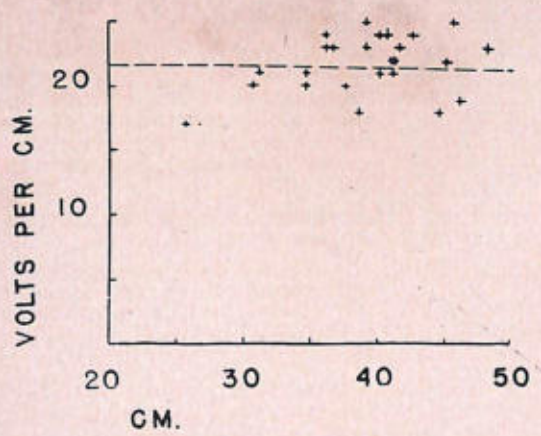
Now, these measurements were made with electrodes 5 cm. apart. The speed of the impulse at the anterior end of the organs is of the order of 2 meters per millisecond. Hence the time lag in 5 cm. would be only about .02 or .03 millisecond, roughly 100 times less than the duration of the discharge. Thus 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.

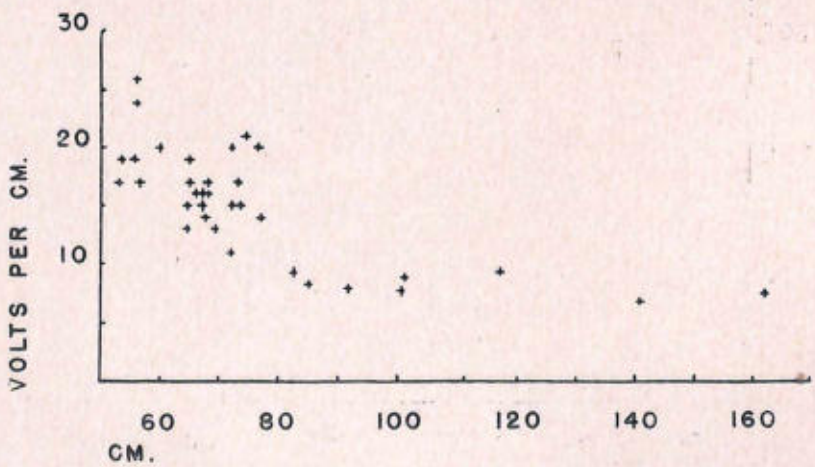
in a proportion about enough to account for the observed independence of voltage and length among the larger fish.

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.

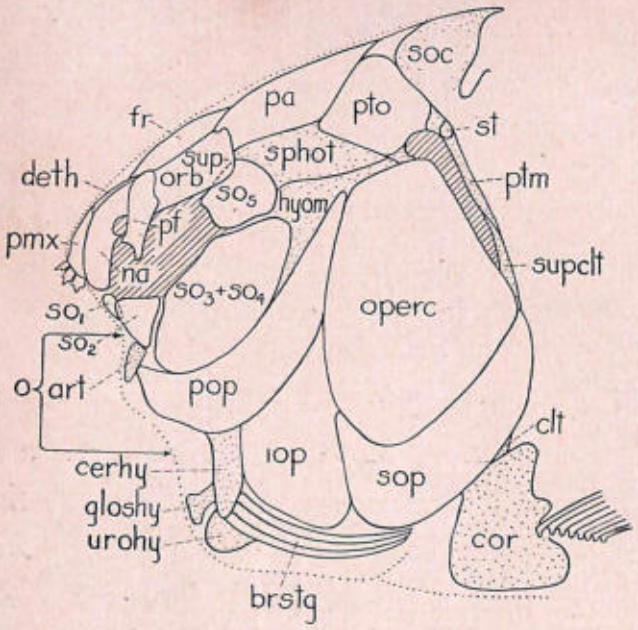
The author is grateful to Mr. Albert Greenberg of Tampa, Florida, for the privilege of studying this specimen. Mr. Greenberg, an accomplished fish culturist, who has reared thousands of this form, *Anoptichthys jordani* Hubbs and Innes, has seen only this single specimen, which was hatched in his establishment. 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 suborbitals of these cave fish, especially so_2, 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, **clt** — cleithrum, **cor**— coracoid, **deth**—dermethmoid, **fr**— frontal, **gloshy** — 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, **supclt** — supracleithrum, **suporb** — supraorbital, **urohy** — urohyal. See text for full explanation.

ward and inward to form the biting vertical "jaws" of this psuedo-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 "0" 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 noncranial 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.

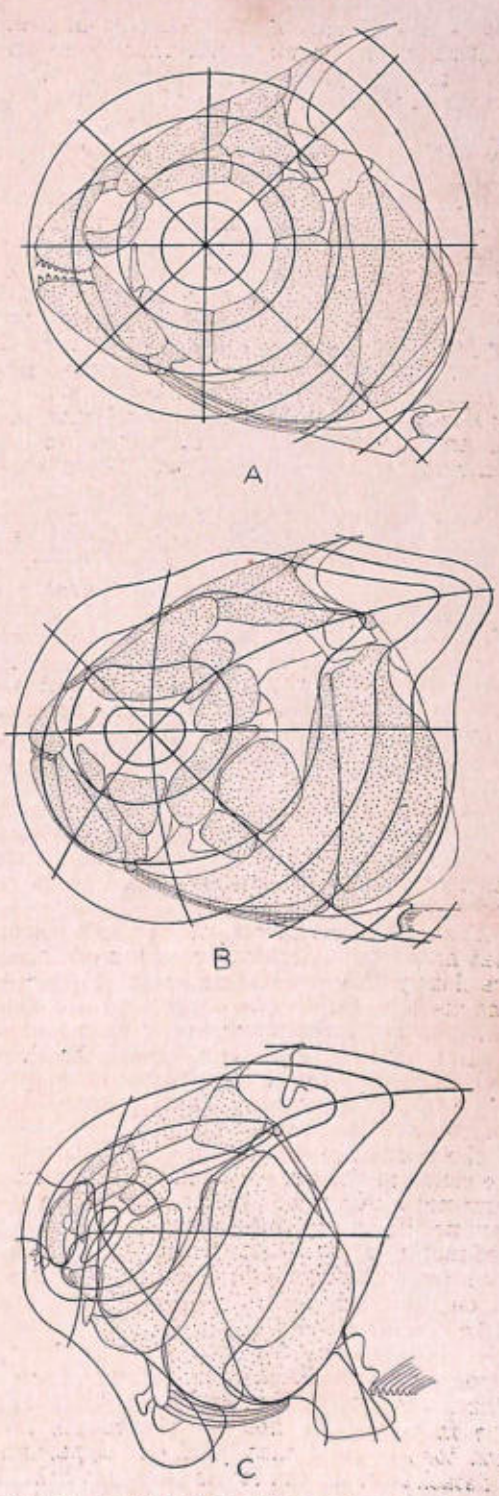
The likelihood of it being traumatic seems very remote, if not fully impossible. Such an injury to this kind of a fish larva would be certainly lethal because of the extreme delicacy and fragility during this period of life. Furthermore the symmetry of the skull would make such an accident most unlikely. 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 stock 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 disfunction 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 symphasis. 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 accompanied 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 Ostarophysi, 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).

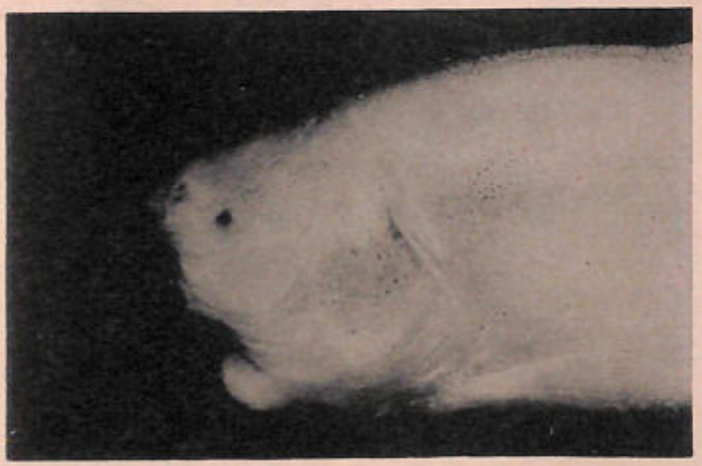

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

COMPENSATING REACTIONS TO THE LOSS OF THE LOWER JAW IN A CAVE FISH.

EXPLANATION OF THE PLATE.

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(A.M.N.H. photographs).

FIG. 1.

FIG. 2.

FIG. 3.

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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(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 Myxococcaceae. 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.

Chrondrococcus 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 nonpathogenic 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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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.).

12.

Notes on the Taxonomy of the Birds of the Philippines.

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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 Philippines[1] 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 entirely 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 subspecies 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 upper wing-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* (Siassi). 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 philipensis 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.

Olgivie-Grant was fully justified to separate this small race from *spilonota*. It is needless to point out that true *spilonota* has never been collected on Mindoro. The type of *plateni* (Rothschild Collection) is a typical specimen of *mindorensis*.

Ninox philippensis spilonota 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 Capunuypugan, 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 *troglodytes*, 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, *whiteheadi*, *"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.]

Hemiprocne 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" macrorhina* (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 *Anthrococeros* 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 *Megalaema, Chotorrhea, Thereiceryx, Cyanops, Mesobucco* and *Xantholaema*. All species must be placed in the oldest genus *Megalaema*.

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 *funebris* (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" striaticeps* 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 *Anuropsis* 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 *Illadopsis* and the Malaysian "*Aethostoma.*" *M. cinereifrons* is extremely similar to *M. pyrrhogenys*, 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 signficance. It otherwise

resembles *S. dennistouni* very closely. *"Dasycrotapha"* 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* (*striaticeps* 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 *striaticeps*, 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 striaticeps*) 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 Muscicapinae). [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 rictal 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 tail-feathers 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 *compilator* (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. *herioti*, 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. herioti* 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 *herioti* 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. venustulus* 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" aureolimbatus* (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 underparts 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 measurments 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*).

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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 stages[2] were utilized:

I. 11-13 mm. total length } Pre-
II. 15-16 mm. total length } metamorphic
III. 20-22 mm. total length } stages.
IV. Hind-limb bud length.
V. 3 mm. hind-limb bud.
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, neutrophiles 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

[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.

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 Erythocyte: 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 %	Standard Error	Thrombocyte %	Standard Error	Neutrophile %	Standard Error	Eosinophile %
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.

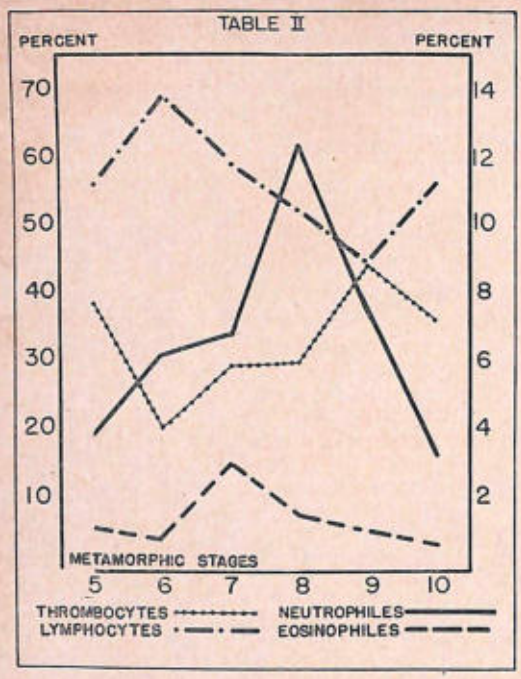
Mitosis and amitosis have never been reported in the circulating blood of the mature adult or larval *Rana pipiens*. However, Dawson (1930) has described mitosis in urodeles, and Charipper and Dawson (1928) have reported amitosis in the peripheral circulation of *Necturus*. The peripheral circulation 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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[1]Contribution No. 715, Department of Tropical Research, New York Zoological Society.

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-

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* superficially 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 remarkable 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 laternaria* Linnaeus.

This genus is also represented by a single specimen which I assigned to the species *Fulgora laternaria*. 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 *laternaria* 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 *laternaria* 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 commisural 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 darker 2
1. Hing wings not entirely transparent, colored on the base at least 6
2. Dorsum of abdomen uniformly colored 3
2. Dorsum of abdomen not uniformly colored 4
3. Tegmina grayish, reddish toward the 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 black 5
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 colored 7
7. Apical area of hind wings transparent, basal area colored 8
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.

Calyptoproctus 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 cylindric 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. Aedaegus 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. Aedaegus 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 apicies 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 mesontum. 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 tubercules on the clavus are chiefly black. Hing 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 reticulate 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 commisural 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 tegminae, the stigmatal 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.

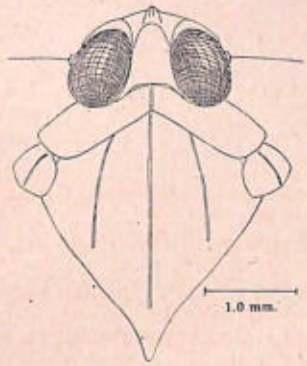
PLATE II.

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.

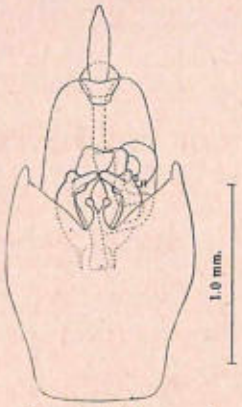
PLATE III.

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.

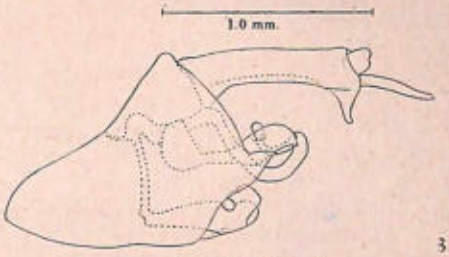
METCALF. PLATE I.



Oliarus beebei Metc.



Oliarus beebei Metc. 2



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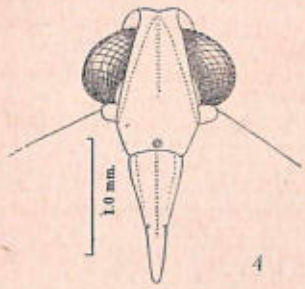
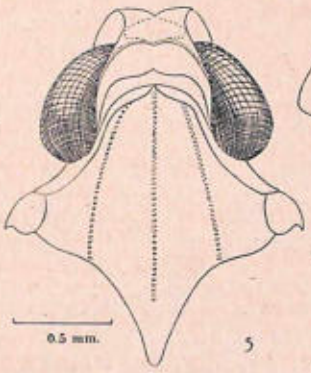


Pintalia castanea Metc. 4



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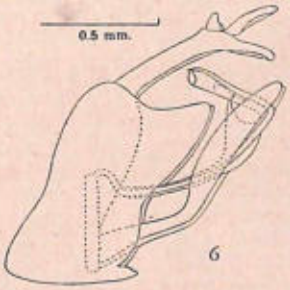

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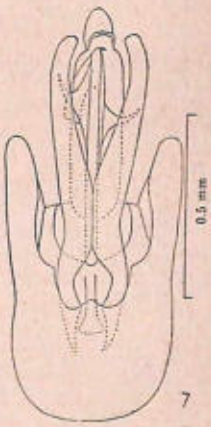

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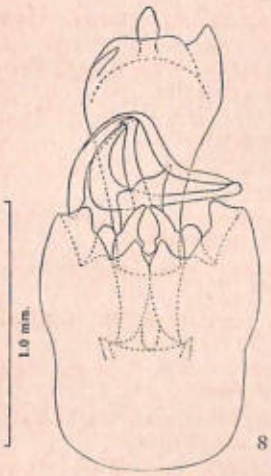

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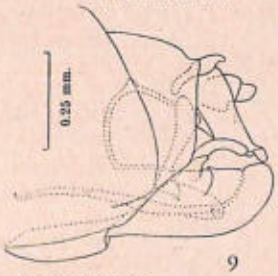
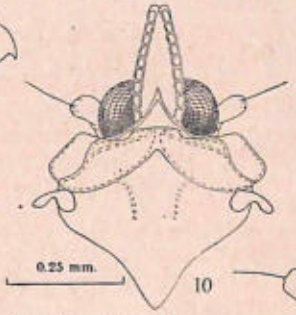
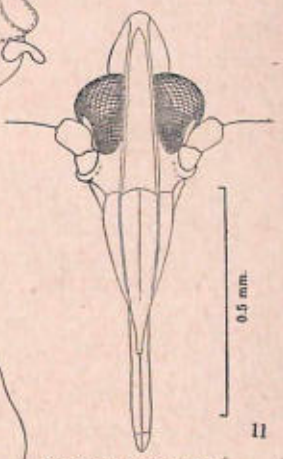


Mysidia rubra Metc. 9



Neocenchrea ochracea Metc. 10



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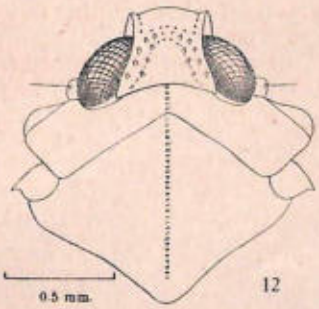

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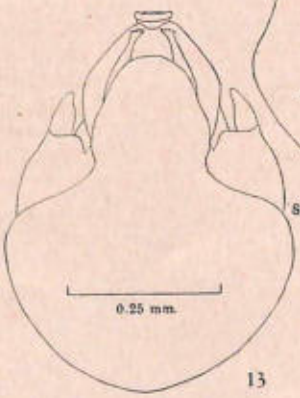
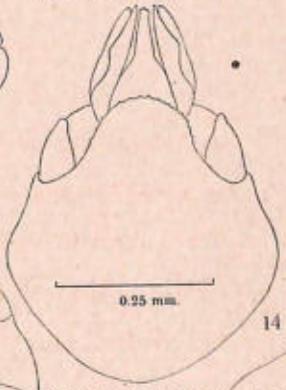
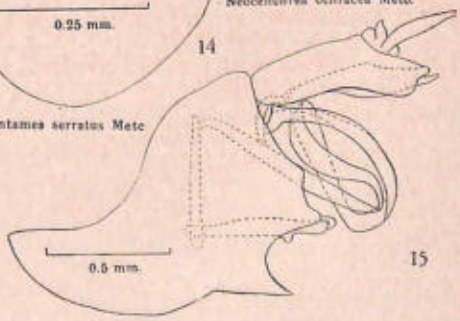


Neocenchrea ochracea Metc. 13



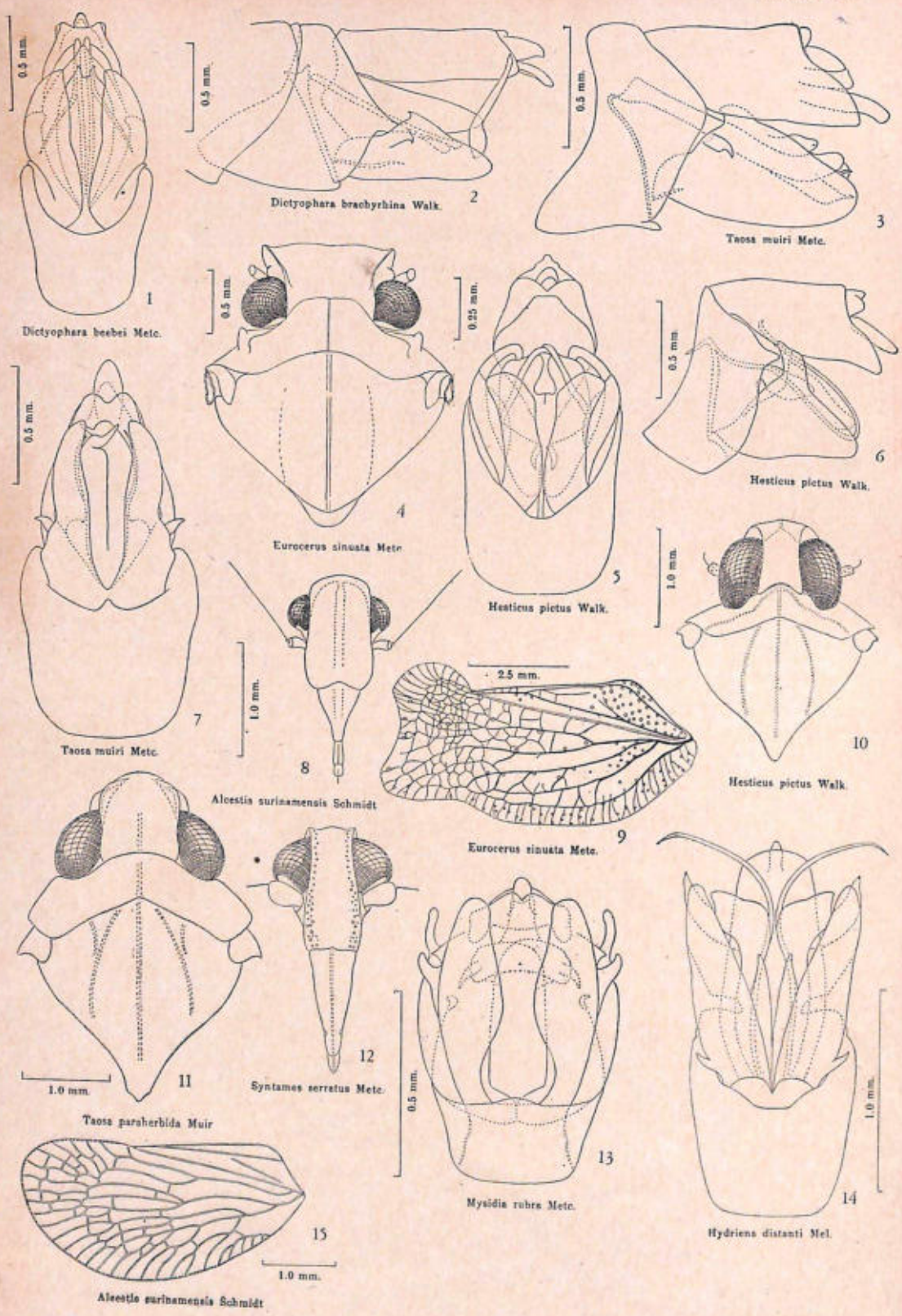
Syntames serratus Metc. 14



Eucanyra bifurcata Metc. 15

Sue D Sparks, del.

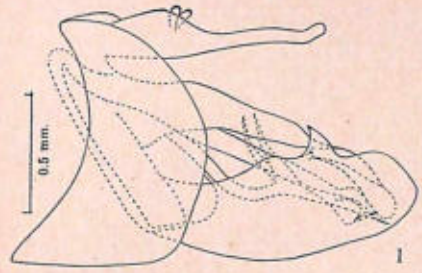
FULGOROIDEA (HOMOPTERA) OF KARTABO, BARTICA DISTRICT, BRITISH GUIANA



Sue D Sparks, del.

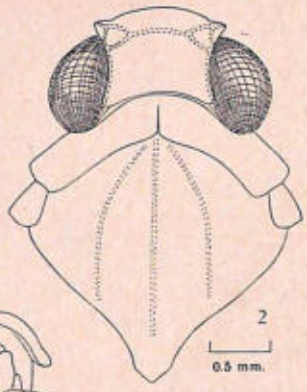
FULGOROIDEA (HOMOPTERA) OF KARTABO, BARTICA DISTRICT, BRITISH GUIANA

METCALF. PLATE III.



1

Alcestis surinamensis Schmidt



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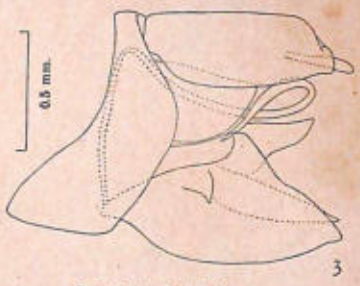
Taosa muiri Metc.



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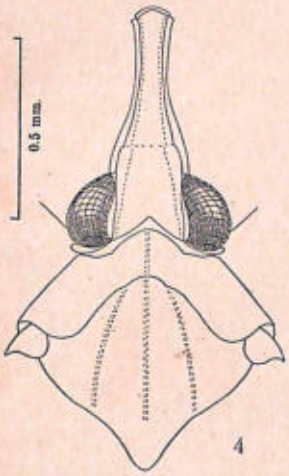
Dictyophara beebei Metc.



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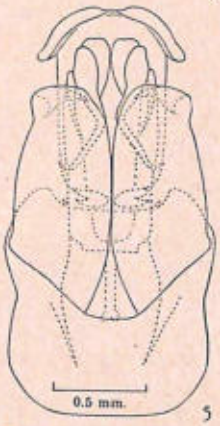
Lappida fusca Metc.



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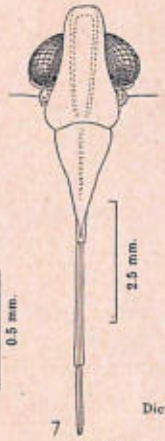
Flatoidinus kartaboensis Metc.

6

Alcestis surinamensis Schmidt



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Hydriena distanti Mel.

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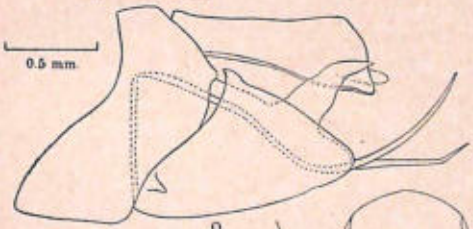
Dictyophara platyrhina Walk.



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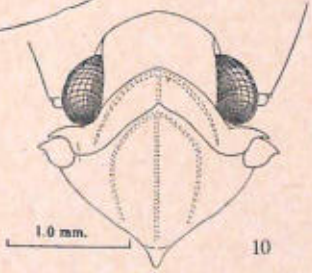

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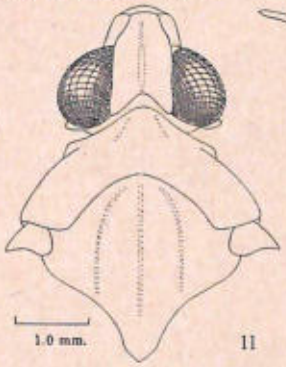

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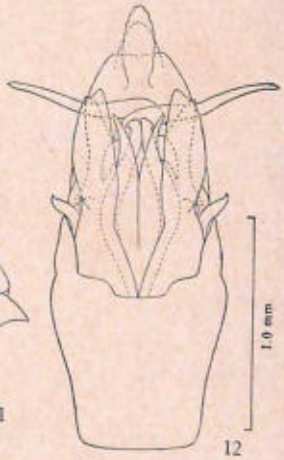

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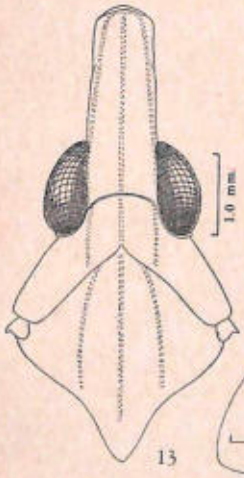

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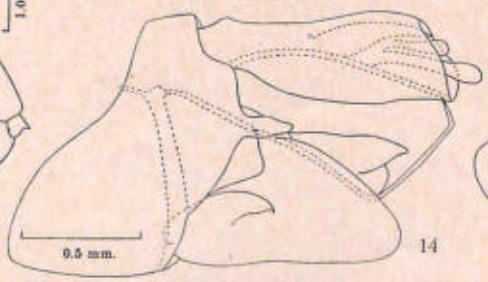

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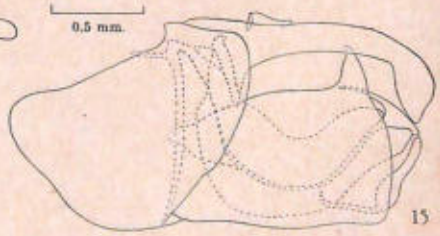
Dictyophara platyrhina Walk.



15

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]

WESLEY R. COE.

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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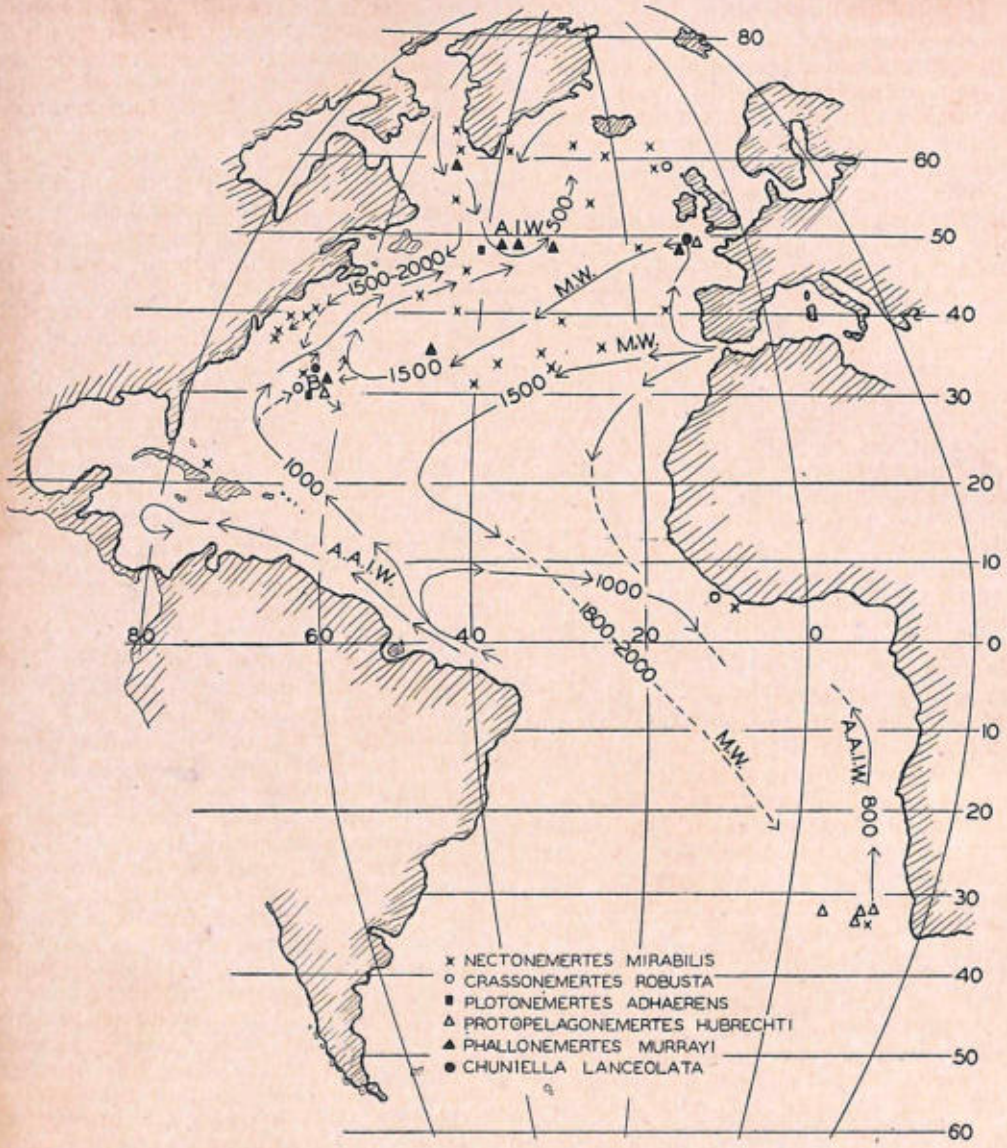
[1] Contribution No. 716, Department of Tropical Research, New York Zoological Society.

[2] Contributions from the Scripps Institution of Oceanography, New Series No. 261.

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-



TEXT-FIG. 1. Correlation of the distribution, insofar as at present known, of six of the species of bathypelagic nemerteans 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 *Parabalaenanemertes 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 hubrechti 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 *Dinonemertes 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 beebei.* (B)
2. ——— *hubrechti.* (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. ——— *hjorti.* (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 ..... Protopelagonemertidae
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 rynchocoel 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 PROTOPELAGONEMERTIDAE.

Key to Genera.

1. Mouth and proboscis opening united; proboscis sheath extends to posterior end of body ..... *Protopelagonemertes*
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 ***Protopelagonemertes*** Brinkmann.

1. ***Protopelagonemertes 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. *Protopelagonemertes 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).

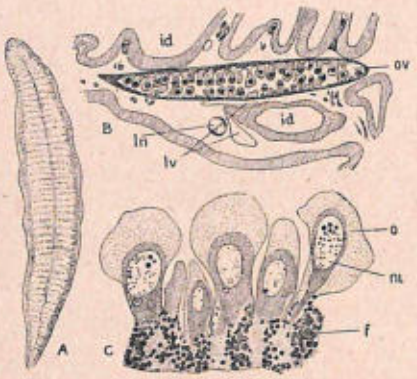
was orange yellow, with paler lateral margins.

2. **Protopelagonemertes hubrechti** Brinkmann.

Bathynectes hubrechti Brinkmann, 1912, 1917, 1917a; *Protopelagonemertes hubrechti* Brinkmann, 1917a Nachtrag; Coe, 1926, 1935, 1936; *Bathynemertes hubrechti* 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 hubrechti*. **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).

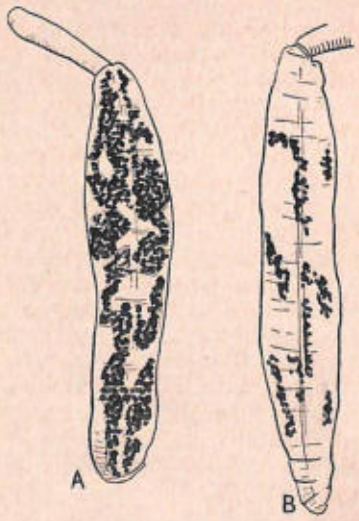
Bathynemertes hardyi Wheeler, 1934.

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. hubrechti* 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.

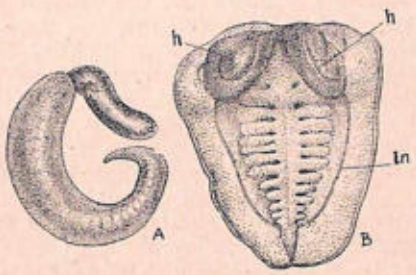
Genus ***Plotonemertes*** Brinkmann.

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.

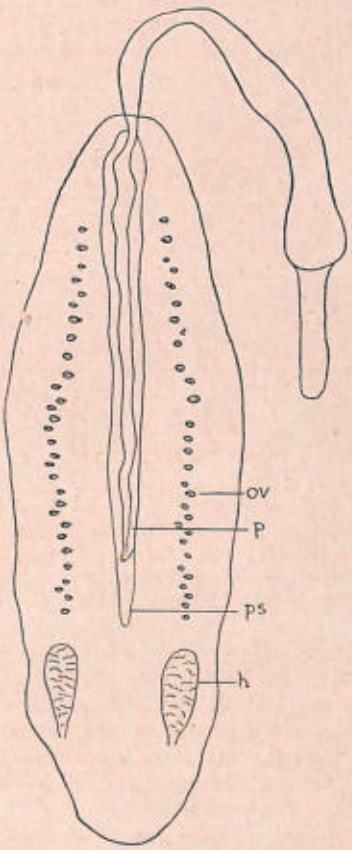
With the exception of *Nectonemertes mirabilis*, this was the most abundant bathypelagic nemertean in the Bermuda area between the depths of 1,100 and 1,830 m. at the times when these collections were made. It was not taken in any of the nets drawn at higher levels. Only a single specimen has been found 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. Detailed 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.



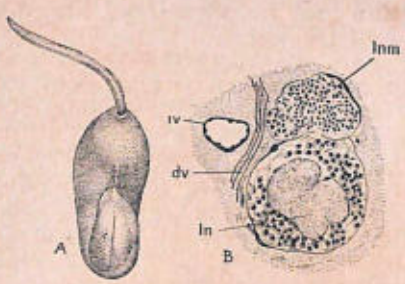
TEXT-FIG. 6. *Plotonemertes aurantiaca*, ventral surface of body of female, showing pair of glandular organs **(h)**, ovaries **(ov)**, extent of proboscis sheath **(ps)**, and attachment of proboscis **(p)**. (After Coe).

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.

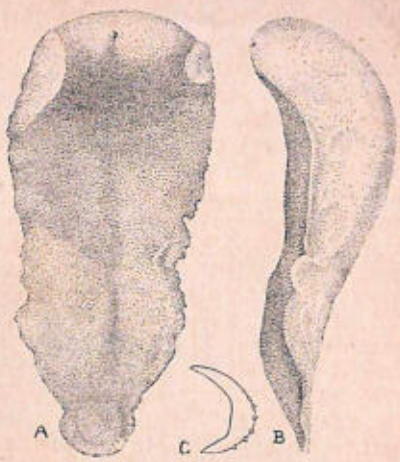
Genus ***Mononemertes*** Coe.

8. ***Mononemertes sargassicola*** (Joubin).

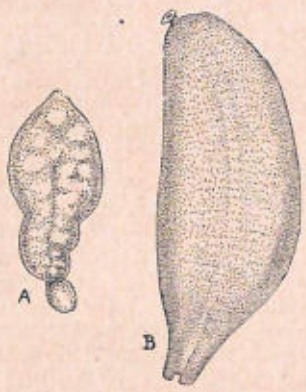
Planktonemertes sargassicola Joubin, 1906; *Mononemertes sargassicola* Coe, 1926.

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**, stylet 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 stylet basis, in number of proboscidial 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 proboscidial 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 spermatic 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.

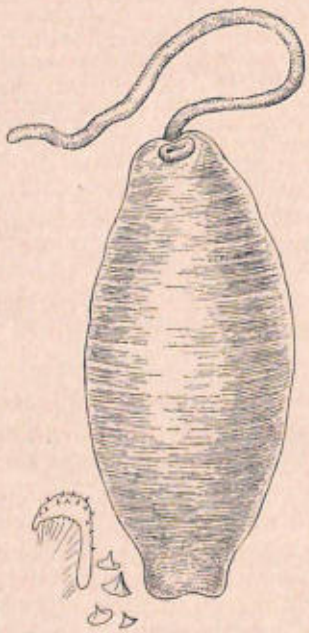
This species is known from 3 specimens; 2 of these were females, while the sexuality of the other could not be determined. Hence the male remains undescribed. The type specimen was collected in the North Atlantic, northwest of Great Britain (Lat. 57°41′ N., Long. 11°48′ W.) at a depth of about 1,666 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.

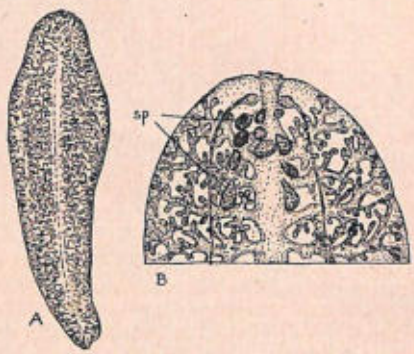
Genus **Buergeriella** Brinkmann.

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*

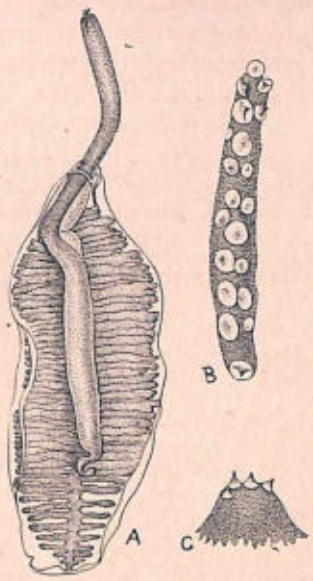
Genus **Paradinonemertes** Brinkmann.

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.

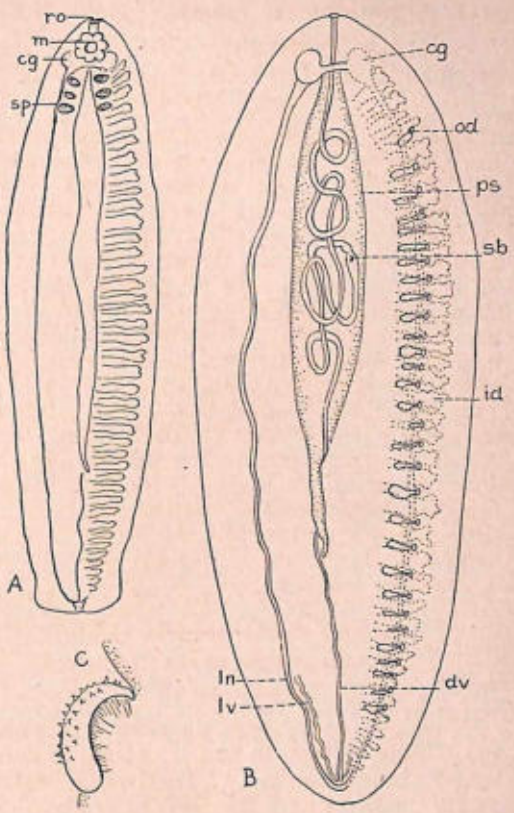
16. ***Dinonemertes alberti*** (Joubin).

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.



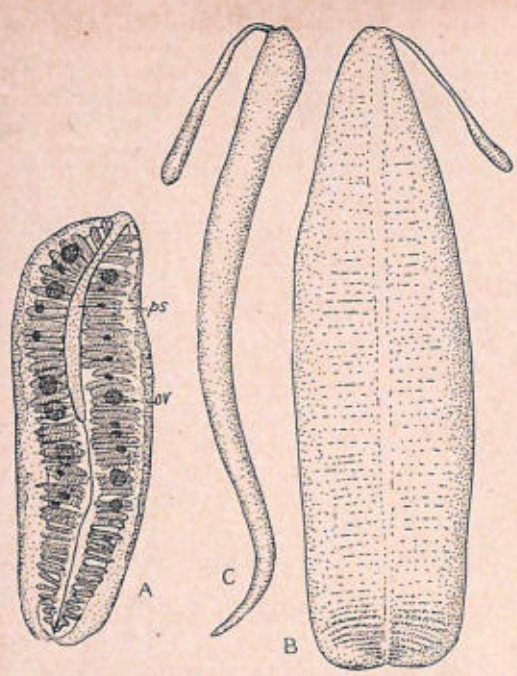
TEXT-FIG. 13. *Paradinonemertes wheeleri.* **A**, male with 3 pairs of spermaries **(sp)**; **B**, female with 30 pairs of ovaries and oviducts **(od)**; other letters indicate: **cg**, cerebral ganglia; **dv**, dorsal vessel; **id**, intestinal diverticula; **In**, lateral nerve cord; **lv**, lateral 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.

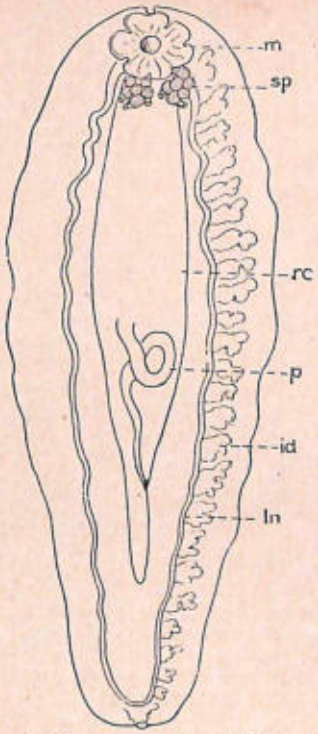
The type specimen was taken from a depth of about 2,000 meters in the Indian Ocean, southwest of India. Two other specimens which Brinkmann (1917) referred to this species were collected in the middle North Atlantic (Lat. 34° and 48°) in nets lowered to 2,000 meters. If Brinkmann was correct in his identification, 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 Bermuda area, where two individuals, one male and one female, were taken at a depth of about 1,800 meters.



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).

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 CHUNIELLIDAE.

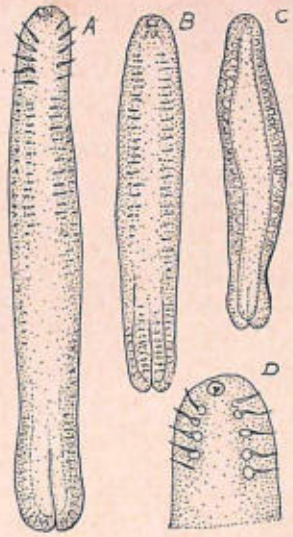
Genus ***Chuniella*** Brinkmann.

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.

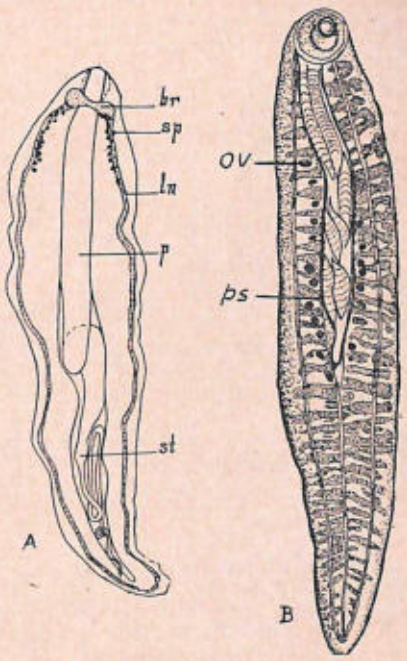
Genus ***Nectonemertes*** Verrill.

24. ***Nectonemertes minima*** Brinkmann, 1915.

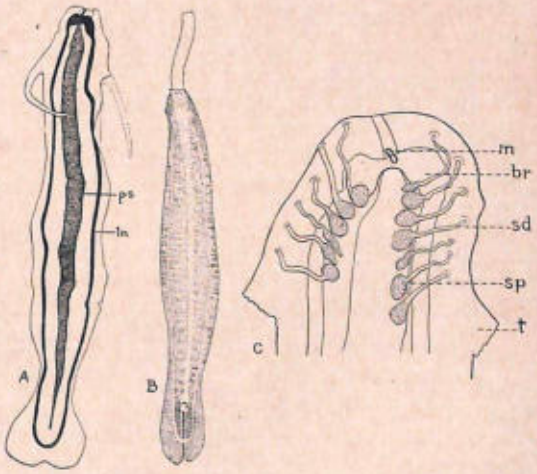
Hyalonemertes atlantica Bürger, 1909; *N. minima* Brinkmann, 1917, 1917a; Coe, 1926.

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.

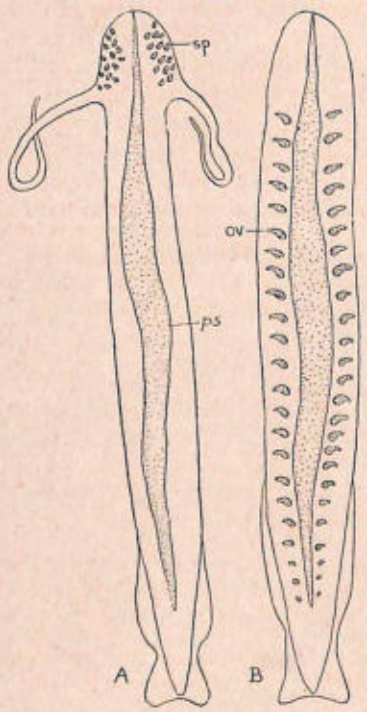
The males are distinguished from those of *N. mirabilis* and *N. primitiva* in having 5 to 7 spermaries on each side of the body back of the head. The female has about 25 pairs of ovaries.

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. kempi* (?) 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 maximum 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. kempi*. 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. kempi* to be a valid species.

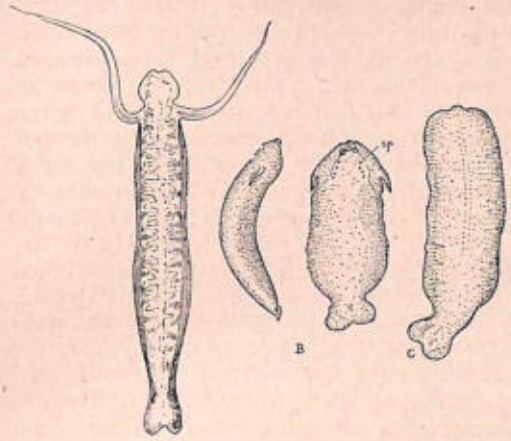
26. **Nectonemertes primitiva** Brinkmann, 1917, 1917a.

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 666 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.

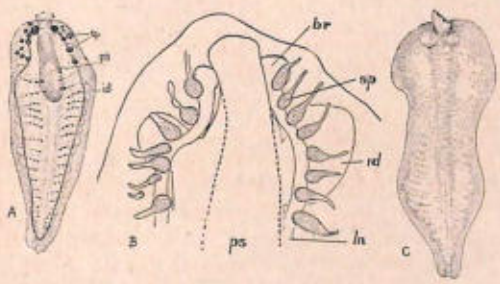
27. ***Armaueria rubra*** Brinkmann, 1917.

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 Atlantic (Lat. 45° to 55° N., Long. 25° to 43° W.), where four specimens were collected at depths of 800 to 1,600 meters.



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).

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*

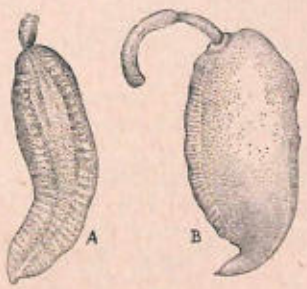
Genus ***Natonemertes*** Brinkmann.

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

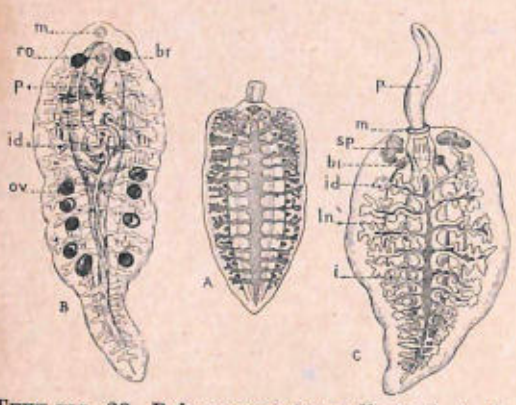
to determine the details of the internal anatomy. The general appearance of the body resembles that of species of *Pelagonemertes* but indicates a different genus because the spermaries are situated in a single row on each side of the body. This specimen was taken in the central North Atlantic (Lat. 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 proboscidial 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 hubrechti* 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.

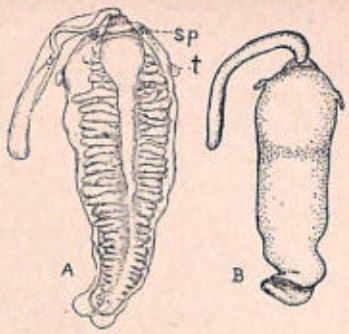
Text-figure 24, A.

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 species were taken in the northern North Atlantic at depths of 660 and 1,200 meters, respectively.



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).

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?).

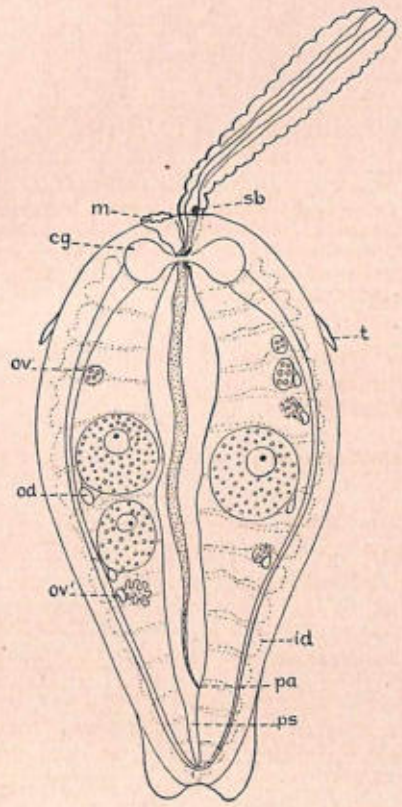
Text-figure 24, B.

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 nemerteans 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).

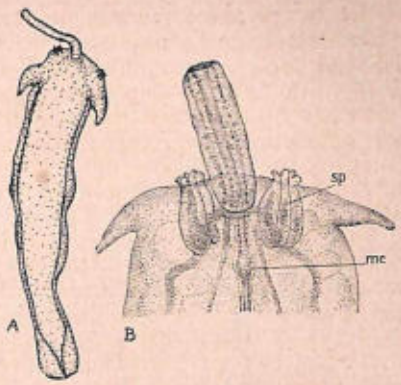
42 (?). ***Balaenanemertes musculocaudata*** Brinkmann, 1917.

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.

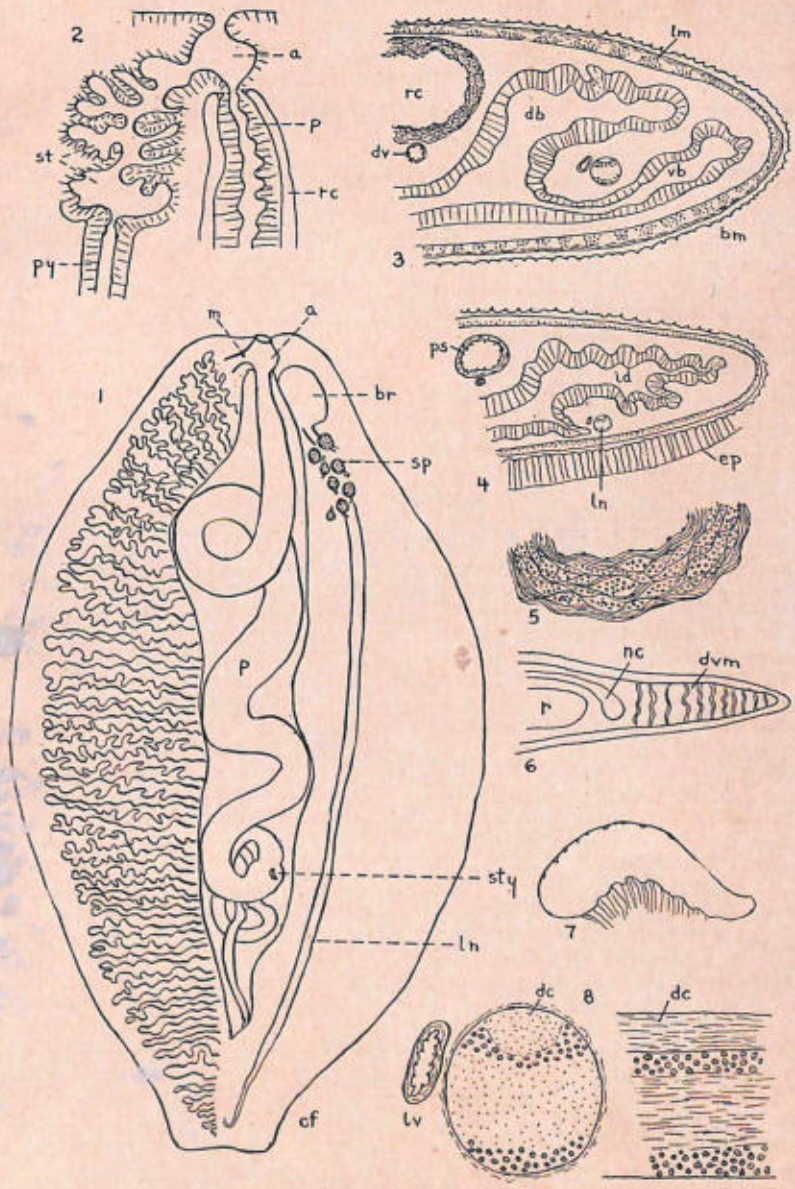
Fig. 1. Outline of body of type specimen, showing intestinal diverticula on one side of the body and ovaries **(ov)** on the other side with the rhynchocoel containing the extremely long, coiled proboscis occupying the central axis; other letters indicate: **br**, brain; **ln**, lateral nerve cord; **m**, 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)**.

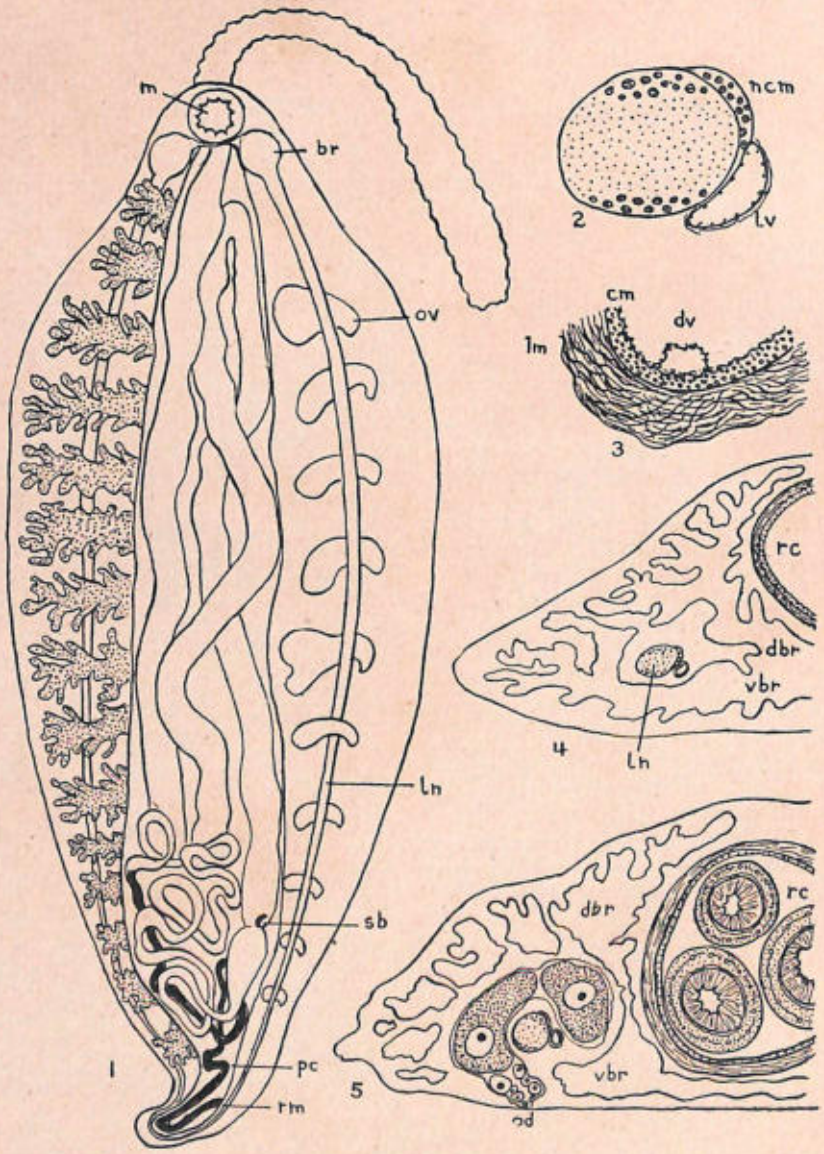
Fig. 3. Portion of transverse section of proboscis sheath with dorsal vessel **(dv)**; **cm** and **lm**, circular and longitudinal muscular layers respectively.

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.

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 isabelita* [Smith and Nigrelli, 1937], hogfish, *Lachnolaimus maximus* [Weissenberg, Nigrelli, Smith, 1937], orange filefish, *Aleutera schoepfii=Ceratacanthus schoepfii*, [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 mentioned 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

TABLE 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)
Lepomis gibbosus	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
Lepomis macrochirus	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 Lepomis cyanellus × *Lepomis macrochirus*	Dexter, New Mexico	U. S. Fish Serv. Hatchery Dexter, New Mex. in winter 1940/41	1	Hubbs		Dec. 19, 1940	300 micra	missing
Lepomis megalotis	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 species[1]: 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).

[1]The nomenclature follows mainly Hubbs and Lagler, 1939.

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-

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)
Pomoxis nigromaculatus	Illinois		1	Kudo			380 micra	missing
	Schuylkill River at Philadelphia, Pennsylvania		1	Weissenberg	7 cm.	Nov. 1939	148 × 103 micra	missing
Huro salmoides	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
Micropterus pseudaplites	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 Centrar-

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 distinctly 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 fractioned 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× 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 susbtance 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 nucleolus[2]. 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

[2]In *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 Guarnieri 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 Guarnieri 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 corn[3]. 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

[3]cf. Goodpasture, 1928; Glaser, 1928; Kunkel, 1928.

viruses. The elementary bodies have in vaccinia[4] 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 Guarnieri 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 Guarnieri 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 Guarnieri bodies. Nevertheless, Bland and Robinow consider it very probable that the Guarnieri body during its whole development contains elementary bodies enveloped in a matrix which is possibly produced by the host cell. Thus they interpret the Guarnieri 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 mantle[5].

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-

[4]The 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.

[5]cf. 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. Shou'd 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. × 1,000.

Fig. 2. Bluegill. Lymphocystis cell of 21 microns in diameter from a section. Fixation with Flemming's fluid; safranin-light green stain. × 625.

Fig. 3. Bluegill. Lymphocystis cell of 22 × 20 microns from a section. Fixation with Flemming's fluid; safranin-light green stain. × 1,000.

Fig. 4. Common sunfish. Lymphocystis cell of 22 × 19 microns from a whole mount preparation. Fixation with absolute alcohol 95 parts, glacial acetic acid 5 parts; Delafield's hematoxylin stain. × 625.

Fig. 5. Common sunfish. Section through a lymphocystis cell of 64 × 54 microns. Fixation with Flemming's fluid; safranin-light green stain. × 625.
(g) ground substance.

Fig. 6. Bluegill. Section through a lymphocystis cell of 80 × 64 microns. Fixation with Flemming's fluid; safranin-light green stain. × 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 × 61 microns. Fixation with Flemming's fluid; safranin-light green stain. × 625.
(h) fenestration of the inclusion body.

Fig. 8. Common sunfish. Two sections **(A)** and **(B)** through a lymphocystis cell of 72 × 54 microns. Fixation with Flemming's fluid; safranin-light green stain. × 625.
(B) bud of the inclusion connected with the main inclusion body by a thin bridge.

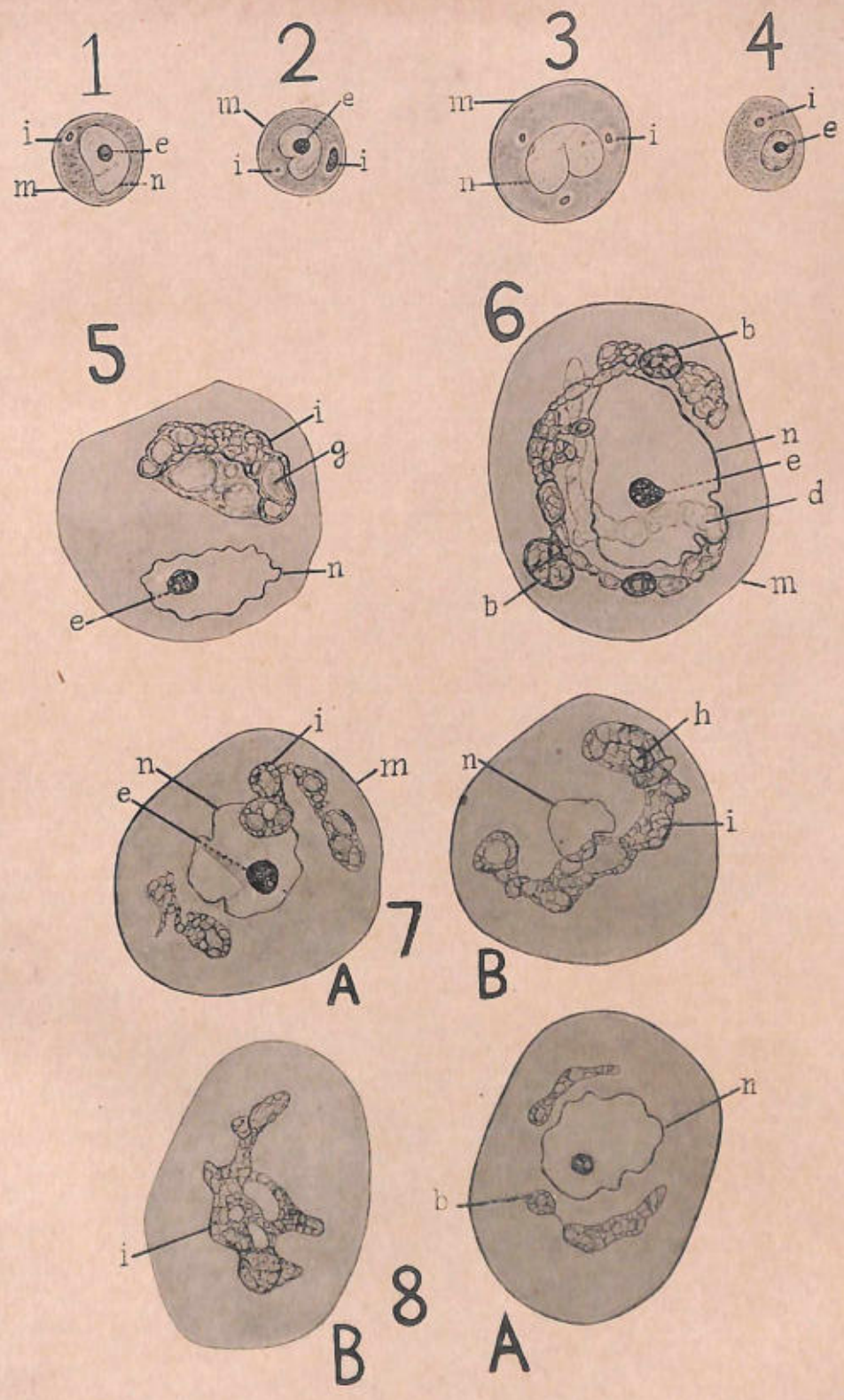
PLATE II.

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. × 340.
(c^1) and **(c^2)** 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 × 185 microns. Fixation with Flemming's fluid; safranin-light green stain. × 340.
(e) nucleolus; **(i)** inclusion bodies; **(m)** cell membrane; **(n)** nucleus.

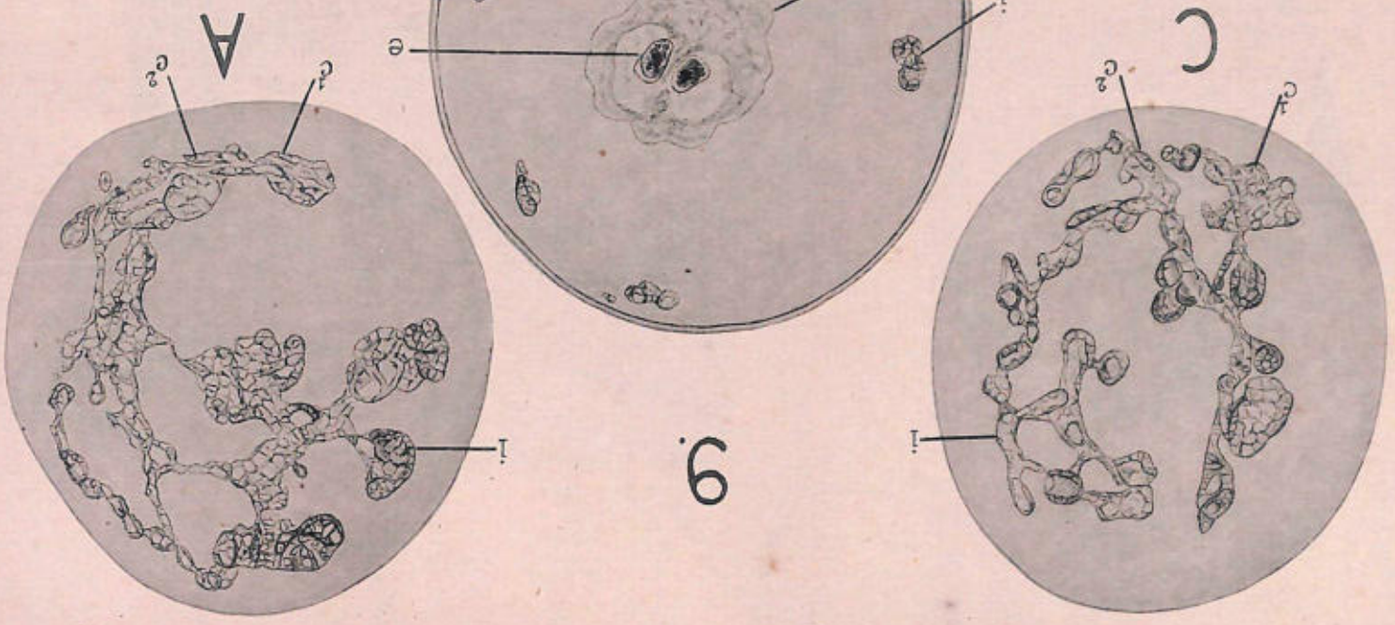
Fig. 11. Bluegill. Stage of the 21st day of experimental infection. Whole mount preparation of the tail fin border. Three weeks before the start of the infection experiment the margin of the fin was amputated. At the time of the experimental infection the regeneration of the fin border was in progress. 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. × 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.

PLATE II.

STUDIES ON VIRUS DISEASES OF FISH.
LYMPHOCYSTIS DISEASE IN CENTRARCHIDAE.



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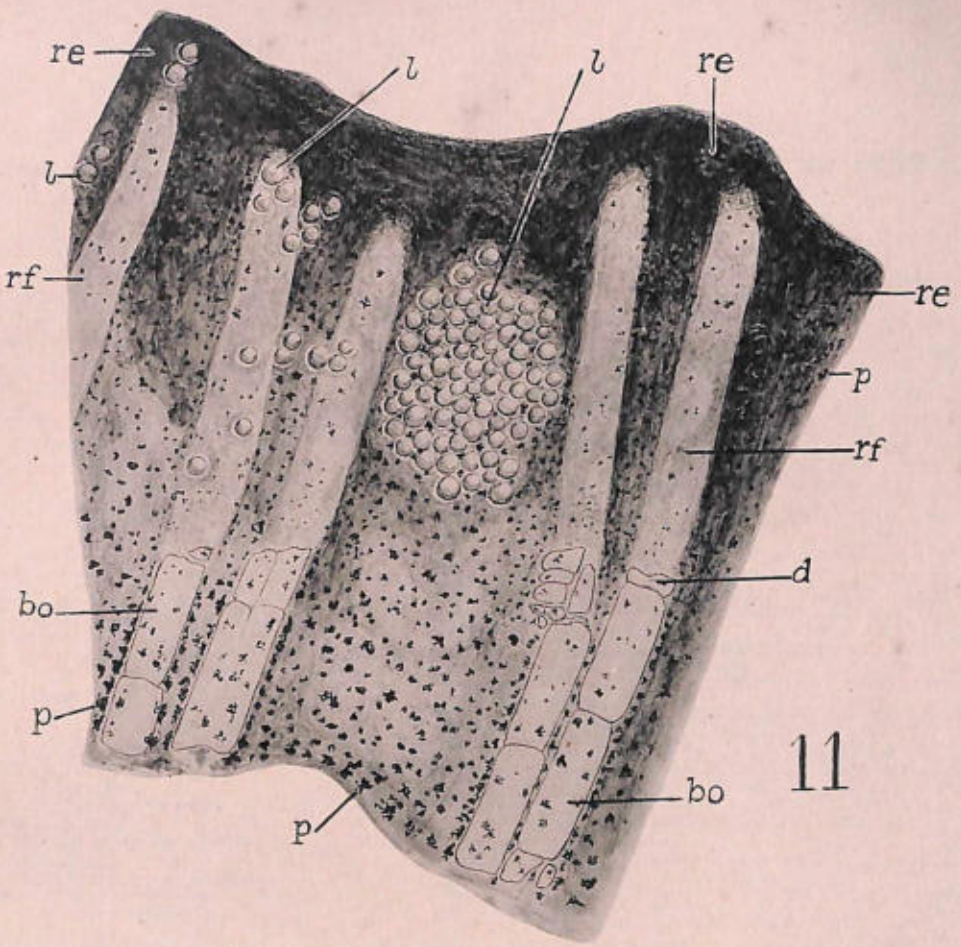
WEISSENBERG.



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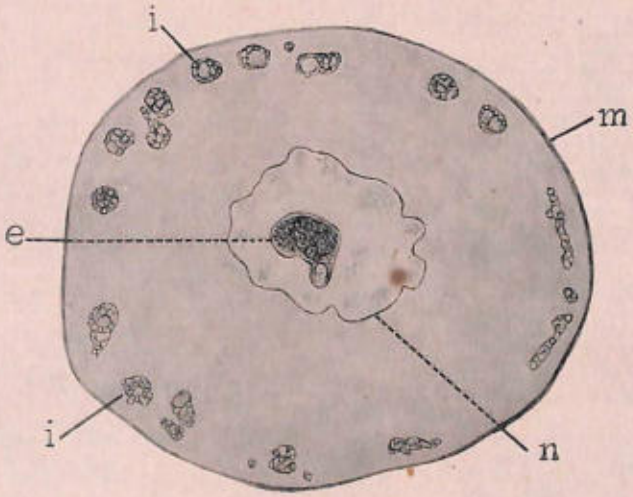

10

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 Hyperiidea 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. Stephensen (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 considerable 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 challengeri Stebbing.

Text-fig. 1 c.

Cyphocaris challengeri Stebbing, 1888, p. 661, pl. 17.

Cyphocaris alicei Chevreux, 1905b, p. 1, figs. 1-2.

Cyphocaris challengeri Schellenberg, 1926 b, p. 212, figs. 6-10; pl. 5, fig. 3.

Cyphocaris kincaidi 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. kincaidi*). On February 3, 1914, the steamer *Bache* took a specimen of *C. challengeri* 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.

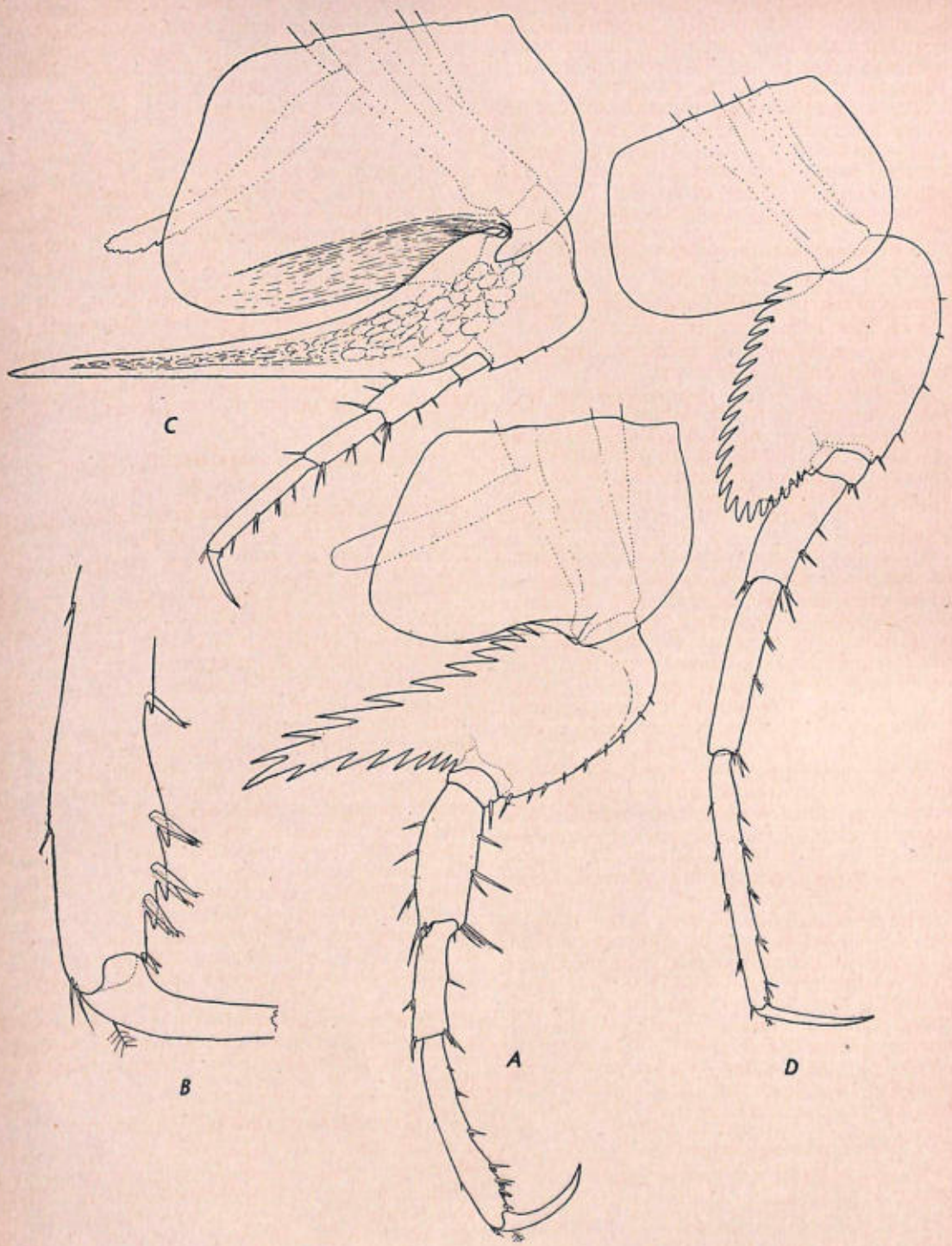
Text-fig. 1 d.

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 challengeri* 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.

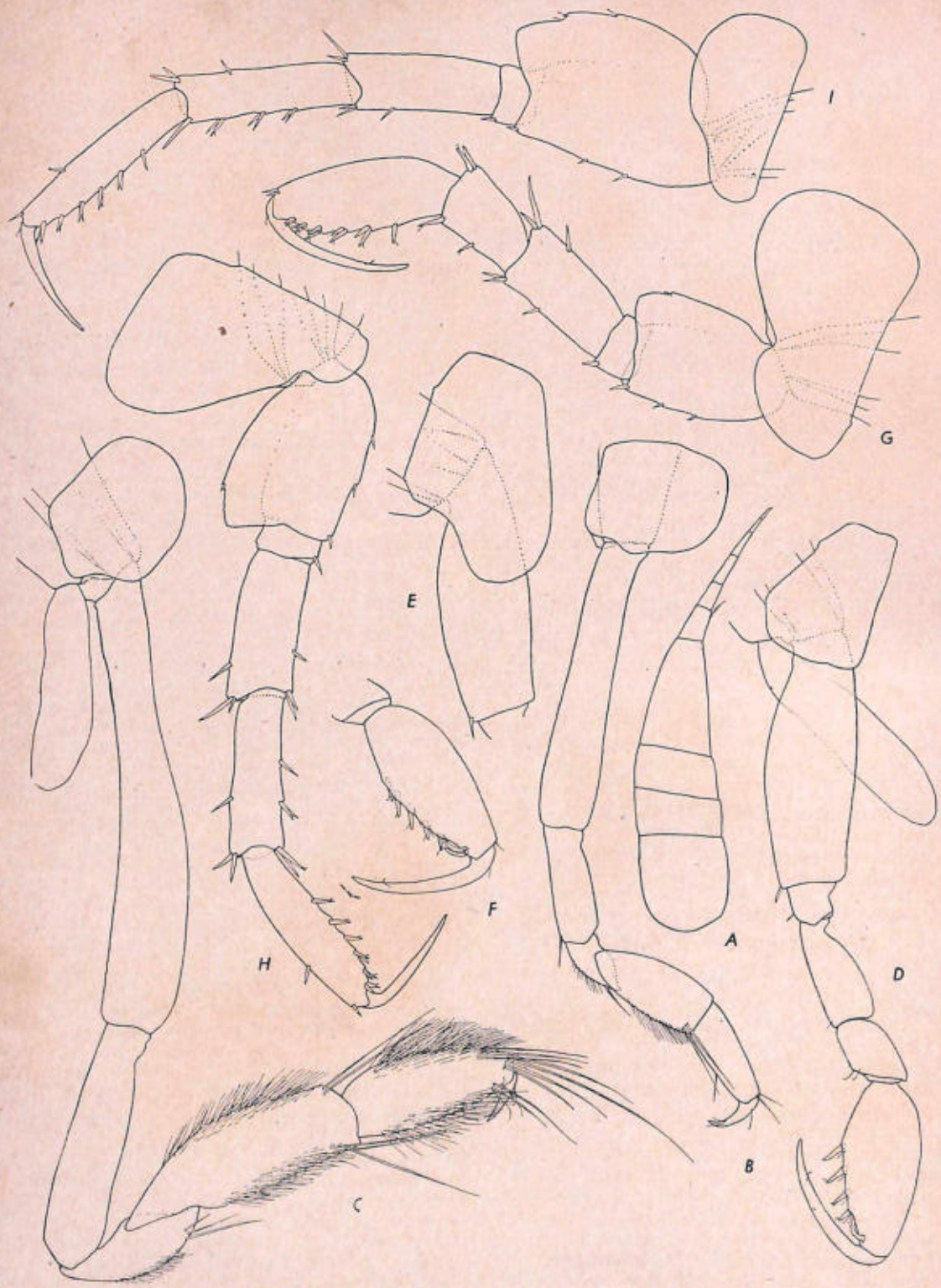
Five specimens were taken at depths of 600 and 900 fathoms.

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).

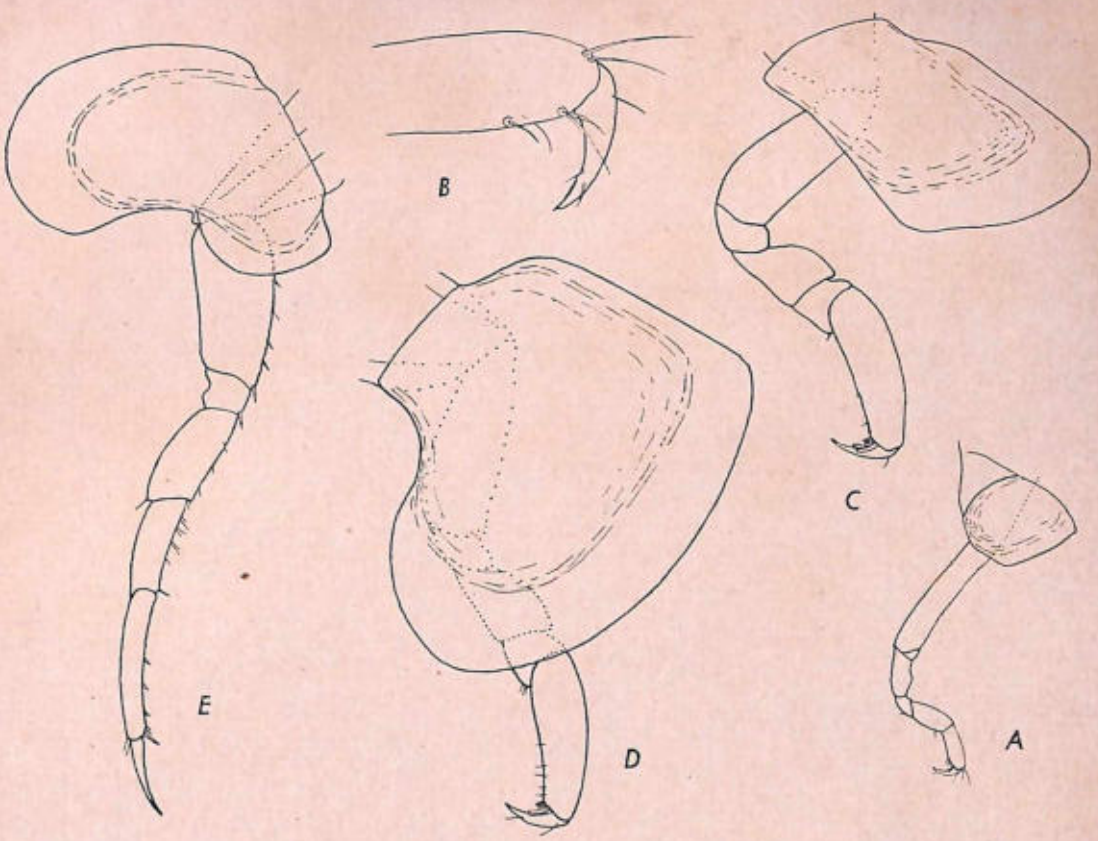
Tattersall says that the two specimens which he studied, measuring 11 mm., appeared to be males, but he does not state his reasons for so believing. The sex of all other recorded specimens has not been mentioned. The Bermuda specimens, the largest of which measures about 11 mm., do not show any sexual 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.

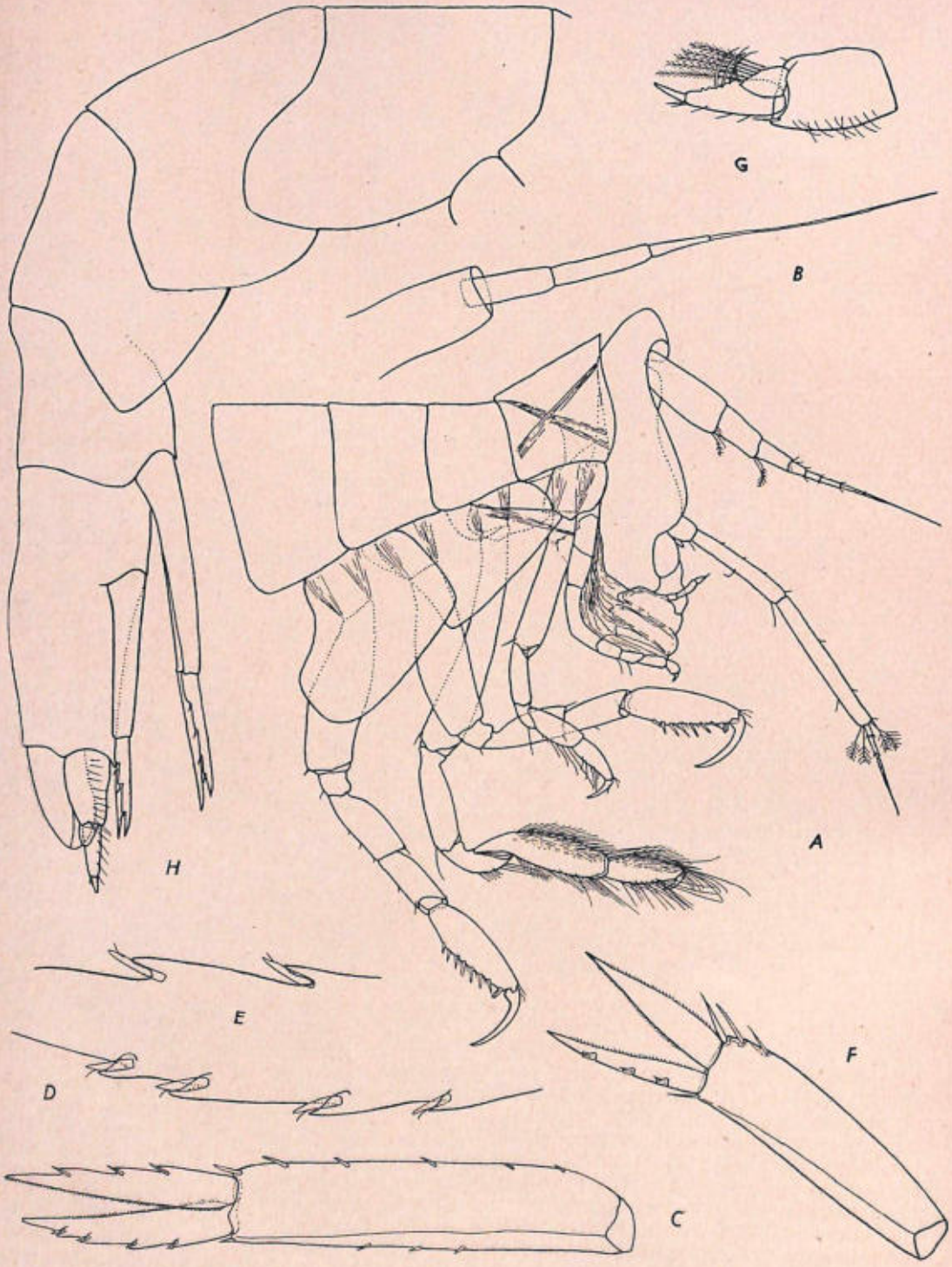
Text-figs. 4, 5.

One specimen was taken at a depth of 600 fathoms.

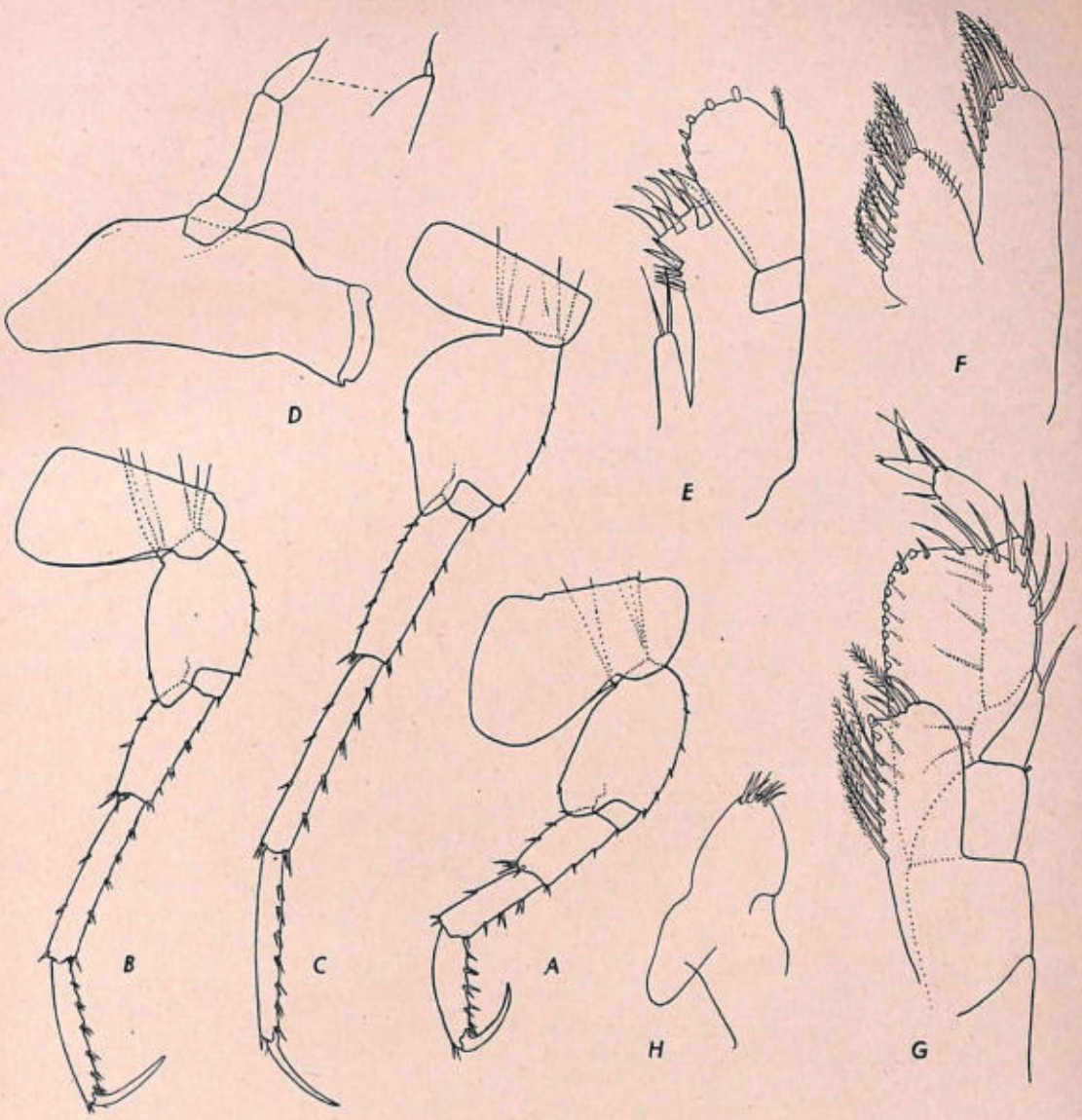
Body with ventral surface bulging in the same manner as noted for *Paracyphocaris praedator*. Integument thin and weak and nearly transparent.

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 boecki (Stebbing).

Andania boecki Stebbing, 1888, p. 735, pl. 36.

Stegocephalus boecki Della Valle, 1893, p. 628, pl. 59, fig. 36.

Parandania boecki 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 peraeopod 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.

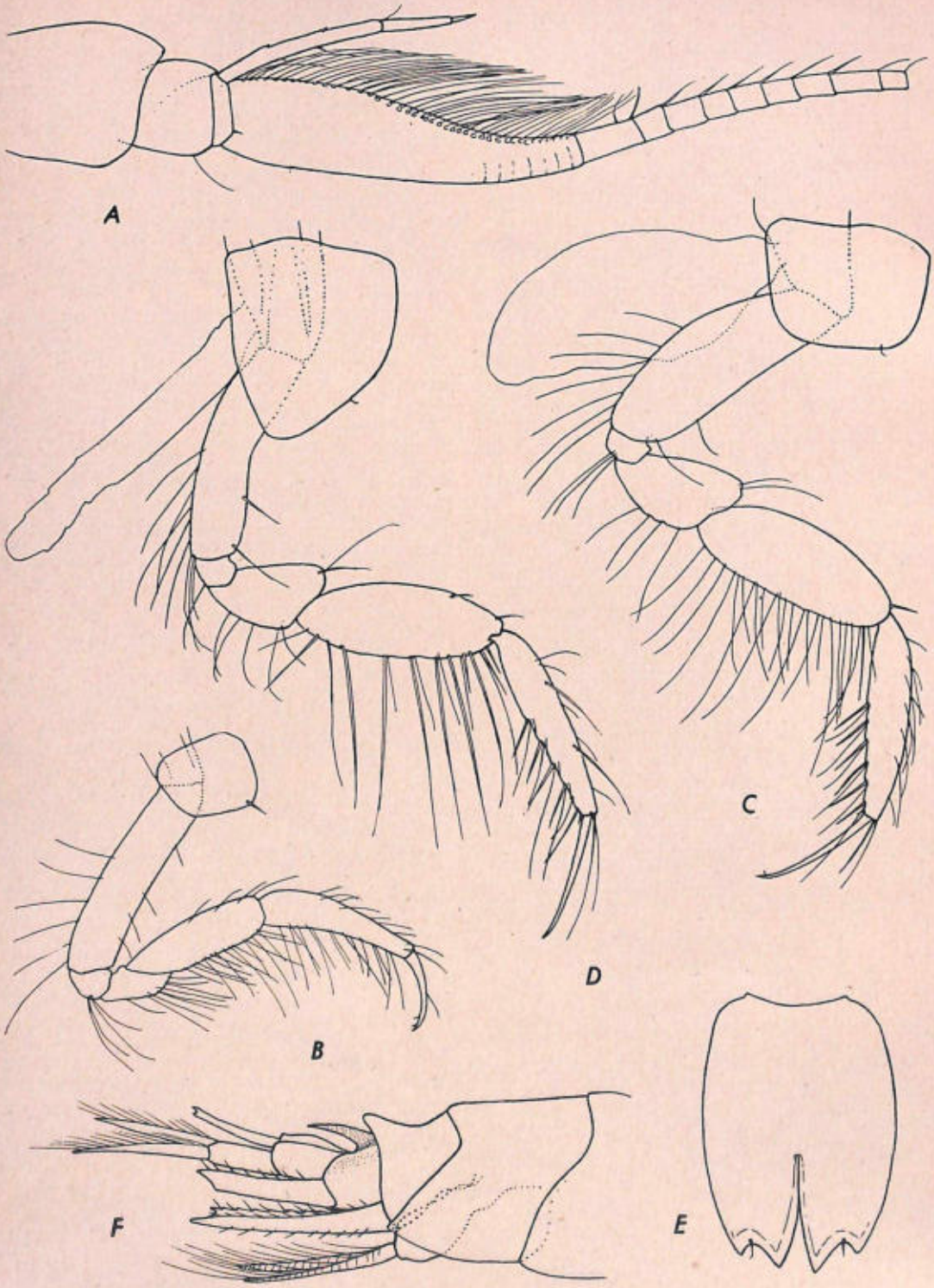
Cleonardo microdactylus Stephensen, 1912a, p. 90, figs. 3, 4.

Cleonardo microdactyla Stephensen, 1933, p. 40, fig. 19.

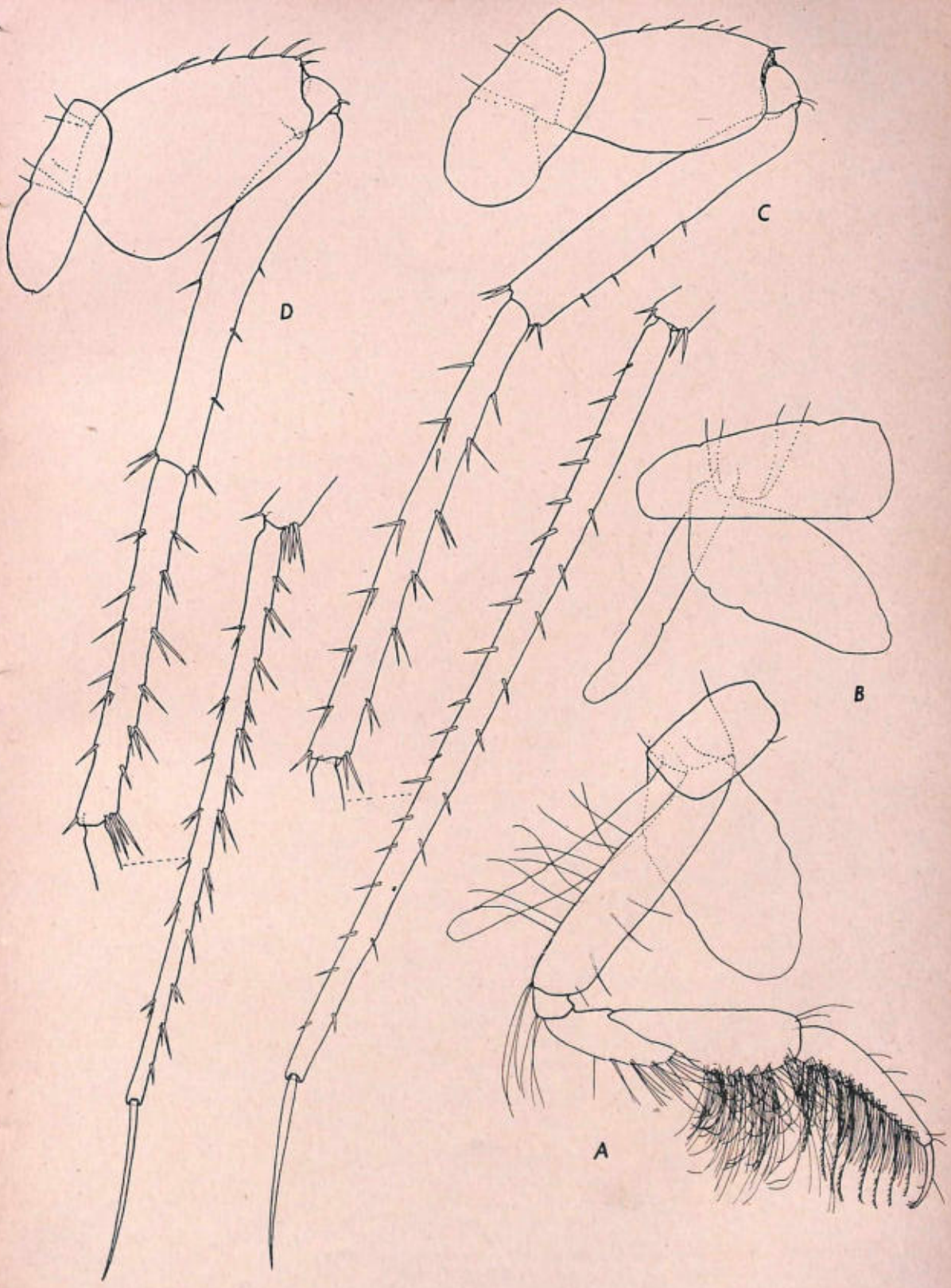
Three specimens were taken at depths between 600 and 800 fathoms.

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* Chevreux, female. **A**, antenna 1; **B**, gnathopod 1; **C**, peraeopod 1; **D**, peraeopod 2; **E**, telson; **F**, posterior end of animal.



TEXT-FIG. 7. *Halice aculeata* Chevreux, female. **A**, gnathopod 2; **B**, coxal plate of peraeopod 3; **C**, peraeopod 4; **D**, peraeopod 5.

TEXT-FIG. 8. *Synopia ultramarina* 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.

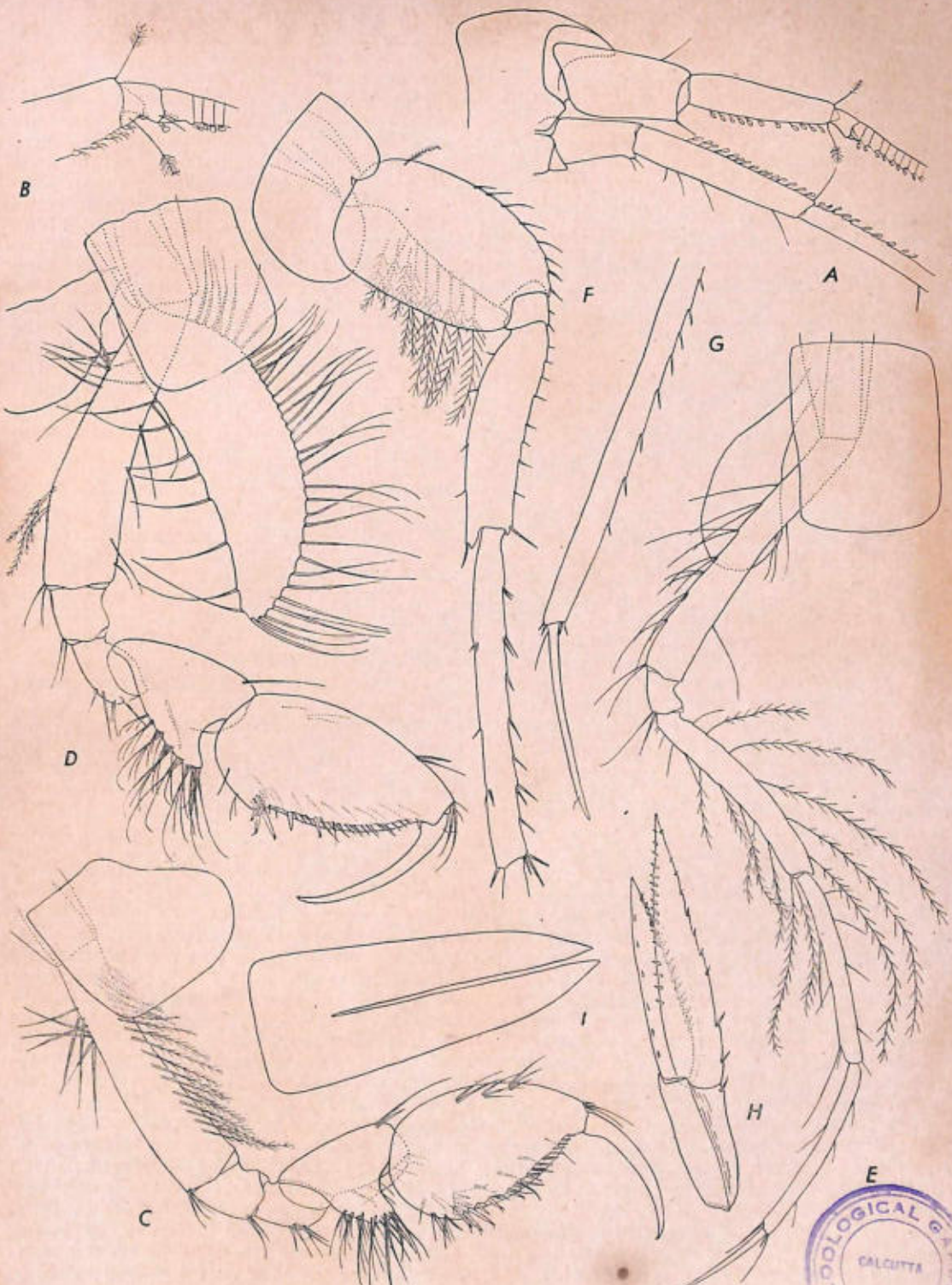
Gracilipes multicalceolus Thorsteinson, 1941, p. 85, pl. 7, figs. 71-77.

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.

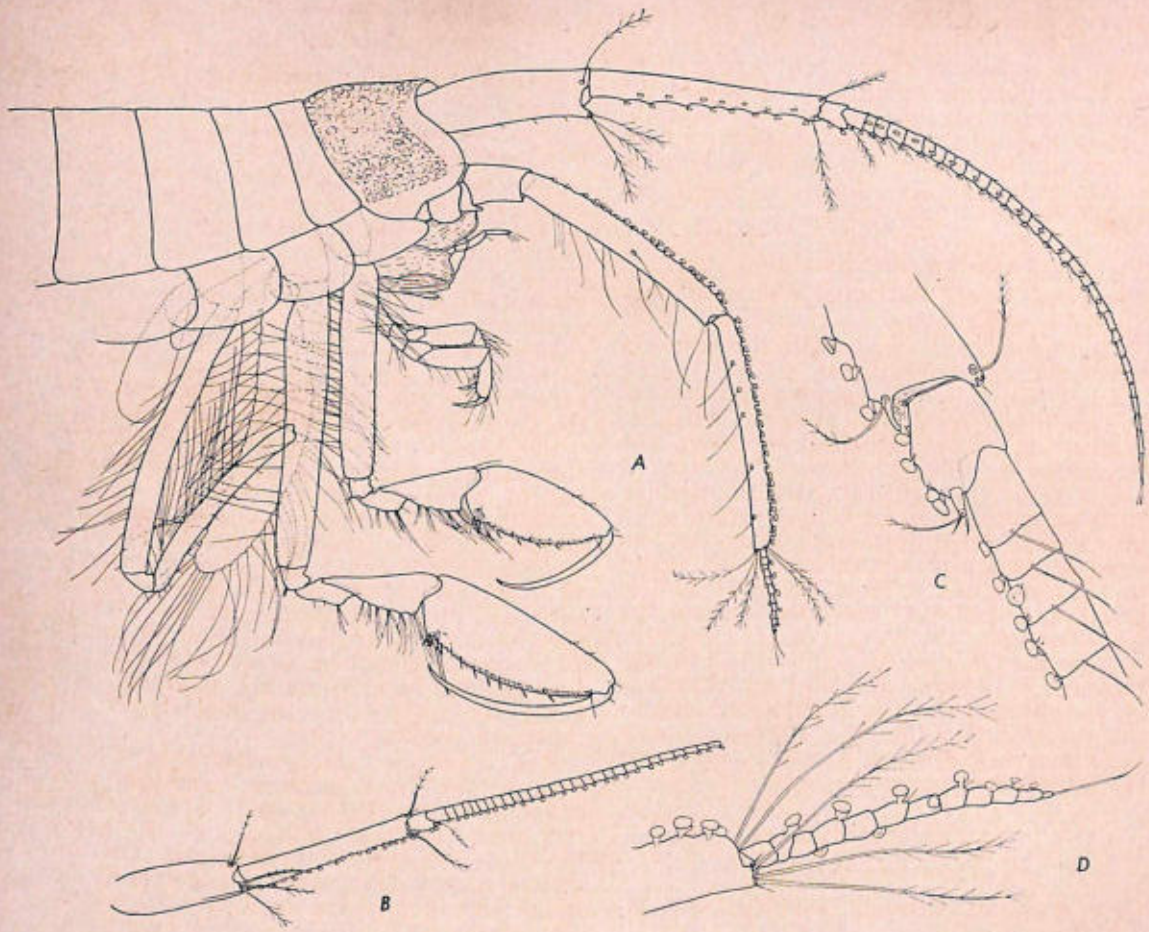
The present specimen is a mature female measuring 10 mm. in length. Barnard believes that Chevreux's and Schellenberg's specimens represent the two sexes of the same species, the former the female and the latter the male. Both specimens are probably small and immature, measuring only about 5 mm.

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



ZOOLOGICAL GARDEN CALCUTTA

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**, peraeopod 1; **F**, peraeopod 4; **G**, sixth and seventh joints of peraeopod 4; **H**, uropod 3; **I**, telson.



TEXT-FIG. 10. *Eusirella elegans* Chevreux, 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 Chevreux (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 peraeopods are all imperfect. The third peraeopod lacks only the seventh joint and is proportionally about as figured by Schellenberg. The second joint of third, fourth and fifth peraeopods is narrow and like Chevreux'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 galateae Stebbing.

Hyale galateae 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.

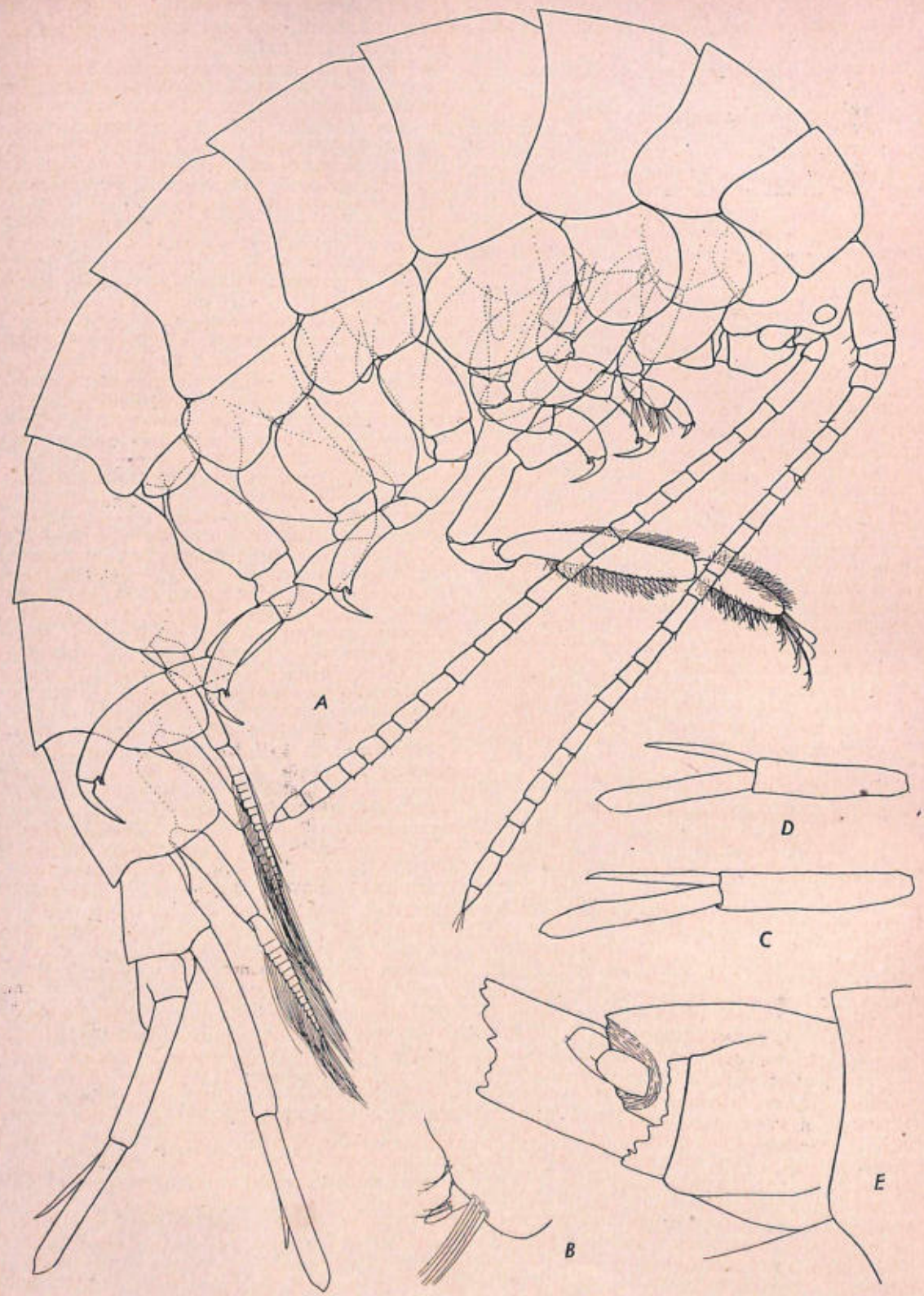
The present specimen is only the third recorded of this remarkably aberrant member of the family Talitridae.

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 *Sunamphitoe 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.

Hyperiopsis tridentata Barnard.

Text-figs. 12, 13.

Hyperiopsis tridentata Barnard, 1937a, p. 147, fig. 4, ♀.

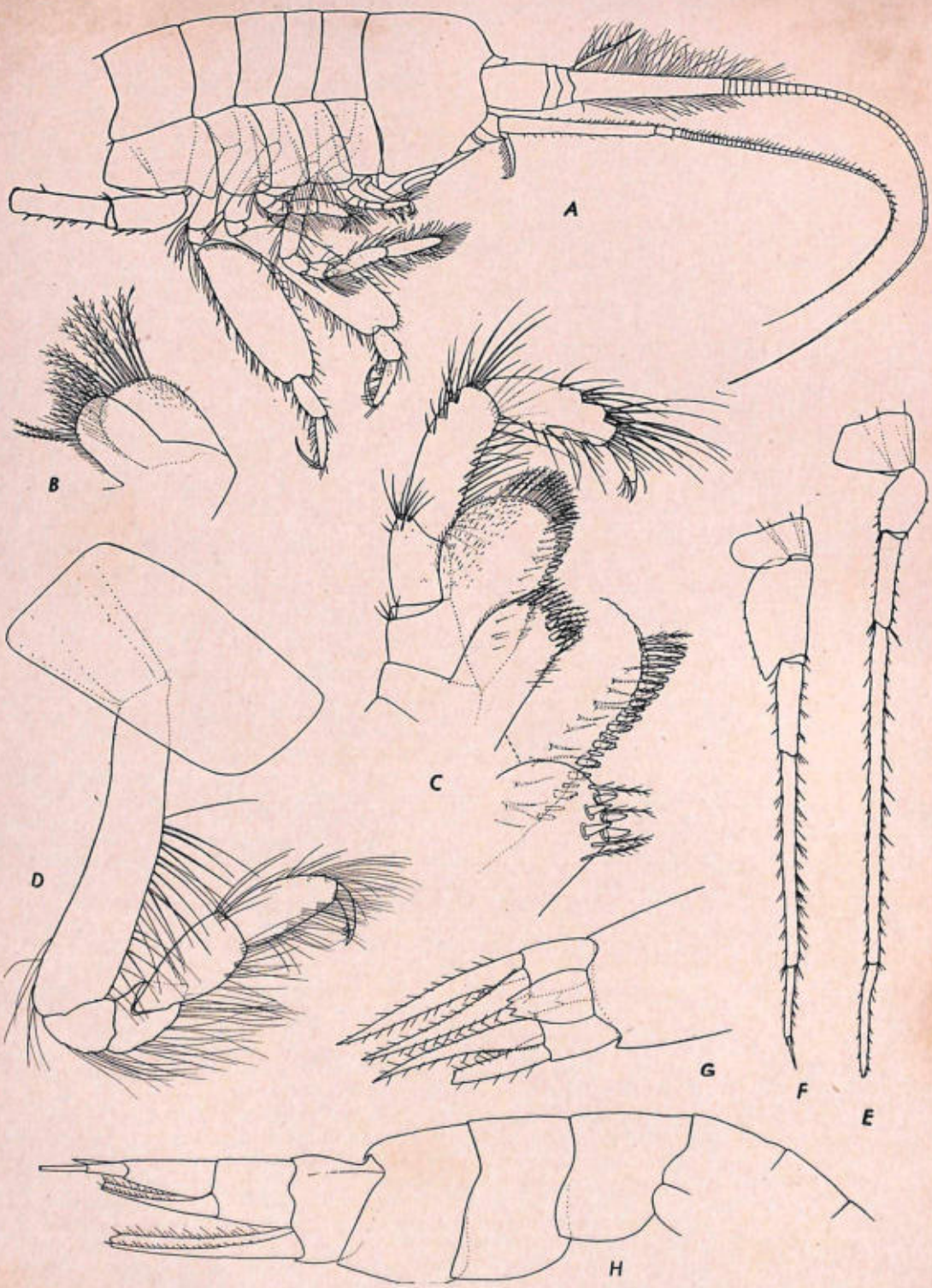
One specimen was taken at a depth of 1,000 fathoms.

I have identified this specimen as *Hyperiopsis 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 character, Barnard could scarcely have failed to have mentioned it.

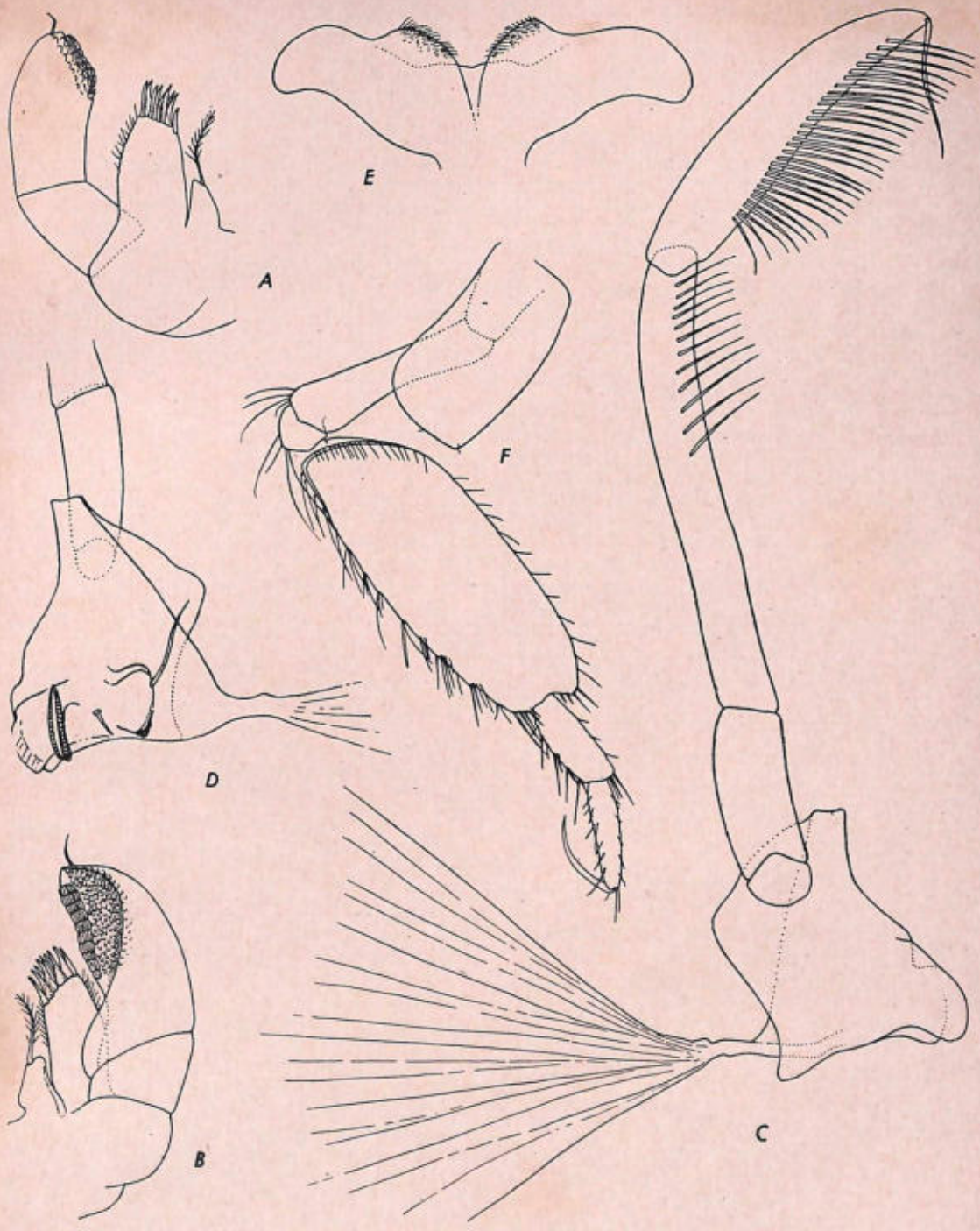
Barnard's specimen was a female 8 mm. in length. The Bermuda specimen measures about 16 mm. in length, and appears to be an immature female. There are no male sexual organs present, gnathopod 2 and peraeopods 1-5 bear large branchiae, and gnathopod 2 and peraeopods 1-3 bear small, cylindrical, undeveloped 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. *Hyperiopsis 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 expanded 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. Pirlot 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.

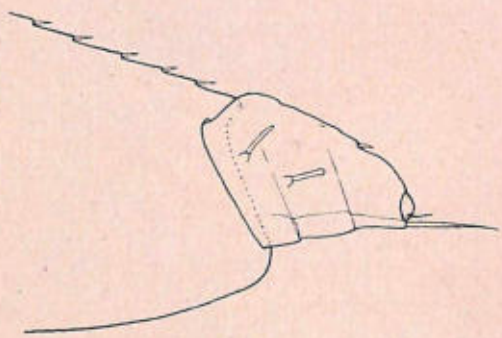
Lanceola sayana Bovallius, 1887a, p. 30, pl. 4, figs. 1-19; pl. 5, fig. 1.

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.

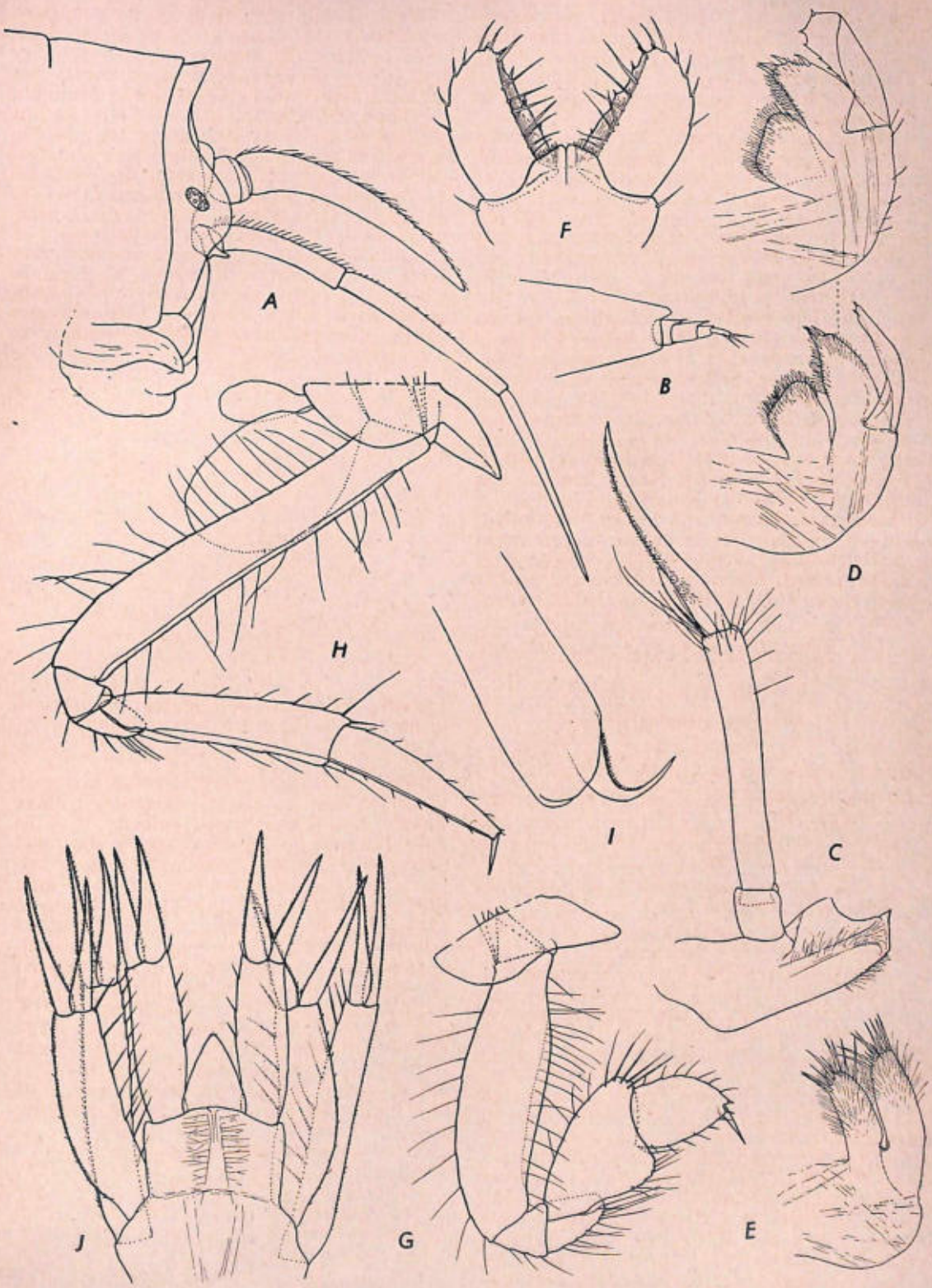
Text-figs. 15, 16 a-f.

Lanceola loveni Bovallius, 1885a, p. 6.

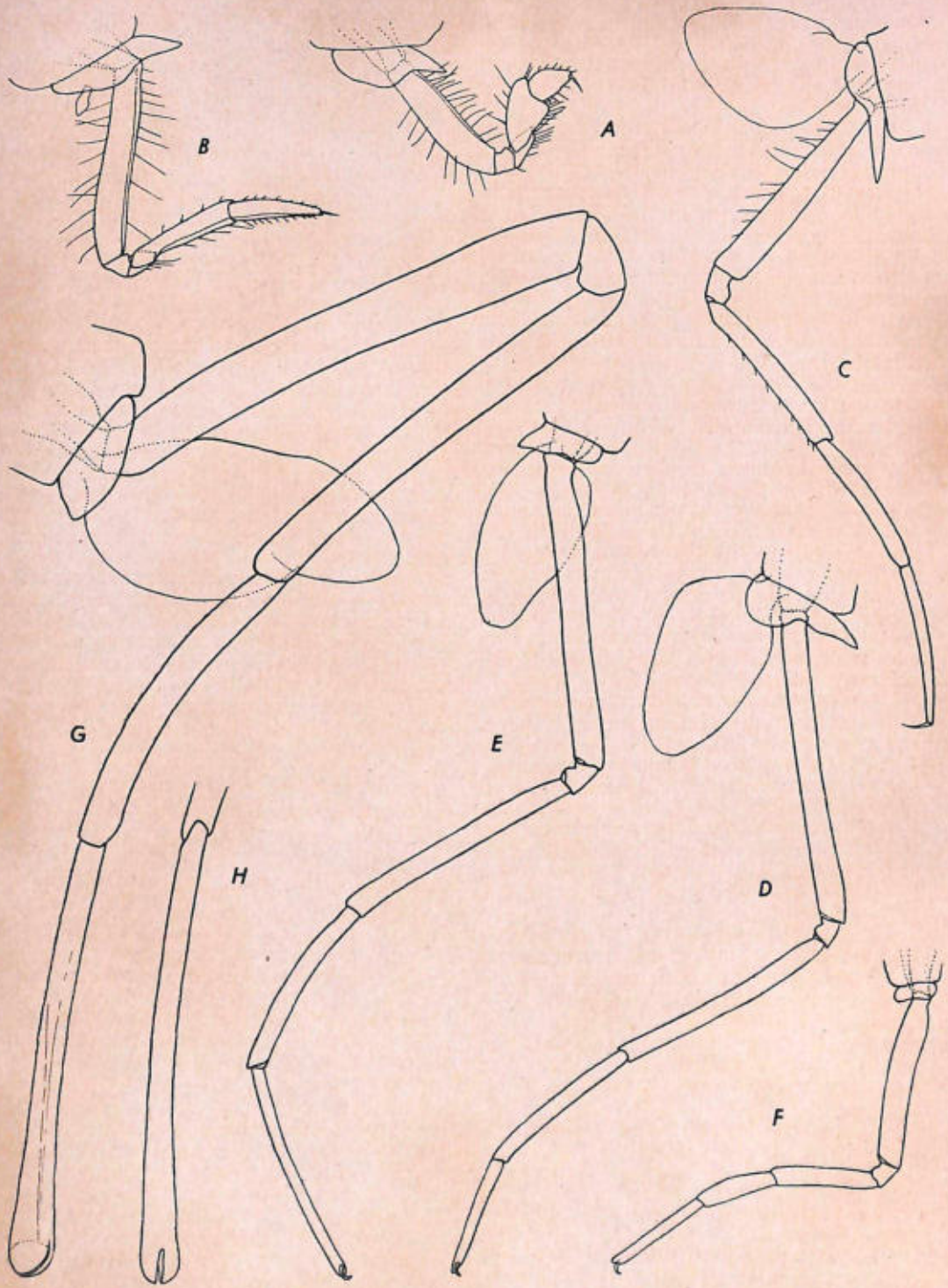
Lanceola loveni Bovallius, 1887a, p. 36, pl. 5, figs. 24-26; pl. 6, figs. 1-13.

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 peraeopod 4; **J**, uropods and telson.



TEXT-FIG. 16. *Lanceola loveni* Bovallius, male. **A**, gnathopod 1; **B**, gnathopod 2; **C**, peraeopod 2; **D**, peraeopod 3; **E**, peraeopod 4; **F**, peraeopod 5. *Lanceola loveni* var. *grossipes*, new var., female. **G**, peraeopod 4; **H**, sixth joint of peraeopod 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.). Pirlot 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.

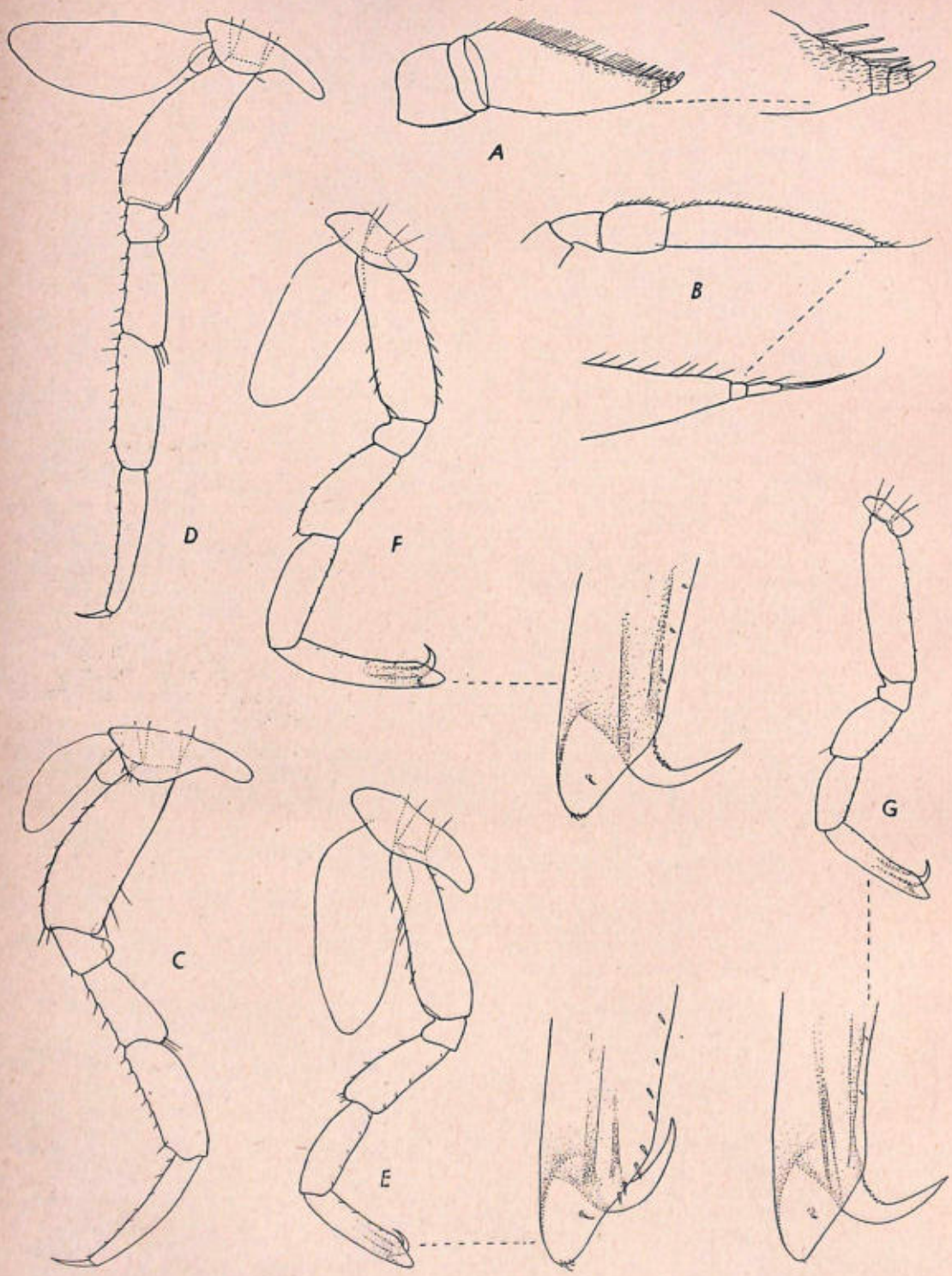
Lanceola clausii Bovallius.

Text-figs. 17, 18.

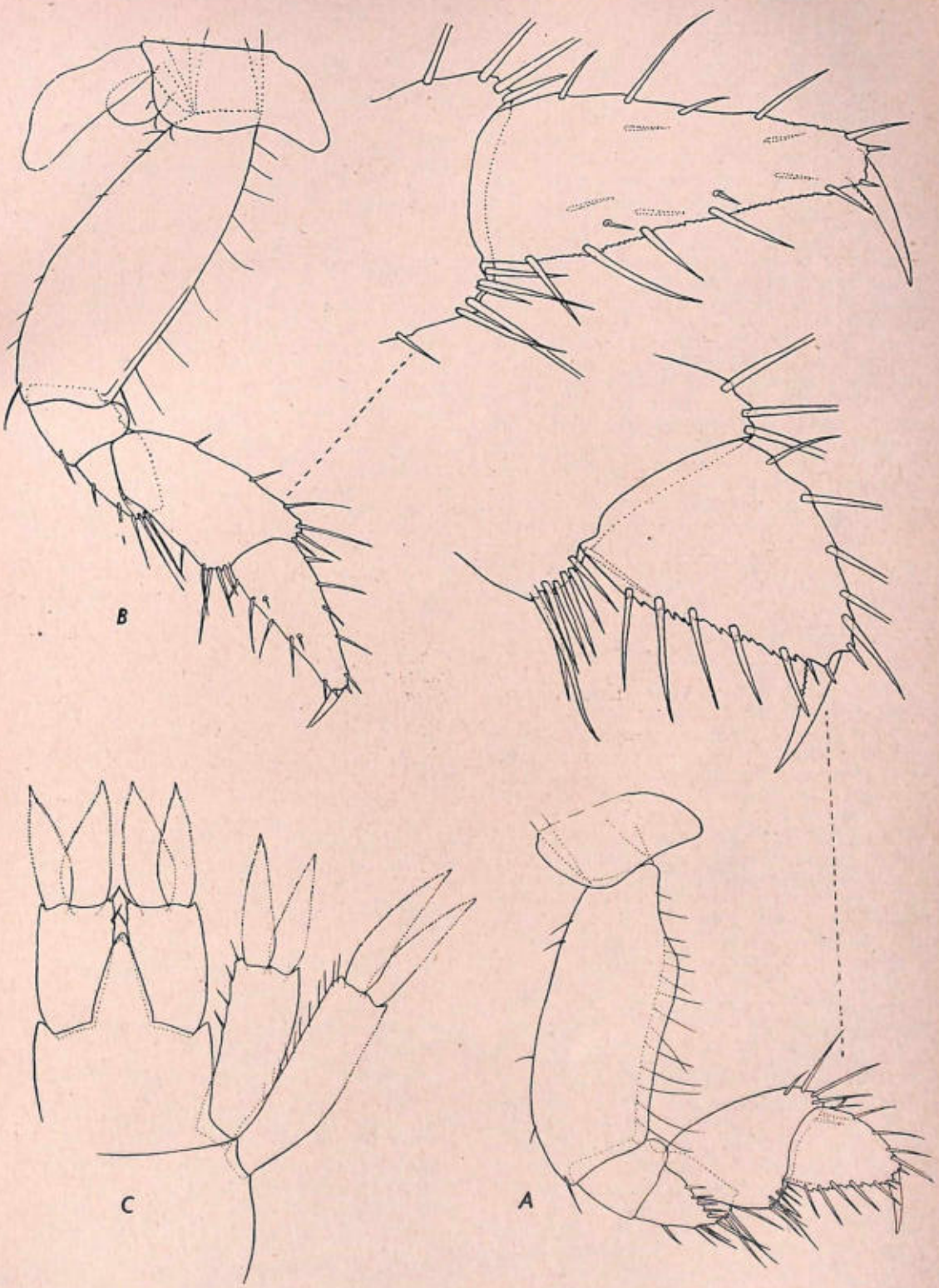
Lanceola clausii Bovallius, 1885a, p. 8.

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 stephenseni (Chevreux).

Text-fig. 21.

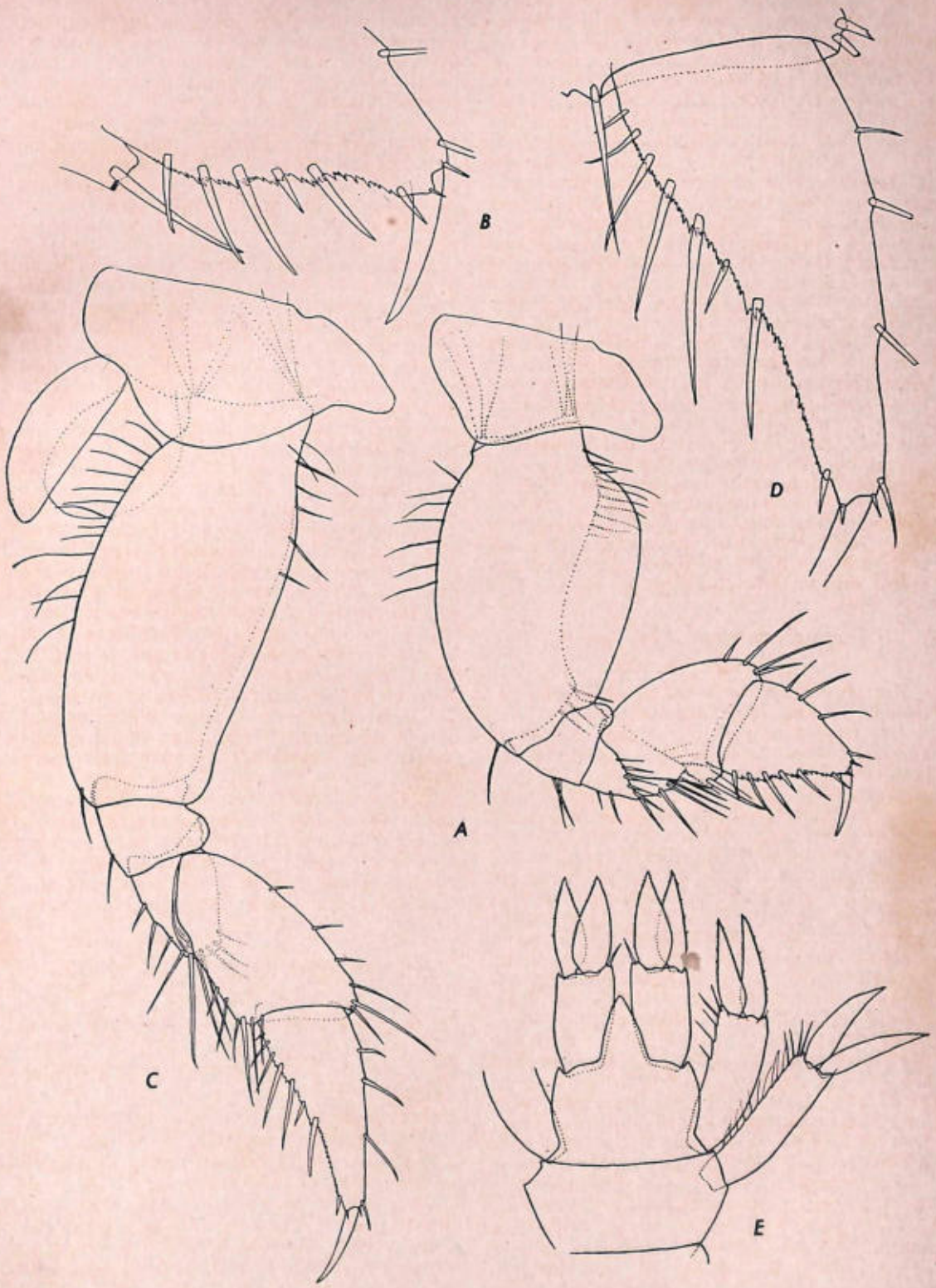
Lanceola stephenseni Chevreux, 1920, p. 4, figs. 1-3.

Megalanceola terrae-novae Pirlot, 1935, p. 2, figs. 1-4 ♀.

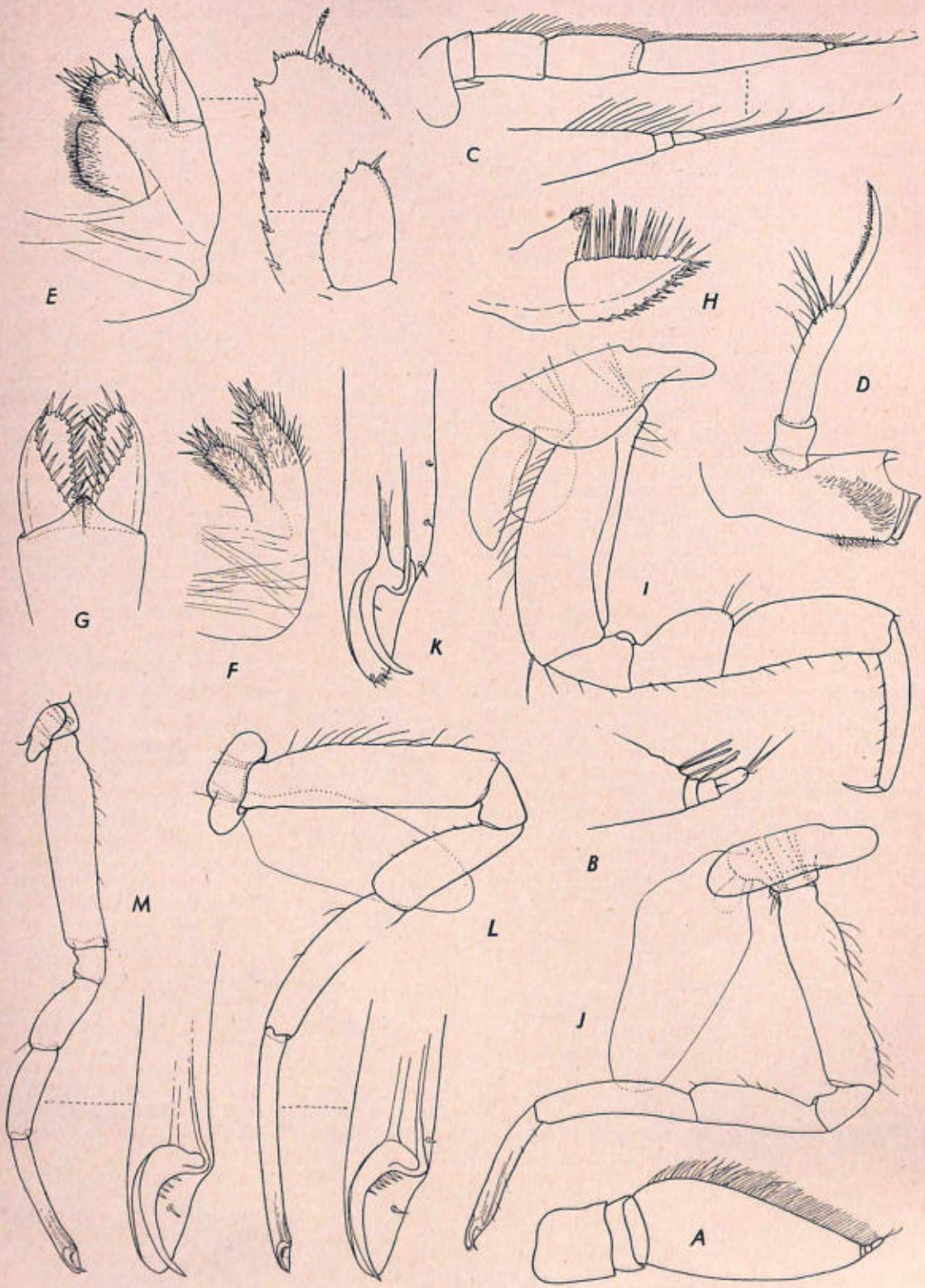
Megalanceola stephenseni Pirlot, 1939b, p. 9, pl. 1, figs. 1-4.

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 stephenseni*, 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**, peraeopod 1; **J**, peraeopod 3; **K**, end of sixth joint of peraeopod 3; **L**, peraeopod 4; **M**, peraeopod 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 Willesmoes 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 Willesmoes 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.

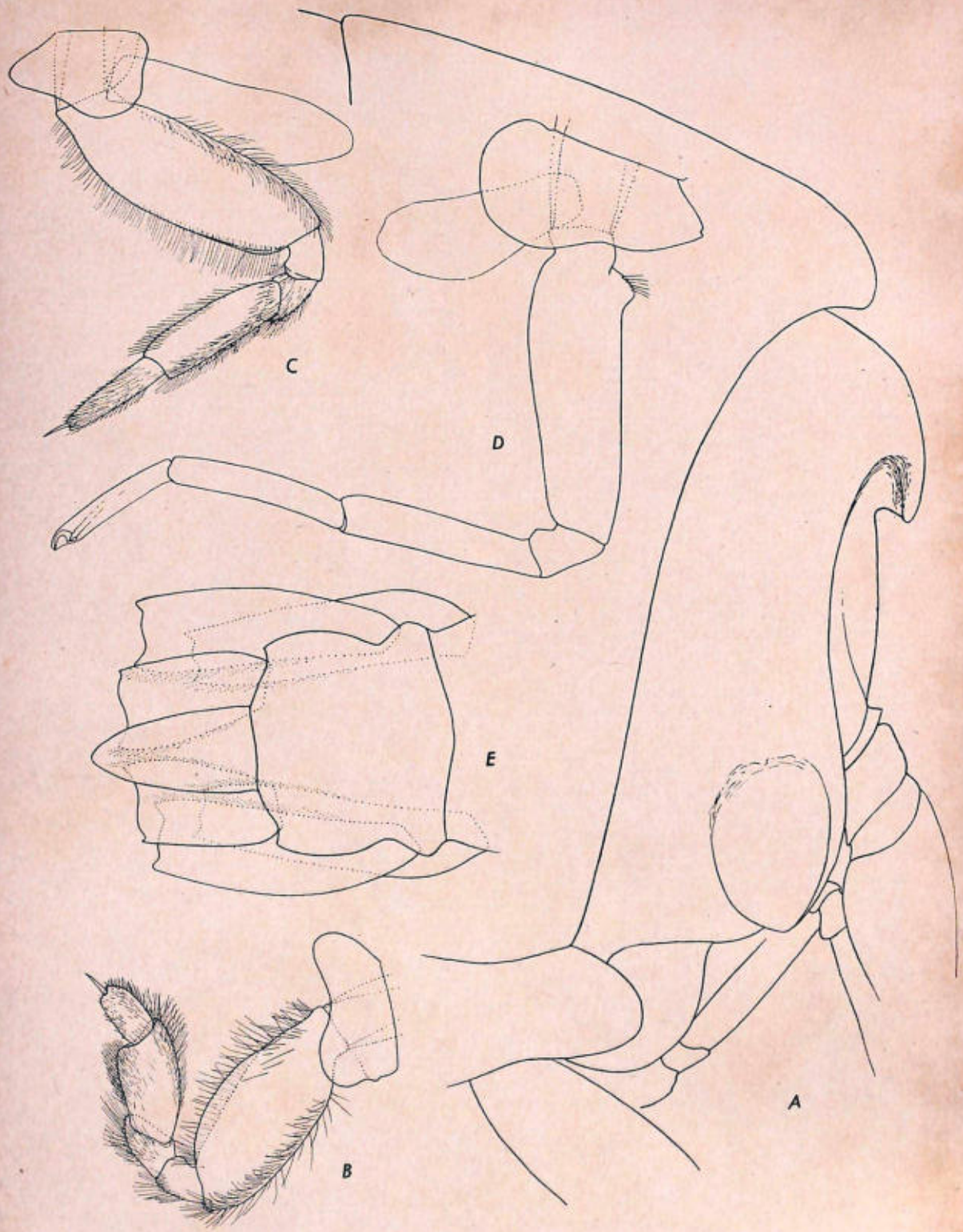
Scypholanceola vanhoeffeni Woltereck, 1909, p. 161, pl. 7, figs. 24a ♂, 24b ♀.

Scypholanceola vanhoeffeni Woltereck, 1927, p. 65, figs. 5a-b, 9.

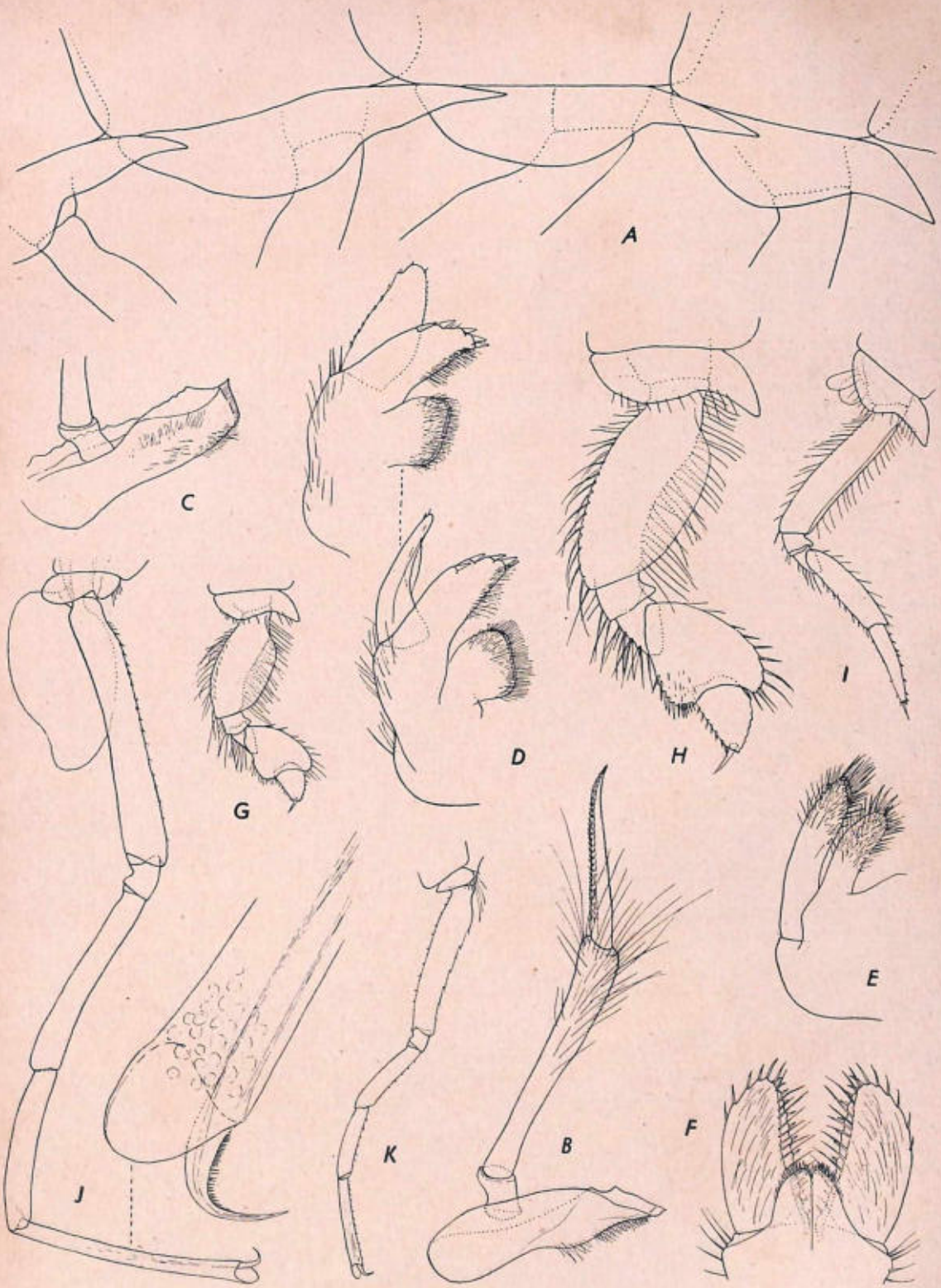
Forty-one specimens, male and female, were taken between 500 and 1,000 fathoms.

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 vanhoeffeni* 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.

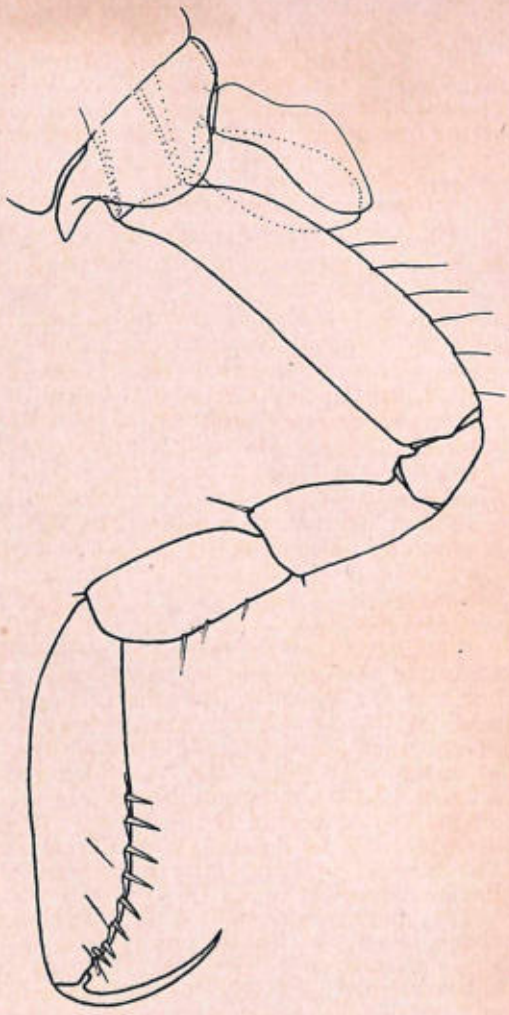
1904, can be determined, *vanhoeffeni* must be regarded as the type of the genus, as it is mentioned by Woltereck (1909) on page 161, whereas *chuni* is not mentioned until page 162, and, as Barnard has already observed (1932, p. 257), Woltereck's figure in his 1905 paper (p. 415, fig. 2) is clearly 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.



TEXT-FIG 23. *Microphasma agassizi* Woltereck. Peraeopod 1.

FAMILY MICROPHASMIDAE.

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 expeditions 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 peraeopods 1-3 (peraeopods 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, p1, 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.

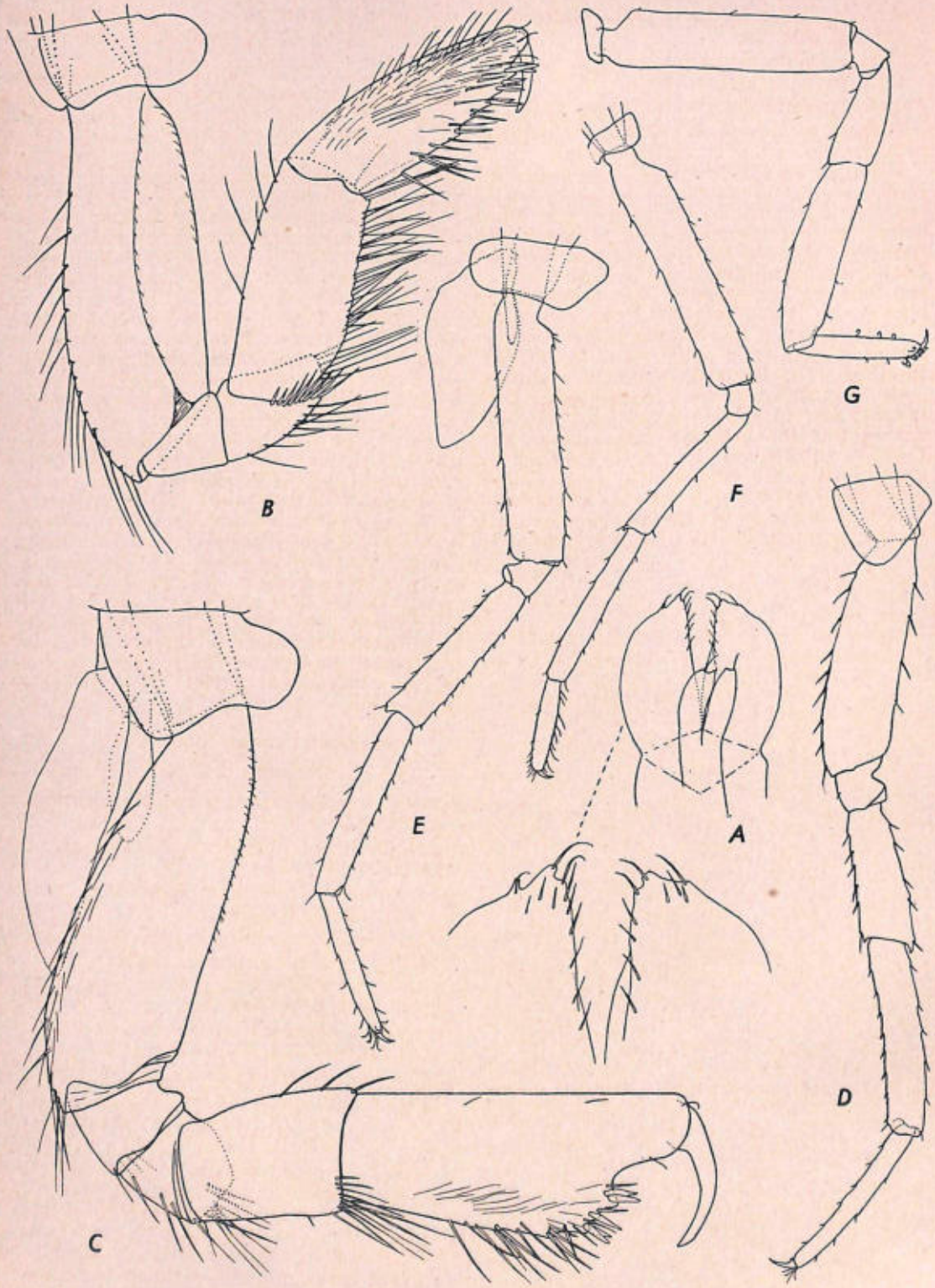
In the genus *Mimonectes*, where the degree of tumidity of the body varies with the development, the proportions of scarcely any two specimens are exactly alike. This, with the difference in appearance of the fully developed males and females, has, in my opinion, led to the describing of the males and 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 chevreusi 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.

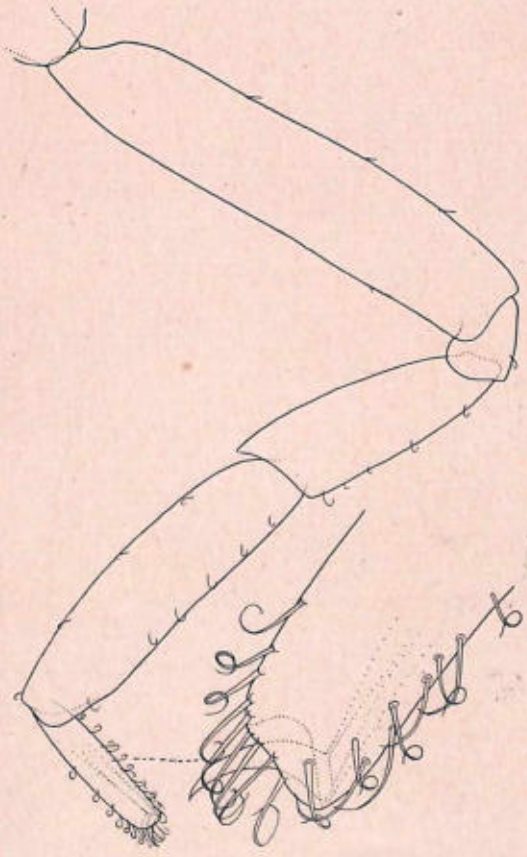
Pirlot (1939, p. 20) has made *Mimonectes chevreuxi* the male of *Mimonectes loveni* Bovallius. The Bermuda material contains both sexes. Most of the females range between 5 and 13 mm. in length and they do not exhibit the globular form shown by Bovallius (1885, pl. 1, fig. 1) but have much the appearance of the figure given by Woltereck of *Sphaeromimonectes diomedeae* (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 diomedeae*. 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.



TEXT-FIG. 25. *Mimonectes loveni* Bovallius, female. Peraeopod 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 diomedeae 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.

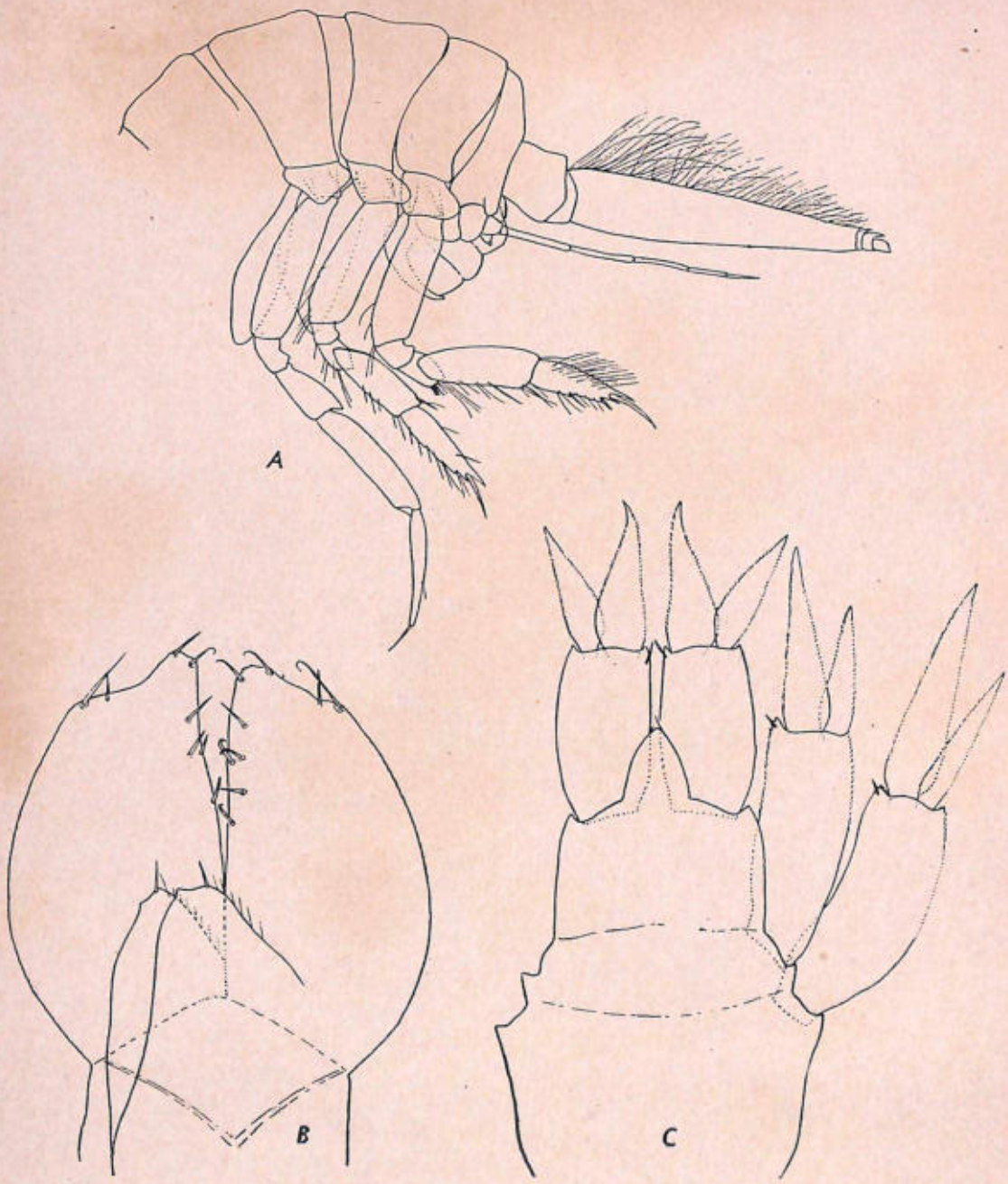
Mimonectes gaussi Stephensen and Pirlot, 1931, p. 531.

Mimonectes diomedeae Stephensen and Pirlot, 1931, p. 531.

Twenty-nine specimens were taken at depths between 500 and 1,000 fathoms.

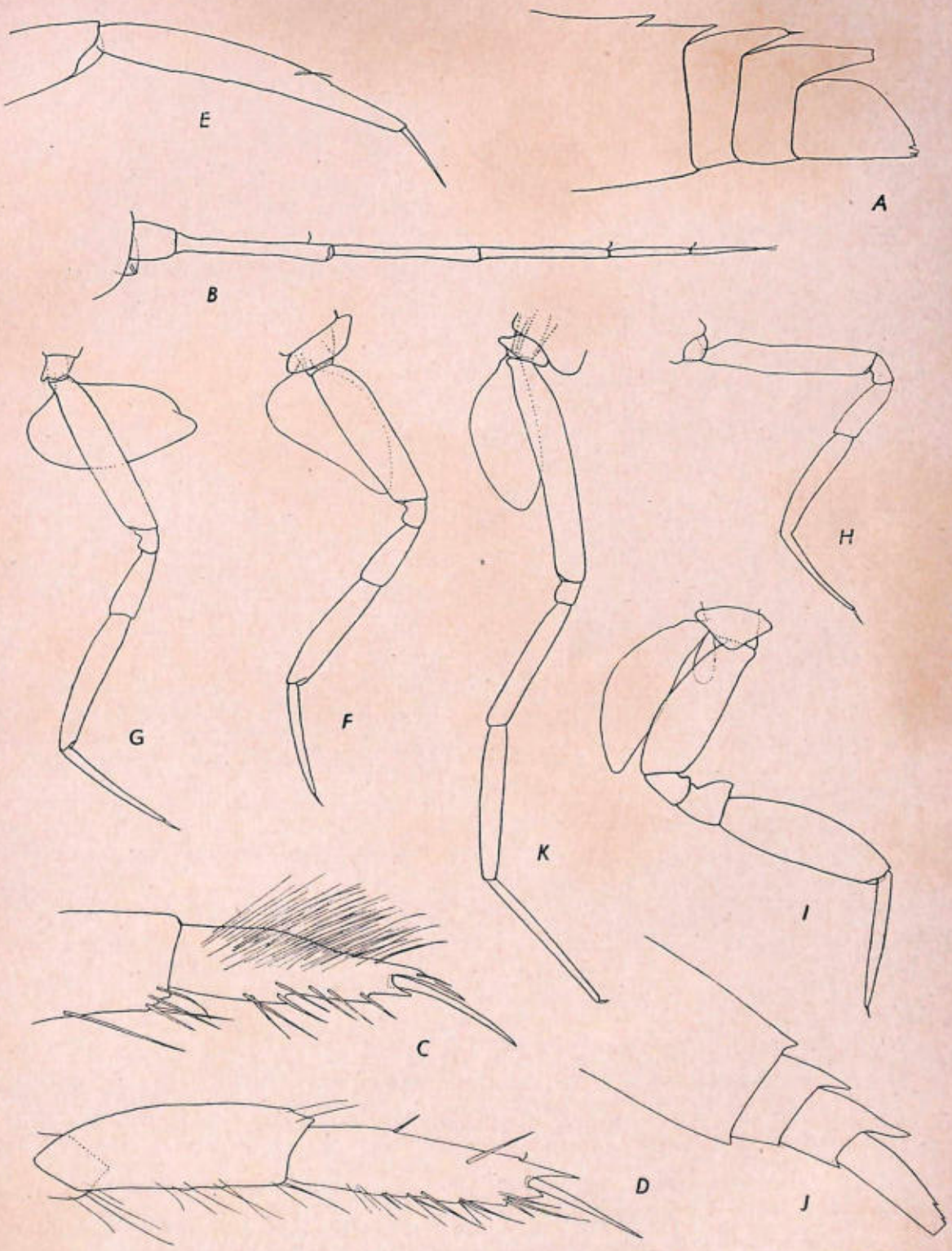
Distribution.—Davis Strait; south of Iceland; north of the Hebrides; Gulf of Gascony; coast of Portugal; Madeira Islands; southeast Atlantic (off South Africa, Barnard); off Peru (*S. diomedeae*, Woltereck); and it is here recorded from Bermuda.

Sphaeromimonectes gaussi Woltereck described from the coast of Portugal, *Para-*



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. diomedeae* 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 *Parascina* 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. diomedeae*, and between *M. diomedeae* 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 diomedeae* 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]

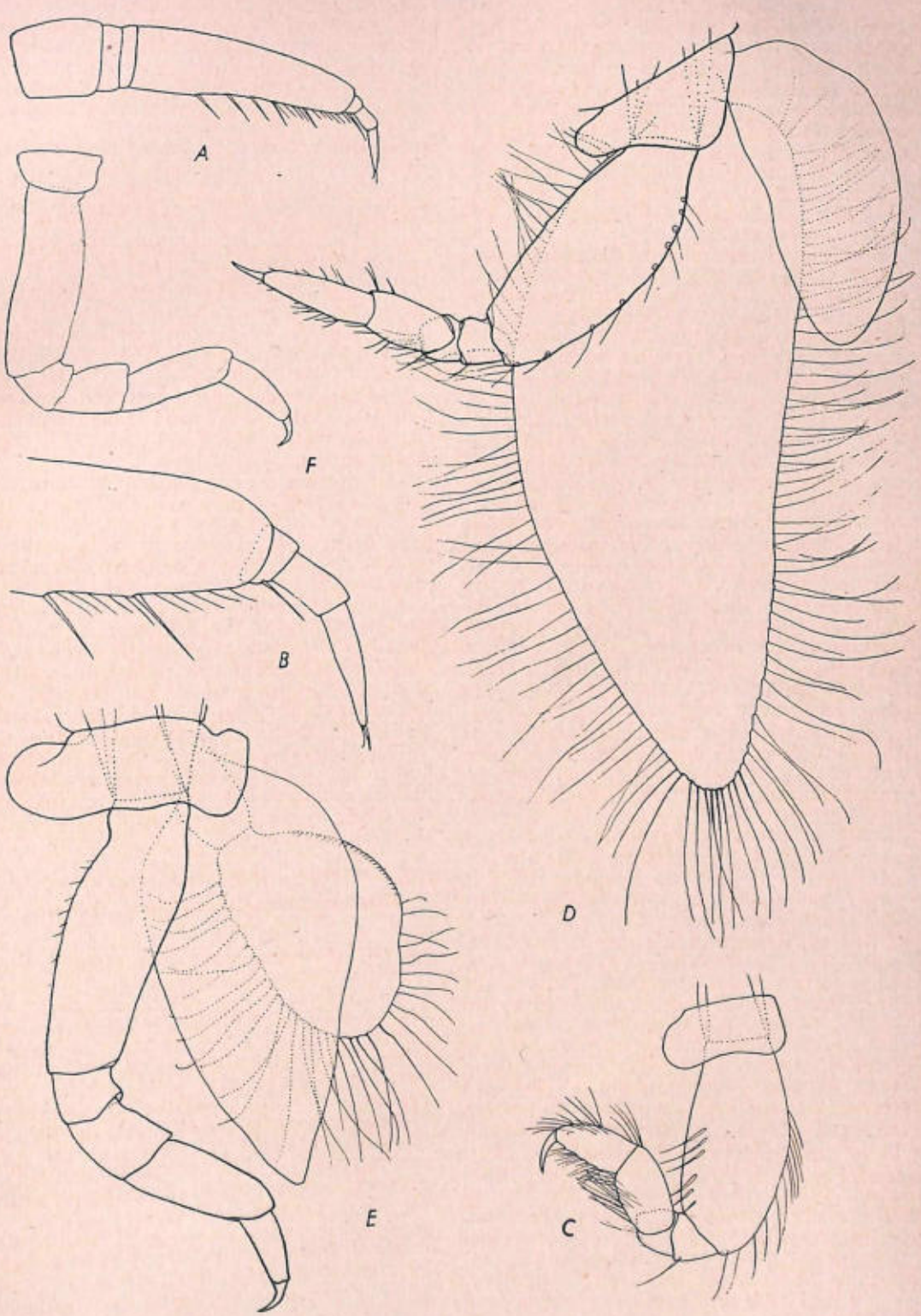
Text-figs. 29, 30

Two specimens, male and female, were taken at 1,000 fathoms.

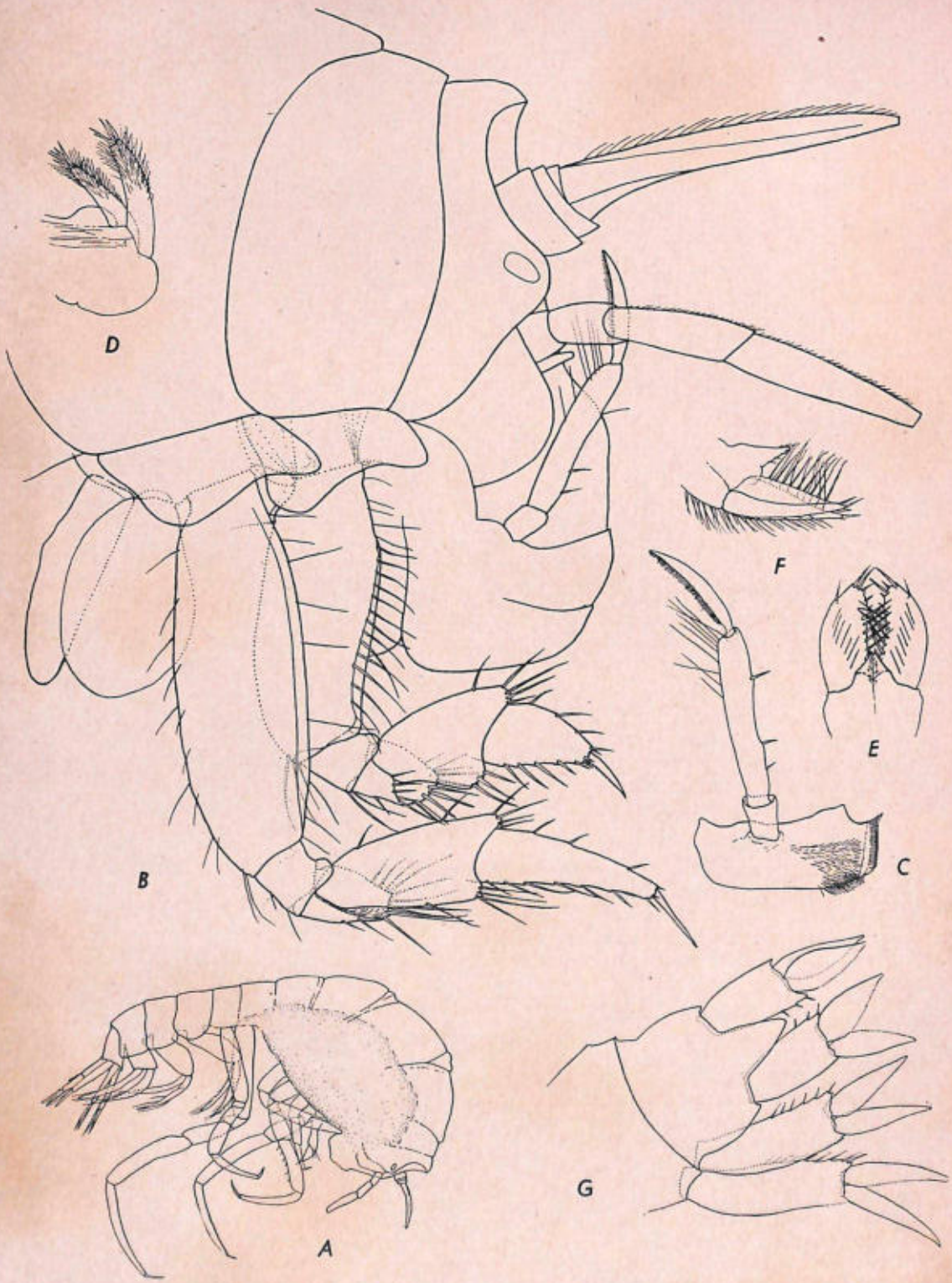
Distribution of the genus.—*Mimonecteola* was founded by Woltereck in 1909 (p. 153) on the specimens taken by the steamer *Albatross* at Stations 4655 and 4717 off the coast of Peru in 1904 and 1905. In 1932 (p. 251) Barnard described *M. macronyx* from a specimen, questionably a female, taken by the 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 diomedeae* 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-

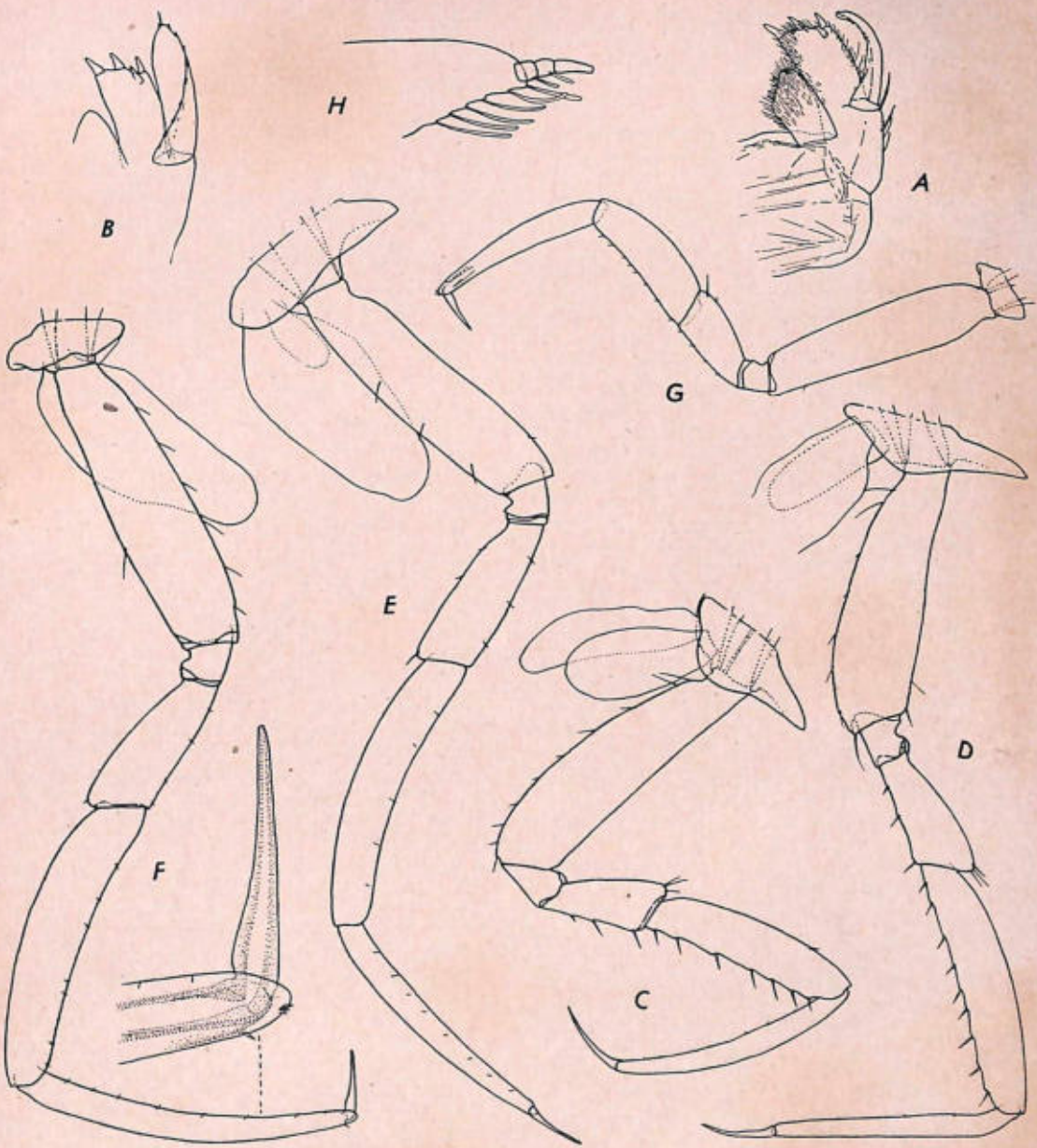
[3] I take pleasure in naming this species in honor of Dr. William Beebe, the director of the Bermuda Oceanographic Expeditions.



TEXT-FIG. 28. *Mimonectes spandlii* Stephensen and Pirlot, female. **A**, antenna 1; **B**, end of antenna 1; **C**, gnathopod 1; **D**, gnathopod 2; **E**, peraeopod 3; **F**, peraeopod 5.



TEXT-FIG. 29. *Mimonectеola beebei*, 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 beebei*, 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. diomedeae* about 9 mm., *M. macronyx* 9 mm., and the present species, *M. beebei*, 9 and 11 mm. All have been taken in tropical or subtropical 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.

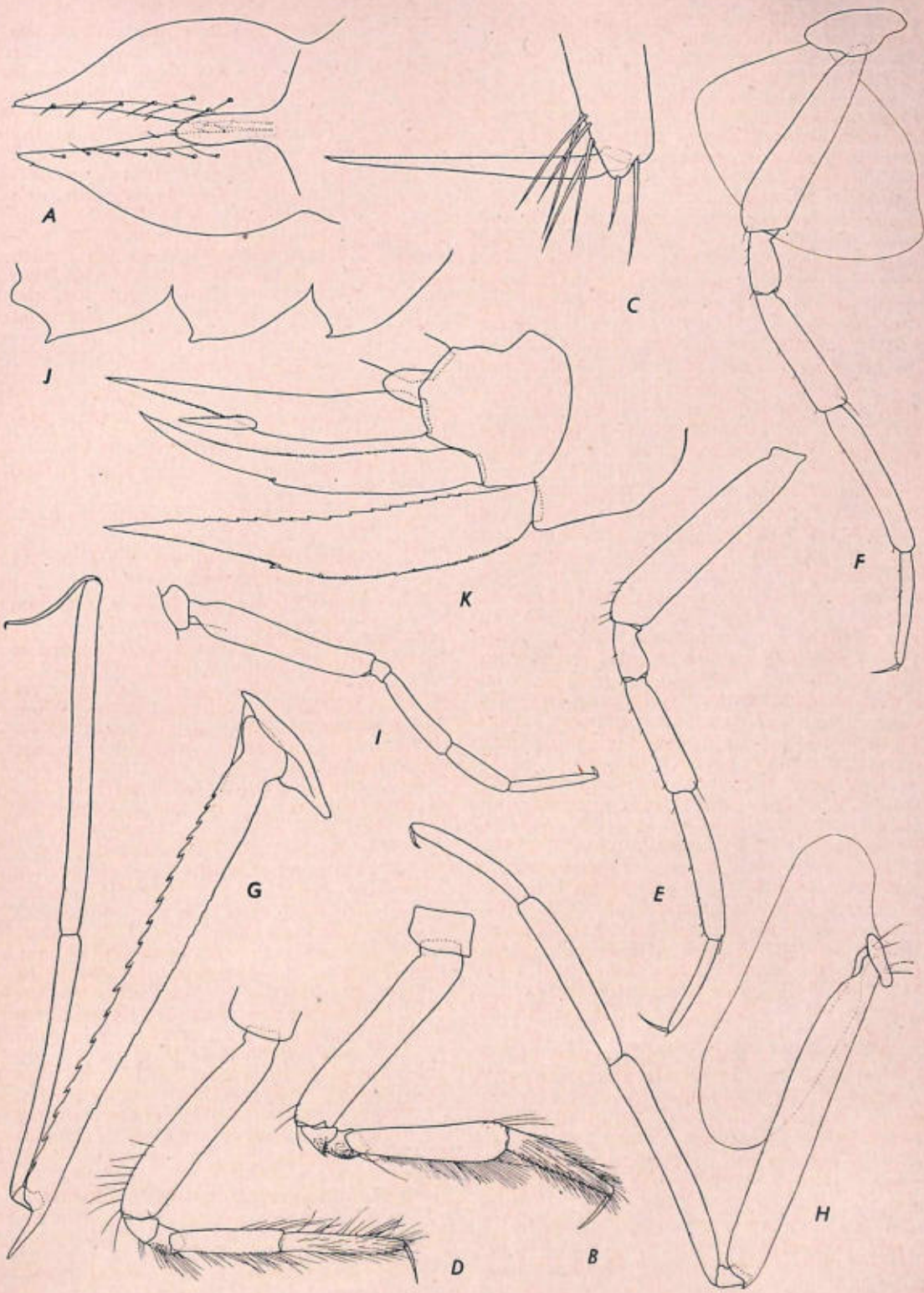
In many of the Bermuda specimens the relative proportions of the joints of the third peraeopod are more like those given by Bovallius for *Tyro sarsi* (=*S. crassicornis* Fabr.) (1887, p. 1; pl. 2, figs. 1-10) than those given by Wagler (1926, p. 326, fig. 2a). Barnard (1932, p. 258) has noted discrepancies 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**, peraeopod 1; **F**, peraeopod 2; **G**, peraeopod 3; **H**, peraeopod 4; **I**, peraeopod 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 (Pirlot); 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.

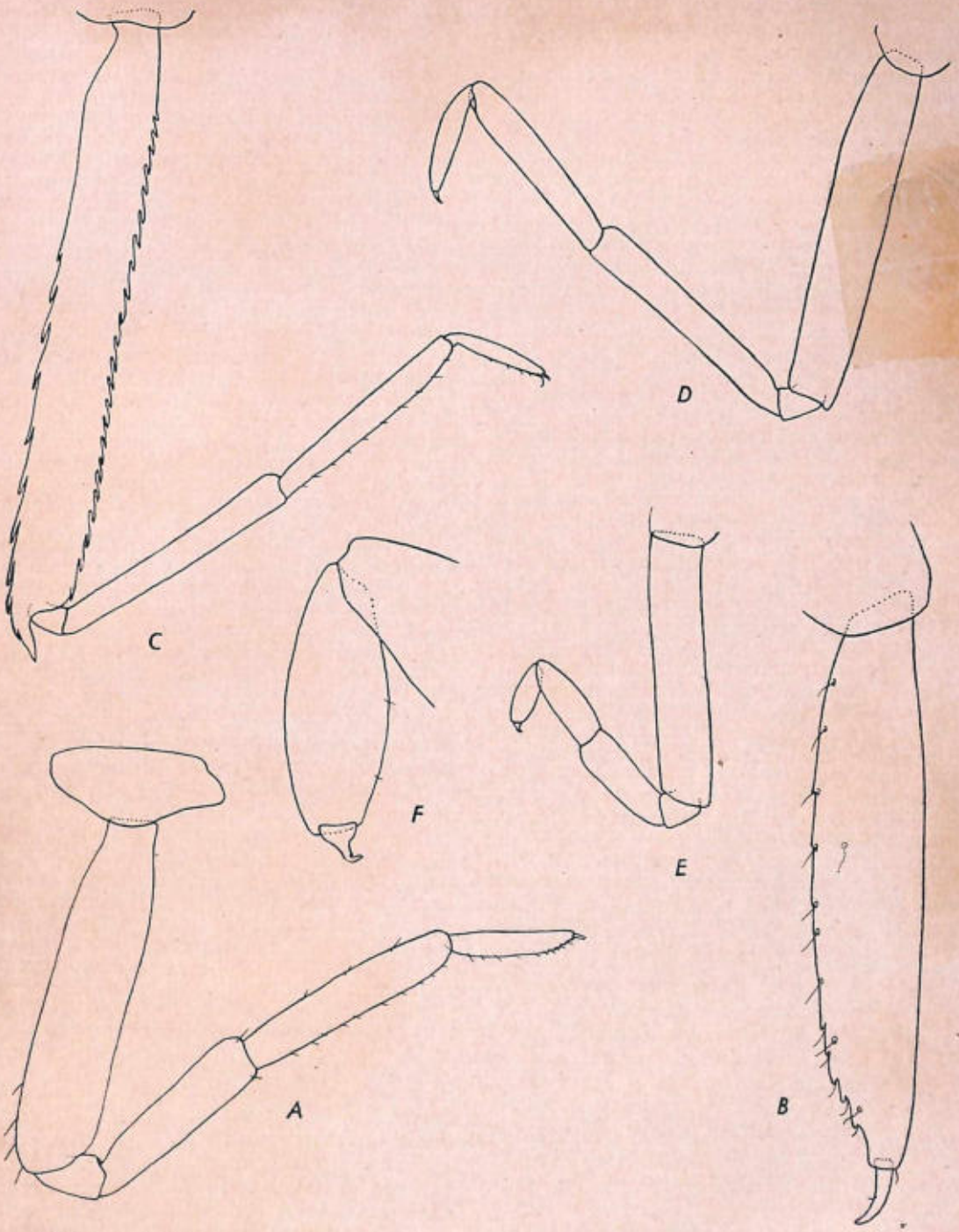
Text-fig. 32.

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 of 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).

Thaumatops magna Woltereck, 1903, p. 455, fig. 2.

Thaumatops 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 blossevillei M. Edw.

Anchylomera blossevillii Milne Edwards, 1830, p. 394.

Anchylomera blossevillii Stebbing, 1888, p. 1433, pl. 177 (literature).

Anchylomera blossevillei 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.

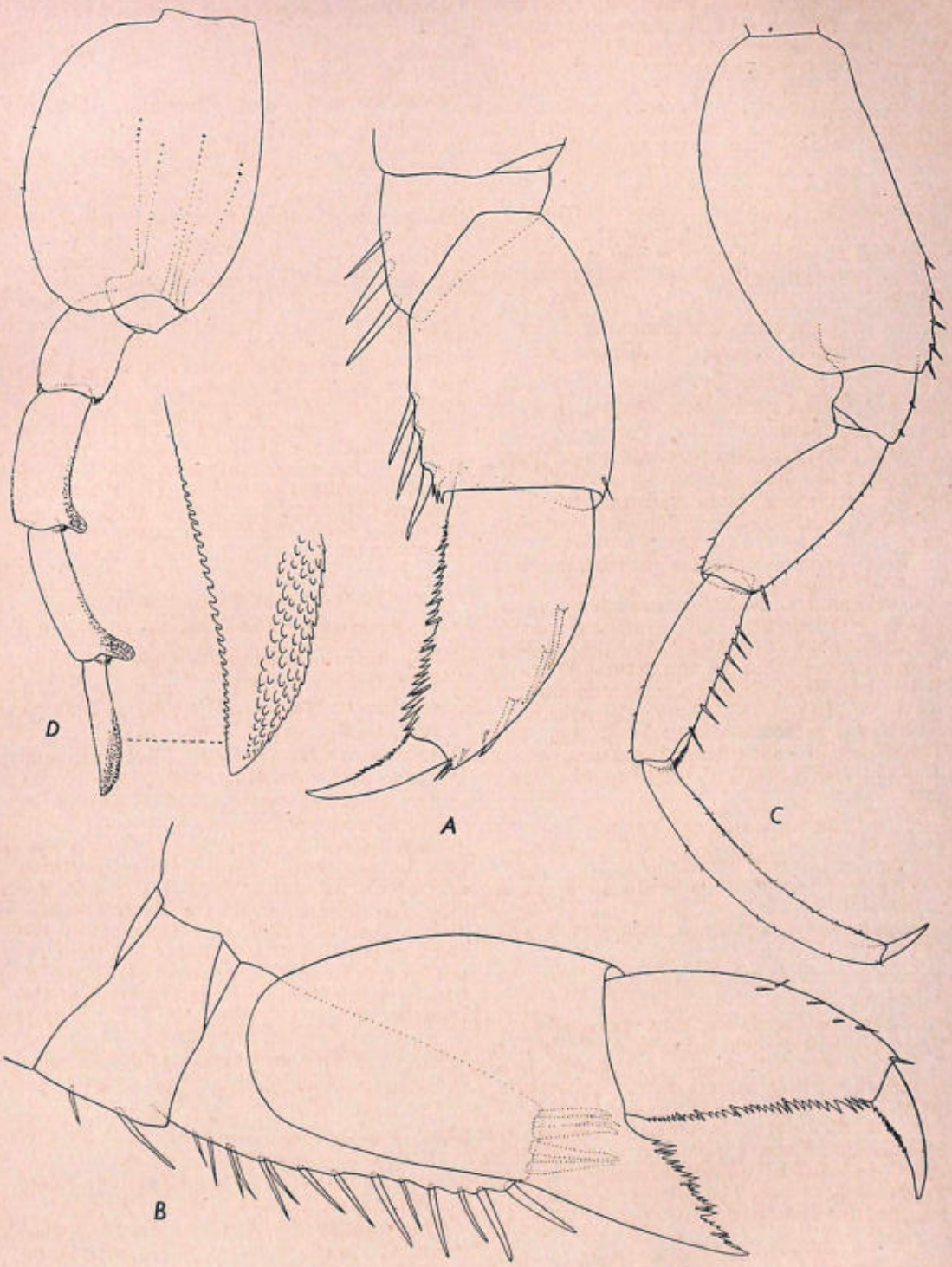
Primno macropa Guérin, 1836, p. 4, pl. 17, figs. 1a-f.

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 cultripes* 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.

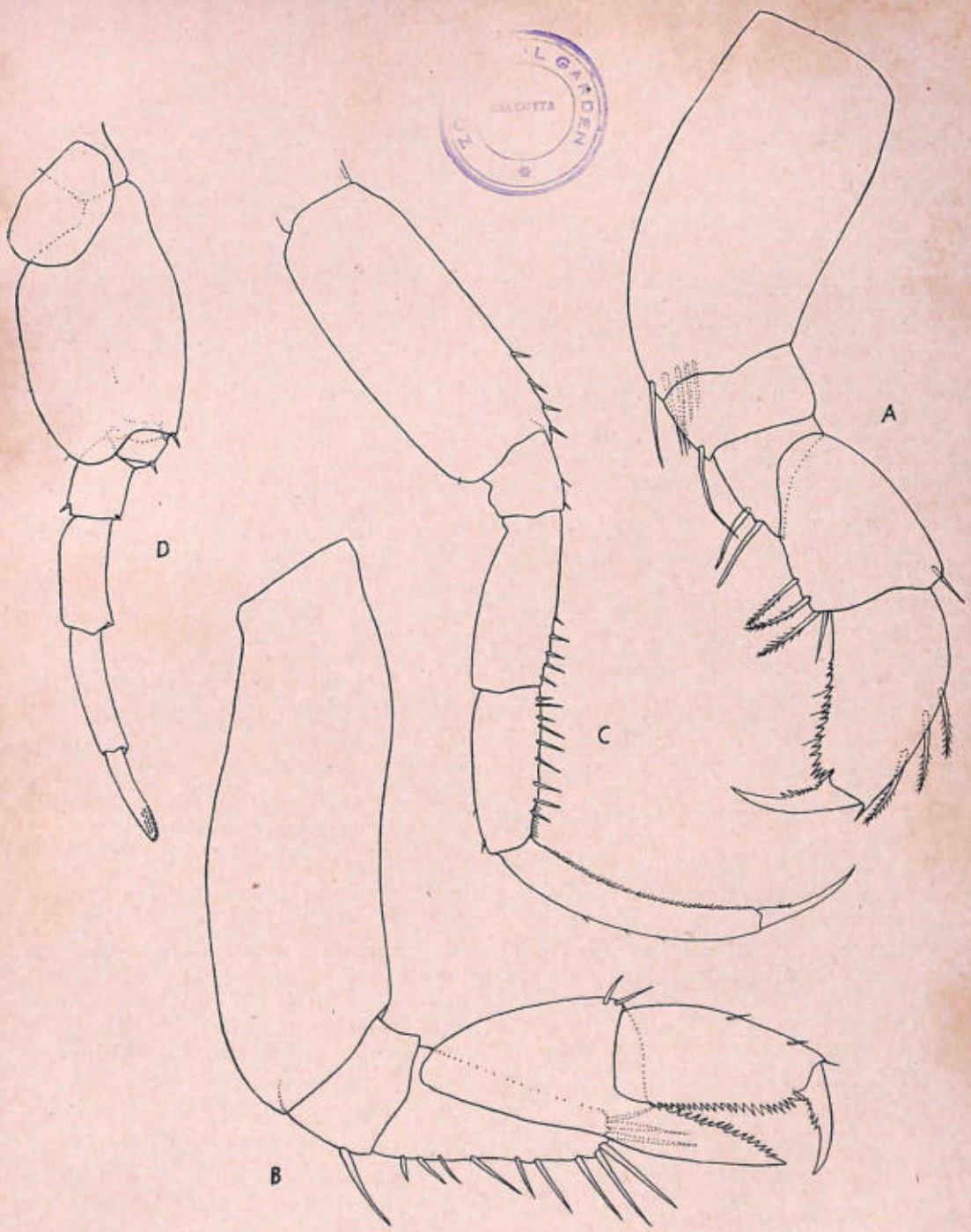
Phronima stebbingii Vosseler, 1900, p. 402.
Phronima stebbingii Vosseler, 1901, p. 36, pl. 4, figs. 4-10.

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).

Phronima 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* Bovallius 1887c, p. 26.

Phronimella hippocephala Giles, 1887, p. 217, pl. 3, fig. 3.

Five specimens were taken at depths between 500 and 1,000 fathoms.

Distribution.—North, mid- and South Atlantic; 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.

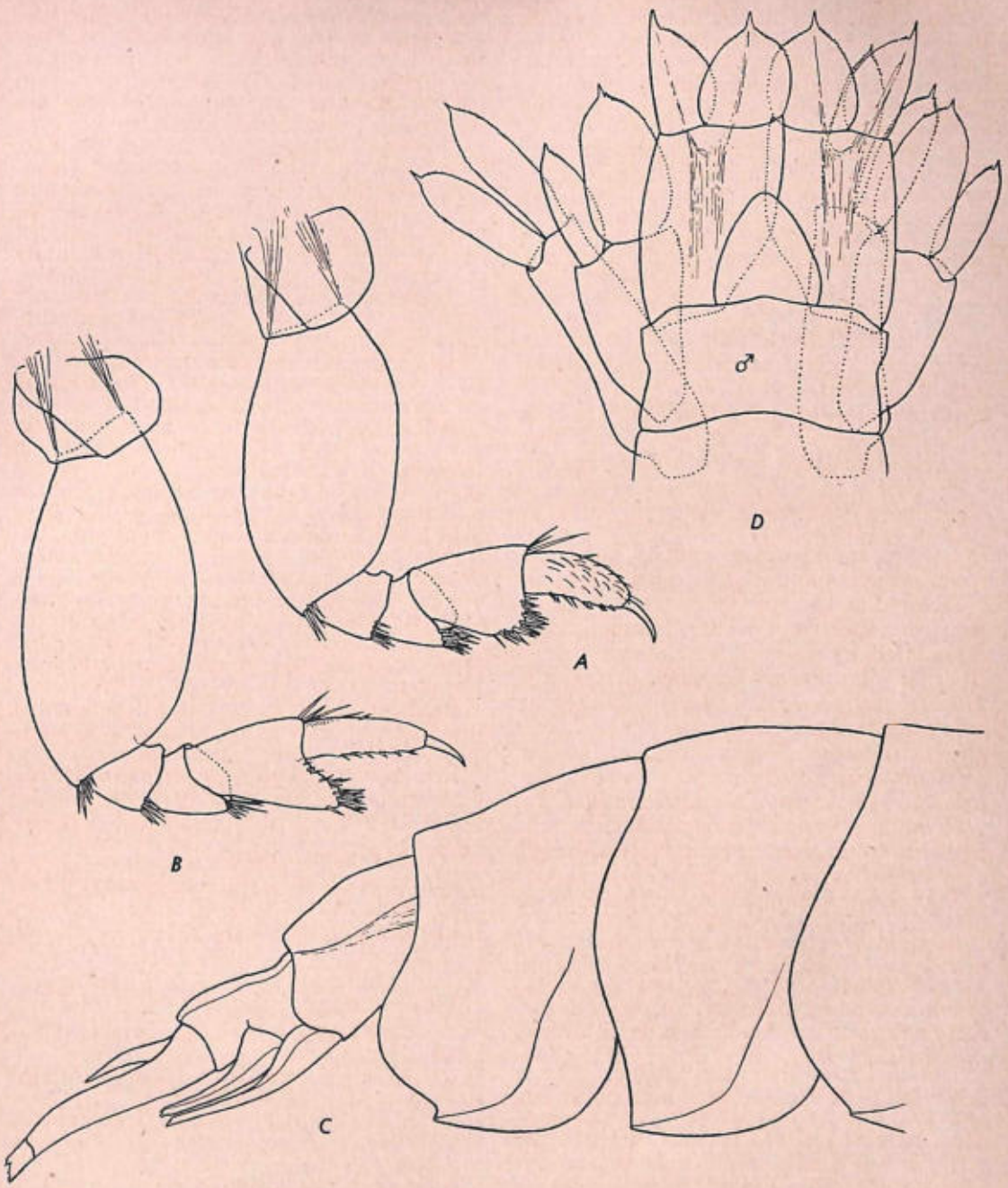
Iulopis mirabilis Bovallius.

Text-figs. 36, 37.

Iulopis mirabilis Bovallius, 1887c, p. 18.

Euiulopis mirabilis Bovallius, 1889, p. 125, pl. 8, figs. 19-33.

Euiulopis mirabilis Spandl, 1927, p. 159, figs. 4 l-m.

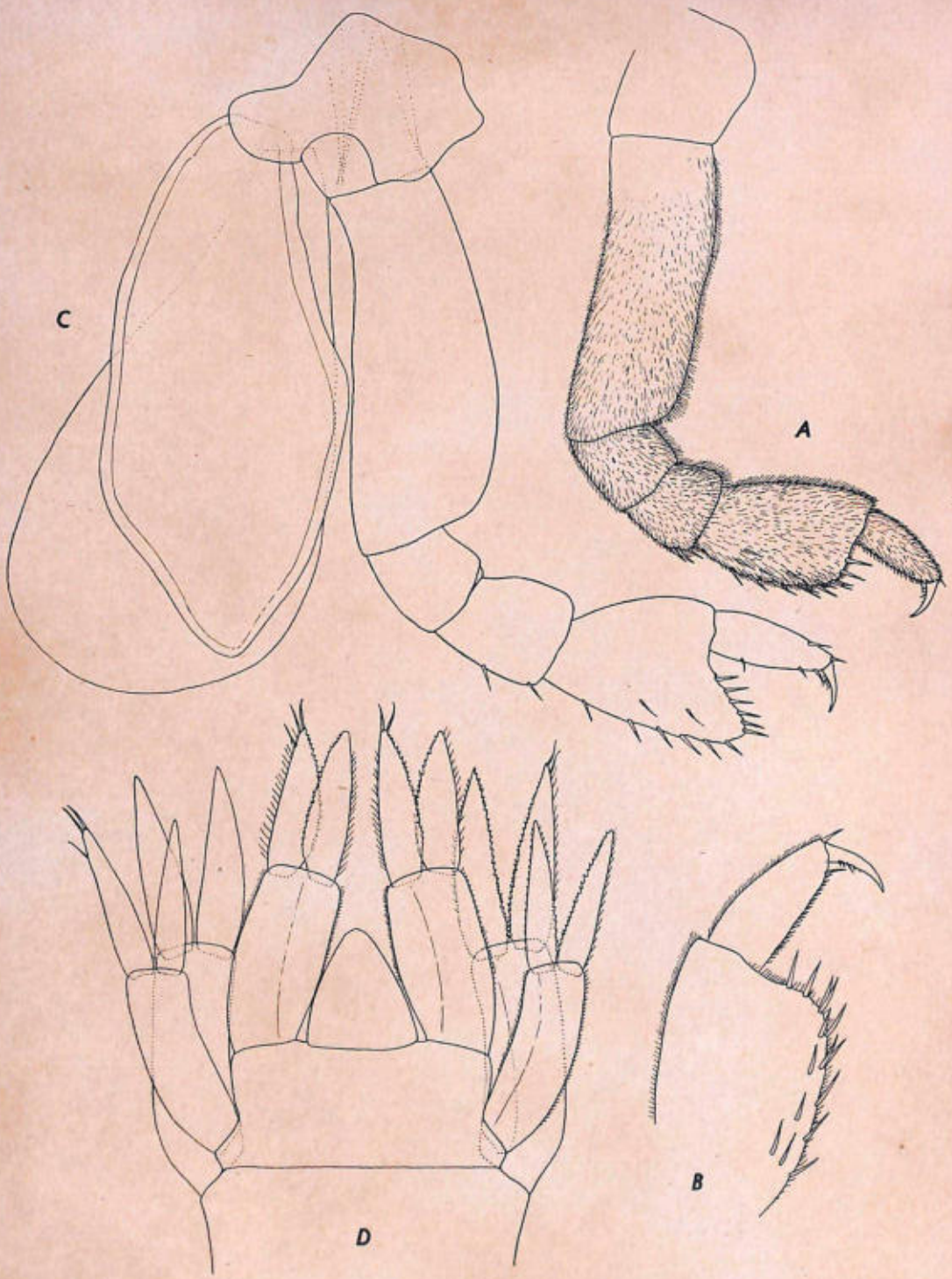


TEXT-FIG. 35. *Hyperia spinigera* Bovallius, male. **A**, gnathopod 1; **B**, gnathopod 2; **C**, metasome and urosome; **D**, uropods and telson.

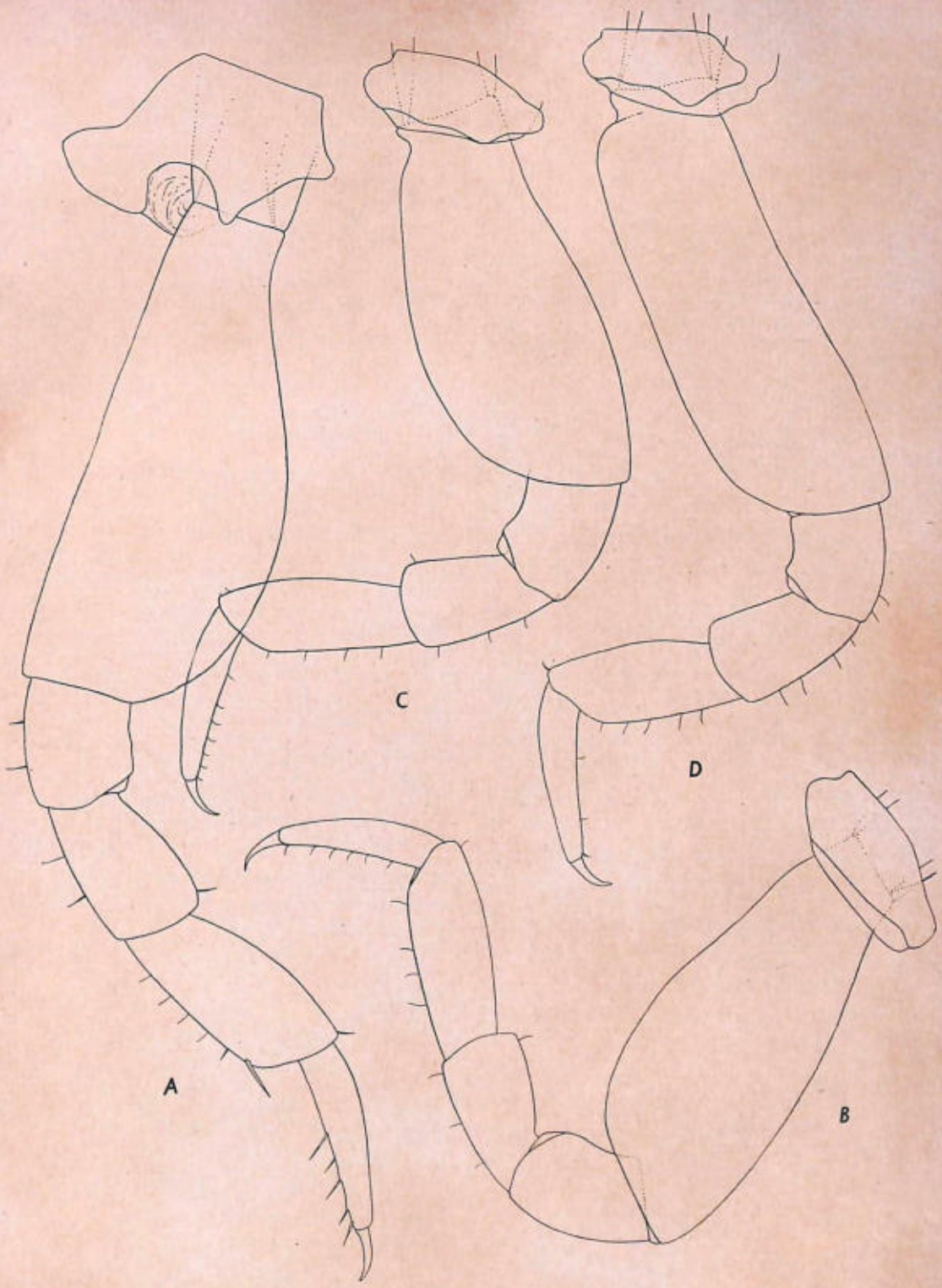
Two female specimens were taken at depths of 700 and 800 fathoms.

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. *Iulopis 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 ural 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 ural 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 *Euiulopis* 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.

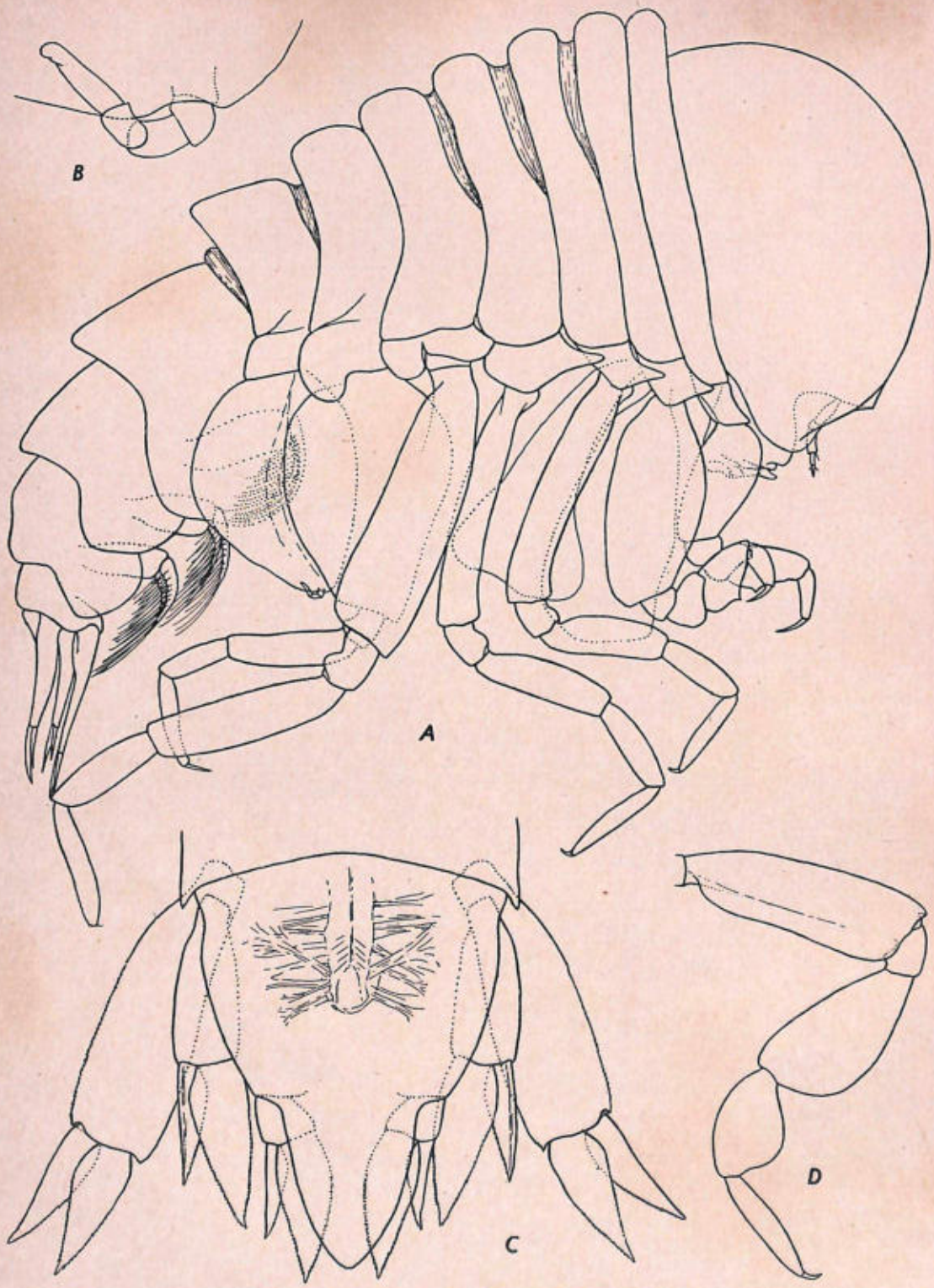
Tryphana malmii Boeck.

Tryphana malmii Boeck, 1870, p. 9.
Tryphana malmii Boeck, 1872, p. 92, pl. 1, fig. 3.
Tryphana boecki Stebbing, 1888, p. 1539, pl. 194.
Tryphaena malmi Sars, 1895, p. 17, pl. 7.

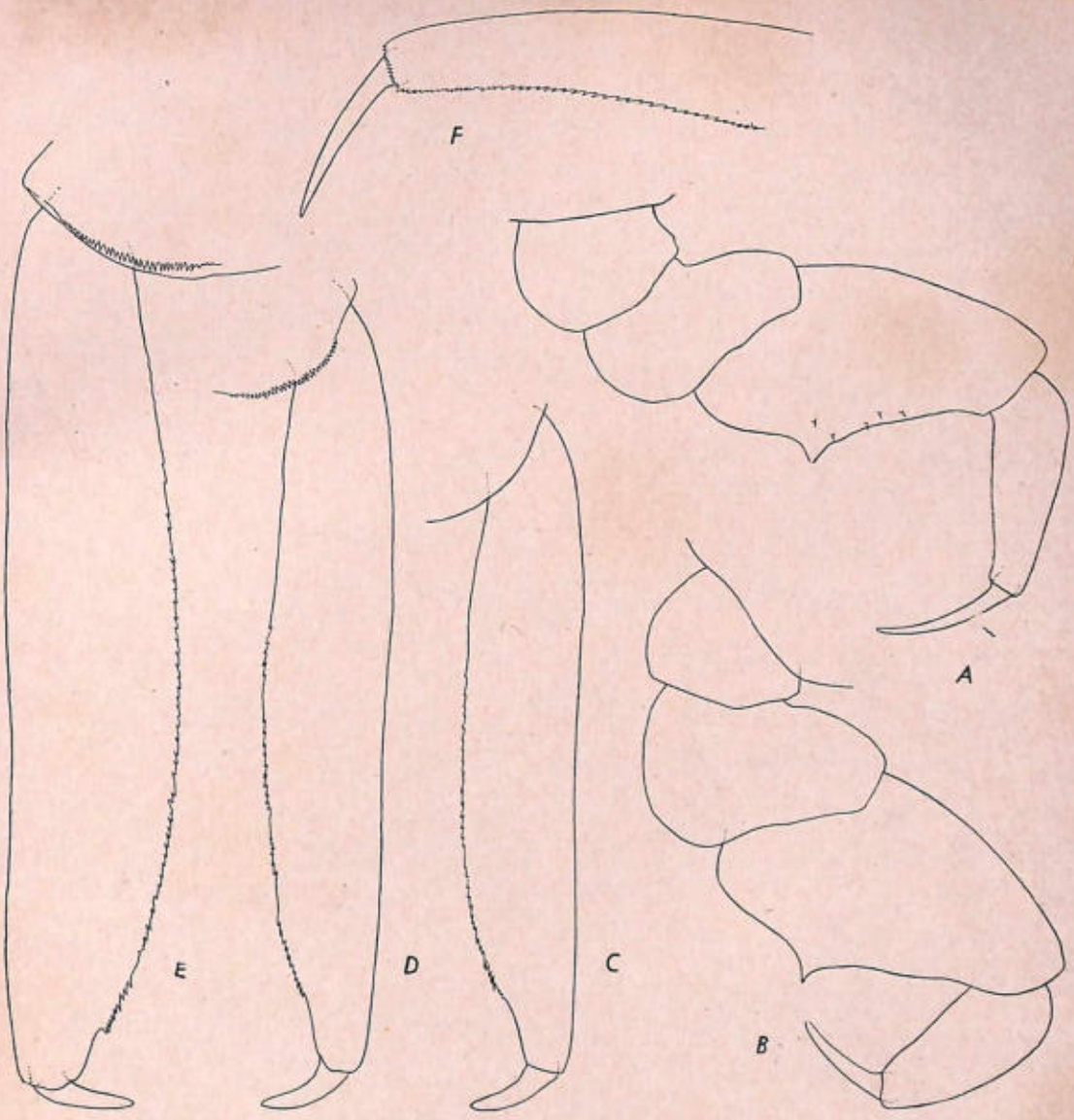
Twelve specimens were taken at depths of 100 and 300 fathoms.

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.

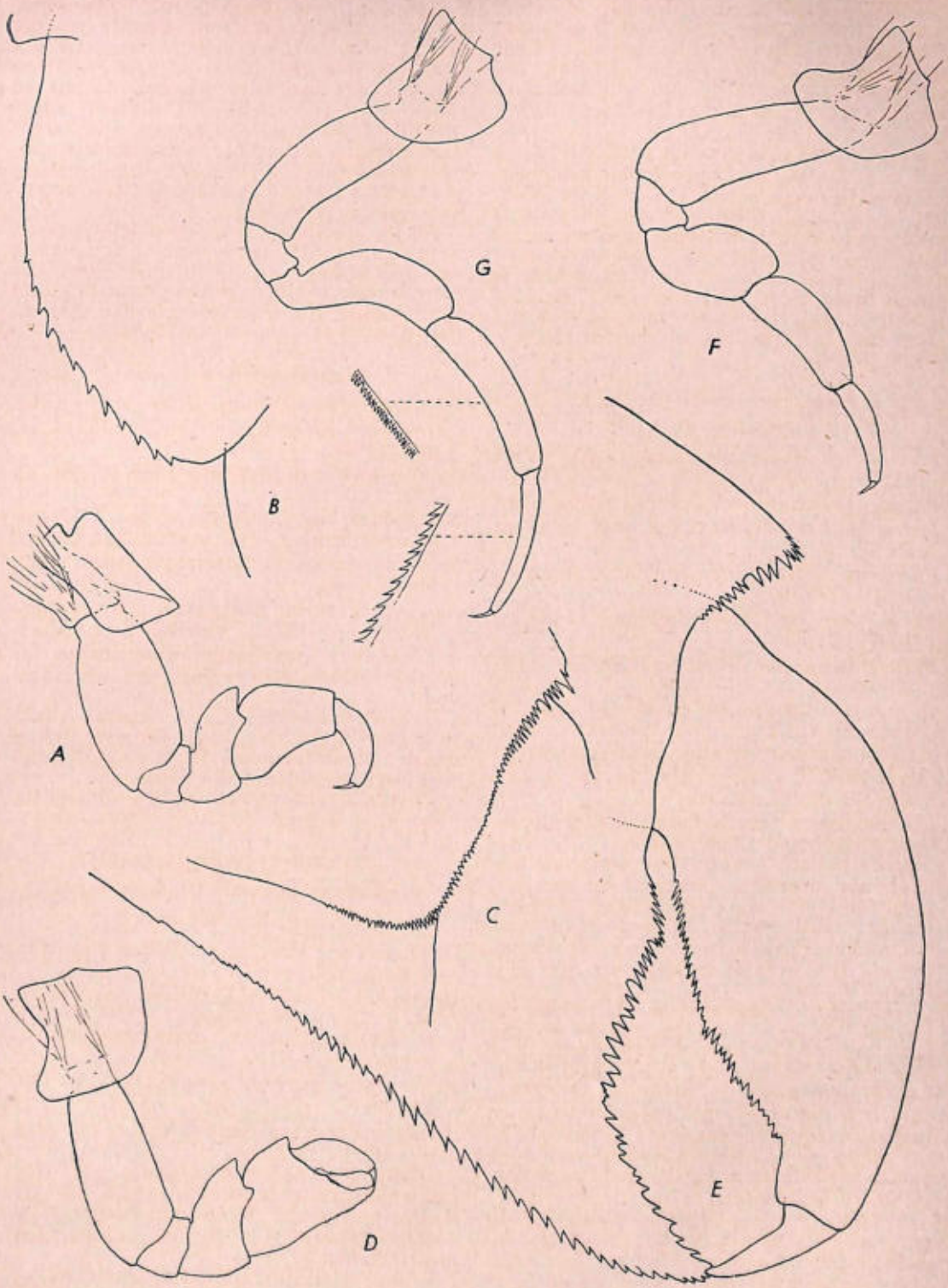
Oxycephalus piscator Bovallius, 1890, p. 56, pl. 1, figs. 8-16, text-figs. 33, 35, 36, 37, 41, 42, 66, 68, 69, 75 (literature and synonymy).

Oxycephalus piscator Spandl, 1927, p. 180, fig. 13.

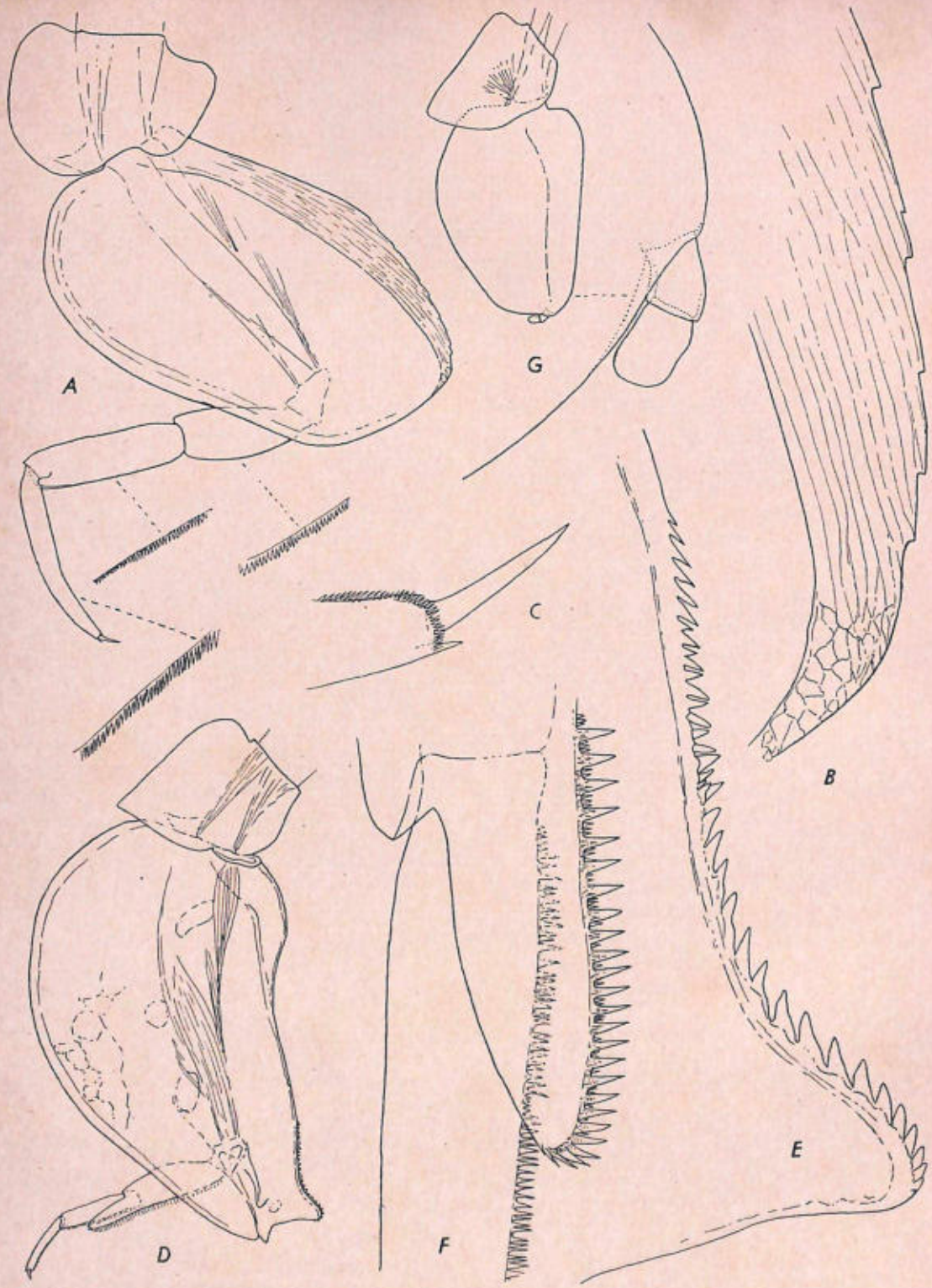
One specimen, a female, was taken at a depth of 800 fathoms.

Distribution.—North Atlantic (41° N., Chevreux), tropical Atlantic, and South Atlantic; subtropical and tropical Pacific; New Zealand (Barnard); Indian Ocean; and Mediterranean.

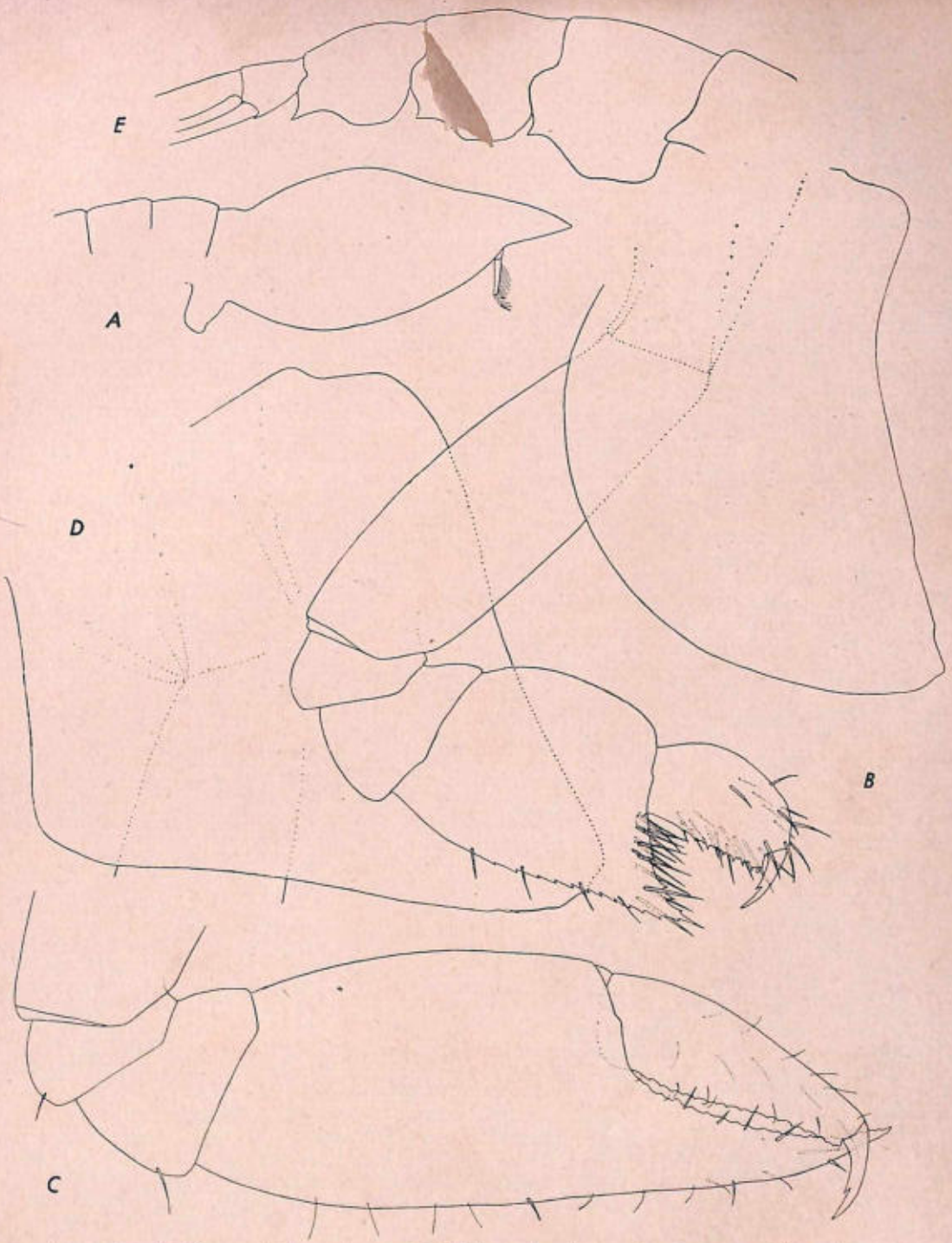
I have identified this single female as *Oxycephalus piscator* M.-E., as it appears to agree in most characters with the description given by Bovallius (1890, p. 64). As the figures given by different authors do not



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**, peraeopod 1; **G**, peraeopod 2.



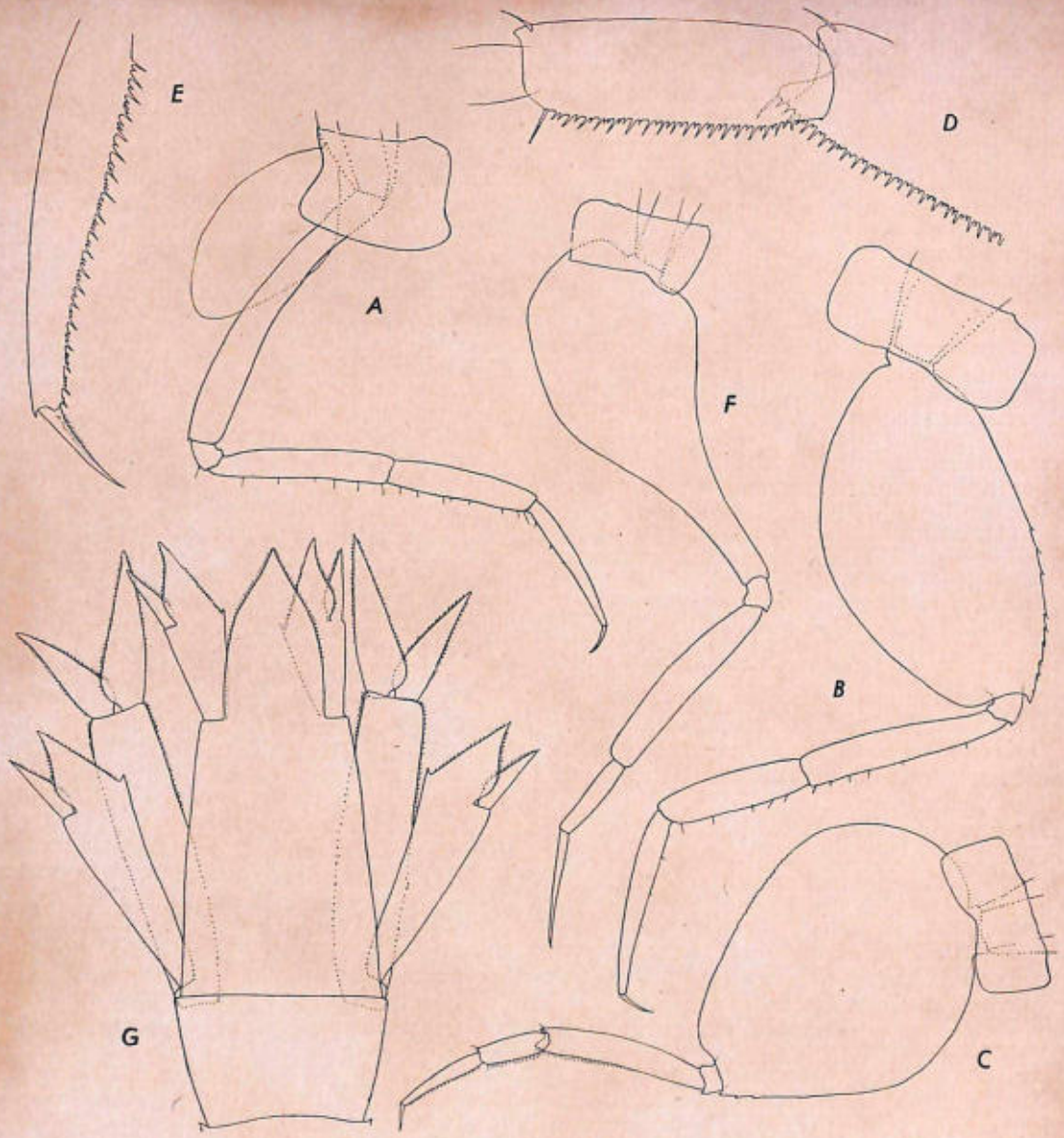
TEXT-FIG. 41. *Parapronoë crustulum* Claus. **A**, peraeopod 3; **B**, lower front margin of second joint of peraeopod 3; **C**, sixth and seventh joints of peraeopod 3; **D**, peraeopod 4; **E**, lower front margin of second joint of peraeopod 4; **F**, lower front margin of fourth joint, and upper 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 *mancinii* 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.

Calamorhynchus pellucídus Streets.

Calamorhynchus pellucidus Streets, 1878, p. 285, fig. 5.

Calamorhynchus rigidus Stebbing, 1888, p. 1600, pl. 206.

Calamorhynchus 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.

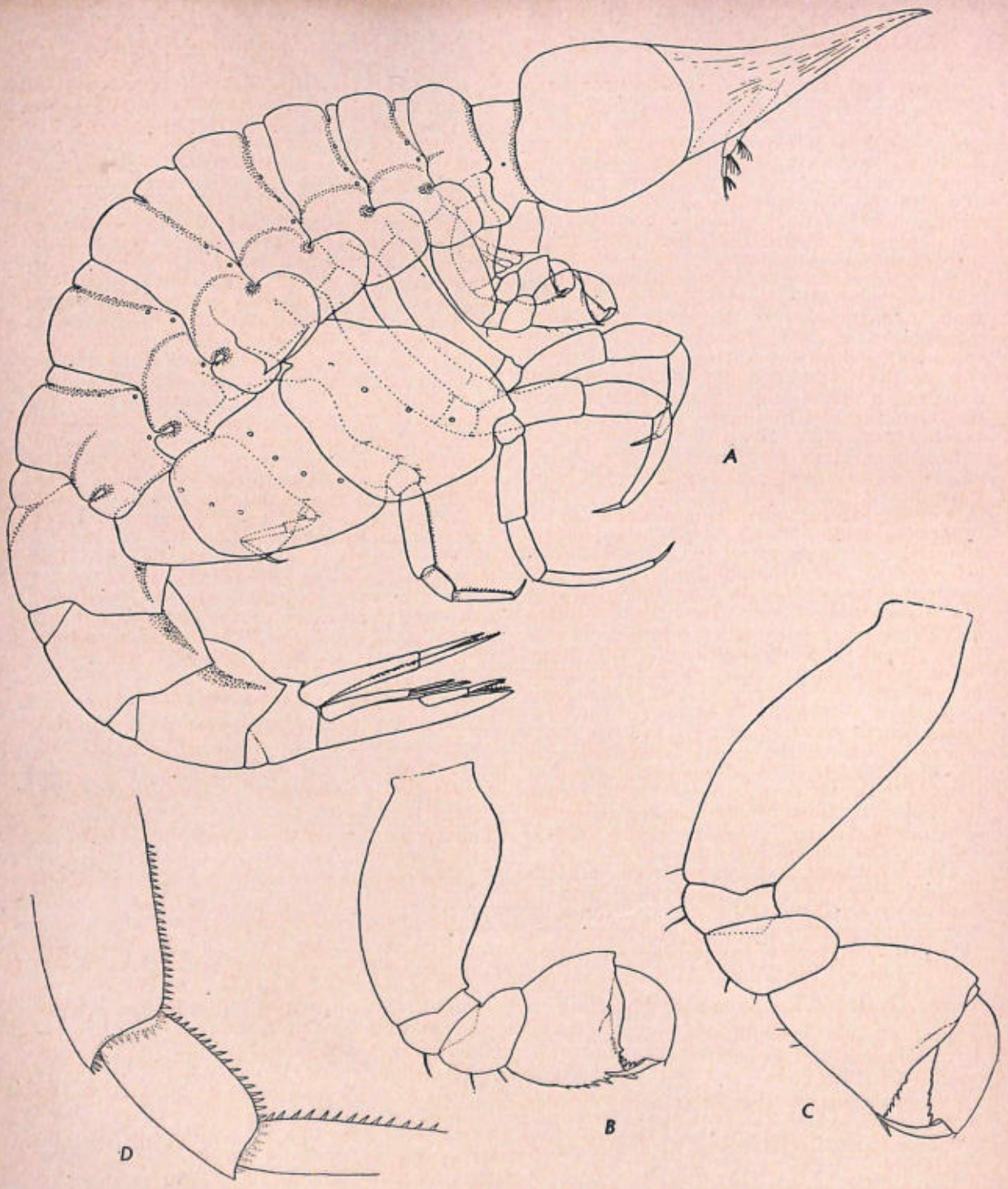
Stebbingella théeli Bovallius, 1890, *Ibid.*, p. 101, pl. V, figs. 1-4; p. 21, fig. 3; p. 35, fig. 60.

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 peraeopod 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 peraeopods 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 théeli* (1890, pl. V, fig. 4.).

Bovallius gives 15-21 mm. as the length of *Stebbingella théeli*, 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. théeli* 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.

Pirlot 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).

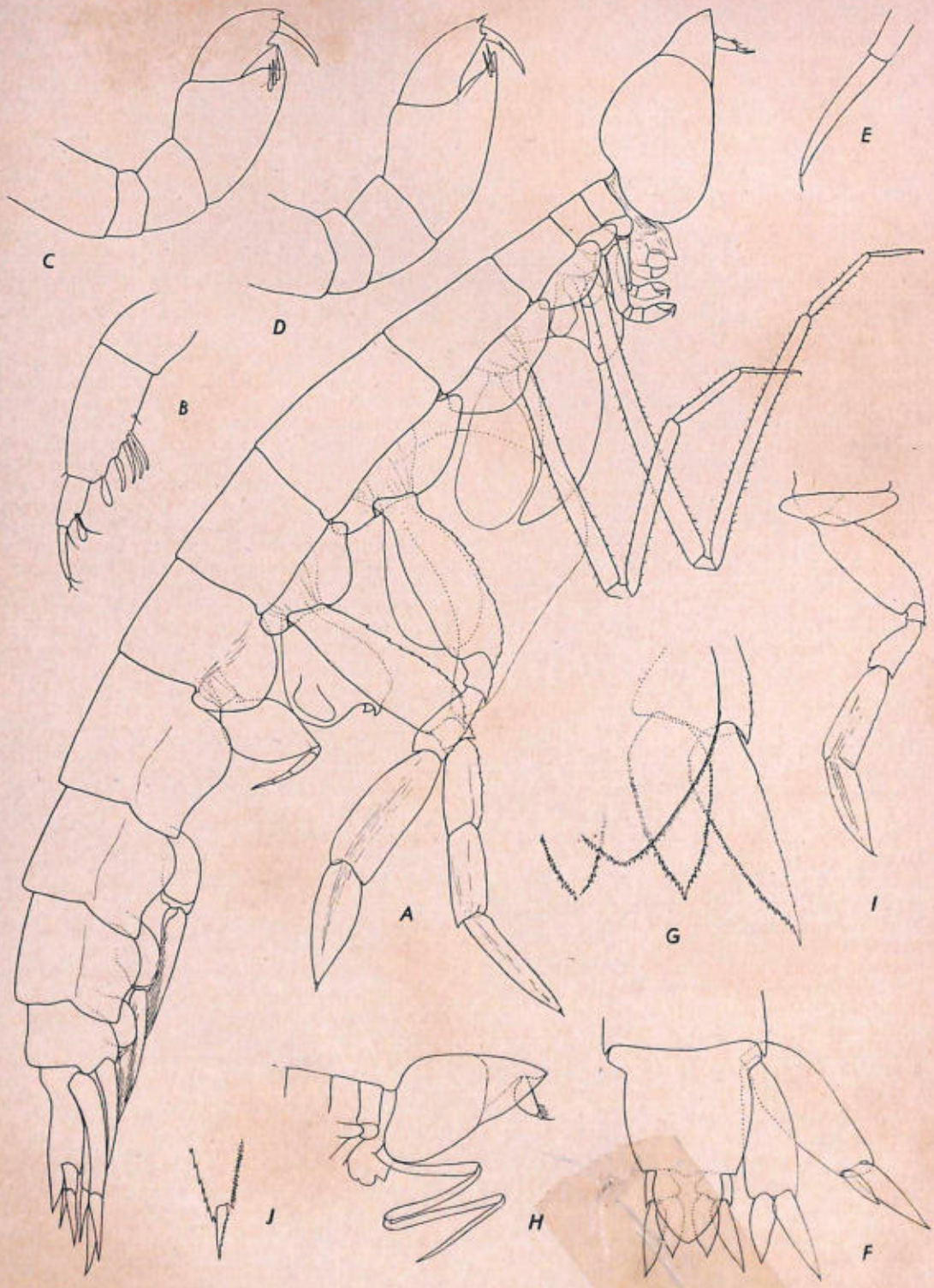
Dorycephalus ambobus Spandl, 1927, p. 203, fig. 28a-c.

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.

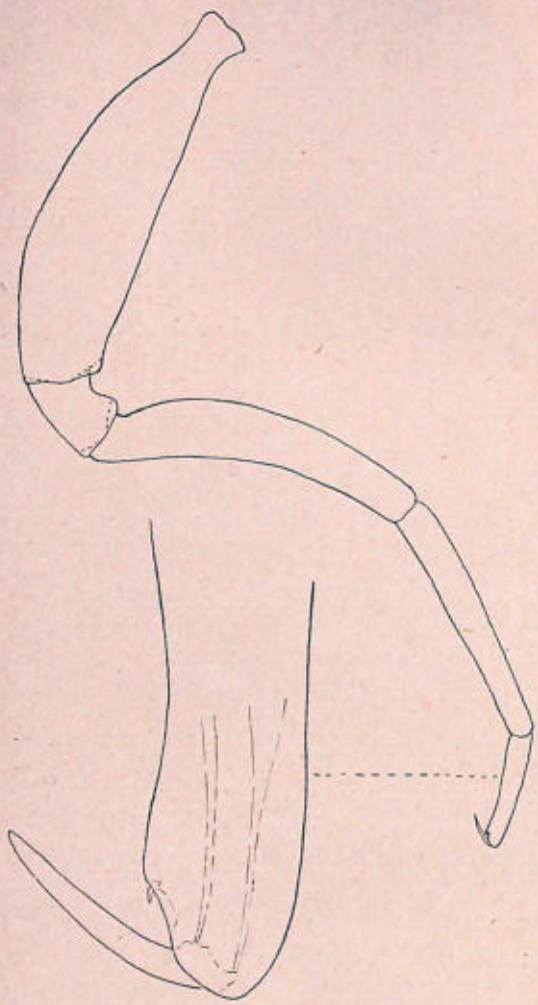
Eutyphis inermis Claus, 1887, p. 37.

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 peraeopods 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). Peraeopod 1.

Platyscelus ovoides (Claus).

Text-figs. 47, 48.

Eutyphis ovoides Claus, 1879a, p. 155 (9).
Eutyphis globosus Claus, 1879a, p. 159 (12).
Eutyphis ovoides Claus, 1887, p. 35, pl. 1, pl. 2, figs. 1, 2; pl. 3, figs. 1-3.
Eutyphis globosus Claus, 1887, p. 38, pl. 3, figs. 4, 15-19.

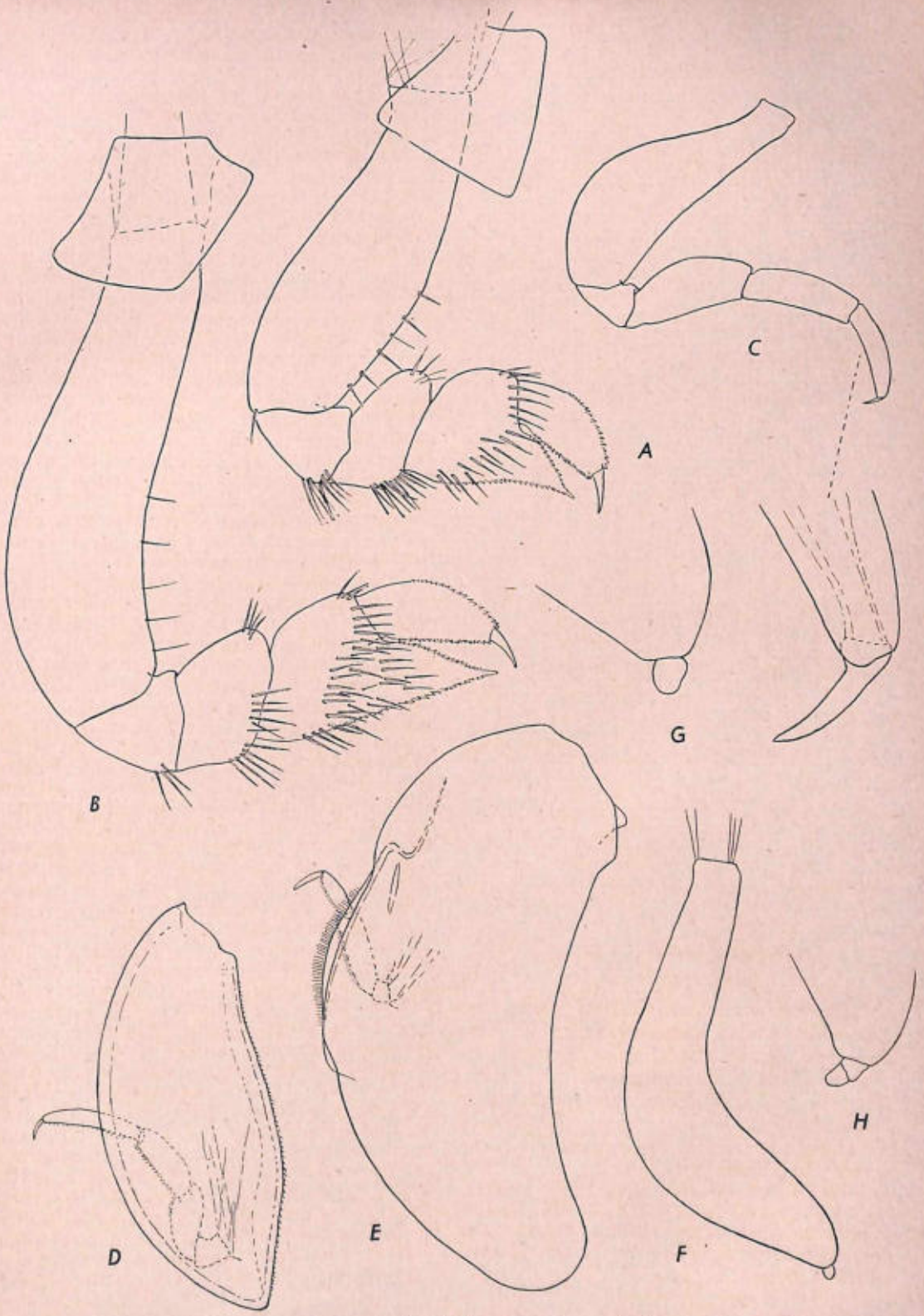
Thirteen specimens were taken from the surface to 800 fathoms.

Distribution.—North and South Atlantic; Mediterranean; North Pacific; South Pacific (*intermedius*); Indian Ocean. The present records are the first for the western North Atlantic.

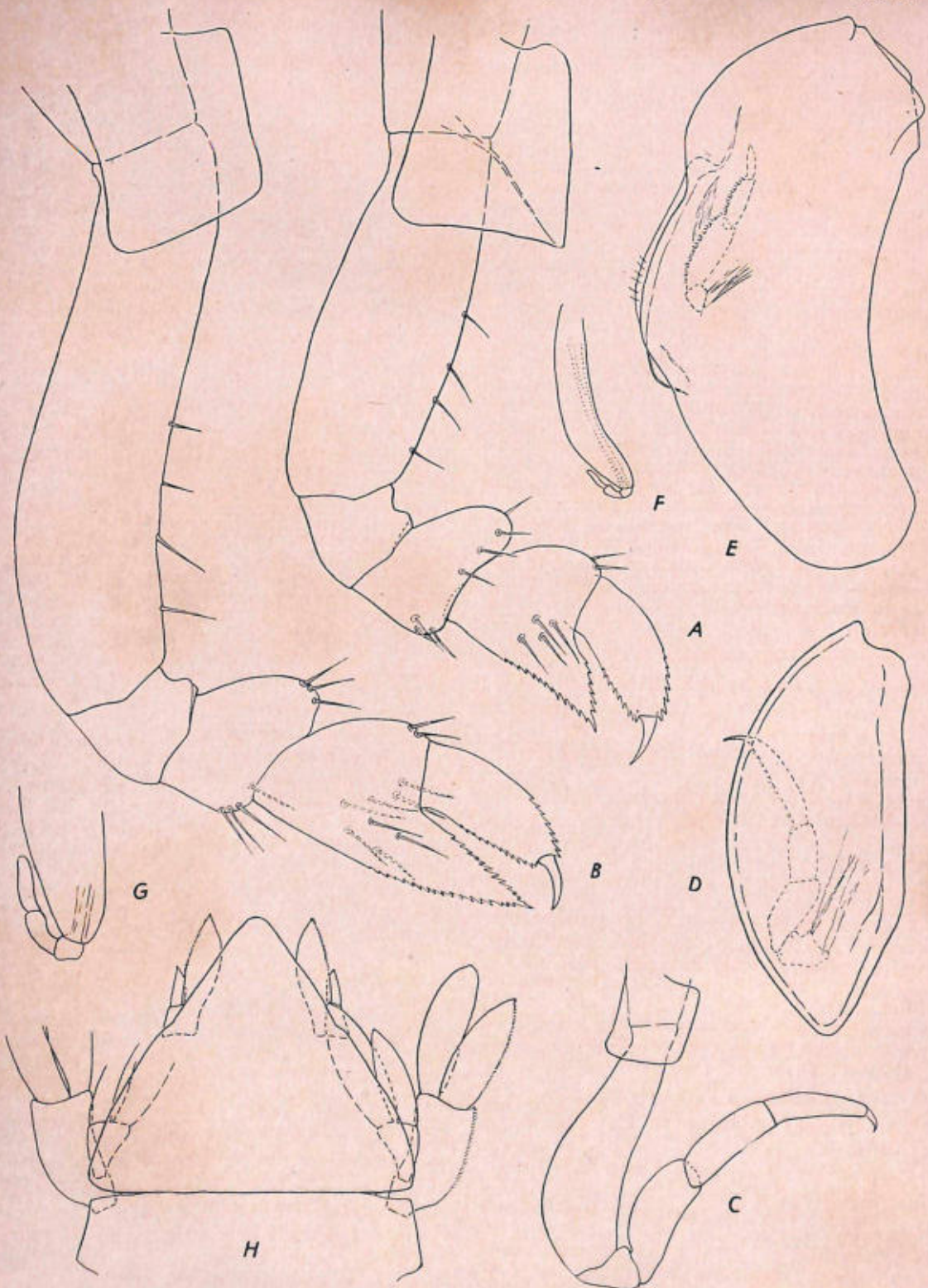
Platyscelus ovoides reaches a length of 20 mm. The present collection contains both male and female specimens measuring from 5-17 mm. All but the three smallest specimens, measuring 5-7 mm., are typical *P. ovoides*. These three smallest specimens appear to be what Claus described and figured as *P. globosus*, which undoubtedly is only the small immature stage of *P. ovoides*. The fifth peraeopod (seventh of Claus) in *ovoides* is reduced to a narrow curved second joint bearing apically a very small atrophied joint. The fifth peraeopod 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 peraeopods 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 peraeopod the serrations extend from the distal portion of the fourth joint to the sixth joint; in the fourth peraeopod 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 peraeopods all possess seven joints and are quite normal in appearance. As the animal grows, a considerable change takes place in the peraeopods, but the greatest alteration occurs in the third, fourth and fifth pairs. The second joint of the third and fourth peraeopods 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 peraeopod the alterations are greater than in the third, the third to sixth joints undergoing greater reduction and the seventh joint becoming lost. The fifth peraeopod suffers the greatest change, becoming finally a short, narrow lamellar appendage bearing a very small apical knob-like third joint. In this peraeopod 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; Hongkong-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. 10-18, 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* Bovallius, 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.

Hempityphis 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 measuing 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.

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.

[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).

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Names in **bold face** indicate new genera, species or varieties; numbers in **bold face** indicate illustrations; numbers in parentheses are the serial numbers of papers containing the Plates listed immediately following.

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1.

Notes on the Taxonomy of the Birds of Malaysia.

JEAN DELACOUR.

New York Zoological Society and American Museum of Natural History.

In the preparation of a handbook of the birds of Malaysia, I have naturally used as a basis "A handlist of Malaysian Birds" by F. N. Chasen (*Bull. Raffles Museum*, Singapore, No. 11, December, 1935), an excellent and most reliable work. But a number of additions have been made, and new facts have been brought to light since its publication. Furthermore, considerable changes have taken place in the nomenclature, mostly as a result of several revisions of families or smaller groups recently conducted by E. Mayr, D. Amadon, H. G. Deignan, S. D. Ripley, C. Vaurie, and myself. All these alterations of Chasen's nomenclature have been incorporated in the forthcoming handbook. I thought it useful to point out the most important of them in the present paper. A bibliography of the Malaysian Avifauna since 1935 will be found at the end of these notes. In most cases, no attempt has been made to revise subspecies, for lack of time. Reasons for their adoption, rejection or addition are not discussed unless they prove of special interest. The same applies to extension or modification in ranges. Particularly the reader is referred to "Notes on the Taxonomy of the Birds of the Philippines" by Jean Delacour and Ernst Mayr, *Zoologica*, 30 (12), November 15, 1945, pp. 105-117, for all changes applying equally well to Malaysian birds, as they will not be discussed here again.

I am much indebted to the curators of the U. S. National Museum, Washington, and of the Academy of Natural Sciences, Philadelphia, for the loan of valuable material, and to my friend Dr. Ernst Mayr for much useful information and help.

Grebes (Podicipidae).

Podiceps novae-hollandiae javanicus has been added to the list. Found in Java. Mayr has discussed the distribution of *novae-hollandiae* and *ruficollis* (*Emu*, 43, 1943, pp. 3-7; 44, 1945, pp. 231-233).

Ducks (Anatidae).

The Australian pochard (*Aythia australis*) has been found in Java, where it seems to be a rare resident in the eastern part of the island (Hiang Plateau). Mayr (*Amer. Mus. Novit.* No. 1056, p. 7, 1940) has shown that the proposed race *lebeboeri* (Bartels and Frank, *Treubia*, 16, p. 337, 1938) is not acceptable. The Javan specimens belong to the nominate race.

Game Birds (Phasianidae).

I do not consider that all Malaysian forms of *Arborophila*, except *charltoni* and races, can be considered subspecies of *brunneopectus* (= *javanica*), as proposed by Chasen. Differences in pattern and general coloration are too great. The Malaysian group forms a superspecies which can be listed as follows: *A. brunneopectus*: *campbelli*, *rolli*[illegible] *mutrana*, *orientalis*; *A. javanica*: *javanica*, *artelsi*; *A. hyperhythra* (*erythrophrys* is but a color phase).

In the general study of the kalij and the [illegible]back pheasants which I have recently undertaken in the preparation of a new monograph, I have been compelled to admit that no natural generic divisions exist among these birds. Characters such as the general color pattern, the shape of the crest or its absence in one or both sexes, the shape and development of the tail feathers, do not show sufficient consistency for clear distinctions. The species *inornatus*, *imperialis* and *edwardsi* are providing links between the different groups to such a degree that no satisfactory divisions can stand. Therefore the generic names *Gennaeus*, *Hierophasis*, *Delacourigallus*, *Houppifer*, *Chalcocomus* and *Diardigallus* are synonyms of *Lophura*, the oldest in date.

Although the species *calchurum* is very distinct in shape, display and voice, it cannot be separated from other *Polyplectron*, as *inopinatum* supplies a perfect intermediate.

Pigeons (Columbidae).

Mayr ("The Birds of Timor and Sumba," *Bull. A. M. N. H.*, 83 (2), 1944, pp. 147-148) has pointed out that the subspecies *Ducula aenea aenea* occurs only in the Lesser Sunda Islands, being larger, more vinaceous than the Malaysian population. The oldest name available for the latter is *consobrina* (Salvadori, 1887, Nias).

Cuckoos (Cuculidae).

We have shown (*Zoologica*, 30 (12), p. 107) that the generic names *Rhopodytes*,

Rhinortha and *Zanclostomus* are synonyms of *Phoenicophaeus*. It follows that *P. curvirostris borneensis* (Blasius and Nehrkorn, 1881) is antedated by *P. diardi borneensis* (Salvadori, 1874). It must therefore be known as *P. c. microrhinus* (Berlepsch, 1895).

Hornbills (Bucerotidae).

Two very similar pied hornbills are found in India and Ceylon: *coronatus* in the south and west and *malabaricus* in the northeast. Both coexist in part of their range (Chota Nagpore and western Bengal) and therefore must be considered two different species. There is a great deal of difference in the shape of the casque, which is narrow, compressed, with flat sides in *coronatus;* broad, swollen and convex on the sides in *malabaricus*. Furthermore, in *coronatus* there is one large black patch on the bill, located on the terminal two-thirds of the casque, including the whole ridge. In *malabaricus*, there are two black patches, one on each side of the casque, leaving out the ridge which is always pure white; they are roughly triangular, extending from the tip of the casque downward to about one-half of the bill and encroaching on the sides of the mandible itself. In *coronatus*, all the lateral tail feathers are white, the central pair alone being black. In *malabaricus*, the lateral feathers are black, with only the terminal quarter white. Farther east, a subspecies of *malabaricus* (*leucogaster*) ranges as far south as Perak in Malaya. Southern Malaya, Sumatra, Borneo and islands are the home of *convexus*, which again has the lateral tail feathers entirely white, as in *coronatus*. All the same, *convexus* is a subspecies of *malabaricus*, not of *coronatus*, as the casque is of identical shape and pattern. This characteristic is much more important than the variation in the color of the tail feathers. As it could be expected from the geographical distribution of these hornbills, the similarity of *coronatus* and *convexus* in this particular point can only be interpreted as a result of convergence, without any phyletic significance.

Barbets (Capitonidae).

The barbets have been revised recently by Ripley (*Auk*, 62, 1945, pp. 542-563). His general conclusions have been adopted, with the following exceptions:

I consider *Megalaema armillaris* (+ *baliensis*), *M. henrici* (+ *brachyrhyncha*), and *M. pulcherrima* as three different species, forming a superspecies, as the differences in pattern are too great, in my opinion, to warrant specific lumping. *M. eximia* (+ *cyanea*) is so different in pattern, coloration and size of rictal bristles from *M. australis* (+ *duvauceli* and races) that they should be considered as two distinct and not very closely related species.

Woodpeckers (Picidae).

The generic names *Callolophus* and *Chrysophlegma* are considered synonyms of *Picus*, no sufficiently important characteristics being found in the different species to warrant generic splitting.

The Malaysian pigmy woodpeckers of the genus *Dendrocopos*[1] belong to two distinct species: *canicapillus* (gray-headed) and *moluccensis* (brown-headed), which coexist in numerous localities. (See Greenway, *Auk*, 60, 1943, pp. 564-574). The Philippine forms belong to a different species: *maculatus*. The three species are very similar, but can be fairly easily distinguished.

The two three-toed species, *javanense* and *rafflesi*, are certainly to be regarded as congeneric, as they have very similar pattern and colors, the differences in the bill (culmen straighter and more angulate, and base covered by short plumes in *rafflesi*) being of specific significance only. Therefore *Chloropicoides* (1847) becomes a synonym of *Dinopium* (1814). It follows that *D. rafflesi borneonensis* (Hesse, 1911) is antedated by *D. javanense borneonensis* (Dubois, 1897). I propose to name it:

Dinopium rafflesi dulitense

nom. nov. for *Gauropicoides rafflesi borneonensis*, Hesse, Orn. Monatsber. 19, 1911, p. 192: Mt. Dulit, North Sarawak, Borneo.

Pittas (Pittidae).

I consider *Pitta schneideri* as a full species, as it is too different in colors from *P. nipalensis*, in both sexes and at different ages. *P. venusta* and *P. ussheri*, both with the crown black, are considered subspecies of the red-crowned *P. granatina* (+ *coccinea*) as none of the forms appear to overlap. *Venusta* inhabits western Sumatra; *coccinea*, Malaya and northwestern Sumatra; *ussheri*, northwestern Borneo; *granatina*, northeastern and southern Borneo. Stresemann (*Temminckia*, 3, 1938, Leiden, pp. 124-125) mentions intermediates in adjoining areas of distribution in Borneo.

Cuckoo-Shrikes (Campephagidae).

In examining the numerous species so far distributed among the "genera" *Coquus, Pteropodocys, Coracina, Volvocivora, Edolisoma*, I fail to see how they can be divided according to any important and stable groups of characteristics. Difference in the size and proportions of the body, bill, wings and tail, or in color pattern, are combined in all sorts of ways, none being of any great signficance. It is therefore advisable to include them all in the genus *Coracina*.

On the other hand, the genus *Lalage* is quite distinct, if restricted to the slender species *nigra, sueuri, melanoleuca, leuco-*

[1] *Dendrocopos* Koch, 1816, replaces *Dryobates* Boie, 1826. Not antedated by *Dendrocopus* Vieillot, 1816.

pygia, aurea, atrovirens, leucomela, maculosa and *sharpei*. The genera *Campephaga, Chlamydochera, Campochera, Pericrocotus, Hemipus* and *Tephrodornis* complete the family.

Leafbirds (Aegithinidae).

Aethorhynchus is a synonym of *Aegithina*. The only species assigned to it, *lafresnayei*, is but a larger edition of *Aegithina tiphia*, with a longer bill. Both species have the same color pattern, and both have two moults in the year, the male assuming a breeding plumage for the mating season. They are obviously so closely related that a generic distinction between them appears to be absurd.

Bulbuls (Pycnonotidae).

A new arrangement of the subspecies of crested bulbuls of the genus *Criniger* has been adopted. It is a little different from that previously proposed in my "Revision of the Genera and Species of the Family Pycnonotidae" (*Zoologica*, 28 (4), 1943, p. 26), and very similar to that recently proposed by H. G. Deignan (The Birds of Northern Thailand, *U. S. Nat. Mus. Bull.* 186, 1945, p. 338).

It now seems to me that these puzzling bulbuls, all very similar, can be divided into two species:

1. *Criniger tephrogenys*—Crest and tail relatively short. Living at lower altitudes in the southern part of the range, where both species coexist. It includes the following subspecies: *xanthizurus, balicus, frater, gutturalis, tephrogenys, robinsoni.*

2. *Criniger ochraceus*—Crest and tail relatively long, living at higher altitudes in the southern part of the range, with the following subspecies: *flaveolus, burmanicus, griseiceps, pallidus, henrici, annamensis, ochraceus, cambodianus, sacculatus, sumatranus, ruficrissus.*

In both groups we find birds with bright yellow, dirty yellow and pale brown underparts, and many intermediates. The extent and intensity of the yellow pigment is only of subspecific significance.

Old World Insect-eaters (Muscicapidae).

I. Robins, Chats and Thrushes (Turdinae).

Like *Kittacincla, Trichixos* Lesson, 1839, is a synonym of *Copsychus* (see "Notes on the Taxonomy of the Birds of the Philippines," *Zoologica* 30 (12), 1945, p. 112). The unique species *pyrropygus* is very close to *saularis* in shape, and to *malabaricus* in habits and voice.

The new name *ater* proposed in the same paper for *Copsychus saularis niger* (Sharpe) is unnecessary, as there is an older name available for the subspecies, so far overlooked: *Copsychus adamsi* Elliott, *Auk*, VII, 1890, p. 348. In a further note, *Auk*, VIII, 1891, p. 117, Elliott recognizes that *adamsi* is a synonym of *niger*.

II. Babblers (Timaliinae).

The heterogenous medley of species variously assigned to the babbler group since the beginning of the last century have been a puzzle to ornithologists until the present days. For many years the present writer has studied them extensively in museums, in captivity and in nature, having observed and collected many different forms in French Indo-China, the richest country in the Orient as far as these birds are concerned. During the last few years, Mayr and I have been preparing a detailed study of the Timaliinae which we hope to have published shortly.

I only want to give here a brief and tentative survey of the principal results and their repercussion on the nomenclature of Malaysian Timaliinae. We have found that there are five distinct groups, or tribes, with or without links between themselves or with the other subfamilies of insect-eaters:

A. Ground babblers (Cinchlosomatini) inhabiting the Australian Region, only one reaching Malaysia (*Eupetes*); a primitive tribe.

B. Jungle babblers (Pellorneini) including the following Malaysian genera and species: *Pellorneum: ruficeps, capistratum; Malacocincla: tickelli, pyrrhogenys, malaccensis, cinereiceps, rostrata, bicolor, sepiaria, abboti; Malacopteron: magnum, cinereum, magnirostre, affine, albogulare.*

The generic names *Aethostoma, Anuropsis* and *Erythrocichla* are considered synonyms of *Malacocincla*. The species *tickelli* belong to that genus, not to *Pellorneum*. *vanderbilti* is probably an altitudinal race of *sepiaria*. Examination of available series shows that the birds named *Malacocincla aenigma* by Riley are identical with those named *rufiventris* by Salvadori. As they agree with the description of the mysterious *perspicillata* Bonaparte, this last name must be used.

Ophrydornis is a synonym of *Malacopteron*.

Through *Pellorneum*, on the one hand, and such birds as *Megarulurus mariei, bivittata* (New Caledonia and Timor) and *Ortygocichla rubiginosa* (New Britain), and *Bradypterus*, on the other, this tribe is connected with the Sylviinae.

C. Scimitar and wren babblers (Pomatorhinini), forming a separate tribe with little connection with any others. The Malaysian representatives are: *Pomatorhinus: montanus, hypoleucos; Rimator: malacoptilus; Ptilocichla: leucogrammica, falcata; Kenopia: striata; Turdinus: marmoratus, macrodactylus, brevicaudatus, epilepidotus; Pnoepyga: pusilla.*

Rhinortha and *Zanclostomus* are synonyms of *Phoenicophaeus*. It follows that *P. curvirostris borneensis* (Blasius and Nehrkorn, 1881) is antedated by *P. diardi borneensis* (Salvadori, 1874). It must therefore be known as *P. c. microrhinus* (Berlepsch, 1895).

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Two very similar pied hornbills are found in India and Ceylon: *coronatus* in the south and west and *malabaricus* in the northeast. Both coexist in part of their range (Chota Nagpore and western Bengal) and therefore must be considered two different species. There is a great deal of difference in the shape of the casque, which is narrow, compressed, with flat sides in *coronatus;* broad, swollen and convex on the sides in *malabaricus*. Furthermore, in *coronatus* there is one large black patch on the bill, located on the terminal two-thirds of the casque, including the whole ridge. In *malabaricus*, there are two black patches, one on each side of the casque, leaving out the ridge which is always pure white; they are roughly triangular, extending from the tip of the casque downward to about one-half of the bill and encroaching on the sides of the mandible itself. In *coronatus*, all the lateral tail feathers are white, the central pair alone being black. In *malabaricus*, the lateral feathers are black, with only the terminal quarter white. Farther east, a subspecies of *malabaricus* (*leucogaster*) ranges as far south as Perak in Malaya. Southern Malaya, Sumatra, Borneo and islands are the home of *convexus*, which again has the lateral tail feathers entirely white, as in *coronatus*. All the same, *convexus* is a subspecies of *malabaricus*, not of *coronatus*, as the casque is of identical shape and pattern. This characteristic is much more important than the variation in the color of the tail feathers. As it could be expected from the geographical distribution of these hornbills, the similarity of *coronatus* and *convexus* in this particular point can only be interpreted as a result of convergence, without any phyletic significance.

Barbets (Capitonidae).

The barbets have been revised recently by Ripley (*Auk*, 62, 1945, pp. 542-563). His general conclusions have been adopted, with the following exceptions:

I consider *Megalaema armillaris* (+ *baliensis*), *M. henrici* (+ *brachyrhyncha*), and *M. pulcherrima* as three different species, forming a superspecies, as the differences in pattern are too great, in my opinion, to warrant specific lumping. *M. eximia* (+ *cyanea*) is so different in pattern, coloration and size of rictal bristles from *M. australis* (+ *duvauceli* and races) that they should be considered as two distinct and not very closely related species.

Woodpeckers (Picidae).

The generic names *Callolophus* and *Chrysophlegma* are considered synonyms of *Picus*, no sufficiently important characteristics being found in the different species to warrant generic splitting.

The Malaysian pigmy woodpeckers of the genus *Dendrocopos*[1] belong to two distinct species: *canicapillus* (gray-headed) and *moluccensis* (brown-headed), which coexist in numerous localities. (See Greenway, *Auk*, 60, 1943, pp. 564-574). The Philippine forms belong to a different species: *maculatus*. The three species are very similar, but can be fairly easily distinguished.

The two three-toed species, *javanense* and *rafflesi*, are certainly to be regarded as congeneric, as they have very similar pattern and colors, the differences in the bill (culmen straighter and more angulate, and base covered by short plumes in *rafflesi*) being of specific significance only. Therefore *Chloropicoides* (1847) becomes a synonym of *Dinopium* (1814). It follows that *D. rafflesi borneonensis* (Hesse, 1911) is antedated by *D. javanense borneonensis* (Dubois, 1897). I propose to name it:

Dinopium rafflesi dulitense

nom. nov. for *Gauropicoides rafflesi borneonensis*, Hesse, Orn. Monatsber. 19, 1911, p. 192: Mt. Dulit, North Sarawak, Borneo.

Pittas (Pittidae).

I consider *Pitta schneideri* as a full species, as it is too different in colors from *P. nipalensis*, in both sexes and at different ages. *P. venusta* and *P. ussheri*, both with the crown black, are considered subspecies of the red-crowned *P. granatina* (+ *coccinea*) as none of the forms appear to overlap. *Venusta* inhabits western Sumatra; *coccinea*, Malaya and northwestern Sumatra; *ussheri*, northwestern Borneo; *granatina*, northeastern and southern Borneo. Stresemann (*Temminckia*, 3, 1938, Leiden, pp. 124-125) mentions intermediates in adjoining areas of distribution in Borneo.

Cuckoo-Shrikes (Campephagidae).

In examining the numerous species so far distributed among the "genera" *Coquus, Pteropodocys, Coracina, Volvocivora, Edolisoma*, I fail to see how they can be divided according to any important and stable groups of characteristics. Difference in the size and proportions of the body, bill, wings and tail, or in color pattern, are combined in all sorts of ways, none being of any great signficance. It is therefore advisable to include them all in the genus *Coracina*.

On the other hand, the genus *Lalage* is quite distinct, if restricted to the slender species *nigra, sueuri, melanoleuca, leuco-*

[1] *Dendrocopos* Koch, 1816, replaces *Dryobates* Boie, 1826. Not antedated by *Dendrocopus* Vieillot, 1816.

pygia, aurea, atrovirens, leucomela, maculosa and *sharpei*. The genera *Campephaga, Chlamydochera, Campochera, Pericrocotus, Hemipus* and *Tephrodornis* complete the family.

Leafbirds (Aegithinidae).

Aethorhynchus is a synonym of *Aegithina*. The only species assigned to it, *lafresnayei*, is but a larger edition of *Aegithina tiphia*, with a longer bill. Both species have the same color pattern, and both have two moults in the year, the male assuming a breeding plumage for the mating season. They are obviously so closely related that a generic distinction between them appears to be absurd.

Bulbuls (Pycnonotidae).

A new arrangement of the subspecies of crested bulbuls of the genus *Criniger* has been adopted. It is a little different from that previously proposed in my "Revision of the Genera and Species of the Family Pycnonotidae" (*Zoologica*, 28 (4), 1943, p. 26), and very similar to that recently proposed by H. G. Deignan (The Birds of Northern Thailand, *U. S. Nat. Mus. Bull.* 186, 1945, p. 338).

It now seems to me that these puzzling bulbuls, all very similar, can be divided into two species:

1. *Criniger tephrogenys*—Crest and tail relatively short. Living at lower altitudes in the southern part of the range, where both species coexist. It includes the following subspecies: *xanthizurus, balicus, frater, gutturalis, tephrogenys, robinsoni.*

2. *Criniger ochraceus*—Crest and tail relatively long, living at higher altitudes in the southern part of the range, with the following subspecies: *flaveolus, burmanicus, griseiceps, pallidus, henrici, annamensis, ochraceus, cambodianus, sacculatus, sumatranus, ruficrissus.*

In both groups we find birds with bright yellow, dirty yellow and pale brown underparts, and many intermediates. The extent and intensity of the yellow pigment is only of subspecific significance.

Old World Insect-eaters (Muscicapidae).

I. Robins, Chats and Thrushes (Turdinae).

Like *Kittacincla, Trichixos* Lesson, 1839, is a synonym of *Copsychus* (see "Notes on the Taxonomy of the Birds of the Philippines," *Zoologica* 30 (12), 1945, p. 112). The unique species *pyrropygus* is very close to *saularis* in shape, and to *malabaricus* in habits and voice.

The new name *ater* proposed in the same paper for *Copsychus saularis niger* (Sharpe) is unnecessary, as there is an older name available for the subspecies, so far overlooked: *Copsychus adamsi* Elliott, *Auk*, VII, 1890, p. 348. In a further note, *Auk*, VIII, 1891, p. 117, Elliott recognizes that *adamsi* is a synonym of *niger*.

II. Babblers (Timaliinae).

The heterogenous medley of species variously assigned to the babbler group since the beginning of the last century have been a puzzle to ornithologists until the present days. For many years the present writer has studied them extensively in museums, in captivity and in nature, having observed and collected many different forms in French Indo-China, the richest country in the Orient as far as these birds are concerned. During the last few years, Mayr and I have been preparing a detailed study of the Timaliinae which we hope to have published shortly.

I only want to give here a brief and tentative survey of the principal results and their repercussion on the nomenclature of Malaysian Timaliinae. We have found that there are five distinct groups, or tribes, with or without links between themselves or with the other subfamilies of insect-eaters:

A. Ground babblers (Cinchlosomatini) inhabiting the Australian Region, only one reaching Malaysia (*Eupetes*); a primitive tribe.

B. Jungle babblers (Pellorneini) including the following Malaysian genera and species: *Pellorneum: ruficeps, capistratum; Malacocincla: tickelli, pyrrhogenys, malaccensis, cinereiceps, rostrata, bicolor, sepiaria, abboti; Malacopteron: magnum, cinereum, magnirostre, affine, albogulare.*

The generic names *Aethostoma, Anuropsis* and *Erythrocichla* are considered synonyms of *Malacocincla*. The species *tickelli* belong to that genus, not to *Pellorneum*. *vanderbilti* is probably an altitudinal race of *sepiaria*. Examination of available series shows that the birds named *Elocincla aenigma* by Riley are identical with those named *rufiventris* by Salvadori. As they agree with the description of the mysterious *perspicillata* Bonaparte, this last name must be used.

Ophrydornis is a synonym of *Malacopteron*.

Through *Pellorneum*, on the one hand, and such birds as *Megarulurus mariei, bivittata* (New Caledonia and Timor) and *Ortygocichla rubiginosa* (New Britain), and *Bradypterus*, on the other, this tribe is connected with the Sylviinae.

C. Scimitar and wren babblers (Pomatorhinini), forming a separate tribe with little connection with any others. The Malaysian representatives are: *Pomatorhinus: montanus, hypoleucos; Rimator: malacoptilus; Ptilocichla: leucogrammica, falcata; Kenopia: striata; Turdinus: marmoratus, macrodactylus, brevicaudatus, epilepidotus; Pnoepyga: pusilla.*

Napothera is considered a synonym of *Turdinus*, as *brevicaudatus* differs from *macrodactylus* by the size only, the different races of both species showing a strikingly similar variation. Contrary to R. M. de Schauensee's opinion (*Proc. Acad. Nat. Sci.*, Philadelphia, 1940, 91, pp. 352-354), I believe that all the forms of the smaller *Turdinus* can be referred to the one species *epilepidotus*, those found in the same area being altitudinal races, not really coexisting anywhere.

The Annamese genus *Jabouilleia* provides a perfect link between *Pomatorhinus* and *Rimator*.

D. Tit babblers (Timaliini). A large tribe, perhaps connected with the titmice (Paridae) through the so-called longtailed tits (*Aegithalos, Psaltria, Psaltriparus*), the parrotbills (*Paradoxornis*), the reedlings (*Panurus*), the American wren tits (*Chamaea*), the oriental genera *Moupinia, Chrysomma, Dumetia* and *Timalia*.

The following occur in Malaysia: *Macronus: flavicollis, gularis, ptilosus; Stachyris: nigriceps, poliocephala, grammiceps, nigricollis, leucotis, maculata, striolata, thoracica, erythroptera, rufifrons, chrysaea, melanothorax; Timalia: pileata; Psaltria: exilis.*

The genus *Cyanoderma* is considered a synonym of *Stachyris*, as the presence, extent or absence of the naked skin behind the eye vary throughout the whole group in a way which is not consistent with other characteristics.

E. Song babblers (Turdoidini). The most differentiated tribe, which appears to be connected with the jungle babblers through *Gampsorhynchus*, not *Lichus* and *Malacopteron*, and also apparently through the wren babblers through *Turdoides* (including *Argya*) and *Pomatorhinus*. They are numerous in Malaysia, but the Himalaya-Indo-China country is their stronghold: *Garrulax: lugubris, palliatus, rufifrons, leucolophus, mitratus, erythrocephalus; Leiothrix: argentauris; Cutia: nipalensis; Pteruthius: erythropterus, melanotis, aenobarbus; Alcippe: castaneiceps, nipalensis, pyrrhoptera; Siva: strigula, cyanuroptera, castaniceps; Yuhina: xantholeuca; Gampsorhynchus: rufulus; Crocias: guttatus; Heterophasia: picaoides.*

Melanocichla and *Rhopocichla* are obviously generic synonyms of *Garrulax*. We also consider *Mesia* a synonym of *Leiothrix*, and *Erpornis* of *Yuhina*.

There has been in the past some confusion between the small species of *Pteruthius; tahanensis*, from Malaya, is a subspecies of *melanotis*, not of *aenobarbus*, the nominate form of which inhabits Java.

III. Flycatchers (Muscicapinae).

The reasons for lumping several genera of flycatchers into the genus *Muscicapa* have been previously given (*Zoologica*, 30 (12), p. 113). The genus *Niltava* must be added to the synonymy of *Muscicapa*, as no clear line can be drawn between the various forms with and without blue patches on the neck of the females. Generic distinction between such species as *sundara, davidi, vivida, cyanomelana, concreta*, etc., is unsound. *Oreicola* is also a synonym of *Muscicapa*. *Drymophila* is apparently a monarch flycatcher, related to *Terpsiphone* and to *Monarcha*.

Flowerpeckers (Dicaeidae).

The group of flowerpeckers (*Dicaeum*) with dark metallic upperparts and partly red underparts, found from S. E. Asia to Australia, is puzzling. One would be tempted to regard them all as geographical subspecies, but two forms coexist in certain places, such as Timor (*maugei maugei* and *sanguinolentum hanieli*). When carefully examined, they are really more different than they appear to be at first sight.

It seems, therefore, necessary to maintain several species. In Malaysia, I consider that *monticola* (bluish above), *sanguinolentum* (purplish), and *ignipectus* (greenish) are separate species; *beccarii*, with no red on the breast, is a race of *ignipectus*, close to *cambodianum* from Indo-China.

Dicaeum agile sumatranum (*Piprisoma modestum sumatranum* Chasen, *Treubia*, 17, afl. 2, 1939, p. 184: Pendeng, Atjeh, N. Sumatra) is antedated by *Dicaeum cruentatum sumatranum* Cabanis, *Journ. f. Orn.*, 1878, p. 101, Sumatra. I propose for it the new name of:

Dicaeum agile atjehense

All the races of thick-billed gray flowerpeckers belong to the species *agile;* I agree with Deignan (Birds of Northern Thailand, pp. 550-551) in this point, and also in referring the Malayan population to the subspecies *modestum*, described after specimens from southern Tenasserim.

White-eyes (Zosteropidae).

The species *javanica* and *squamifrons* are so different from other *Zosterops*, all very similar in a general way, that it seems better to refer them to the genus *Apoia*, the type of which is *A. goodfellowi*, from Mindanao.

Finches (Fringillidae).

The species *estherae* is certainly not referable to the genus *Serinus*, but to *Carduelis*, its nearest relative being *C.* (= *Hypacanthis*) *monguilloti* from the mountains of southern Annam.

Drongos (Dicruridae).

This isolated family is now in the course of revision by Dr. C. Vaurie. Dr. Mayr and I are in accord with him in recognizing only two genera of drongos, for the 18 species of

that family: *Dissemurus*, for the species with the external rectrices greatly elongated, the long bare shafts terminated into a spatula; and *Dicrurus*, for all the other species with a more normal tail. *Bhringa* becomes a synonym of *Dissemurus*, and *Chaptia* of *Dicrurus*.

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2.

A New Name for a Philippine Flowerpecker.

ERNST MAYR.

American Museum of Natural History.

Dicaeum hypoleucum pontifex Mayr.

New name for *Dicaeum everetti* Tweeddale, 1877 (late), *Ann. & Mag. Nat. Hist.*, (4) XX, p. 537, not *Prionochilus everetti* Sharpe, 1877 (early), *Ibis*, p. 16. As stated previously (Delacour and Mayr, 1945, Notes on the Taxonomy of the Birds of the Philippines, *Zoologica*, 30(12), 1945, p. 114) there is no reason for excluding the species *agile* (of which *P. everetti* Sharpe is a subspecies) from the genus *Dicaeum*. *Dicaeum hypoleucum pontifex* Mayr is exactly intermediate between *obscurum* (Luzon) and *hypoleucum* (Sulu-Mindanao). It resembles *obscurum* in the color of the upperparts, but differs by the whitish gray underparts and the dark brown legs.

3.

Further Notes on Display Forms of the Long-tailed Bird of Paradise, *Epimachus meyeri meyeri* Finsch.

LEE S. CRANDALL.

(Plates I-III).

In a previous paper[1] three distinct display forms of the Long-tailed Bird of Paradise, *Epimachus meyeri meyeri* Finsch, were described. Later, a second male presumed to be of the same subspecies was received at the New York Zoological Park. Variants of the display forms of this specimen have been noted and are recorded in the present paper.

The bird referred to in the original paper was collected at Deva-deva, Central Division, Papua, in October, 1928, by Mr. J. A. Ward and the author. Immature at the time of capture, the bird assumed full male plumage in September, 1931. Three distinct display forms were noted: pumping, horizontal, (referred to in the original paper as inverted) and upright. This bird died September 18, 1936.

The second bird, an adult male still living in the New York Zoological Park, was received in 1937, from a collection obtained by Mr. Shaw Mayer, in the Waria River area[2] of Southeast New Guinea. While the points of origin of these two birds could hardly be more than fifty air miles apart, they are separated by the formidable ramparts of the Wharton Range. After differences in display form had been noted, the possibility of subspecific difference came naturally to mind. This was suggested to Dr. A. L. Rand, who at that time was occupied with a study of New Guinea birds at the American Museum of Natural History. Following is a quotation of a letter from Doctor Rand, written under date of October 31, 1940, after examination of available material had been completed:

" . . . Now about *Epimachus*. I have just gone over what material we have from north of the Range in southeast New Guinea. We have only three specimens with undoubted localities. They are definitely smaller than the average from south of the Range but still fall within the limits of variation. There seem to be no other differences of taxonomic importance, and on the basis of the material we have here, at least, it would not be possible to separate them. Greenway, studying the collection from near Wau, came to the same conclusion some years ago . . ."

Since it appears that, at least in the light of present knowledge, the two birds in question are subspecifically identical, no explanation of difference in display form is offered.

The "pumping" form, seen only once in the first bird, has not been noted in the second. The "horizontal" or "inverted" form, with pectoral shields concealed, used frequently by the first, is seen rather rarely in the second but in identical manner. It is in the upright form that striking differences occur.

In the first bird, at the climax of the upright form, the pectoral shields were thrown upward, like two arms, the narrow tips being separated by an inch or more. The tail was held completely rigid and compressed. In the second bird, the shields are joined at the top, forming a broad fan, giving a quite different appearance. At the same time, the short outer tail feathers are rapidly opened and closed, the long central ones remaining quiescent. All other parts of the ritual are identical with those originally described.

While these variations have been noted seasonally since 1937, publication has been withheld pending availability of suitable photographs of the second bird. These have now been obtained through the skill and patience of Mr. Samuel Dunton, staff photographer, and are presented herewith.

1 *Zoologica*, Vol. XI, No. 7, Dec. 3, 1932, pp. 82-84.

2 N. Wharton-Tigar, *Avicultural Magazine*, Fifth Series, Vol. II, June, 1937, p. 182.

EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. *Epimachus meyeri meyeri* in normal position.

Fig. 2. Raising the pectoral shields for display. This position approximates the climax of the form originally described.

PLATE II.

Fig. 3. Shields fully expanded and tightly closed above.

Fig. 4. The outer tail feathers are rapidly opened and closed.

PLATE III.

Fig. 5. At the full climax, with plumes expanded and body flattened, the curved beak is opened to show the yellow interior of the mouth.

FIG. 1.

FIG. 2.

FURTHER NOTES ON DISPLAY FORMS OF THE LONG-TAILED BIRD OF PARADISE EPIMACHUS MEYERI MEYERI FINSCH.

FIG. 3.

FIG. 4.

FURTHER NOTES ON DISPLAY FORMS OF THE LONG-TAILED BIRD OF PARADISE EPIMACHUS MEYERI MEYE[illegible]NISCH.

FIG. 5.

FURTHER NOTES ON DISPLAY FORMS OF THE LONG-TAILED BIRD OF PARADISE EPIMACHUS MEYERI MEYERI FINSCH.

4.

Field Notes on the Snakes of Kartabo, British Guiana, and Caripito, Venezuela.

WILLIAM BEEBE.
Director, Department of Tropical Research, New York Zoological Society.

(Plates I-XIII; Text-figs. 1-4).

[This contribution[1] 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 William Beebe. The Guiana expeditions were made during the years 1909, 1916, 1917, 1919, 1920, 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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[1] Contribution No. 735, Department of Tropical Research, New York Zoological Society.

INTRODUCTION.

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 for many 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 collection of the Department of Tropical Research or in those of the American Museum. In the latter case the original field numbers are still attached with the additional catalogue numbers of the museum.

In the strictly limited localities at Kartabo and Caripito, we collected eight families of snakes, comprising thirty-six genera and fifty-four species. Six of these species were missing from Kartabo, in each case the snake being exceedingly rare at Caripito, represented by only a single individual. There were absent from Caripito twenty-two species or 40 per cent. of the total number. This lack was in line with many other groups of organisms, a comparative paucity of fauna due apparently to the extremes of dry and rainy seasons, these factors resulting on a considerable percentage of terrestrial or low-climbing forms finding life difficult or impossible at the heights of drought or of innundation.

Early in March, 1919, at Kartabo, we collected many specimens of an eel-like fish, *Synbranchus marmoratus*, the Marbled Eelfish. These lived in leaf-choked creeks or in swamps and varied in length from 60 to 900 mm. They fed on small crabs and fish and possessed considerable powers of terrestrial locomotion, making their way across many yards of dry land from one body of water or swamp to another. In the laboratory they frequently made their escape from a pail and flipped about all night, taking no harm, although coated for many hours with a thick layer of dust and dirt. This introductory paragraph is to detail an important factor in the following complex.

The casual hoeing of an Akawai Indian was the direct cause of our discovery of a remarkable concentration of snakes. Within a period of eleven days, from March 20th to April 1st, 1919, from a marshy field given over for several years to the cultivation of rice, we obtained seventeen Tricolored Coral Snakes, *Micrurus lemniscatus*, varying in length from ten to thirty inches. Every one of these, with one exception, had swallowed a Marbled Eel or *Synbranchus*, almost exactly ten inches long. The seventeenth snake had two eels in its stomach, whose lengths, 7.5 and 2.5 inches, absurdly enough totalled ten inches.

The men with the hoes were provided with containers and with promised rewards, and the resultant serpentine fauna of this marshy field comprised six species. Five of these were colubrine and the sixth was the above-mentioned species of coral snake. All these were united by several more or less unrelated factors: first an apparent preference for a wet, swampy terrain, combined with fossorial or nocturnal habits. In the case of four species they were associated by a pronounced diet of *Synbranchus*. Finally, and rather abstractly, we observed the presence in each of considerable scarlet in scale coloring.

The following is a résumé of this unusual aggregation of snakes, all taken in the single rice field.

Micrurus lemniscatus: Seventeen taken from rice field in late March, each individual feeding on a single 10-inch *Synbranchus*. *Color*: banded with black, white and scarlet.

Erythrolamprus aesculapii: Three of these coral snake mimics were collected, one feeding on a small real *Micrurus*, and two on *Synbranchus*. *Color*: black, white and scarlet banded.

Hydrops triangularis: Eight of these snakes from the rice field were all crammed with *Synbranchus*, one of these latter being only 70 mm. in length. *Color*: red above, white below, with many dark cross-bands.

Liophis breviceps: One from the same field with several earthworms and a 150 mm. *Synbranchus* in its stomach. *Color*: dark above, scarlet below with black cross bands.

Oxyrhopus petola: Two caught in rice field. Stomachs empty. *Color*: black, with numerous scarlet and yellow bands.

Pseudoboa coronata: One from rice field with a half-digested *Synbranchus* in its stomach. *Color*: scarlet, with black and white banded head.

Without the accident of hoeing in this particular spot, these six species and more than thirty-five individual snakes would never have been discovered.

Family Leptotyphlophidae.

Two species out of the forty-odd accredited to the single genus in this family were found at Kartabo and one of these at Caripito. These small snakes are doubtless much more common than captures indicate, the apparent rarity being due both to a nocturnal and fossorial life, and to their being frequently mistaken for earthworms.

Superficially they are not unlike the members of the succeeding family, but differ in character of dentition, osteology and scalation. There are only fourteen rows of body scales.

Leptotyphlops albifrons (Wagler, 1824).

Names: Worm Snake, Yellow-faced Worm Snake, Ant-nest Worm. Sabbai-ballu, "one

who lives in cushie ant nest" (Akawai Indian).

Range: From Mexico throughout almost all South America and in many of the West Indies.

General Account: These worm-like snakes just miss being lizards, for beneath their scales are the remains of very distinct hind limbs, bits of all three pelvic bones as well as traces of femurs. They are essentially burrowing and nocturnal, and spend most of their time in or near the nests of ants and termites. By their hard, impenetrable scalation they are protected from the attacks of these insects, and feed almost wholly upon them, their eggs and pupae. Especially during the rainy season they creep about the jungle floor, sometimes covering considerable distances and even climbing to moderate heights. Their teeth are few and delicate and confined to part of the lower jaw. They show unexpected power in pushing through jungle débris and termite nests, aided by a hard, pointed, caudal spine, and are exceedingly difficult to hold in the hand. They are probably the smallest of all snakes and the largest I ever measured was less than eight inches over all.

Both at Kartabo and Caripito we found them fairly common and were it not for their fossorial and nocturnal habits many more would doubtless have been seen.

I find scattered notes on fourteen specimens of this species:

Spec. No. 1: Kartabo, June 10, 1919, length 142 mm., diameter 3.2 mm. This snake was found in the course of digging a pit in the jungle in rolling, sandy soil. The tiny animal was two feet beneath the surface, and ten or fifteen yards from the nearest ant or termite nest. It was very active and its tongue played continually. It escaped from our hands three times, before we could secure it, forcing its head between our fingers. The general color was dark brown, hardly any lighter below, with the edges of the scales barium yellow, the spot on the snout reed yellow and the tail tip amber yellow.

Spec. No. 2 (Cat. No. 249): Kartabo, June 23, 1919, length 180 mm. Caught in daylight, coiled around a live bamboo twig close to the ground and the laboratory door. In the same clump a swarm of Attas were crowding into a hole, probably the reason for the presence of the snake, especially as two crushed *Atta* workers were found in its stomach.

Spec. No. 3: Kartabo, June 23, 1919, length 135 mm. Taken in a nest of Attas or leaf-cutting ants by our Indian hunter.

Spec. No. 4: Kartabo, July 4, 1920, Color Plate 153, length 143 mm., weight 1.1 gram. Body unusually dark brown, almost black, head and tail creamy white. A half-digested mass of ant legs and heads was ready for ejection.

Spec. No. 5: Kartabo, August 31, 1920. Snout and tail dull olive yellow. Caught on a dead twig in a trail with swarms of termites in all directions after a nocturnal attack by a tamandua anteater on their low-swung nest. Watched the snake for half an hour, during which time it climbed eighteen inches up the rough bark of a half dead tree, winding in and out of crevices toward the damaged termite nest. I caught it when it had only three feet more to go to reach the nest. The termites ran past and over it, with neither snake nor insects paying any attention.

Spec. No. 6: Kartabo, June 10, 1922, length 170 mm. A single oval egg with half-formed shell found in oviduct.

Spec. Nos. 7, 8 and 9: Kartabo, All taken on March 1, 1924, in daytime, within an area of six feet on the surface of a jungle trail, during a light rain. Two of the snakes had been feeding on the cocoons of ants, the contents having been squeezed out and the husks about to be extruded.

Spec. No. 10: Kartabo, April 29, 1924, total length 162 mm., tail 10 mm., diameter 3 mm., weight 1.4 gram. Caught in heavy rain, creeping across trail.

Spec. Nos. 11 and 12 (Cat. No. 2884): Kartabo, May 23, 1924, lengths 100 and 150 mm. Both were taken near the entrance of a large *Atta* nest. The tongue of one was brilliant scarlet.

Spec. Nos. 13 and 14 (Cat. No. 30132): Caripito, June 8, 1942, lengths 125 and 195 mm.

Leptotyphlops septemstriata

(Schneider, 1801).

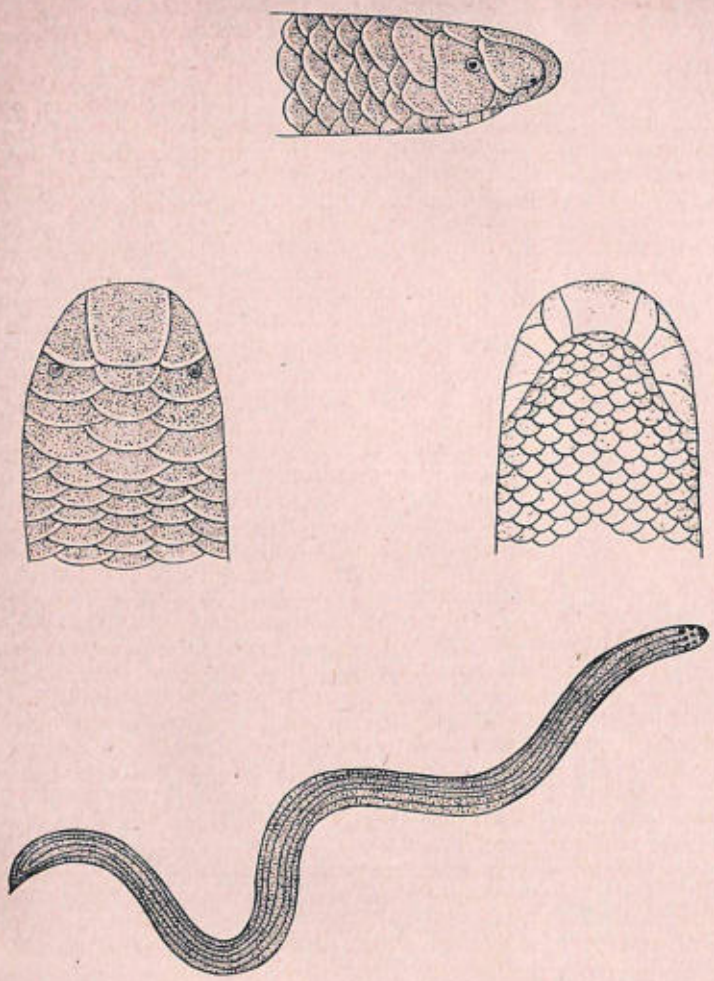
(Plate I, Fig. 1).

Name: Seven-lined Worm Snake.

Range: The Guianas and Amazonia.

General Account: Habits in general like those of *albifrons*. In appearance this species lacks the pale head and tail, and the body color varies from pale lilac to rich golden orange with seven to nine dark lines down back and sides. In most specimens the lowermost line is broken or reduced to a fine thread of pigment. The average size is larger than in *albifrons*, the largest reaching a length of nine inches.

This small snake can traverse considerable ground. One individual on a cloudy day covered eighteen feet over damp, forest débris in forty-eight minutes and then vanished forever. The seven-lined is less common than the other species. We did not find it at Caripito, and I have records of only twelve at Kartabo, with notes on two of these.



TEXT-FIG. 1. *Leptotyphlops septemstriata.* Lateral, dorsal and ventral views of head, and entire snake.

No. 343: Color Plate 243, October 6, 1920, length 170 mm., tail 6, body width 5, height 4 mm., weight 1.7 gram. Found in a small termite nest, under the spathe of a palm at the edge of the jungle. In its stomach were the remains of five mangled termite workers. The general color, above and below, was pale lavender with a silvery sheen. It showed seven lines with traces of two more. These were olive brown, beginning back of the head. The eye showed a round pupil of unusually large diameter, the narrow iris being pale pink.

On smooth ground the snake progressed slowly with vigorous undulations of the body, getting as much leverage from the lateral curves as from the pointed tail. It was absolutely smooth and slippery, difficult to hold. No effort at biting was observed even under provocation.

No. 504: Color Plate 325, February 24, 1922, length 215 mm., tail 6.5, body width 5.3, height 4.5 mm., weight 3.7 grams. Found in a ground termite nest, one hundred yards back in the jungle. When held in the hand the edges of the scales could be distinctly felt and seemed to be an effective aid in pushing. The body was golden orange, deepening to tawny red toward head and tail. Seven longitudinal lines of dark brown, turning to black toward head and tail, and two other, very faint lines, making nine in all, extended down back and tail. The ventral scales were dark golden yellow. In some lights the entire snake shone like burnished gold. The small eye was distinctly pinkish.

FAMILY TYPHLOPHIDAE.

Only a single genus and species out of the five genera and more than twenty neotropical forms contained in this family were observed by us in the survey of the localities included in this paper. These burrowing snakes are larger than those of the preceding family and have twenty or more rows of body scales.

Typhlops reticulatus (Linnaeus, 1758).

(Plate I, Figs. 2 and 3).

Names: Burrowing Snake, Two-colored Ant Snake, Spine-tailed Blind Snake.

Range: North and central South America.

General Account: These burrowing snakes frequently found in ant and termite nests are in general larger than the worm snakes, but show the same blunt head, spiny tail and firm, close-fitting, hard scalation. The eye is small and counter-sunk, and the mouth is edentulous except for a few teeth in the upper jaw.

Fifteen were recorded at Kartabo and three at Caripito, although others were reported at both places. The pattern and colors were varied. Six or seven were jet black above, several more dark brown, and one pale brown above. As to the ventral surface the black specimens usually showed contrasting white, while the dark brown snakes were pink below. The head and tail showed decided asymmetrical variation in pattern.

Cat. No. 232: Kartabo, July 30, 1920, length 255 mm., tail 10.5, body width 11.2, height 10, head length 4, eye diameter 1 mm., weight 16 grams. Most of dorsal area shining jet black, but head pale, immaculate back to end of rostral. Third dorsal scale white. Tail black, but with a seven-scale-wide white break, beginning with the eighth scale from the caudal end, broken only by the twelfth and thirteenth dorsal scales which are black. White below. In stomach two *Atta* workers.

Cat. No. 241: Kartabo, September 3, 1917, length 170 mm. Found in small termite nest near ground with no apparent exit of sufficient size. This individual was the palest worm snake of this species found at Kartabo. Pale tawny brown above and creamy write below. It was extremely sensitive to a sudden light flashed on it after dark.

Cat. No. 260: Kartabo, August 7, 1919, length 230 mm., snout 3.5, eye diameter 1 mm., weight 19 grams. Burnished dark brown above, pale salmon below. In preservative the latter has turned to rich chestnut. The rostral and nasal scales were dark salmon, with an irregular black blotch on the latter.

Cat. No. 263: Kartabo, Photograph 909, September 8, 1919, length 330 mm., weight 26 grams. Caught in early evening creeping over jungle leaves. On a smooth board this snake progressed very slowly, less by the rapid, lateral undulations of the whole body than by the constant sticking in and pushing with the short, stout caudal spine. Repetition of this movement was constant, and seemed certainly to be the chief function of this organ. The food was a mass of about twenty termites, well crushed, and mixed with bits of nest débris.

Cat. No. 581: Kartabo, May 8, 1922, length 365 mm., tail 14 mm., weight 40 grams. Caught when crawling out of the ground, ten feet from an *Atta* nest. I followed it as it crept for fifteen or twenty feet to a sandy bit of the jungle, when it burrowed so fast that it was necessary to dig it from a depth of about eighteen inches. It was brownish-black above, pinkish below. The latter color changed in preservative to cinnamon buff. The rostral was wholly pink and the nasals partly and asymmetrically of the same color. From the eye to the back of the head the dorsal black extends well down on the sides. At the tail a broad band of the ventral color stretches clear across the dorsal black.

Cat. No. 30113: Caripito, May 20, 1942, length 200 mm. Brownish-black above, lemon yellow below.

Cat. No. 30113a: Caripito, May 20, 1942, length 230 mm., weight 10 grams. Caught in Pit No. 12, in open llanos, thirty feet from low jungle. Brownish-black above, lemon yellow below. Head black with four, short, broad bands of buff down rostral and nasals, to tip of snout which is all buff. Below lemon yellow on fore body, paling back of this area. The dorsal black extends around on to the ventral side at the level of the posterior part of the head, but does not meet on the mid-ventral line. The same pattern holds for the tail, the black almost meeting on the ventral line a short distance from the tail tip. The scales are so hard and close fitting that it seems as if no ant or termite could penetrate them. I tested this later with another specimen by dropping it into a mass of angry *Atta* ants. It suffered no harm from the workers although they did their best, and in spite of being badly bitten myself I could not persuade the giant-headed soldiers of the home guard to attack the reptile.

A half grown worm snake dropped in a tangle of army ants had short shrift, and a dozen of the insects fixed their jaws into the unfortunate snake before I could retrieve it and drop it into alcohol.

Every structure of this snake is adapted for burrowing; the mouth is shark-like, far overhead by the snout, the eye is small and under the scales, the mouth is small with slight ability of mastication, either merely crushing or swallowing its ant food whole. In a specimen taken soon after the present one were the remains of 36 termites and even a recognizable guest staphylinid. These snakes show great resistance to death by drowning, surviving in water for an hour or more with no access to air.

Family Iniliidae.

This is another primitive family of degenerate eyed, burrowing snakes. The eyes are very small and sunken beneath the scales, while the dorsal and ventral scales are all small and sub-equal. The coloration is brilliant, pink and yellow, with numerous, broad, irregular cross-bands of black. A single genus and species is known from South America.

Inilius scytale (Linnaeus, 1758).

(Plate I, Figs. 4 and 5).

Names: False Coral Snake, Scarlet Ground Snake, Chain Snake. Sarree-booh, "love on the leaves" (Akawai Indian).

Range: Northern South America, east of the Andes.

General Account: This is a strange snake. It is the only neotropical representative of its family, it has pelvic vestiges connecting it with the worm snakes and boas, and it is brilliantly colored although in structure as well as in habits it is decidedly fossorial. It was not rare and we caught a considerable number at Kartabo, but did not find it at Caripito. I noted no habits of especial interest.

Eight specimens of these brightly colored burrowing snakes were found from April to July 1916, and three others in June and July, 1920, in a deserted rice field, where we also captured twenty true coral snakes (*Micrurus lemniscatus*).

Coll. No. 227: May 30, 1919, length 560 mm. Found among the decayed mould of a fallen tree. This individual possessed fifty-one black bands, of which sixteen are semi-bars. All of these latter are uniformly alternate, ending abruptly at the mid-line. The ground color is coral red, with the head brownish. The small eyes are in the center of a single scale, close to the anterior edge of the first black bar. In the stomach were three small *Typhlonectes* and four crushed Orthoptera.

Coll. No. 240a: Color Plate 268, November 8, 1920, length 660 mm., tail 27, body width 12, height 10, head length 13, width 11.5 mm., rows of scales 21, ventrals 225, subcaudals 13. This snake has forty-four black cross bars on its coral red background, of which eleven are Y-shaped, being double on one side. The lower sides and ventral surface are pale straw yellow. In life the eye has a large, round pupil, with a narrow pink iris, the whole flat and under scale. In preservative, after twenty-four years the black has changed to pale cinnamon brown, and the red to creamy white.

Coll. No. 3516 (body) and 3517 (skin): Female breeding, Color Plate 771, June 21, 1924, length 530 mm., tail 20, body width 13, height 12, head length 14, width 9.5, eye diameter 1 mm., scale rows 21, subcaudals 14, weight 38.5 grams. The colors are bright scarlet, jet black, and clear, strong lemon yellow below. After the color plate was made, the snake was skinned and mounted on a sheet of pasteboard. Today, in 1946, twenty-two years afterwards, the colors of the skin are exactly as in life. There are forty black bands, whole or broken, of which twenty-three are complete, a few are Y-shaped, and others are alternate, crossing each other in mid-back.

Family Boidae.

Among boas we find the largest and most powerful of serpents. Like the preceding families they are primitive, and possess the remains of a pelvis, while some even have an external claw altered from its original use as an aid in locomotion in lizard-like ancestors to a sexual function. Cretaceous fossil boa-like creatures which lived fifty million years ago are so much like living species that we may assume that little evolution has taken place throughout this long period.

In South America there are seven genera and about fifteen species. Of these, four genera and five species were recorded in the course of our studies in British Guiana and northeastern Venezuela.

Boa canina Linnaeus, 1758.

(Plate II, Figs. 6 and 7).

Names: Green Tree Boa, Dog Boa, Yellow-faced Boa, Parrot Snake. Yea-tah-yah-mo (Akawai Indian).

Range: Northern and central South America.

General Account: No tree boas were seen at Caripito, and only five taken at Kartabo. Others were probably often in full view but unobserved owing to their quiescent habits in the daytime and their protective coloring. In general the color is bright green above, spotted and narrowly banded with white, with much of the head and the under parts yellow. This ruptive patterning, combined with the spots of sunlight on the jungle foliage, renders the snake all but invisible.

We found it usually bunched or draped in a more or less compact ball or closely wound series of coils. It was not vicious, and after a preliminary fight for freedom, seemed to accept captivity with a sort of watchful waiting.

Coll. No. 228: Color Plate 36, Pelvis KOH 19123, May 25, 1919. Length 1540 mm. (5 feet), weight 910 grams (2 pounds). General color above peacock green with the usual irregular white cross bands, and olive yellow below, this latter color extending over much of the face and all labials. Iris light orange brown. This pigmentation

made the snake darker than any other specimen.

Found on a branch six feet up, and it made no effort to escape until seized, when it struck viciously and constricted with all its force. It soon relaxed and clung closely but not too tightly to my hand and arm as I carried it to the laboratory.

Coll. No. 559: Color Plates 373 and 374, Photographs 1740, 1754, 1755, 1756, 1757 and 1762. April 23, 1922. Length 1330 mm. (4 feet, 4 inches), tail 200 mm., head length 52, width 40, body width 24, height 34, eye diameter 7 mm., weight 437 grams.

Colors: General color of head above parrot green, lighter on snout and around eye; the deeply pitted upper labials light viridine yellow with pinkish shading on their most recessive parts. Lower labials pale greenish-yellow shaded with light viridine yellow. Body above parrot green anteriorly shading through calliste green to yellow green on the tail. Starting on neck are scattered transverse markings, sometimes joined, sometimes alternating, one to five or six scales wide on median line, tapering on upper sides. These markings are white, more or less clouded with gray. They are vaguely bordered with a wide clouding of dark ivy green, these borders being very wide anteriorly, sometimes running into each other, while posteriorly they are sparse. Sides of body yellow green, lighter toward tail. There are a few small touches of empire yellow here and there along the sides, and one large one about mid-body. Extreme lower sides of body empire yellow anteriorly the remainder being faintly mottled with the same color, while glaucous blue scales appear here and there along the area of greatest girth and toward the tail. Here there are also a few splotches of pinkish-white at long intervals. Chin and ventrals napthaline yellow, while a faint lateral stripe of empire yellow extends down the tail.

Pupil vertical, the line of the pupil extended up and down by a deep groove heavily stippled with dark gray. Iris straw yellow with faint gray stippling all over, which becomes more dense and arranged in the form of two crescents on the sides of the pupil, leaving narrow lines of clear straw yellow next to the pupil. Veins in iris and its periphery faintly tinged with orange. Mouth inside lavender tinged with bluish-white. Predominating colors of universal sheen over whole body are bengal green, chrysophrase and golden orange.

Boa endris cookii (Gray, 1842).

Names: Yellow-marbled Tree Boa, Brown Tree Boa. Ya-mung (Akawai Indian); Macaurel, Oroya (Spanish).

Range: Northern South America, Panama, Lesser Antilles and Trinidad.

General Account: Six of these tree boas were recorded from Kartabo and two from Caripito. The variation in both ground color and pattern is very considerable, and is most confusing for ocular field identification. But a tree snake with vertical pupils, plain gray or brown, or with intricate dull yellow mottlings will probably be this species.

This boa is essentially arboreal and nocturnal, although they seem at times to descend to the ground as is proved by two specimens of the terrestrial frog *Elachistocleis ovalis bicolor* which I took from the stomach of one boa. Trust in immobility and their resemblance to branches and twigs seems reflected in the ease with which they can be approached in daylight and seized. Poor eyesight may also have something to do with this.

Coll. No. 349: Kartabo, June 3, 1920, length 650 mm. *Color in Life*: Unmarked buffy-brown, and only slighter lighter below. It was coiled in a tree, and when seized by the neck managed to get two of its long anterior teeth into my finger, at the same time vibrating its tail against the twigs so that I was startled by the rattling. The Indians are in deadly fear of this boa, and with more superficial reason than in the case of colubrine tree snakes. The number and length of the anterior fang-like teeth, the swollen posterior portion of the head, the vertical pupils, and the unusually loud hiss of the buffy tree boa, all have sinister appearances. But the teeth and mouth are always clean and the bite innocuous.

Coll. No. 2677: Kartabo. Color Plates 683 and 684, April 5, 1924. Total length 1200 mm. (4 feet), body 940 mm., tail 260, body width 16, height 26.5, head length 29.5, width 19, eye diameter 4 mm., rows of scales 58, ventrals 276, subcaudals 120, weight 172.2 grams. *Color in Life*: General color of body light grayish-olive, with many alternating patches, some complete, some broken, on each side of dorsal aspect, olive brown. These darken dorsally and fade downward into very much broken perpendicular lateral streaks and markings of buffy olive which reach to the edge of the ventrals. The dorsal markings are darker toward the head and the tail. Also toward the head and tail they take on the appearance of the Greek letter omega, at midbody looking like thick, downward-pointing crescents. All these markings have a faint center of cream color, and are rimmed above with the same. The space between is filled with a mottling of grayish-olive, with a few dark splotches, forming a more or less continuous wavy line down the dorsal

ridge. Head, labials and anterior chin cream color, with an area in front of eye light grape green. Head above covered with finely interwoven pattern of dark brown lines, which leave still finer lines of the cream between. One heavy lateral dark streak backward from the eye, a narrower one from eye forward and up over snout; two from upper part of eye backward, small spot and a few crescentic markings on nuchal region. Neck and posterior chin and anterior ventrals tinged with tea green; remaining ventrals pale olive buff, each tinged with creamy buff along posterior edge, and with very fine stippling of grayish-olive, which becomes pronounced toward tail, where there is a mass of confused mottling. A few dark spots on snout and lower labials. Posterior upper labials with deep notches. Iris dull cream color with fine gray stippling, pupil rim more brilliant, and an area of dark sepia stippled around the vertical pupil.

Coll. No. 30059: Caripito, April 20, 1942, Total length 1880 mm. (6 feet, 2 inches), tail 370 mm. *Color in Life*: Above uniform olive green, changing posteriorly into pale brown, with more and more black encroaching on the scales from well before the anus to tail tip. Below creamy white, each scale washed with a sheen of lavender. Along both sides of the ventrals from a distance before anus equal to the length of the tail, there is an irregular series of black spots, becoming larger and extending clear across ventrals under the tail. The tail ends in a sharp spine. In preservative the colors change to olive buff above, and warm antimony yellow below. This boa was caught coiled among the small branches of a low tree at the edge of the savanna. It allowed itself to be grasped around the neck, when it coiled and uncoiled like lightning, hissing loudly.

Coll. No. 30150: Caripito, June 22, 1942, length 700 mm. *Color in Life*: Light red-brown, appearing uniform at first glance, but after being grasped, a series of faint, but dark markings became apparent, quite distinct on the tail, in general pattern recalling those on No. 2677, but in only two indistinct shades of brown. There was a slight but definite color change, the dark markings remaining after death. Below pale yellow brown. The eye with its vertical pupil appeared large and conspicuous in life, and was of such a rich orange brown that until killed and identified we labelled this specimen the Orange-eyed Tree Boa.

Constrictor constrictor constrictor
(Linnaeus, 1758).
(Plate III, Figs. 8, 9 and 10).

Names: Boa Constrictor. Land Camoodie (Creole).

Range: Northern and central South America, east of the Andes.

General Account: The boa constrictor is a fairly common snake both at Kartabo and Caripito. At the latter place we found only small and medium specimens but at Kartabo, among the twenty or thirty collected, eight were from eleven feet to twelve feet six inches in total length, measured when still alive, before shipping north to the New York Zoological Park.

The pattern and color of this snake are too well known to make it worth while to reproduce my detailed notes. At Kartabo there were two more or less distinct and definite color phases, independent of age or sex. One was characterized by rich, warm hues of chestnut and browns, and the other was darker and colder in general color, with drab and olive greens replacing the warmer tones. Invariably the body colors increase in brilliancy and contrast throughout the length of the tail, but in spite of this apparent conspicuousness these serpents were exceedingly difficult to discover in daylight when they were draped over a fallen tree, or coiled in the crotch of a branch.

The eyes, which would be revealing characters, are always obliterated by two to four black or brown marks radiating forward, down and back. The one from the nostril back to the eye bisects the iris, thus destroying all appearance of regularity of outline. (Plate III, Fig. 8).

In greater detail, the iris is rather abruptly, pigmentally divided transversely just above its equator. When the eye is at rest this line coincides exactly with the sharp division of color which separates the pale brown of the upper head from the black line extending along the upper side of the head and face. The eyeball has sufficient mobility at times slightly to disrupt the exact continuity of this pattern of iris and scales. The upper part of the iris is pale smoky gray, sparsely and irregularly flecked with dark; the lower portion is fuscous, obscurely mottled, and paling at the very bottom (quite invisible most of the time) and near the pupil. This latter results in a bright thread-width line around the pupil. The pupil is narrow and vertical, extending almost across the entire iris, and coming to a sharp point above and below.

Most of our specimens were taken at night, as they crawled along the trails or crept over low branches. A small boa was captured in the thatched roof of an Indian benab just as it was seized by a six foot black jungle racer (*Cloelia c. cloelia*). This was the only enemy of the boa constrictor I recorded. Three stomachs contained the following: Cat. No. 692, one large *Ameiva* and a small *Cnemidophorus;* No. 2757, an

Ameiva tail, a large antbird, a spiny rat; No. 2876, one large *Ameiva*, a spiny rat, which in turn contained four embryos.

Eighty per cent. of our boa constrictors were captured at the height of the long rainy season, May through July. Like other boas these snakes put up a strong fight when first caught, then give up and in most cases can be handled at will thereafter without showing any resentment or attempt at attack.

On June 28, 1922, our Indian hunter Degas reported a large land camoodie coiled near his village. We found a boa of large size wound over a fallen log with a burrow of sorts just beneath. It had been there at least five days and the brilliancy of its skin seemed to indicate a recent shedding. We rushed it and took it home and with some difficulty found that it measured at least twelve feet, six inches over all.

The next day when I was preparing to remove the boa from its cage for the purpose of photography I was surprised by a loud hiss which lasted so long that I sent for a stop watch. I pounded on the cage wire, the snake struck short, and laying its head flat on the ground it hissed steadily for 25 seconds. In response to intermittent pounding on the wire it hissed 17 times with an average of 20 to 30 seconds each time. The intervals lasted from five to ten seconds and during these short periods the air rushed into the lung and the body visibly swelled. The sound was exactly like steam escaping from a radiator. The hiss did not seem particularly loud, yet was distinctly audible 100 feet away.

A few days later I held its head for a water color portrait and found that I needed all my strength to uncoil its tail when that organ once got a twist around my body. When first caught it gave forth a most nauseous odor but this was not noticed again. In handling it many times I never saw it make a swift motion.

Four boas were measured immediately after death, as follows:

Cat. No.	692	692a	2757	2876
Total length	880 mm.	910 mm.	1345 mm.	1650 mm.
Tail	96	105	155	190
Eye diameter	4.4	5	6	7
Body width	23	23	50	53
Body height	34	34	70	76
Rows of scales	91	96	93	95
Ventrals	237	239	243	239
Sub-caudals	58	63	57	60
Weight	277 grams	309 grams	4 lbs.	7.5 lbs.

Epicrates cenchris cenchris (Linnaeus, 1758).

(Plate IV, Figs. 11, 12 and 13).

Names: Rainbow Boa, Ringed Boa, Peacock-eyed Boa. Aboma (Creole).

Range: Northern and central South America.

General Account: The rainbow boa is not rare; at Kartabo we took 12 individuals, and two at Caripito. The Kartabo snakes occurred from March to May. None of these specimens showed the uniform coloration ascribed to some captured in other parts of Venezuela. All of our snakes had the rings and ocelli well developed. Three, however, showed a general pale brown and orange pattern with little iridescence, while all the others were of rich dark colors, with pronounced yellows and were brilliantly iridescent. Most of these boas were coiled on branches in the daytime, or moving slowly on the ground in twilight or moonlight. Two were captured as they were trying to rob hen roosts near Indian benabs.

Coll. No. 315: Kartabo, March 5, 1921, Color Plate 314, total length 914 mm., rows of scales 52, ventrals 250, subcaudals 63. This was one of the pale types with very little iridescence, not typical of the majority of the specimens. The iris reflected this diminishing or lightening of pigment, and was pale silvery, densely shot with a maze of fine black veins. The pale clay color of the interior of the fifty-odd dorsal circles made these stand out much more strongly than in the darker individuals. The post ocular black band was very prominent.

This boa had devoured an antbird and a pullet, the latter from the coop of our Akawai Indian hunter, where the snake was captured.

Coll. No. 732: Kartabo, May 10, 1922, Color Plate 381, Photograph 1802, total length 1828 mm. This boa was the most beautiful specimen we saw, its steel-blue iridescent markings contrasting strongly with the rich orange background. *Color in Life*: In detail it was orange brown above, shading through ochraceous tawny and tawny to cinnamon brown on lower sides. Ring markings on back alternating with large oval splotches of dark blue-black on lower sides. These side markings have a small crescent of warm buff above their center, topped with a larger crescent of shining blue. Head above, pecan brown with darker markings. Sides of face livid brown. Labials vinaceous fawn clouded with deep purplish-gray. Ventrals light buff tinged with pink. Ground color of tail pale reddish, the markings clouded with gray. Claw ivory

yellow. Rainbow-like iridescence over the whole snake, the sheen over the ground color mainly golden, green and orange, over the markings chiefly indigo, greenish-blue and violet. Iris very dark brown, a little lighter in a faint border around the vertical pupil, but everywhere veined with black.

One day when I lifted this six-foot boa by the neck it threw three coils around my wrist and lower arm and twisted the tail across the coils in a strong tight overlapping lock. The head and neck remained limp in my hand but the rest of the body began a slow, rhythmic pressing, tighter and tighter. This turned to a throbbing which I soon found was the beating of my own blood. My hand became reddish, then bluish, and the veins stood out strongly. After taking movies of this effect I was glad to unwind the boa as the pain was considerable. Traces of the compression were visible the following day.

Coll. No. 2635: Kartabo, March 3, 1924, Color Plate 652, total length 1600 mm. (5 feet, 3 inches). Rows of scales 48, ventrals 274, subcaudals 61, weight two and one-half pounds. The background of dark brown shows little iridescence, but the rings and ocelli are ablaze with shining ultramarine, and the dorsal crescents of the lateral ocelli are brilliant gold. The labials, chin and under surface are mouse gray.

Coll. No. 2867: Kartabo, May 20, 1924, total length 1360 mm., tail 194, body width 36, eye diameter 5.2 mm., rows of scales 51, ventrals 276, subcaudals 61, weight two and one-quarter pounds. This boa was caught in the chicken coop of our Indian hunter, but its stomach was still empty.

Coll. No. 30173: Caripito, July 31, 1942, total length 1200 mm. Captured at dusk stalking a large frog which seemed unaware of its enemy's approach. *Color in Life*: Background above down to lower sides chestnut brown, below pale orange yellow. Dorsal pattern a series of more or less regular, contiguous rings formed of narrow, blue black lines. Some of the markings fail to extend across the back, resulting in hour-glass rather than paired rings. On the sides in the concavity patterns formed by the junction of the dorsal rings is a series of ornamental ocelli, each a large, round, iridescent blue spot, bordered on the dorsal half by a wide crescent of yellowish-white, and above this a second, similar but narrower boundary of blue black. Alternating with and below these ocelli are two series of irregular and less distinct roundish or oval spots. The ventral scales are immaculate. In this four-foot boa there are 56 of the rings and ocelli from head to tail tip.

Eunectes gigas (Latreille, 1802).

(Plate V, Figs. 14, 15 and 16).

Names: Anaconda. Water Camoodie (Creole). Ow-oo-rah, Sal-urring-mah, "quick runner" (Akawai Indian).

Range: South America east of the Andes.

General Account: The anaconda is the giant among American serpents with an accredited length of 29 feet, but the largest taken by us was close to Kartabo, where one of these boas measuring 17 feet, two inches was shot from a branch overhanging the water a mile down river.

Eleven were taken and others seen at Kartabo, and two small ones at Caripito. This is essentially a water snake and from three stomachs we took 27 fish, including sharp-spined catfish and four species of armored catfish. Occasionally they were found in the jungle but never very far from the river, and more often coiled on a branch over the water or on the sandy shore.

The following individual will serve as typical of the species;

Coll. No. 540: Kartabo, May 27, 1922, Color Plates 371, 372, Photographs 1742, 1743, total length 917 mm. (three feet), tail 90, eye diameter 5 mm., weight 280.4 grams. Another young anaconda only two-thirds (665 mm.,) as long as the present one, weighed only one-quarter (69 grams) as much.

Color in Life: Top of head dark olive, almost black on orbits; side of face in front of eye, upper labials and post oculars dark olive. A broad cinnamon band equal in width to eye extends from eye to posterior point of jaw, becoming darker and narrower on side of neck. This cinnamon band is bounded below by a narrowed band of black which extends along the neck. Back olive green with many alternately placed, irregular, large, round and oval black spots. Sides buffy brown with smaller, more crowded spots of orange yellow, edged with black. The lowermost of these are much broken and extend in places over the ventrals. Chin pale pinkish-cinnamon flecked laterally on the throat with gray and black. Ventrals warm buff with exceedingly variegated markings composed of small, black, geometrical patches, which frequently form two broken, longitudinal lines. Pupil vertical, much shorter than in the boa constrictor. Also it is not double pointed but rounded above and below, and with a slight median constriction. Iris dark citrine with faint dark mottlings.

This, like a number of other specimens, was taken on the sandy beach in front of Kartabo on a moonlight night. It was so lethargic that it allowed me to pick it up, whereupon it put up the usual, brief boine fight. It is difficult to distinguish anacondas

when they lie motionless, for they rest so flatly on the sand that they scarcely cast a shadow, and when they move, it is so silently and in so straight a line that the ear and eye give little warning. More than once I have attempted to catch a snake and have seized only sand, the serpent having vanished without my sensory knowledge, leaving only the faint shadow of a shallow depression in the sand.

Family Colubridae.

This family contains the great majority of living serpents, but satisfactory characters for sub-division are still to be found. In the present paper twenty-five genera are included, leaving only eleven belonging to all the other families, and 39 species as compared with only fifteen representing the remaining families of serpents. With the exception of the worm snakes, boas and such poisonous forms as the coral, fer-de-lance, bushmasters and rattlers, all others are classified as colubrine.

Atractus trilineatus Wagler, 1828.

(Plate VI, Figs. 17 and 18).

Names: Stub-tailed Snake, Three-lined Worm Snake.

Range: Guianas, Eastern Venezuela and Trinidad.

General Account: This is a small, round, stocky snake, with small pointed head and very short, stubby tail adapted for burrowing. The eye is small with round pupil. It is dark brown above, with three longitudinal black lines, and usually lemon yellow below. It is fairly common both at Kartabo and Caripito, but discoverable chiefly by digging. In the dim light of the jungle it may, at first sight, be mistaken for *Leptotyphlops*.

In a dozen specimens the total lengths varied from 112 to 256 mm. They were taken from March through August. *Atractus* is a rather slow moving snake, never biting, but pushing continually with both head and tail. The latter has a sharp pointed tip which is used with considerable force as in *Leptotyphlops*, driving the creature ahead through one's fingers. When placed on soil it at once burrows out of sight. A female of 250 mm., had three eggs in the oviduct, two complete with leathery shells ready for deposition. They were oblong, equal-ended and measured 20 by 8 mm.

Coll. No. 525: Kartabo, April 3, 1922, Color Plate, total length 235 mm., tail 14, head length 6, eye diameter .9 mm., ventrals 139, subcaudals 15, weight 5.6 grams. *Color in Life*: Head above cinnamon brown with distinct asymmetrical mottlings of mummy brown. Back hazel brown with three longitudinal stripes of dark clove brown. Upper labials citrine yellow. The upper side of body below the lateral dorsal stripes, tawny olive and below this a faint, narrow line of brown. Lower labials, chin and anterior ventrals lemon yellow. Remaining ventrals mustard yellow with pinkish tinge. Iris dark cinnamon brown.

Coll. No. 246: Kartabo, August 31, 1920, length 256 mm., tail 14.7, head length 6.5, body width and height 6 mm., ventrals 150, subcaudals 13, weight 5.6 grams. In life this specimen was fuscous above, with the three lines brownish-black. The ventral surface pinkish-buff, which deepened to tawny olive on lower sides. Iris very indistinct, with black mottling.

A young specimen taken March 6, 1924, only 165 mm. in length, had a tail of 14 mm., ventrals 135, subcaudals 19 and a weight of 2.7 grams. This was taken from the stomach of an *Erythrolamprus aesculafii*.

All of the *Atractus* taken at Caripito were considerably lighter in color than the Kartabo ones, with the ventrals creamy white. Two out of five (Nos. 30070, 30122) were found in Pit 13, the only one dug outside of the jungle proper, a few yards from the nearest trees, at the edge of the open savanna.

Chironius carinatus (Linnaeus, 1758).

Names: Golden Tree Snake, Yellow-lipped Tree Snake. Yellow-belly (Creole). Sipo (Native).

Range: Northern South America to Brazil and Bolivia.

General Account: This is a rather slender snake, essentially arboreal, either sage green above and bright yellow below, or blackish-brown above and steel blue below. It is usually found draped among dense foliage or creeping slowly along. When frightened it can move faster than the eye can follow. It is nervous and vicious in disposition and can seldom be caught without getting in at least one bite. Its enormous gape gives it an especially alarming appearance although it is quite harmless. The eye is unusually prominent with a round pupil.

About 25 specimens were taken and others seen, from March through August at Kartabo. We did not find it at Caripito. In length our captives varied from 600 mm. (two feet) to 2850 mm. (nine feet, four inches), this being, I think, the record for the species.

Colors in Life: Coll. No. 2612: Young snake. Pale blue above with wide white vertebral stripe. Pale yellow below.

Col. No. 2814: 900 mm. Dark olive green above, picric yellow below.

Coll. No. 2822: 1249 mm. Dark olive green above with a purplish tinge, pale yellow below.

Coll. No. 2802: 957 mm. Color Plate 133, head and body above grayish-olive, with a

light vertebral band. Below empire yellow on labials, fading down neck to pale lemon yellow, into the general ventral color of light greenish-yellow. Tail lemon yellow below. Eyes very prominent; iris inner half brackish-brown, changing rather abruptly with a concentrated stippled margin into pale silvery yellow on the outer half. Pupil surrounded by a very narrow yellow ring. Tongue long, slender, shooting out 20 mm., rich dragon's-blood red.

Coll. No. 2801: 741 mm. Very young snake. Top of head saccardo umber, back brownish-olive, russet on snout. Upper labials, throat and first few ventral strontian yellow, shading through green to honey yellow under tail. Sides of body sage green. Outer edge of iris colonial buff flecked with orange. Dark patch around pupil brown, flecked with gold.

Coll. No. 2668: 1020 mm. Like No. 2802, but with two bright lateral yellow stripes along tail.

Coll. No. 2764: On the dark brown of the back, at mid-body, this individual has a number of oblique markings, angled, pointing backward, narrow bands in pairs, the width of the pair equalling the interspaces. These are composed of broken lines of lemon yellow spots, much smaller than the scales on which they occur. The ventrals of the anterior half of the body are colored steel blue and lemon yellow in equal proportions. On the posterior half of the body the blue dominates, but on the tail the yellow again appears abruptly and eliminates the blue. The upper labials, chin and throat are immaculate golden yellow. After 22 years, the skin of this snake, mounted on cardboard, shows no change of color whatever.

Coll. No. 2855: 1420 mm. Color Plate 1176, sage green above, the pale vertebral stripe scarcely visible. Upper labials, chin and anterior ventrals chalcedony yellow with faint gray line down center, brightening to empire yellow under tail.

Food: One snake was caught with quite half of its body wedged between the wire meshes of a cage in the laboratory holding five *Hyla maxima*. Another was captured while climbing up to a nest of two nestling antbirds. A third had swallowed a large *Leptodactylus* frog.

Measurements of freshly killed specimens:

Coll. No.	2801	2940	2802	2668	2764	2855	2922	320
Total length (mm.)	741	903	957	1020	1125	1420	2320	2850
Tail (mm.)	201	328	257	420	395	500	883	950
Jaw length (mm.)	21.5		25	29	33	39	42.5	46
Eye diameter (mm.)	4	5.5	6	6	6.5	8	8.5	10
Rows of scales	12	12	12	12	12	12	12	12
Ventrals	151	190		150	159	154	184	184
Subcaudals	140	180		146	139	129	190	194
Weight (grams)	6.8	19	13	52	68.5	180	1 lb.	1½ lbs.

Chironius fuscus (Linnaeus, 1758).
(Plate VI, Fig. 19).

Names: Red-fronted Tree Snake; Green Tree Snake. Cow-um-bung, "one who lives in high bush" (Akawai Indian).

Range: Northern and equatorial South America.

General Account: A long, well-built, constricting arboreal snake. Typical pattern brown above with numerous, well-spaced, pale, dark-edged, double cross bands, below yellowish-white mottled with brown, head with black posterior eye streak, reddish on snout, labials and anterior ventrals. Two vertebral lines of black along dorsal keels. Individually the cross bands may be wholly lacking in both young and adults, or the entire snake may be green, deeper above and pale below. We saw none of the green phase longer than 535 mm. Besides the possession of 10 rows of scales (instead of 12 as in *C. carinatus*), the iris in this species is characteristic. In the green phase the dark mottling covers almost the entire iris evenly, but in all brown forms the only part of the iris free from the solid brown is the periphery of the upper fifth of the visible eye, this being pale gold. (Plate 0, Fig. 0). All the various color phases were taken within the quarter square mile of jungle at Kartabo. We did not find this snake at Caripito.

Of the 24 specimens captured, more were taken on the ground than was the case with *C. carinatus*. Three of these were of the green phase. All were active and vicious, striking at every opportunity.

Colors in Life: Col. No. 3294: Rich red brown above, salmon below. Col. No. 3554: June 12, 1919. Liver brown above, covered with a purplish sheen, ferrugineous below.

Coll. No. 2669: Color Plate 151, 1242 mm. General color above cinnamon brown, with two dark brown vertebral stripes. Faint oblique cross bands of fuscous about an inch apart, each with a broken border before and behind of the dark color. Top of head chestnut brown, changing to russet anteriorly. Upper labials white, the anterior three, and the upper parts of all cinnamon rufous. Ventrals white heavily tinged with pale ochraceous salmon toward head, mottled thickly toward tail with vinaceous and dusky. Lower three-fourths of iris dark brown ground color, heavily marbled and mottled with gold and black. Upper one-fourth pure gold,

streaked upward and toward the edge with flecks of black. Very narrow unbroken pupil ring, gold on upper fourth, and orange on lower three-fourths. A broad streak for 10 mm., back of eye bluish iridescent black. From gape and back along the upper edge of the ten anterior ventrals a series of large spots of bright red.

Coll. No. 3112: 2350 mm. This large specimen is very dark red, with all labials and chin shields red, the post ocular black streak lost in the dark red, and the pale upper part of the iris darkened to a grayish-cream.

Coll. No. 527: 535 mm. Head and back cromium green, becoming dark greenish-glaucous on sides of body and malachite on sides of face, and cobalt on upper labials. First few lower labials touched with beryl green, remainder of lower labials and chin bluish-white. Ventrals pale nile blue, becoming deeper and strongly tinged with olive toward the tail. All body scales edged with translucent dark gray. Pupil rim brilliant buffy white. Iris, cartridge buff above, much whiter and more brilliant below. Anterior of iris covered with brownish stippling, arranged in faint streaks. This stippling irregularly surrounds the pupil, resolving into upwardly-converging streaks above, and irregularly streaking below.

Coll. No.	3294	3554	2669	624	2798	3112
Total length (mm.)	340	512	571	1270	1370	2350
Tail (mm.)	124	165	221	380	410	755
Jaw (mm.)	10		18.5	29	32	40
Eye diameter (mm.)	2.5	7		7	7	9
Ventrals		165	150	147	147	164
Subcaudals	137	122	132	95	101	121
Weight (grams)	2.5		11.2	233.5	277	

Coll. No. 2669: 571 mm. This young specimen is colored almost like No. 2669 except that the vertebral stripes are almost invisible, only a faint, much broken line. All the labials are much whiter and the gold of the upper iris is much more diffused. In the present snake the cross bands begin 110 mm. back of the snout, and end 100 mm. from the tip of the tail. There are 30 of these pale centered marks, but on the tail they become very broken and irregular. The skin of this snake was mounted on cardboard on the day it was collected, April 1, 1924, and now, 22 years later, every pattern and color is clear and unaffected.

Coll. No. 3554: 512 mm. Peacock green above, lichen green under chin, and glaucous green on the ventral surface. Gold streaking of iris is very much diffused.

Coll. No. 821: Color Plate 348, 950 mm. There are 38 cross bands on this brown snake, and the anterior red is very strong on chin and sides of anterior body. The ventrals elsewhere are quite white.

Optical Fundus: Dr. Casey Wood analyzed the fundus of the right eye of snake No. 2669 as follows:

Eyeground dark blue gray covered with uneven, brilliant silvery dots. The optic disc is large, round, dirty white, with moss green edges. Only a faint suggestion of opaque nerve fibers is apparent. There is one large vein running from the lower periphery straight up into the papilla where it disappears from view. Two smaller veins, one on either side of it converge and join over the lower end of the disc and then continue as one across the center of the disc to near the upper edge where it again divides, this time into three branches. Near the lower edge of the papilla, under a spot where the two small veins join, is a round dark area which may be a depression in the disc.

Food: The stomach contents of five snakes are as follows: (1) A pullet just swallowed in the coop of our Indian hunter, where the snake was captured. (2) One medium *Leptodactylus caliginosus*. (3) Bones of a jungle mouse or young rat. (4) Full-grown *Anolis* and several small mollusks, probably the food of the lizard. (5) A large *Leptodactylus mysticenus*, 53 mm. in length.

Measurements of freshly killed specimens:

Cloelia cloelia cloelia (Daudin, 1803).
(Plate VI, Fig. 20).

Names: Black Tree Snake. Masurana (Indian Name).

Range: Northern and central South America.

General Account: A large, round-bodied, strong and active, arboreal snake. Black or dark gray or reddish-brown above, white or yellowish-white or rarely salmon colored below. Fourteen taken at Kartabo but none at Caripito. These fearless snakes feed on lizards and both poisonous and harmless snakes. They seem equally at home among branches and on the ground.

Coll. No. 643: Kartabo, July 1, 1922, total length 2145 mm. *Color in Life*: Olive brown above, anterior upper labials and below pale salmon. Pupil a wide vertical, iris brown mottled with darker.

Coll. No. 250: Kartabo, September 1, 1920, total length 1595 mm. *Color in Life*: Brownish-gray above, upper labials and below creamy white. Coll. No. 3274: Kartabo, Color Plate 230, July 23, 1922, *Color in Life*:

Above slaty black, upper labials slightly paler. Below yellowish-white. Pupil a wide, vertical slit, iris rich coral red, mottled with darker red.

Food: The stomach contents of five snakes were as follows: (1) When chloroformed this individual disgorged a 300 mm. *Ameiva* in general appearance uninjured. (2) Nothing but its own shed skin. (3) One large *Ameiva*. (4) Caught in the act of killing a small *Constrictor constrictor* in the roof of an Indian benab near the laboratory. (5) Two small fer-de-lance in stomach, one partly digested, the other fresh.

Measurements of freshly killed specimens:

Coll. No.	3528	3278	250	643	3274
Total length (mm.)	1322	1470	1595	1870	2030
Tail (mm)	272	260	276	275	430
Eye diameter (mm.)	3.5	4.5	4	4	4.5
Rows of scales	19	19	19	19	19
Ventrals	216	235	240	220	220
Subcaudals	83	78	72	60	72
Weight (grams)	381.5	330	1¼ lbs.	1.5 lbs.	2.5 lbs.

Dipsas catesbyi (Sentzen, 1796).

(Plate VI, Fig. 21).

Name: Catesby's Snake, Brown-saddled Snake.

Range: Guianas, Colombia, Ecuador, Brazil, Peru and Argentina.

General Account: A gentle, rather deliberate snake, slender, with rounded head and long tail. Above cinnamon brown with numerous black half-bands, bounded with white on the sides. The markings may be alternate rounded spots, or opposite, or assume saddle shapes. The body is much compressed, strongly keeled along the mid-back. Eye very large and protuberant. Iris black. Half a dozen were taken at Kartabo, but none seen at Caripito. All were climbing among slender branches in low jungle growth. In size we found it ranging only between 530 and 645 mm. over all.

Measurements and Color in Life: Coll. No. 240b, Kartabo, April 27, 1919, total length 590 mm., tail 150 mm., ventrals 173, subcaudals 97. In preservative this individual has changed to light brown saddles and pale pinkish flesh color elsewhere.

Coll. No. 3293: Kartabo, August 31, 1920, total length 600 mm., tail 176 mm., ventrals 178, subcaudals 94, weight 15.4 grams. In this specimen the dark bands are reddish chestnut.

Coll. No. 149: Kartabo, American Museum 18153, Color Plate 176, July 23, 1920, total length 620 mm., tail 150 mm., eye diameter 3, body width 7.8 mm., body height 11 mm., ventrals 180, subcaudals 91, weight 15 grams. The head is black with irregular bluish-white markings, with a narrow nuchal band just back of gape snuff brown. Dorsal surface tawny brown with about 40 half-bands of blackish-slate. Most of these bands alternate with each other, but some are opposite but do not join. Ventrals white with large longitudinal, irregular blotches of dark reddish-brown, cleanly outlined. The iris is quite indistinguishable from the jet black pupil.

Coll. No. 3253: Kartabo, May 10, 1920, total length 630 mm., tail 187 mm., ventrals 206, subcaudals 123.

Coll. No. 226: Kartabo, American Museum 18154, July 30, 1920, total length 660 mm., tail 215, head length 9.5, eye diameter 3.5, body width 6, body height 8 mm., ventrals 209, subcaudals 125, upper labials, right 9, left 10, weight 11.5 grams.

Color in Life: The head is variegated with white, chiefly in the form of an imperfect band around the snout and a collar back of the parietals. Much of the side of the face is white, also chin and throat except 3d, 4th, 5th and 6th lower labials and two central spots which are black. The first three narrow dorsal bands, dividing the very elongate black saddles, are white, and in the next four the bands become medially tinged more and more strongly with brown, until from the 8th on the usual pattern of a white-edged brown band is seen. There are 41 black saddles altogether. Below, brownish-white, marked with irregular, longitudinal spots of brown. The dorsal saddles, in this specimen, result in a close approach to the pattern of *Dipsas indica*.

Food: The food of No. 243 consisted of three small snails and an equal number of newly emerged, soft-bodied wood roaches.

Dipsas indica (Laurenti, 1768).

(Plate VII, Figs. 22 and 23).

Name: Snail-eating Snake.

Range: Guianas, Colombia, Ecuador, Peru, Bolivia, Paraguay, Brazil and Argentina.

General Account: Only three specimens of this little snake were taken at Kartabo and none at Caripito. It is a slender, narrow-necked, round-headed serpent, with many black saddles along the body framed in tawny brown, and a black and white head. It is slow in movement and with large eyes, active both in daylight and at night. In disposition it is exceedingly gentle and wholly unresentful of handling. All were taken among branches in second growth jungle.

Measurements and Color in Life: Coll. No. 76, Kartabo, American Museum No. 18179, May 12, 1916, total length 648 mm., ventrals 205, subcaudals 120. Above, this specimen was brownish-gray, whiter toward head, with numerous very large saddles of black.

Coll. No. 2678: Kartabo, Color Plates 685 and 686, April 8, 1924, total length 620 mm., tail 190, head length 11.5, head width 7.5, eye diameter 2.6, body width 5.5, body height 9 mm., rows of scales 13, ventrals 198, subcaudals 115, weight 7.7 grams.

Food: (1) 5 small land snails, swallowed whole with a few bits of shell. (2) A mass of soft tissue, probably slugs, and 2 ants.

Dipsas variegata

(Dumeril and Bibron, 1854).

(Plate VII, Figs. 24 and 25).

Name: Many-banded Snake.

Range: Guianas, Colombia and Brazil.

General Account: Only four of these little snakes were taken at Kartabo, and none at Caripito. All were found coiled up in the day time low down in the débris of bamboo clumps. They are light brown above and creamy white below, with numerous, broken dark brown or black bands extending almost around the body. On the lower sides each of these expands into a large, rounded spot occupying a lateral third of one or two ventrals. The eye is very characteristic. The pupil is a broad vertical oval. The iris is greenish-yellow, heavily dotted with reddish-brown on the upper half, less densely below.

Coll. No.	2670	247
Total length (mm.)	385	451
Tail (mm.)	100	96
Eye diameter (mm.)	2.5	3.5
Rows of scales	17	15
Ventrals	175	174
Subcaudals	99	95
Weight (grams)	5.2	

Measurements and Color in Life: Coll. No. 347, Kartabo, Color Plate 292, January 13, 1921, total length 300 mm., tail 75, head length 7, head width 6, body width 6, body height 8 mm., ventrals 180, subcaudals 84. General color above and half down sides mouse gray with two black patches on back of head. Upper head scales mottled with black. Labials and face scales edged irregularly with black. Entire length of body banded with about 50 transverse bands, some broken, considerably separated on ventral surface. Between these are fainter, more broken series of black spots. On the lower lateral surface all these end in a black spot. Ventral surface pale yellow becoming whitish toward tail.

Eye: Pupil broadly vertical, less slit-like than in wholly nocturnal snakes. A pale gold rim around pupil. Iris with a ground color of ivory yellow or gold, lighter toward outer rim. This is heavily dotted with red brown on the upper half, dying out toward the lower part of the iris and internally, leaving considerable clear yellow on the inner and lower portions of the iris.

Coll. No. 649: Kartabo, male, August 18, 1922, total length 637 mm., eye diameter 3.2 mm, ventrals 175, subcaudals 89, weight 22.3 grams.

Dryadophis boddaerti boddaerti

(Sentzen, 1796).

(Plate VII, Figs. 26 and 27).

Names: Checkered Jungle Snake (young), Brown Lined Snake (adult).

Range: Northern half of South America.

General Account: Medium-sized, slender snake, almost altogether terrestrial. Young, brown or gray, checkered on back and sides, and with variegated pattern on head. Adult, plain brown or gray above with two longitudinal pale lines. Iris golden in upper fourth. Not rare; active and in captivity biting at every opportunity.

Measurements of freshly killed specimens:

528	787	2743	301	283
475	618	1190	1352	1410
	138	320	310	290
		5	5	6
17	17	17		
176	188	182		
97	108	101		
	50	155	87.3	115.6

Color and Pattern in Life: Young checkered snakes are brown or grayish-black above, with many cross bands of white or pale drab on the body, tail uniform. These bands are narrower than the inter-spaces and confined to the dorsal scales. On the sides there is a corresponding series of white bands, but alternating with the dorsal ones. The top of the head is mottled with light and dark brown, and the labials and anterior lateral scales are boldly marked with black and white. Below, whitish mottled on anterior ventrals and on sides of remainder. Iris mottled red or red brown on the lower three-fourths, golden or pale orange above. Total lengths 285 to 450 mm.

Individuals of intermediate size have the dorsal pattern more or less distinct, giving way to a uniform brown or grayish-brown, with traces or a half-developed pale lateral lines.

In the adult snake the pattern is a uniform brown or gray brown above with two distinct paler lateral lines extending the full length of the body. Whitish or grayish-

white below in Kartabo specimens. In all Caripito adults the ventrals are sulphur or bright yellow.

Individual Patterns.

Coll. No. 247: Kartabo, Color Plate 192, August 6, 1920, total length 451 mm. Top of head bone brown, each scale narrowly margined with dark apple green, sides of head lighter green shading to bluish-white on upper labials. First to fifth upper labials irregularly edged with black along posterior borders, a large round spot on posterior half of sixth and anterior half of seventh. A wide band of brown on eighth extending upward to black center of occipitals. Chin shields and ventral surface bluish-white, anterior half of every ventral pearl gray. Dorsal body brown with 39 narrow, transverse bands of cinnamon buff edged with black, ending abruptly at tail. Tail fuscous above, smoke gray below. Iris, lower four-fifths rich red brown, upper fifth lumiere green.

Coll. No. 30, 196: Caripito, August 21, 1942, total length 285 mm. Quite similar to No. 247, except that it wholly lacks the cephalic green, the top and sides of head being coarsely mottled in shades of brown. A continuous but irregular band of white extends from eye to gape.

Coll. No. 2636: Kartabo, Color Plate 650, March 1, 1924, total length 375 mm. Differs from typical juvenile pattern of No. 247 in lacking all green on head, and in having body pattern strongly contrasting brownish-black and white, and in having the superior fourth of iris silvery.

Coll. No. 2670: Kartabo, April 1, 1924. Differs from No. 247 in having essentially seal brown ground color with pale brown markings. Throat heavily mottled, and checkered pattern more of squares than of narrow bands and rectangles. The dorsal cross bands become more narrow and irregularly oblique on posterior third of body. The preserved skin mounted on cardboard has altered in no way from the colors of life as recorded 22 years ago.

Intermediate Pattern.

Coll. No. 528: Kartabo, Color Plate 351, April 1, 1922, total length 475 mm. The head is olive brown above, deepening on sides to sepia along top line of upper labials. All labials and chin bluish-white, while the anterior upper and all lower labials are edged with slate color. Sixth to ninth upper labials have irregular splotches of gull gray, which shade into burnt umber on upper edges of eighth and ninth. Top and sides of body hair brown, with faint transverse bands almost as wide as inter-spaces, of snuff brown which terminate along a pale gray lateral line, and alternate with similarly colored square patches on lower sides. All body markings faintly edged with black anteriorly. The lateral line dies out at mid-body. Ventrals dirty white toward neck, shading back through smoke gray to pinkish-buff. Pupil rim flame scarlet, iris pale gold on upper quarter.

Coll. No. 787: Kartabo, April 19, 1922. General color above saccardo umber, faint drab cross markings, shading to hair brown. Pale lateral line well developed, olive buff on tail. Upper fourth of iris golden, remainder burnt umber mottled with darker.

Adult Pattern.

Coll. No. 2743: Kartabo, April 27, 1924, total length 1190 mm. Seal brown above with single pair of pale lateral lines. Throat mottled, and extreme anterior and posterior ventrals dominately grayish-blue, with considerable olive buff on mid-body ventrals. In the stretched and preserved flat skin faint traces can be seen on the interscale area of the juvenile dorsal pattern, but this is absolutely invisible in the living snake.

Coll. No. 301: Kartabo, July 23, 1920. Similar to No. 2743 except that there is a faint tinge of greenish-buff on anterior ventrals.

Coll. No. 283: Kartabo, Color Plate 138, June 12, 1920, total length 1410 mm. General color above brown, with a broad stripe down each side of light drab. Upper half of head uniform brown, upper labials light mineral gray, under parts grayish-white. Pupil ring rufous turning to gold at the top. Lower three-fourths of iris pecan brown, upper fourth antimony gold flecked with darker.

Four Caripito adults (No. 30184, total length 880; No. 30275, total length 1055; No. 30276, total length 970; No. 30278, total length 955 mm.) show almost identical patterning and coloring. Uniform seal brown above with faint pale lateral line. Labials and ventrals sulphur or bright yellow, with considerable lateral marking of blue gray. Subcaudals with or without central, irregular dark mottling. Chin and throat with more or less blue gray edging to scales. Black band nostril to eye and eye to gape present or absent.

Food: Five of these snakes had eaten the following: (1) One small frog. (2) A very young *Ameiva*. (3) 4 unidentifiable reptile eggs. (4) This snake captured at the base of a stub from which it had just caught and eaten a nestling *Glyphorhynchus*. (5) 3 small frogs and a large scarlet-winged grass-hopper.

Drymarchon corais corais (Boie, 1827).

(Plate VIII, Figs. 28 and 29).

Names: Yellowtail, Tiger Snake, Rat Snake, Black-and-yellow Jungle Snake. Cribo, El Tigre, Raba Amarilla (Native).

Range: South America, south to tropical Brazil, Paraguay, northern Argentina and Bolivia.

General Account: A large, fierce, terrestrial snake, black variegated posteriorly with yellow. Rare at Kartabo where we recorded only three in eight years. More common at Caripito where 12 came to our attention and six were captured. Several were killed on the road by cars. In the jungle it was necessary to fire instantly to obtain a specimen, for otherwise the speed of the reptile gave but a moment's glimpse. Several snakes were longer than eight feet, and the largest measured nine feet, eight inches. A shed skin, complete except for part of the tail, was a full eight feet six inches. In eastern Venezuela there is a wide-spread belief that if a pregnant woman encounters one of these snakes she will be beaten by its tail and her child will be delivered at once.

Coll. No. 30086: Caripito, Color Plate 1567, May 5, 1942, total length 2540 mm. (8 feet, 4 inches), head 62, eye diameter 8, snout 22 mm., weight 8 pounds. *Color in Life*: Above blue black as far back as 600 mm. before the tail, when the dorsal ground color changes to empire yellow and then to warm orange. The black is continued in this yellow area as paired bands. After four of these pairs, the bands begin to degenerate, diminishing in width and purity, but they continue in a succession of about 30 to the tip of the tail. The rostral, nasals, internasals, loreals and all the upper labials are ivory white, with a flecking of black on the loreals and 6th, 7th and 8th labials. This white color continues on the chin, throat and ventrals, each of the latter with an invasion of black from each side, never meeting in the middle. The subcaudals are yellow orange like the upper side. The iris is dragon's blood red with a gold pupil ring.

Coll. No. 30144: Caripito, June 18, 1942, total length 1448 mm. (four feet, 9 inches). The pattern and color in general are very similar to those of No. 30086, but there is less white on the snout and upper labials.

Food: Five yellowtails had eaten the following: (1) A medium sized opossum and 2 *Ameivas*. (2) 2 young opossums and an eighteen inch fer-de-lance. (3) 3 *Leptodactylus* frogs. (4) 1 *Bufo marinus* and a spiny rat. (5) 2 spiny rats.

Erythrolamprus aesculapii (Linnaeus, 1758).

(Plate VIII, Figs. 30, 31 and 32).

Names: False Coral Snake, Necklace Snake.

Range: Northern and central South America.

General Account: Brilliantly hued, tricolored snakes of rather small size, found crawling through the jungle or occasionally dug up a foot or more beneath the surface. Not nearly as common as the true coral snakes which they so much resemble. In three instances *Erythrolamprus* was taken within a few feet of a *Micrurus* individual. Typical coloring of a dozen or more Kartabo snakes, a succession of 13 to 18 triannuli (two black and one white ring), separated by scarlet. The white bands are narrow and of even width, the black bands are wide above and narrow below, the scarlet bands are narrow above and wide below. I found none with single black bands, and no yellow ones. All the snakes taken at Caripito had each black band split in two by intrusive white bands, sometimes equal to the black in width, and the scarlet bands were much wider than in the Kartabo specimens. The largest snake of this species was 26 inches in total length. Individuals varied greatly in disposition, some being active and irritable, and others quiet, permitting any amount of handling.

Measurements of freshly killed specimens:

Coll. No.	259	258	2973	254	256
Total length (mm.)	253	393	540	545	545
Tail (mm.)	31	52	90	66	74
Eye diameter (mm.)	2.5	2.5	3	3	3
Ventrals	189	189	187	186	191
Subcaudals		49	46	42	45
Weight (grams)...	4.6	12.8	56.5	33	30.2

Coll. No. 256: Kartabo, Color Plate 160, figs. a and b, July 2, 1920, total length 545 mm. *Color in Life*: Fourteen scarlet bands, each set off by a pair of black and a pair of white. The bands are ivory white and flame scarlet. Black and scarlet equal in width above (about 12 mm.), white narrower (about 5 mm.). Iris blackish-brown, almost indistinguishable from pupil.

Coll. No. 258: Kartabo, Color Plate 160, fig. c, July 16, 1920, total length 393 mm. *Color in Life*: Thirteen scarlet bands, equal to the black above (about 9 mm.) and widening to twice that width below. White bands 4 mm. above, slightly wider below. Black 9 mm. above narrowing to 4 mm. below.

Coll. No. 254: Kartabo, August 24, 1920, total length 545 mm. *Color in Life*: Thirteen scarlet bands, and a scarlet tail tip. Scarlet very wide, 15 mm. above, 20 to 23 mm. below, wider than black. White strongly black-tipped. Rostral, anterior labials and chin shields tinged with apricot buff.

Coll. No. 259: Kartabo, April 16, 1922, total length 253 mm. *Color in Life*: Thirteen scarlet bands, and thirteen black-bounded white bands excluding the incipient one on the head. Head black with broad band of pale grass green from gape almost to orbits, extending clear across head above.

Snout buffy brown, first two labials and anterior chin shields warm buff. The usual white bands are, on this individual, grass green tipped with gray. Iris dark cinnamon brown.

Coll. No. 2973: Kartabo, Color Plate 767, June 17, 1924, total length 540 mm. *Color in Life*: Fifteen pairs of black paired bands, wide above, narrowing below to two to four ventrals. These black bands are separated by narrower bands of pale grass green, somewhat wider on the ventral surface (one and a half to three scales wide), and above with jagged edges dovetailing with the black. The inter-spaces are orange red, narrower than the black rings dorsally, but below, widening out abruptly to a maximum of seven ventral scales. The cephalic black pair is incomplete, the pale central band covering the occiput, and dying out at the labials, the anterior black ring being very small, extending across the orbits and ending in an irregular line along the mouth. The snout, all lower labials except the posterior two and under chin and neck are solid orange red. The pale ring of the thirteenth pair covers the anal region, the fourteenth the central portion of the stumpy tail, and the last, very much reduced, extends almost to the tip, leaving a tiny speck of scarlet at the extreme end. Iris very dark rich brown.

Coll. No. 334: Kartabo, May 28, 1920, total length 456 mm. 18 annuli. No. 335: Kartabo, June 21, 1920, total length 475 mm. Very dark specimen, all red scales black tipped. 18 annuli. No. 335a: Kartabo, June 25, 1920, total length 502 mm. 18 annuli. A scattering of whitish scales mixed with some of the black.

Coll. No. 30008: Caripito, Color Plate 1511, March 10, 1942, total length 524 mm. 15 annuli. Black bands split into equal parts by intrusive white bands. No. 30143; Caripito, June 18, 1942, total length 365 mm. 16 annuli. Black bands equally divided by white, making four black and three white to each annulus. Very dark colored snake.

Food: (1) Remains of small snake, 2 large crickets. (2) 150 mm. *Atractus trilineatus* in fairly good condition; indeterminate mass which may have been an amphibian. (3) Very small *Micrurus* half digested. (4) Small lizard too far gone for identification. (5) Half digested *Tantilla longifrontale*, and two small *Synbranchus*.

Helicops angulata (Linnaeus, 1758).

Name: Brown-banded Water Snake, Water Labarria.

Range: Northern half of South America.

General Account: Helicops was not found at Caripito, and was rare or else difficult to detect at Kartabo as only four are in the records. It is apparently rather aquatic in habits as two were seen swimming in the Cuyuni River. A third was captured in 1916 and sent north to the Zoo. A fourth killed in the jungle had an indeterminate mass of fish scales in its stomach.

Coll. No. 3266: Kartabo, May 10, 1922, total length 870 mm., tail 225 mm. In general its pattern was olive gray above with numerous wide, dark brown transverse bands. Below it was straw yellow with a checker-board pattern of alternate squares of dark brown.

Hydrops triangularis (Wagler, 1824).

Names: Red-and-black Banded False Coral Snake. Pung-gak, "living in ground" (Akawai Indian).

Range: Guianas, Amazon valley, southern Colombia.

General Account: Small burrowing snake, red-and-black banded above, white below, living in close association with *Erythrolamprus* and *Micrurus*. Several were caught crawling through jungle in the rainy season, and eight were taken in a single rice field, in company with the two above mentioned species. All were feeding on *Synbranchus*. Locally common at Kartabo, but not observed at Caripito. These are slow moving, non-biting, dark-loving snakes.

Coll. No. 244a: Kartabo, Color Plate 88, March 24, 1919, total length 440 mm., ventrals 171, subcaudals 60. *Color in Life*: Seventy-three series of patterns. Below, the ground color is pure white, with two series of dark brown blotches close together, sometimes opposite, sometimes alternate. These narrow suddenly and extend upward as scale-width vertical bands, not quite meeting on the mid-back. The back is red brown, while between each of the lateral, vertical lines is a conspicuous spot of bright coral red, suffusing from three to five scales over two rows.

The head has four irregular cross bands of black, with inter-spaces, counting from the snout backward, of pale brown, dark brown, dark red and bright red. The succeeding nuchal band of black almost meets above, and is the broadest on the whole snake. The head is small and the eyes inconspicuous, the iris reddish. The general impression of the lateral pattern is of successive layers of red-brown, bright red and white, cut by numerous vertical black bands.

This and seven other specimens were captured in one ploughed, marshy rice field. In the present specimen there were two *Synbranchus* in the stomach, one partly digested and the other quite fresh and 70 mm. in length. All eight *Hydrops* had from one to three *Synbranchus* eels in their digestive tract.

Coll. No. 3261: Kartabo, March 26, 1919, total length 385 mm., tail 83 mm., eye diam-

1.2 mm. *Color in Life*: Seventy-one black annuli, some alternate, some joined to make a "Y." Rufous red above changing to bright red on the sides and to white below. The black bands are narrow above and widen abruptly below, where the white interspaces are of only two scales width.

Coll. No. 3292: Kartabo, March 26, 1919, total length 427 mm., tail 80 mm. *Color in Life*: Reddish above, changing into coral on sides. The dorsal markings are rather atypical of this species, consisting of alternate narrow black bands which barely reach the middle line. Each band widens on the sides and below, until the ventral aspect is of alternate triangles of black, two scales apart, and with bases separated from each other and across the mid-line by white. The ventral aspect of this snake is decidedly darker than the dorsal.

Imantodes cenchoa (Linnaeus, 1758).

(Plate VIII, Figs. 33 and 34).

Names: Thread Snake, Night Climber, Chunk-headed Snake.

Range: Mexico and Central America and South America south to Paraguay and northern Argentina.

General Account: A very long, attenuated snake, with short, thick, enlarged head and enormous golden eyes with vertical slit pupil. Pinkish-brown with numerous large saddles of dark brown. The eye has a decided forward and downward slant, the angle with the mid-snout line being 43 degrees, doubtless an adaptation for nocturnal pursuit. None seen at Caripito, five at Kartabo. Found by accident coiled in masses of leaves or débris in parasitic plants. Active at night, twice entering laboratory, once in pursuit of a *Hyla rubra*.

When caught it was very active, tying itself into knots, and with considerable power of compression. It gave forth, from the anus, a most evil-smelling liquid.

Coll. No. 329: Kartabo, Color Pate 232, August 7, 1920, total length 1025 mm. (40.5 inches), tail 255, head length 12, head width 9, neck width 4, body width 5, eye diameter 3.5 mm., weight 18.5 grams. *Color in Life*: General color above sandy brown, snout and sides of head vinaceous buff with a slight yellowish tinge. Six or eight large, symmetrical patches on top of head, and about seventy large, diamond-shaped dorsal body saddles of chocolate brown. On the posterior half of the body these break on each side into a small lateral spot. Throat and lower labials pale grayish-buff, becoming speckled on the ventrals and shading to gray on the tail. Pupil a narrow, almost vertical slit, with a backward superior inclination. Iris golden, with irregular indistinct fleckings and streaks of orange and golden brown. Two narrow lines of light yellow along both sides of the pupil, and a small patch of dark brown at top and bottom.

Coll. No. 346: Kartabo, August 16, 1922, total length 1190 mm. (47 inches), tail 380 mm., head length 14.5, head width 8.5, eye diameter 4 mm., rows of scales 17, ventrals 286, subcaudals 168. This specimen had ninety-eight brown saddles. A much darker snake than No. 329.

Leimadophis reginae (Linnaeus, 1758).

(Plate IX, Fig. 35).

Names: Reticulated Snake.

Range: Panama, Colombia, Ecuador, Peru, Venezuela, Guianas, Trinidad and Brazil.

General Account: Found both at Caripito and Kartabo, four specimens at the former, and six at the latter locality. It is an active snake of medium size, well able to climb but usually found on the ground. Olive or bright green or lemon yellow above, with black edges to the scales giving a strong reticulated appearance. Below pale buffy yellow or bright empire yellow (Kartabo), or dominately scarlet (Caripito), both phases strongly and irregularly marked with black spots.

In temperament this snake is usually timid, making no effort to bite, but with ceaselessly flowing tongue. It is strong for its size and when its head was being drawn never ceased to constrict with its entire body. When angered, the head is raised and the neck flattened and widely expanded, becoming a cobra in miniature.

Coll. No. 270: Kartabo, Color Plates 126 and 132, June 7, 1920, total length 580 mm. (23 inches), tail 155 mm., weight 26.7 grams. *Color in Life*: Above serpentine green, brightening to light cress green toward head, with large, indistinct, dark reticulations along the back, and a line of large, distinct dark spots down each side, merging into a solid, black, lateral line from 50 mm. in front of vent to tail tip. Beneath, the head is light buffy yellow, deepening to mustard yellow below tail. From the neck to vent, a series of transverse, blue black bands or half-bands occupies the entire width of the ventrals. An average of every fourth scale is clear, unmarked yellow, and a larger number of half, alternating bands than of whole ones. Ventral tail unmarked yellow. Iris, lower four-fifths light mahogany red, mottled and lined with darker. Upper fifth, slightly forward of center, capucine yellow almost clear.

Coll. No. 284: Kartabo, July 20, 1920, total length 608 mm. *Color in Life*: Gener[illegible] color above olive, reticulated with d[illegible] brown. Top of head fuscous, head mar[illegible]

cedar green, lateral neck scales parrot green. Labials, chin, throat and anterior ventrals pale ochraceous buff. Posteriorly the ventrals are mottled more and more with pale salmon, deepening and changing to aniline yellow on subcaudals.

Coll. No. 291: Kartabo, October 6, 1920, total length 811 mm. *Color in Life*: Head brownish-olive, deepening toward snout. Two median patches of dark lettuce green directly back of eyes, below which are patches of cinnamon brown. A narrow line of black exter[illegible] top of upper labials, and back from [illegible] point of mouth, and down a few scales [illegible] the neck. Labials, throat and anterior neck pale ochraceous buff ground color, shading through buffy olive to grayish-olive on tail. Down the back are faint criss-cross markings of dark brown, surrounding faint, irregular whitish spots, which extend in a double dorsal row. Sides tinged with gray and with about 53 spots of dark brown, which merge into a narrow lateral line on tail. Ventrals salmon buff with blue-black markings; subcaudals chamois. Iris with upper fourth straw yellow, lower three-fourths mottled pecan brown. Pupil rim gold above, orange rufous below.

Coll. No. 2976: Kartabo, June 17, 1924, male, total length 2320 mm., tail 60, eye diameter 2.5, body width 6 mm., rows of scales 17, ventrals 139, subcaudals 49, weight 6.5 grams. *Color in Life*: Although only nine and a quarter inches in length this young snake is exactly like No. 291, except that the body and tail above are bone brown throughout, and the faint dorsal spottings are very obscure. Also the anterior ventral scales are pinkish-buff, shading back to cinnamon on posterior half of body, and to honey yellow under tail.

Coll. No. 30075: Caripito, Color Plate 1562, April 30, 1942, total length 570 mm., tail 85, head 16.2, snout 6.5, eye diameter 4.5 mm., weight 52 grams. *Color in Life*: Above dull lemon yellow on basal half of each scale, with the distal half or a very wide margin black. Some scales marked with lateral margins of scarlet. Below, from the tip of lower jaw to the ninth ventral bright lemon yellow, from the ninth back gradually replaced from the center outward with bright flame scarlet, the yellow on the extreme lateral edges soon merging with the greenish or lemon of the dorsal scales. The ventral scarlet irregularly marked laterally with black lines, not quite forming cross bands. At irregular intervals an entire scale may be pearl gray, about ten of these in all. Just before the anus the black dies out and the scarlet persists to the tip of tail. Top of head olive green, variegated with black, [illegible] broad band of black extending back from [illegible] habitude to the last head scale. Upper labials bright yellow, extending back beneath the lateral black head band. Iris gold on upper fourth, rich chestnut below, marked laterally with black. It was a female and contained many small, undeveloped eggs, about 1 mm. across. In the body cavity was a four-inch tapeworm.

Coll. No. 30131: Caripito, June 8, 1942, total length 506 mm., tail 148 mm. *Color in Life*: Above dark gray, edged on each scale with black, appearing wholly black in general. Labials, chin and anterior ten ventrals straw yellow. Rest of body ventrals coral red, changing under tail to rich salmon. Ventral chin, neck and tail immaculate. The rest with a black pattern of alternating squares of one scale width, with alternating transverse narrow lines, extending to right or left of the squares.

Coll. No. 30139: Caripito, June 3, 1942, total length 568 mm. *Color in Life*: Bright green and black above. Below red, with the black markings limited to narrow cross lines, except on posterior half of body where a medium black thickening on the ventrals is seen.

Coll. No. 30216: Caripito, May 3, 1942, total length 195 mm., tail 51 mm. *Color in Life*: Almost uniform brown above. Red collar across nape and an imperfect collar-like marking from eye obliquely back from gape. Pink below, irregularly marked.

Food: No. 291 had swallowed two frogs and a small bird. No. 2976 was caught attempting to eat a very small, 28 mm., frog with half-absorbed tail which it had just caught in a jungle pool. No. 30075 had eaten a *Hyla rubra*. No. 30139 had a 190 mm. *Ameiva* in its stomach.

Leimadophis taeniurus bipraeocularis

(Boulenger, 1903).

Names: Side-spotted Snake.
Range: Colombia and Venezuela.
General Account: This species is represented by a single, very young specimen picked up in a jungle trail at Caripito on June 24, 1942. In total length it is only 125 mm., with a tail of 27 mm. It is red brown above, with rostral, labials and all under parts pale yellow. There is a deep yellow scallop on the side of the neck which bites into the dorsal brown, and back of this a round spot is pinched off from the dorsal color. These spots continue posteriorly, spaced closer and closer together until, on the posterior third of the body and on the tail, they merge and form a solid, distinct lateral line.

Leimadophis typhlus (Linnaeus, 1758).

Names: Pink Ground Snake.
Range: South America in general.
General Account: A short, thickish snake,

dark green above and lemon yellow below, or dull pink above and bright pink below. I have observed no gradations in life between these phases. In preservative the colors alter radically or are completely lost, and even in dried skins the green changes to dark olive. From the point of view of human observation this is a gentle snake, allowing handling and not attempting to bite. When striving to escape or when teased, it raises the head to some distance and flattens the neck, making it look twice natural size. Even when thoroughly alarmed it progresses only by rather slow undulations, as we might expect from the short, thick body. I have never been able to persuade it to any swiftness or quickened progress. This is one of the very few jungle snakes which are terrestrial and yet, at least in one color phase, green in color. *L. typhlus* was not observed at Caripito, but seven were collected at Kartabo, three in the green phase, four in the pink.

Measurements of freshly killed specimens:

Coll. No.	2785	2834	332	624
Total length (mm.)	175	425	545	585
Tail (mm.)	38	102	106	100
Eye diameter (mm.)	3	4.5	4.5	5
Rows of scales	19	19	19	19
Ventrals	167	145	140	147
Subcaudals	53	53	53	50
Weight (grams)		44	44.2	85

Coll. No. 332: Kartabo, Color Plate 233, September 14, 1920, total length 545 mm. *Color in Life*: Above elm green, shading laterally through parrot green to lemon yellow. Upper labials mineral green, shading back to chalcedony yellow. Lower labials and throat strontian yellow. Ventral surface primuline yellow, with a light grayish-pink reflection. Iris, upper fifth pinkish-buff with dark brown flecks, remainder dark red brown. Distinct pupil rim bittersweet orange, with upper fifth orange buff.

Coll. No. 624: Kartabo, June 17, 1922, total length 585 mm. A female containing five eggs, apparently full sized but without shell, round-ended ovals, 7 by 17 mm. This snake was in the pink phase.

Coll. No. 2642: Kartabo, Color Plate 654, March 15, 1924. *Color in Life*: General color above dull pink. Head above brown with a greenish cast, snout and sides of head olive. Lower labials pale pink. The dorsal pink shades laterally into vinaceous, with the ventrals a brighter pink than the back. Faint dark, oblique stripes show here and there along the sides as the snake bends laterally. The center scales of the distensible hood on the neck have half hidden white streaks on their anterior edges, set off by similar streaks of salmon. Iris brilliant orange in upper quadrant, the rest dark brown with a red tinge.

Coll. No. 2834: Kartabo, May 21, 1924, total length 425 mm. Adult male in breeding condition, testes 21 mm. *Color in dried skin*: The mounted skin of this specimen has altered from the living green to olive green above. The anterior three-fourths of the body has been stretched in mounting and this artificial distension reveals a pattern, wholly concealed in the living snake. This pattern consists of about thirty inverted Vs with the arms directed backward from the mid line. These are made by the separation of scale rows in two rows of the olive green scales on dark skin background, then two rows set in yellow skin bases. The stretching is to the extent of one-fifth, the total length in the freshly killed snake being 425 mm., and in the mounted skin 530 mm. The V-shaped marks become visible in the living snake only when it distends its neck in the terrifying attitude which it assumes when thoroughly frightened.

Food: Three of these snakes had fed on frogs, one on a 47 mm. *Leptodactylus mystacinus*. No. 2834 had swallowed a small frog and, rather surprisingly, a mass of more than one hundred good-sized ants, not the disturbed food of the frog.

Leptodeira annulata annulata

(Linnaeus, 1758).

(Plate IX, Fig. 36).

Names: Saddle-back Snake, Annulated Night Snake.

Range: South American south to and including Paraguay and northern Argentina.

General Account: One of the commonest small snakes at Kartabo, where upward of two dozen were observed. Only two were collected at Caripito. One specimen measured 900 mm., but all others were well under this measurement. This snake is nocturnal, as indicated by its narrow, vertical pupil. When disturbed or alarmed it gives off a very offensive odor, but almost never attempts to bite on capture. It spends the day curled up under the loose bark of fallen logs or in crevices of bark as high as six feet from the ground. It seems to prefer swampy localities and several times I found it actually in jungle pools.

In general the color above is pale cinnamon buff with a series of large irregular spots down the back. These are found in all shapes, sometimes fairly evenly rounded, or confluent in zigzags or actual cross bands. Every type may be found in one snake. A black post orbital band and buffy or whitish ventrals are generally characteristic. The number of saddle markings varies from 38 to 76.

Measurements of freshly killed specimens:

Coll. No.	235a	347	235b	2875	333
Total length (mm.)	210	312	375	470	900
Tail (mm.)	50	75	100	148	225
Eye diameter (mm.)	2	3	3	4	5
Rows of scales	21	23	19	21	21
Ventrals	192	201	193	196	189
Subcaudals	83	91	100	87	88
Weight (grams)	2.2	3.5	6.5	29	48

Coll. No. 347: Kartabo, Color Plate 140, figs. a and b, June 12, 1920, total length 312 mm. *Color in Life*: Darker than the general run of this species. Head above olive brown, body tawny ol[illegible]ots blue-black. Throat, chin and a [illegible]or ventrals gray, remainder of ve[illegible]aceous buff. Series of dorsal spots round and oval, four or five merged together or alternate, about 76 in all. A line of small, round, black dots down each lateral line, alternating with the dorsal saddles. Pupil a narrow, vertical slit. Iris pecan brown flecked with gold. Caught in tent pursuing a small frog.

Coll. No. 235a: Kartabo, June 27, 1920, total length 210 mm. Much paler and grayer than usual. General color above pale drab, ventrals lighter. Top of head and dorsal spots dark gray. About 62 spots, saddles and bands along back. Iris gray. Taken in shallow water in an old tank, sharing the space with hundreds of very small tadpoles.

Coll. No. 333: Kartabo, Color Plate 140, fig. c, September 24, 1920, total length 900 mm. *Color in Life*: Above cinnamon brown with about 62 blue-black markings, mostly saddle-shaped, occasionally joined together. Sides of head and snout tawny with a streak of mummy brown from eye to angle of jaw. Below this a streak of orange buff, tinging the upper part of the anterior ventrals. Labials, throat and ventral surface light buff with faint mottlings of mineral gray. Iris orange rufous, lighter around the pupil and streaked with dusky. Caught under bark, six feet from ground. It was coiled in intimate association with a mass of termites and a large whip scorpion.

Coll. No. 30,152: Caripito, June 24, 1942, total length 585 mm. *Color in Life*: Pale brown above with dorsal markings of dark brown. On the nape there are two short, thick, longitudinal bands, then four pairs of alternating short bands, changing into more or less rounded spots. Some of these are double, others dumbbell-shaped, a few yoked three together. They continue to the tip of the tail but are fainter beyond the anus. Sides with a series of faint, brown, short, longitudinal lines. Below pale yellow brown. Iris dull golden brown. Caught swimming across a small jungle pool.

Food: Three stomach contents were: (1) 2 frogs and 8 tadpoles. (2) 1 tadpole, 1 small *Hyla rubra*. (3) Bones, probably of [illegible]mphibians, 1 small lizard.

[illegible] habit.

Leptodeira rhombifera Günther, 1872.

Name: White-bellied Night Snake.

Range: Mexico to northern South America.

General Account: A single specimen taken at Caripito represents this species. It was found coiled in a mass of leaves at the base of a jungle tree.

Coll. No. 30,143: Caripito, June 19, 1942, total length 465, tail 90 mm. *Color in Life*: Hair brown above with 42 dark brown spots, large, mostly round or oblong, several yoked together down back of body. These are continued on the short tail but indistinctly. The brown of the sides pales abruptly into the ventral aspect which is immaculate pure white.

Leptophis ahaetulla ahaetulla
(Linnaeus, 1758).
(Plate IX, Fig. 37).

Names: Whip Snake.

Range: Northern South America.

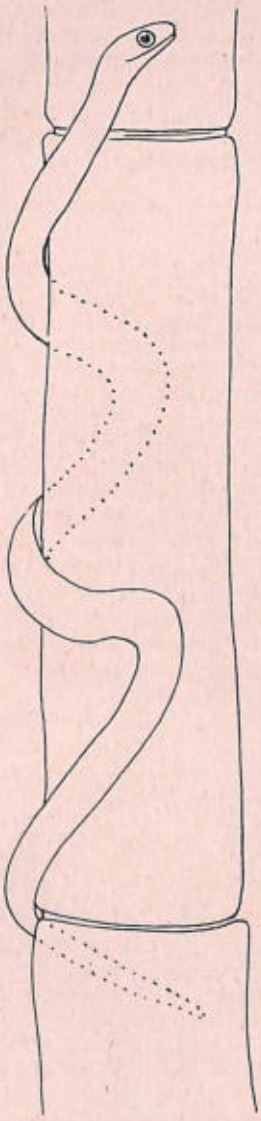
General Account: A long, slender, tree-climbing snake, green or blue, rarely brown above, with usually a dorsal and two broad lateral yellow-brown stripes. Below white anteriorly, changing into pale brown posteriorly, or everywhere below bright yellow (large, Caripito specimens). A black line through sides of head divides the dorsal and ventral colors. Eye golden yellow, with fore and aft black areas continuing the lateral black line of head.

Thirteen specimens taken at Kartabo, two at Caripito and two others seen. All the Kartabo snakes were relatively small, only one reaching 1200 mm., brightly colored above, dull below, and exceedingly slender. All the four Caripito snakes were very large, the two captured being six feet, and seven feet, eight inches respectvely. All were dull colored above and brilliant below, and relatively heavy-bodied.

These snakes are excellent climbers and often rest quietly for hours draped over branches and twigs. Six of those taken at Kartabo, however, were hunting on the ground. One had just caught a leopard *Hyla*. It relinquished its hold on the frog in the excitement of being captured, but ten minutes later when placed in a wire cage with the still unhurt frog, it again attacked and this time swallowed the unfortunate amphibian. Two were caught in the laboratory when they dropped from the rafters to the floor.

The small Kartabo specimens were nervous and bit at every opportunity. No. 245, with a total length of 975 mm., when set at liberty for an hour in the laboratory compound, made straight for the nearest bamboo stem and would not be turned aside. It

climbed the stem, which was six inches thick and exceedingly smooth, ascending rapidly by throwing S-shaped coils around half the circumference, and holding on by pressure on opposite sides of the stem. It soon shifted to an adjoining shrub, climbing easily among the slender branches, holding the head and neck raised stiffly, and occasionally swaying them from side to side.



TEXT-FIG. 2. *Leptophis a. ahaetulla.* Snake climbing bamboo.

This head-rearing seems to be a habit. From a level of foliage in a bush-covered clearing a single object projected, and closer examination showed this to be six inches of head and neck of a brilliant green and white whip snake. It permitted me to approach and actually grasp its neck, but instantly the little serpent became a fiend, seized my finger and so jerked its head from side to side that its teeth tore the flesh and caused a few drops of blood to escape. Unlike the boas it fought until I shut it tightly in a snake bag.

Color in Life: Coll. No. 609, Kartabo, Color Plate 398, June 10, 1922, total length 1030 mm., weight 27.6 grams. Head grass green with an indistinct, oval, dark grayish blotch on top, between [illegible]ghtly back of orbits. Back general[illegible]reen with a median dorsal line [illegible]um yellow, beginning narrowly on the back of the neck and widening and shading to old gold on tail. All the back scales are shaded on the outer edges with black and are turquoise green on the inner edges, giving a brilliant blue green tinge to the general color. Side of head tinged with chrysophrase and paling to light green about the super orbitals. There is a narrow, lateral, preocular line of black faintly shaded below with gold, running through the base of eye. Behind the eye this becomes wider and stronger and the gold almost covers the eighth labial. The upper labials below this lateral line are bluish-white. The lateral line becomes indistinct black and gold stippling on the side of the neck, widening and becoming light cadmium on anterior sides, widening and deepening again to a broad line of bronze on posterior body and tail. Chin and under neck white with pinkish tinge, becoming more and more heavily shaded with pale pinkish lavender and deepening through buff to dull brownish-lilac on posterior ventrals and tail.

Iris strongly empire yellow around pupil, becoming lighter and greenish toward periphery. Two patches of olive green stippled with darker, small and barely touching iris on left, larger and wider on right, both sides fraying out downward in bright crescents. These dark marks continue the black, lateral head line through the orbit.

The colors of this specimen after twenty-four years of preservation have all gone. It is now dark brownish-black above, leaden blue below, labials, chin and throat pale pink.

The dullest, darkest Kartabo specimen was No. 2763, with a total length of 1132 mm., in which the back was hair brown, with the top of the head, a narrow vertebral line, and two broad lines on the lower sides greenish-blue. The chin and throat were white, and all ventrals steel blue.

Coll. No. 30174 was a six-foot specimen taken in Caripito. I pulled it down as it rested sprawled across the branches of a low jungle growth. When dragged free it struck at me several times but was [illegible]

nearly as antagonistic as the smaller Kartabo snakes. It was dark olive green above, with a paler green vertebral line, shading down the sides to the same apple green of the vertebral line, and on down to chalcedony yellow on the ventrals. Below, this color deepened to bright yellow chrome on the whole lower head, the labials, the chin and anterior neck and under tail. In preservative the colors are altered to a uniform brown above, greenish-yellow below.

Measurements of freshly killed specimens (all from Kartabo except the two largest):

Total length (mm.)	356	1035	1132	1252	1310	1835	2340
Tail (mm.)	100	480	460	510	490	690	865
Eye diameter (mm.)	3	4.5	4.5	5	5	9	9
Ventrals	156	152	168	164	153	182	182
Subcaudals	171	170	165	167	161	184	172
Weight (grams)	2.1	25	30	55	55	384	219

Leptophis ahaetulla ortoni (Cope, 1875).

Name: Keeled Whip Snake.

Range: Venezuela and Colombia.

General Account: A single specimen taken at Caripito represents this subspecies. It was climbing slowly and apparently had its eye on a small *Anolis*. Coll. No. 30163; Color Plate 1618, July 1, 1942, total length 1587 mm. (five feet), tail 553 mm. In brilliancy of the upper surface it resembles the small specimens of *Leptophis ahaetulla ahaetulla* taken at Kartabo, but in brightness of ventral yellow it recalls the large specimens of *ahaetulla* captured at Caripito.

In general color above it was turquoise blue from snout to tail tip. The lowermost two or three scales throughout the body, from the gape to the vent, were bright orange, while the labials, chin, throat and ventrals to vent were white. The orange spreads across all subcaudals as well as the sides of the tail. A narrow, preocular black line is continued pigmentally through the iris itself, and on to a stronger black line along the side of the head to the last upper labial. The top and bottom of the iris are bright yellow.

In this specimen, after four years in preservative, all color is lost, the dorsal scales being brown, and ventrals steel blue.

Leptophis caeruleodorsus Oliver, 1942.

Name: Blue-back Yellow-belly.

Range: Northeastern coast of Venezuela, Trinidad and Tobago.

General Account: This is the only specimen taken of this species. Coll. No. 30,280: Caripito, July 1, 1942, total length 1216 mm., tail 490 mm. Turquoise blue above, green yellow below.

Liophis breviceps Cope, 1860.

Name: Red-bellied Burrowing Snake.

Range: Guianas and Ecuador.

General Account: A small, thick-set snake, with short tapering tail and small head and eyes, and burrowing habits. The largest captured measured 22 inches in length. Dark above with many faint, yellow cross bands, red below with numerous black, scale-wide cross bands. Little variation among individuals. Four were taken at Kartabo and one at Caripito. One of the former was four inches under ground in a marshy rice field in company with many *Micrurus* and *Erythrolamprus*, feeding on earthworms. Others were taken among jungle débris, burrowing at the first hint of danger. When handled it was unexpectedly quick and active in motion.

Coll. No. 338: Kartabo, adult female, October 9, 1920, total length 560 mm., tail 95, eye diameter 2 mm., ventrals 161, subcaudals 54, weight 56 grams. *Color in Life*: Dorsal surface brownish-black with about 90 narrow, faint, irregular transverse bands of pale vinaceous buff. Labials, chin, throat and subcaudals creamy white, the latter heavily marked with alternating spots of black. The ventrals are coral red with about 36 broad, black, disjointed cross bands. They are of two or three scales width, and are rarely unbroken, but usually disjointed at the center. Eye small, pupil round and large, no visible pattern on iris. This female contained eight large, oblong, shell-less eggs.

Coll. No. 30,146: Caripito, June 19, 1942, taken on the ground in jungle, starting to burrow at first alarm, total length 206 mm., tail 43 mm. *Color in Life*: Black above with faint yellow markings in indefinite bands. Below, throat pale yellow, changing gradually into bright coral red, paling again at the tail. Black cross bands on ventrals exactly as in No. 338. Very active and quick when alarmed and in the hand.

In this same specimen, when preserved after four years, all the yellow and red colors have vanished.

Food: No. 338 had devoured one large and a second smaller earthworm. Another snake had eaten three earthworms, two medium myriapods and a 150 mm. *Synbranchus*.

Liophis cobella cobella (Linnaeus, 1758).

Names: Banded Tricolored Snake, Red-bellied Ground Snake.

Range: Guiana, Venezuela, Trinidad, Colombia and Brazil.

General Account: A small black snake with imperfect, narrow white dorsal bands, scarlet below with broad bands of black; head and tail below whitish, the latter with imperfect black bands. A second color phase is brown above, salmon below, with very faint white and scarlet bands.

Six of these small snakes were taken at Kartabo, the largest eighteen inches in length, and the smallest and most brilliantly colored less than eight. One specimen was captured at Caripito. Few observations in life were made. It is a ground snake, found in the jungle or among bamboo clumps, diurnal, and feeds on small frogs and lizards. The remains of bones alone, prevented any more definite identifications. One specimen (No. 166), under eight inches, was remarkably strong for its size, making no attempt to bite, but pulling hard with its curved tail. When set temporarily at liberty, instead of trying to crawl to safety it actually twisted up the posterior part of the body into a tight, overhand knot, although it was quite uninjured

Color in Life: Coll. No. 166, American Museum No. 18159, Kartabo, June 10, 1920, Color Plate 134, figs. a and b, total length 192 mm., tail 29, head length 8.2, eye diameter 1.75 mm., weight 1.8 grams.

Above blue-black with several complete, narrow whitish bands across the neck, all the ones on the body fainter and hardly meeting. These bands widen abruptly on the sides and change at once to the double ventral coloration, a broad band of carnelian red about three scales wide, succeeded by a black band averaging two scales in width, and so on. Not counting an abortive black band which stops on the posterior side of the head, there are 34 of these black bands. On the tail are 21 imperfect bands of black. The red fades out to seashell pink on chin, throat and lower labials, and the tail becomes abruptly grayish-white. There are 65 dorsal bands of white, including one on the mid-head which ends in two whitish spots on the anterior part of the parietals. Pupil round, iris very dark russet brown, hardly distinguishable from the pupil black.

Coll. No. 219: Kartabo, June 22, 1920, total length 200 mm., tail 41, head length 8.5 mm., weight 2.6 grams. The coloring of this small specimen is very unlike that of No. 166. General color above saccardo brown, more or less regularly barred broadly with dots of black. All labials and throat pale ochraceous buff, shading on ventrals to light salmon, and this on all the main body ventrals to coral red. This fades posteriorly to buff again. Instead of wide ventral red bands, both the red and the black are narrow and irregular, often only a single scale in width, and usually alternate, not meeting in the middle. The iris has a broad irregular inner band of vinaceous tawny, shading externally to roods brown.

Coll. No. 165: Kartabo, September 14, 1919, Color Plate 254, total length 450 mm., tail 92 mm., weight 26 grams. Head and back above dark olive with faint bands of violet gray, upper labials, chin and throat pale pinkish-buff, ventral surface salmon shading to d[illegible] and head and tail, with about [illegible] ranging and broken bands of violet gray.

Coll. No. 224: Kartabo, October 12, 1920, Color Plate 134, fig. c, total length 480 mm., tail 90, head length 14, head width 10.3, eye diameter 3, body width 9 mm., ventrals 153, subcaudals 57, weight 24.2 grams. General color above buffy brown flecked with olive brown, paling to deep olive buff on sides. Back with very faint markings of dark brown. Upper labials grayish-olive edged with black. Throat and lower neck pale pinkish-buff with scattered fleckings of black. Ventrals apricot buff paling to colonial buff on tail, and crossed with numerous irregular bands of violet gray. Iris brown near pupil, mottled with dark on outer area.

Coll. No. 30,287: Caripito, April 14, 1942, total length 206 mm. Independent description corresponds exactly with that of No. 166, except that the scarlet is more intense.

Lygophis lineatus (Linnaeus, 1758).

Name: Red-striped Snake.

Range: Guiana, Venezuela, Colombia, Brazil, Paraguay and Argentina.

General Account: A single specimen caught as it was swimming a jungle pool near the Kartabo laboratory. It had eaten three *Hyla rubra*, all very young specimens with tail barely absorbed.

Coll. No. 3563: Kartabo, September 3, 1924, male, total length 453 mm., tail 142 mm. *Color in Life*: Dark brown on head becoming paler toward tail. Three longitudinal stripes, one vertebral, two lateral, bright red extending full length of snake. A bright red brown band from snout through eye to lateral neck. Salmon below.

Oxybelis aeneus aeneus (Wagler, 1824).

(Plate IX, Figs. 38 and 39).

Names: Ashy Tree Snake. Whip Snake, Lizard Snake (Creole).

Range: Mexico, Central and northern South America.

General Account: A very long and slender tree snake, ashy white above, brown below, dark line through eye, throat white. In sage green in front and back, white [illegible] and below. Fairly common at Kartabo [illegible]

a dozen specimens were taken and others seen. Also found at Caripito.

In size my specimens varied from three feet to six feet, three inches. All were found among slender branches in open jungle or near the rivers. The extreme slenderness and the reversed, dorso-ventral pattern of coloring, combined with the irregular draping of the body over branches, and complete immobility, all make them extremely difficult to detect. When disturbed they vanish almost between winks, and the instantaneous dash two [illegible] thirty feet away leaves the eye com[illegible]

Birds' eyes detect them better than humans', and one snake in tall bamboo was so mobbed by small birds and jays that it fell thirty feet to the ground close to me.

A curious habit is that of protruding the tongue full length, about equal to the length of the head, and holding it motionless. It is lemon yellow for three-fourths of its length and dark at the tip. Whether this slight addition to the serpent's resemblance to irregular twigs is the origin or stimulus of this phenomenon, I cannot say, but I observed it at various times in the same snake and in three other individuals. On April 3, 1922, I caught an ashy tree snake back of the laboratory. Whenever it squeezed a few inches of the attenuated neck free of my hand its tongue appeared full length and "froze" in that postion, simultaneously putting an end to all struggling. When several feet of the tail were at liberty, this end of the snake slowly reared upward, and curved around into an amazingly large and complete circle, a full eight inches in diameter. The slender muscles supported the two free and elevated body lengths without apparent effort.

These snakes never made any attempt to bite, but when first caught they frequently emitted from the anus a clear fluid, giving off a most peculiar and pungent odor, most difficult to wash off.

Measurements: Coll. No. 2966, Kartabo, June 17, 1924, male, gives, in the flesh, the following measurements: total length 1360 mm. tail 560, jaw 29, head width 10, body width 6, eye diameter 4 mm., rows of scales 17, ventrals 196, subcaudals 184, weight 30 grams.

Color in Life: Coll. No. 231, American Museum No. 18179, Kartabo, August 8, 1920, Color Plate 196, total length 1720 mm., weight 24 grams. There is little variation among these snakes so this description may be taken as typical. Top of head sepia. An indefinite streak along side of head which deepens to a narrow band of black just above the upper labials, and continues across the iris in two areas of dark green. [illegible] second to fifth upper labials with narrow shading of black along upper edge. A streak of pale vinaceous buff extends across the top of the preocular, tinging the lower portion of the supra ocular and continuing in a horizontal line a little back of eye, where it deepens to umber. Upper labials pale yellow, shading downward to bluish-white. Throat bluish-white with faint tinge of pink. Body above light ashy, ventral surface dark vinaceous brown. A narrow rim of picric yellow extends around the lower four-fifths of the pupil, widening toward the top and shading to silver white, which extends over all the upper part of the iris. Large irregular patches of parrot green lie on either side of pupil flecked with black. The lower part of iris is silvery white flecked with maize yellow.

Food: Some of the hunting of this snake must take place on the ground as shown by certain stomach contents. Here is the food of four individuals: (1) A medium-sized *Ameiva*. (2) Two *Anolis chrysolepis*. (3) Two small treefrogs, one a *Hyla rubra*. (4) *Hyla rubra* and a female manakin.

Parasites: A five-foot snake captured on February 24, 1922, had three large ticks fastened tightly to the head, one of which, on the left lower side of the jaw, had worked half-way back from the tip of the mandible, inducing such severe injuries that the entire lower jaw was shrunken and distorted.

Breeding: No. 2648, a six-foot female captured on March 17, 1924, contained three fully formed eggs measuring 7 by 17 mm.

Oxybelis fulgidus (Daudin, 1803).

(Plate IX, Fig. 40).

Names: Green Whip Snake, Emerald Tree Snake. Parrakeet Snake (Creole). Wah-coo-qua-malee, A-di-a-mung, "living with leaves" (Akawai Indian).

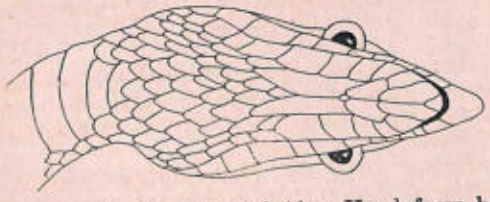
Range: Mexico and Central America, south to Bolivia and northern Argentina.

General Account: This is a large, slender tree snake, with long, pointed, overhanging snout, dark green above, yellow green below, with a narrow white lateral line. It is about as common at Kartabo as its relative, *Oxybelis a. aeneus*, and has very similar habits. Twice, when disturbed, I saw these snakes puff out the anterior portion of the body, thus bringing into full view the orange and yellow colors usually concealed beneath the scales, and described below.

Seven feet, one inch, was the largest snake captured. In ten specimens, none under four and a half feet in length, the ventrals varied from 200 to 214, the subcaudals from 150 to 162. A 1608 mm. total length specimen weighed 89 grams, and another 2063 mm. over all, weighed 224 grams or one-half pound. In most individuals the sharp tip of the snout overhangs the lower jaw by 4 or 5 mm.

No. 532 was shot as it was creeping slowly along some slender branches toward a male Gold-headed Manakin. I watched it for many minutes as it slowly reached forward with its chin and neck, testing every dead twig with flickering tongue, and laying the trail for the five feet of following body and tail. I only discovered it because a cluster of leaves moved slightly when there was no wind. Twice when I took my eyes away I lost it completely although it had not moved in the interim. The extremely slow forward motion conveyed to my eye below no sense of movement, and the tail was so slender and tapered so gradually that it was difficult to determine whether one saw it or not. The color of the belly was exactly that of sunlit leaves from below. In the preserved specimens the greens have all turned to blue.

As I watched I was suddenly aware that the snake was observing me, although it was directly overhead. My glasses focussed on the ventral view of the head showed the eyes so twisted out and down that more than half of the iris and pupil were clearly visible, directed straight downward each side of the head. The eyeball must have been rotated a full ninety degrees downward. When I remained quiet for a few minutes the eyes disappeared and the snake began its insensible forward motion toward the bird. I shot it when it was almost within striking distance.



TEXT-FIG. 3. *Oxybelis fulgidus*. Head from below showing ventral vision.

Measurements: Coll. No. 2854, Kartabo, May 29, 1924, adult male, total length 1610 mm., tail 550, jaw length 42.5, eye diameter 6 mm., ventrals 205, subcaudals 161, weight 136.2 grams.

Color in Life: There is very little variation in pattern and color among these snakes, so the following may be considered typical. Coll. No. 523, Kartabo, March 1, 1922, Color Plate 320, total length 1608 mm., tail 530 mm., weight 142.5 grams. Head above dark forest green. Side of face the same with a loral streak of chalcedony yellow. Upper and lower labials, chin and ventrals dominately yellow green. Body above forest green, while sides of body and upper corners of ventrals are stone green. Lateral line pinkish-white, which, cutting ventrals close to upper border, becomes deep yellow toward neck. All scales of labials, chin and ventrals edged with pinkish flesh color. Pupil rim golden yellow. Pupil slightly pulled out at upper posterior corner, where the rim pigment widens, becoming yellowish-white, then tawny. A patch of thick golden buff in upper anterior edge of iris, also an irregular crescent of buff to the left of center, below which it widens to the right along the base of iris. Remaining iris is dark brown, flecked in the upper posterior corner with radiature patches of orange buff, [illegible] of pale [illegible] toward the fr[illegible]nder many of the scales is apric[illegible]range.

Dermal Coloring in Life: Coll. No. 708, Kartabo, August 19, 1922, Color Plate 669, adult female, total length 2063 mm., weight 194 grams. In life, ordinarily, the close fitting, tile-like, overlapping scales of the neck show only the scale color of dark green above and yellow green on the lateral rows. Several times when alarmed, these snakes were seen to distend their neck, cobra-wise, when the green colors of the seventeen rows of scales became subordinated to the broad bands of orange which cover the skin between the scales. In a dead snake, when the skin was stretched laterally, these wide bands were seen to alternate with equally wide bands of pale yellow.

An emerald tree snake with a normal neck width of 16 mm. permits lateral stretching to 70 mm. Except in the case of the several extreme dorsal rows of scales, the lateral relation of scales to intervening expanse of skin is 4 to 8 mm., or twice as much colored skin as scale. These alternating yellow and orange bands are directed obliquely forward from their apex on the vertebral line. They are dominantly dorsoventral in extent, as horizontally the scales are less capable of separation.

Food: Three snakes had eaten the following: (1) Remains of a small lizard, probably *Anolis*. (2) Two medium *Anolis chrysolepis*. (3) Bones of a small bird.

Breeding: No. 708, collected August 19th, contained six fully-formed but shell-less eggs, even-ended oblongs, 10.5 by 22.5 mm.

Oxyrhopus petola petola (Linnaeus, 1758).

Name: Narrow-banded False Coral Snake.

Range: Mexico south to Brazil and Argentina.

General Account: This is a small snake, black with many rather narrow, more or less imperfect, transverse rings of white and red. It is semi-fossorial in habits and noctural, although the rather vertical pupil is very broad. Only four specimens were taken at Kartabo, two of which were uncovered in the same rice field which yielded many *Micrurus*, *Hydrops*, *Erythrolamprus*, *Liophis*, etc.

It is a gentle snake, showing no resentment at being handled. One died after a half hour's accidental exposure to the sun.

Color in Life: Coll. No. 92, Kartabo, March 26, 1919, total length 260 mm., tail 64 mm., upper labials 8, entering eye fourth and fifth, ventrals 214, subcaudals 90, weight 3.2 grams.

Ground color above shining purplish-black, cut by 45 bands, several of which are broken and do not meet, the others extending clear across. The widest is that on the [illegible] part [illegible]ad. This is creamy white as are [illegible]ven or eight, then a pink ting[illegible] apparent and this increases posteriorly, until the bands on the tail are coral red. The ventral scales are white. In preservative after twenty-seven years, this same snake had become pale white, with dorsal bands of light brown. Removed from preservative, and with excess moisture shaken off, the weight is 3.1 grams, as compared with 3.2 grams immediately after death.

Coll. No. 508: Kartabo, March 1, 1922, Color Plate 326, total length 250 mm., tail 65 mm., weight 3 grams. This individual differs from No. 92 chiefly in having almost double the number of dorsal cross bands in a jet black ground color. These are so narrow that they should be called lines instead of bands. On the back of the head behind the gape there is a broad band of scarlet. The next few rings and those of the lower back and upper tail are arranged in a more or less definite succession of a band of scarlet between two narrow creamy white rings, but througnout all the rest of the dorsal surface there is no regularity. Complete and incomplete whitish lines alternate with corresponding scarlet ones, in no regular order. After the anal area of greater regularity, the tail ends in a succession of regular white bands. The labials, chin, throat and the ventrals, back to the sixteenth, are all slate gray, the rest of the under side being creamy white.

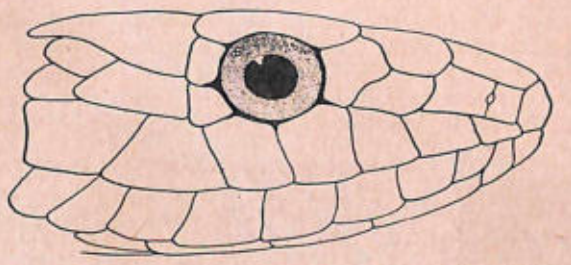
Philodryas viridissimus (Linnaeus, 1758).

Name: Two-colored Green Tree Snake.

Range: Guianas, Brazil, Colombia, Ecuador, Peru and Bolivia.

General Account: A tree snake of medium size, dark green above, yellow green below, iris brown with gold dots over upper portion. Rare at Kartabo where only two specimens were taken.

Color in Life: Coll. No. 3264, Kartabo, June 19, 1920, Color Plate 148, total length 910 mm., tail 230, eye diameter 4, body width 11, body height 15 mm., weight 57 grams. General body color lettuce green above, [illegible]ading laterally to greenish-yellow on ven[illegible]scales. Top of head parrot green, two [illegible] spots on scales in front of eye and three behind, forming a broken facial band. Upper labials emerald green, shading posteriorly to light yellow green. Lower labials, chin and throat pale greenish-gray touched with pale cinnamon pink. Scales back of gape, along lateral neck and forming anterior border of the first fifty ventrals, beryl green, which in spite of its name in Ridgway's Key appears a most delicate blue. This color occurs sporadically on other ventral scales and on all the caudal ventrals.



TEXT-FIG. 4. *Philodryas viridissimus*. Eye in detail.

Pupil round. Iris a tangled mesh of dark cinnamon brown with a sparse but conspicuous flecking of gold dots across the upper portion. Inside of mouth pallid blue violet, tongue blue green, tipped with violet and black. Caught at dusk, draped quietly over foliage.

Coll. No. 3557: Kartabo, July 1, 1924, male breeding, total length 1195 mm., tail 315, jaw length 28, eye diameter 4, body width 14, body height 19 mm., rows of scales 19, ventrals 217, subcaudals 121. Caught in low bush while it was being mobbed by three hummingbirds.

Pseudoboa coronata Schneider, 1801.

Name: Black-headed Scarlet Snake.

Range: Venezuela, Guianas and Brazil.

General Account: Only two specimens, the larger twenty inches in length, were taken at Kartabo. The first, No. 507, caught on the ground near the laboratory, was described, painted, and then made its escape the same night, and was never seen again. Two weeks later, on March 15, 1922, a second specimen, No. 3287, identical in coloring and 455 mm. in length, was found in the same rice field as all the other real and false coral snakes, a half-digested eel in its stomach. At Caripito only a single specimen was taken.

Measurements and Color in Life: Coll. No. 507, Kartabo, March 2, 1922, Color Plate 324, total length 485 mm., tail 105, head length 9, head width 7, eye diameter 1.5, body width 7, body height 8 mm., rows of scales 17, upper labials 7, ventrals 174 caudals 89, weight 10.5 grams.

Dorsal head scales and band on neck black. Sides of face and lower labials dull gray, shaded with darker. Band of yellowish-white at back of head with two pink lateral patches. This band widens on sides of head and joins the general whitish tone of the chin and throat. Body above coral red, each scale tipped slightly with dark gray. Ventrals yellowish-white, tail grayish. Iris dark.

This species seems equally rare at Caripito where a single one was collected as it was making its way slowly across a trail. Coll. No. 30,112: Caripito, May 21, 1942, total length 296 mm., tail 70 mm. Its color was exactly like that of No. 507 except for an irregular series of very faint dusky, short, cross lines at intervals down the back. The pupil was very slightly vertically oval.

Pseudoboa neuwiedii

(Dumeril and Bibron, 1854).

Name: Brown and Yellow Snake.

Range: Guianas, Trinidad, Venezuela, Colombia, Panama and Costa Rica.

General Account: Two specimens only from Caripito, not found at Kartabo. Both were taken on the ground and put up a lusty fight when seized. Both were identical in coloring, light sepia or seal brown above with the head definitely darker, almost black. Below yellowish-orange. Coll. No. 30,135: Caripito, June 13, 1942, total length 906 mm., tail 196 mm., weight 151 grams. No. 30,162: Caripito, July 2, 1942, total length 793 mm., tail 222 mm.

Pseustes poecilonotus polylepis (Peters, 1867).

(Plate X, Figs. 41, 42 and 43).

Names: Liana Snake, Bird-eating Snake.

Range: Venezuela, the Guianas and Brazil.

General Account: I know of no Creole or Indian name for this well-known snake, and the variety of pattern and coloring defy usual adjectives. In the field we called it the Liana Snake owing to its astonishing imitation of a monkey ladder, and the Bird-eater on account of the dominant nature of its food. At Kartabo we found it common and at least two dozen specimens were encountered in the quarter square mile of jungle. These varied from seventeen inches to five feet, while at Caripito the only specimen obtained measured a full six feet.

The majority of the snakes were seen or taken on the ground, but three times I saw them in trees. A male in full breeding condition was captured as it was swimming the Mazaruni River where the stream was almost a mile in width. The adult snakes from 1100 mm. (about three and a half feet) upward are monochrome above and below in two phases, one a deep olive green with lemon yellow lower head, chin and throat, and the other a rich red brown with yellowish-orange anterior lower parts. In the young, at least from 446 mm., the variation is still more extreme, the basic colors being red brown, or gray or olive above, banded with darker shades of the ground color, with face and throat black-marked white or green-marked yellow. The iris is the most stable character and almost always offers a reliable, superficial means of field identification. In general the iris is mottled silvery, with dark pigmented areas fore and aft, which are crossed with about three, distinct, white, vein-like lines, radiating from a narrow area on the [redacted] and post[redacted] equator of t[redacted] out to the external rim o[redacted].

Individuals differ from one another as much in their emotional display as in their pattern and pigmentation. No. 336, definitely a young snake, was very strong in its constricting ability, but in spite of much handling made no attempt to bite. Nos. 2667 and 2727, approaching adult size and patterning, were extremely vicious, striking repeatedly and vibrating their tails with great vigor.

One outstanding habit which, in my experience is confined to this and to a congeneric species, is that of contorting the entire body and tail into a series of rigid undulations. In a four foot snake there was about twenty of these successive half curves on each side of the body. When lying on the ground in this condition the snake's resemblance to a short extent of the common monkey ladder is startling. Three times on the ground, twice among branches, I have seen this effect. For example on March 23, 1922, I wrote, "I caught a three foot Liana Snake (No. 521) wholly reddish-brown, at the entrance of Puruni Trail. It lay across the trail rigid as an iron rod, with every inch regularly bent and waved, as if a section of liana had recently fallen. Snakes of all species look much like this when they have been killed with chloroform. This individual never moved even when my hand approached within an inch of his head. Not until I pressed down on his neck and gripped him, did he 'break trance' and coil around me like a flash. From this moment on he fought all the way home.

Measurements and Color in Life: Coll. No. 334, Kartabo, October 2, 1920, Color Plate 229, fig. a, a young male, total length 446 mm., tail 125, eye diameter 4 mm., ventrals 198, subcaudals 131, weight 7.5 grams. A specimen in the yellow brown phase with typical eye pattern, but somewhat browner. Pinkish-buff above shading to tawny olive toward head and tail. Lace-like pattern on head and face markings dark snuff brown. About 42 irregular, broken bands on dorsal orange cinnamon, becoming grayer and [illegible] definite toward tail. These bands are st[illegible] along their edges with umber. Sides [illegible]

stippled with hair brown and deep orange. Ventrals white, mottled heavily with fuscous, which becomes an almost solid color toward tail. Upper edges of ventrals with 40 patches of chestnut brown, each of which covers three ventral scales.

Coll. No. 78a: Kartabo, September 10, 1919, total length 609 mm., weight 16 grams. General color light grayish-olive, with broad, irregular bands of dark grayish-olive. Beneath, ivory white anteriorly, becoming more and more suffused with olive until it is concolorous wi[redacted]k. Pupil a longitud- white, very br[redacted] yellow buff, with a suffusion [redacted]n in front and back, reaching the pupil. A few transverse white lines across these dark areas.

Coll. No. 251: Kartabo, August 23, 1920, Color Plate 229, figs. b and c, total length 615 mm., tail 176, eye diameter 5.5 mm., ventrals 191, subcaudals 125, weight 18.4 grams. General color above light grayish-olive with broken irregular mottling of fuscous and hair brown on head. Three short, black bands project down over the white upper labials, the central one extending straight down from the eye and covering a lower labial. A faint dark stripe of mottling extends along side of face. The body shows 40 wide, diagonal, rather irregular, transverse bands of deep grayish-olive, sometimes narrowly split in two. The anterior scales of these bands are touched with black. The throat is white with black marks. Ventral surface white on neck, becoming more and more thickly stippled with dark brown which coalesces near the tail. The lower parts are also flecked with hair brown. Pupil slightly ovate horizontally. Iris pinkish-buff, finely stippled with white. Three spots of snuff brown in front, behind and below, and three irregular white lines radiating toward pupil from anterior and posterior outer rims.

Coll. No. 2727: Kartabo, March 29, 1924, total length 953 mm., tail 260 mm., ventrals 200, subcaudals 126, weight 75.5 grams. A specimen with distincter dorsal markings and with the typical white streaks in the iris but fainter than usual. Head above grayish-olive with symmetrical lighter and darker markings, and a dark streak running diagonally across eighth labial to eye. Upper labials amber yellow with patches of lime green. Lower labials pinkish-white with a large patch of lime green below eye, and a speckled area of the same color around snout. Large lateral patch of orange scales just back of and below point of jaw. Ventrals and scales of three lower rows, for about four inches from head, edged anteriorly with apricot yellow.

General body color violet brown with fine [redacted]ling of green, shading to clouded hazel [redacted] body, and russet on tail. More than half of the entire length has eighteen irregular, dorsal, faintly crescentic markings, composed toward the head, of red-edged, dark-mottled, green scales with a few scattered brown spots, backed with coral pink skin. The remaining markings on the rest of the body are extremely faint and on their way toward obliteration. Ventrals pale mottled buff toward head, shading backward to fawn color. Iris light pinkish-cinnamon, with brilliant white pupil rim, broken bebore and behind. Dark patches of sepia at each side of pupil, and white radiating veining.

Coll. No. 521: Kartabo, March 22, 1922, Color Plate 349, total length 1565 mm., tail 355, eye diameter 6.2 mm., weight 136 grams. This snake is almost solid red brown above. In detail head above walnut brown, with shadings of burnt umber on orbits. Snout vinaceous tawny, upper sides of head brownish-olive, paling laterally where the color passes through eye. Below this line the upper labials are light cadmium touched with orange. The scales around nostril and snout are vinaceous tawny. Body above red brown, becoming more thickly flecked with terra cotta toward ventrals. The part of the ventrals which extend up the sides are of this same terra cotta. Lower labials, chin and under neck are buffy yellow touched with darker yellow and reddish toward snout, with a few whitish streaks under the neck which merge backward with large mottlings of pale rose, into the main ventral color of dark orange red. Toward the tail the ventrals acquire a bloom of pale violet gray. Pupil rim broken at both sides, of brilliant ivory. Iris light buff, with sparse black stipplings above, which are denser below. Two solid patches at each side of iris dark brown, fraying out at edges and shot with a few silvery white veins.

Coll. No. 336: Kartabo, October 2, 1920, Color Plate 245, total length 1310 mm., weight 111 grams. Solid dark olive green above. Wax yellow on labials, chin and throat, becoming mottled posteriorly with olive green on a few anterior ventrals, until the whole is concolorous. Iris, lower three-fourths buffy-brown, upper fourth sandy, with fine white stippling. Strong pupil rim of clear buff, two or three radiating lines silvery white, from anterior and posterior outer iris edge almost to pupil. After twenty-six years in preservative the whole snake is vinaceous brown.

Coll. No. 30,175: Caripito, July 15, 1942, female breeding, total length 1806 mm., tail 463 mm., weight 490 grams. Plain olive green above, below bright chrome yellow on chin, throat and jaw scales upper and lower. From here back, the bright color dulls within a few inches to the general color of the ventral surface, olive buff. Iris dark hazel

brown with silvery veins as usual, silvery white above and below.

In full grown monochrome snakes, long after the dorsal, transverse bands of the juvenile pattern have disappeared from the scales, these bands reappear in strong outline when the skin is stretched. On the skin between the scales they are etched throughout life, although under no stress of danger or excitement have I ever seen this species distend its neck as other serpents do.

Food: No. 2665 had swallowed two eggs of a seedeater, with sufficient shell for at least this identification. In the stomachs of three other snakes were the bones of small birds, and in one the bones of a small hawk, probably the Bat Falcon (*Falco rufigularis*).

Breeding: No. 30,175, Caripito, July 15, 1942, total length 1806 mm., was a female weighing 490 grams. There were eleven eggs in the oviduct, shell-less oblong yolks, each 15 by 45 mm.

Pseustes sulphureus sulphureus

(Wagler, 1824).

(Plate X, Figs. 44 and 45).

Names: Puffing Snake, Black-tailed Golden Snake. Yellow-belly (Creole). Sal-la-bu (Akawai Indian).

Range: Guianas, Trinidad, Venezuela, Peru, Ecuador and equatorial Brazil.

General Account: This large powerful constrictor was as common at Kartabo as its congener, *P. poecilonotus polylepis*, and its pattern and color variation were even more confusing. While the dorsal coloring may be monochrome, olive, brown or yellow, this is not an adult pattern but may occur in an individual only one-third grown. The usual pattern shows a series of conspicuous dorsal cross markings, crescents or bands, single or double, or even more intricate figures. The general tendency is a gradual change from yellow background with black markings on the head and anterior body, to black with corresponding yellow markings posteriorly. A nine-foot snake taken at Caripito was larger than any captured at Kartabo. This snake in pattern was curiously like a very large *Drymarchon c. corais* but with completely reversed color pattern. Concealed dermal markings are very characteristic and correlated with an optical defense mechanism. Also the rigid, liana-like habits are as strongly developed as in the preceding *P. polylepis*. Both of these habits were exhibited in an individual Yellow-belly which I caught on May 10, 1924, near the laboratory at Kartabo. My journal note reads as follows:

"May 10, 1924. Worked among the branches of a giant fallen jungle tree near the Cuyuni River for three hours, and later while running home before a threatened heavy rain, I leaped over a bit of monkey ladder lying directly on the trail. After I had gone on some distance I seemed to remember a curious regularity about the stick and went back. It was a splendid *Phrynonax sulphureus* (No. 2857) lying flat, stiff and straight but strongly and evenly waved. The snake moved only a fraction of an inch as I slowly brought the gun barrel across its neck, but then it struck viciously and threw its coils tightly about the gun and my leg. I was loaded down with birds and an aguti and could not free [illegible] and so light home. In a vi[illegible] gave a magnificent exhibiti[illegible], the entire anterior third swelling up as if filled with two or three hen's eggs. As the skin of the throat and anterior body rose, swelled and expanded, the inter-scale golden skin color leaped into view, merging with the scales themselves. On each side of the posterior throat conspicuous streaks of purplish-black appeared. It presented a truly fearsome sight, and simultaneously the tail quivered and rattled noisily against whatever object was within reach." (Plate X, Figs. 44 and 45).

With all the bewildering array of pattern and color variations, it is especially valuable in the field to find one character of satisfactory reliability, which delineates this species: The iris has a remarkably consistent pattern, the background brownish-black, with a fine mist of paler brown lines radiating outward from the bright silvery pupil ring to the outermost borders of the visible eyeball. It thus differs radically from the iris of the congeneric species, *Pseustes polylepis*.

Measurements and Color in Life (in order of size): Coll. No. 15, Kartabo, June 15, 1919, total length 890 mm., weight 56.2 grams. A dull, olive brown snake with faint oblique markings on anterior two-thirds of back dull yellow. This color occurs between the scales so that when they are completely in place the snake is uniformly olive brown. Beneath pale lemon yellow, gradually becoming smoky brown on the posterior third, both above and below. Iris clove brown, with a regular dense mesh of olive brown, and a narrow bright gold pupil ring.

Coll. No. 2691: Kartabo, April 9, 1924, skin preserved, Color Plates 690, 691 and 692. Head isabella color, shaded with olive and black. General body color olive brown shading to tawny on posterior third, and gray on tail. Thirty-six arrow-shaped, forward pointing black-edged dorsal markings which become broken toward ventrals. These are buffy brown shading to dark wine color posteriorly and very dark gray on under surface of tail. The dorsal markings are narrow on the anterior body, leaving large i[illegible] terspaces with a faint stripe between [illegible] interspaces becam[illegible] narrow towar[illegible]

where they exist as faint rings. As the dorsal markings become larger they acquire a light central streak and the stripe between them becomes stronger. Scales of the body color, especially on the dorsal area, have partially concealed edges of apricot yellow, posteriorly becoming more orange. Scales in the center of the mid-body dorsal markings have white edges. The anterior lateral scales have lemon yellow edges which make the body appear to shade into the citron yellow of the forward ventrals, which become mottled on mid-body with dull brown. They [illegible] almost black on tail.

There is a dark streak backward from the eye extending the length of the head along the side of the neck, becoming broader and broken laterally. The scales in the center of this have white edges. The skin under this marking is velvet black, as also are several large scale spots under the chin. Labials, chin and neck bright yellow, the five posterior upper labials and four lower just under the eye with black rear edges. The eye and iris are typical of the species.

Coll. No. 2733: Kartabo, April 16, 1924, skin preserved, total length 812 mm., tail 201, jaw length 27, eye diameter 5.5, body width 12, body height 16 mm., rows of scales 21, ventrals 224, subcaudals 142, weight 39.5 grams. This specimen is duller in every way than No. 2691. The black under-neck skin marks are very faint, occurring as a broken line instead of forming large blotches as in other individuals.

Coll. No. 238: Kartabo, August 27, 1920, Color Plate 213, total length 1342 mm., tail 242, eye diameter 6 mm., ventrals 219, subcaudals 144, weight 93.5 grams. Head above is buffy olive green, back the same, shading on posterior third to brownish-olive. Tail wholly black. Anterior half of body indistinctly banded with dusky, posterior half with 12 or 13 bands of hazel. Upper labials and ventral head empire yellow, shading posteriorly through olive yellow to light brownish-olive, and to purplish-black on tail.

Coll. No. 2857: Kartabo, male, May 10, 1924, total length 2060 mm., tail 550, eye diameter 9, body width 26, body height 41 mm., ventrals 222, subcaudals 135, weight 679 grams (1.5 pounds). This snake was very fierce when first caged and puffed out all along the body for a distance of at least twenty inches, the largest swelling being near the neck, a full three inches from side to side. The head seemed small and shrunken in its sunken position in the large bulging mass.

Coll. No. 30,281: Caripito, July 1, 1942, total length 2752 mm. (nine feet), tail 756 mm., ventrals 221, subcaudals 143, weight [illegible] grams (3.25 pounds). Above pale olive head plain with a narrow black line from the eyes back to three-fourths length of head behind. A series of dorsal V-shaped, black marks; narrow arms leading obliquely back from the apex. These marks become thicker as to arms and closer together, until at mid-body they merge and the pattern becomes solid black with well separated, double, vertical bands of sulphur yellow. These die out after four or five faint double lines on the tail. All of the remaining tail is jet black. Below, pale sulphur yellow, with a lateral series of freckled black spots, beginning at three feet from the head. These become more numerous, forming a checkerboard pattern with the sulphur yellow. About five feet back of the head, the black becomes dominant on the belly, leaving a lateral series of bright yellow spots which die out at the vent. Iris hazel with the usual outwardly directed series of fine dark brown lines.

Food: Consisting wholly of birds. (1) A domestic chicken and the feathers of some small bird. (2) Bones of birds. (3) Caught while being mobbed by a pair of kiskadees, with the head of the snake almost at the nest which contained three nestlings, twenty-five feet above the ground.

Siphlophis cervinus cervinus

(Laurenti, 1768).

Name: Yellow Frog Snake (Creole).

Range: Guianas, Trinidad and Brazil.

General Account: In 1916 and in 1920 I took three specimens of this snake, sent them north alive to the New York Zoological Park, where they were named by Dr. G. K. Noble. No. 182a was taken on December 20, 1920, and was 810 mm. over all. I find no further data.

Spilotes pullatus pullatus (Linnaeus, 1758).

(Plate X, Fig. 46).

Name: Tiger Snake.

Range: Mexico south to northern Brazil and Argentina.

General Account: Three specimens were caught at Kartabo in 1919, and two others at Guanoco, Venezuela, in 1922. All were sent alive to the New York Zoological Park. A sixth snake found half-devoured by vultures had the remains of a bird in its stomach. All these Tiger Snakes were brilliantly colored with contrasting black and yellow, and none were under five feet in length. No other notes were made.

Tantilla longifrontale (Boulenger, 1896).

Name: Black-headed Snake.

Range: Venezuela and Colombia.

General Account: This species was not found at Kartabo. The only specimen from Caripito was taken from the stomach of an *Erythrolamprus aesculapii*, which was 410

mm. in total length. The latter snake was uncovered in a patch of sand and leaves inside high jungle.

This little black-headed snake was quite perfect anteriorly, but having been swallowed tail first, the posterior part of its body and its tail were half-digested. It is Coll. No. 30,145 and was taken with its devourerer on June 18, 1942, and measures approximately 124 mm. over all.

The entire top of the head and nape is black except for a pale band across the nostrils and two large patches, side by side, on the nape. Laterally on the head, there is much less black around the eyes than in *T. melanocephala*, and considerably more white pigment back of the gape.

Tantilla melanocephala (Linnaeus, 1758).
(Plate X, Fig. 47).

Name: Pink-headed Snake.

Range: Central and South America south to Argentina.

General Account: A small dark brown snake, the head about the same size as the body, with no appreciable neck, tapering gradually to tail. Head darker, body lighter brown, snout, chin, throat, two nuchal bands and sides of body pinkish. Ventrals pale green.

Six specimens were taken at Kartabo but none at Caripito. Several of these were sent north alive, but on two, some detailed notes were made. All were found on the surface of the jungle floor except one which was burrowing. They were gentle snakes, almost never striking, and were delicate as well as timid, and did not survive long in captivity.

Measurements and Color in Life: Coll. No. 236, Kartabo, Color Plate 205, August 19, 1920, total length 328 mm., tail 66, head length 7.5, eye diameter 1.5, body width 5.5, body height 4.5 mm., rows of scales 15, ventrals 144, subcaudals 61, weight 3.3 grams. Head bone brown, snout dark russet brown and two narrow cross bands back of head pink. Back russet with three lateral lines of pink, separated by a broader upper and a narrower line of mottled black. Sides of head buffy pink. The brown of the head extends downward in three rather regular curves, one enclosing the eye, a second touching the gape and a third on the lateral scales of the neck, immediately in front of the lateral lines. Eye, pupil very large and round. Iris narrow and brilliant scarlet, rather dusky antero-posteriorly.

Coll. No. 325: Kartabo, September 12, 1920, total length 296 mm., tail 60 mm., weight 2.2 grams.

Food: Two specimens had eaten small insects, including two wood roaches.

Trypanurgos compressus (Daudin, 1803).
(Plate X, Fig. 48).

Name: Red-headed Water Snake.

Range: Guianas, Trinidad, Venezuela, Colombia, Bolivia and Brazil.

General Account: Two specimens were taken at Kartabo, one of which is No. 18,151 in the American Museum of Natural History. Not seen at Caripito. This is a slender, oval-headed snake, head and iris pink, a narrow pale yellow nuchal band, then an inch of black. The rest [redacted] ke is red [redacted] about 45 bl[redacted] rnate [redacted] one-third as w[redacted] erspaces. Whitish below.

One of the snakes was taken near the river, the second, No. 3267, November 20, 1920, total length 570 mm., became tangled and drowned on the submerged rope hawser of our motor boat, tied up at the Kartabo laboratory wharf. It must have become entangled in attempting to climb up from the water.

Measurements and Color in Life: Coll. No. 200, Kartabo, Color Plate 122, June 6, 1920, total length 450 mm., tail 105, eye diameter 2.3 mm., weight 6.5 grams. Head dark carnelian red, iris the same, pupil broadly vertically elliptical. Posterior head dull sulphur yellow. Body brownish-red with black markings. Below pinkish-white. Width of yellow collar 3.5 mm., black zone 16 mm. Forty-seven irregular markings of black along back and sides, extending from the black collar to the 15 mm. of tail tip, which are black. Of these markings 13 are complete bands, the rest being two rounded spots, alternating with each other. The relative widths are, black bands 3 mm., red spaces 8 mm.

Xenodon colubrinus (Günther, 1858).
(Plate XI, Fig. 49).

Name: False Fer-de-lance, Frog-eating Snake. False Labaria (Creole).

Range: Central America, Colombia, Peru, Bolivia, Brazil and British Guiana.

General Account: A heavy, thickset snake with very short tail. Adult usually mottled reddish-brown or grayish-black above with many indistinct cross bands of gray. Face and snout black, below mottled pale buff. Pupil round with scarlet ring, iris dark mottled. The young have twelve or more five-banded dorsal figures of gray and black on red brown background; white and mottled below. This terrestrial species was found occasionally at Kartabo, but not seen at Caripito. It occurred in marshy localities or wet jungle. No. 253 was caught when swimming a half-mile-wide river. The young are remarkably like fer-de-lance in patte[redacted] color and movements, especially s[redacted] posture.

Measurements and Color in Life: Coll. No. 652, Kartabo, April 29, 1922, young male, total length 445 mm., tail 60, head length 14, body width 12.5, body height 11 mm., ventrals 153, subcaudals 45, weight 33.5 grams. This young snake closely resembles a fer-de-lance except for the lack of a lemon yellow tail. The dorsal series of black and gray V-bands have the apices touching each other on the mid-dorsal line, unlike the condition in No. 240.

Coll. No. 240; Kartabo, Color Plate 212, August 20, 192[illegible] length 450 mm., tail [illegible] diam[illegible] [illegible]als 148, subcaudals 49, w[illegible] [illegible]. Head mottled with varying shades of pinkish-brown, pale on sides with brown blotches. There is a fairly distinct black line or band from snout above the nostrils back to eye, and from posterior eye to gape. The markings of the back are in the form of successive angled bands. The sequence of these, proceding posteriorly, is as follows: a wide, red brown interspace, V-shaped gray band and black band pointing posteriorly, a narrow red brown band or interspace, V-shaped black band and gray band pointing anteriorly, another wide red brown interspace, etc. There are 12 of these five-banded figures distributed along the body, giving place on the tail to faint, indefinite gray and black markings.

The chin and throat are immaculate white. Sides of body whitish, interrupted with large spots of brownish-black. These have a regular relation to the dorsal markings, there being one for each of the wide interspaces, and one for each of the four boundary bands of the narrow brown interspace. The mid-portion of the ventrals is mottled buff and olive brown, beautifully iridescent in strong contrast to the upper dull brown and gray surface. The eye is silvery with this color almost obliterated by a tangle of red brown threads radiating more or less regularly outward in all directions from the pupil. The ring around the latter is lemon yellow.

Coll. No. 735: Kartabo, male, August 29, 1922, total length 610 mm., tail 91, eye diameter 15.5 mm., ventrals 146, subcaudals 54, weight 36.5 grams.

Coll. No. 253: Kartabo, Color Plate 174, July 20, 1920, American Museum No. 18173, total length 970 mm., tail 125, head length 23, eye diameter 7 mm., weight 152.4 grams. Back reddish-brown with about 35 faint, irregular cross bands surrounded by brownish-black. Scales flecked with olive buff and mottlings of warm red brown, becoming redder near ventrals. Top of head brown, flecked with buff, the flecks increasing and [illegible]rging to form a pale temporal band. [illegible] face and ventral surface of head [illegible]s[illegible]ith scattered irregular spots of pinkish-buff. Ventrals buffy pink mottled with rose and brownish-olive. Iris dark brown finely flecked with gold, pupil round, with a bright red outer ring.

Food: (1) Large *Bufo marinus*. (2) A 55 mm. *Bufo typhonius*. (3) 3 *Microhyla microps*. (4) 27 tadpoles and half-tailed young frogs. (5) 1 young *Bufo guttatus*.

Xenodon severus (Linnaeus, 1758).

(Plate XI, Figs. 50 and 51).

Names: Frog Snake. Crapeau or Mattopi Snake (Creole).

Range: The Guianas, Venezuela, Colombia, Ecuador, Peru and Brazil.

General Account: A very poisonous-looking snake, with flat head, expansive neck, thick body and short, stubby tail. It is, however, a rapid mover. It was fairly common at Kartabo but not taken at Caripito.

The variety of pattern and coloring is almost indescribable. The adult snake tends to be monochrome, green, brown, black or rufous, and yellowish or gray below. But dorsal bands or spots may persist in large specimens, black-edged scales or more definite bands. The young usually have a complex angular pattern of bands and hourglass figures. One fairly consistent mark is a large central nuchal patch of pink, red, orange or rufous, surrounded by one or more concentric bands of the same color. This becomes very conspicuous when the snake flattens its neck, cobra-like. When dozens of detailed kodachrome photographs are available of individuals carefully measured and sexed, some semblance of order may emerge from the infinite variety of pattern and pigmentation. I present seven descriptions.

Most of these snakes were taken in bamboo clumps or when they were crawling across trails or over the jungle floor. Their pattern made them almost invisible when not in motion. No. 77 when frightened took to the water at once and swam to a floating bush. No. 65 was caught when swimming far from land, well out in the river. It swam very high, compressing the body as the boat approached and thus bringing all the concealed markings into view. It tried to climb aboard and when netted flattened its head and struck repeatedly. The markings were so much like those of a fer-de-lance that for a time we did not dare handle it.

No. 510 was one of the most nervous and irascible snakes I have ever seen, striking at the least annoyance, and spreading its neck to an astonishing width and flatness. This was done apparently by means of the ribs, and the conscious object was always to keep the flattened side toward the object of rage or fear, exactly as a male golden pheasant orients its ruff and body plumage broadside to the hen. At times, as I walked around the displaying snake, it would slowly

revolve its expanded neck, and even fold up one side to keep it broadways toward me. Attempts to take motion pictures were very difficult as the snake tired almost at once and after several short displays attempted only to escape.

Measurements and Color in Life: Coll. No. 344, Kartabo, Color Plate 256, October 12, 1920, half-grown male, total length 342 mm., tail 38, head length 15, eye diameter 5, body width 16, body height 10 mm., rows of scales 21, ventrals 139, subcaudals 34, weight 22.8 grams. This young snake differs in pattern from most adults. General color above dark brown, lighter on sides. There are twelve backward-pointing, broad, transverse-angled bands of pale wood brown, edged with darker, diminishing in width toward the tail, and breaking up into small, dark patches along the sides. The first of these bands lengthens out into an irregular head marking, back of the eyes. General color of head hair brown, with narrow transverse bands of gray across top of snout and between eyes, also a broad black velvety stripe backward from eye. Upper labials and sides of neck pale brownish-pink. Lower labials and chin creamy white. Ventral surface gray, with quite regular square pink patches along sides, which merge above abruptly with the wood brown of the sides. Iris, upper fifth pinkish-buff, the rest brown stippled with black. A narrow pupil ring of buff.

Coll. No. 2734: Kartabo, April 22, 1924, preserved skin, total length 485 mm., tail 50, jaw length 29, eye diameter 5.5, body width 19, body height 14 mm., ventrals 139, subcaudals 41, weight 24.5 grams. Dark brown with eight very wide pale brown, slightly angled bands, Ventrals dark gray edged with yellow. A large central nuchal area, and a broad anterior, triangular crescent pink, visible in the stretched skin.

Coll. No. 510: Kartabo, Color Plate 322, March 2, 1922, total length 640 mm. Above dark ferrugineous brown, becoming more red laterally, and changing beneath to pale reddish-ochre. Under surface of head orange buff. The background of the iris is tawny brown, except for lower right hand quarter, which is light buff, quite reddish at the bottom. The whole iris is finely stippled with dark brown; the narrow pupil rim is cinnamon.

Coll. No. 65: Kartabo, September 11, 1919, total length 711 mm., weight 80.5 grams. General color above dark ochraceous brown, with 12 to 15 angular, irregular, darker areas occupying the entire width of the dorsal surface and dying out toward the tail. Each dark area is bordered anteriorly and posteriorly with an irregular connected series of large spots of brownish-black. Beneath pale cream color, suffused with pale brown, becoming gray mixed with red on tail, and yellowish beneath the head. Sides of body with equally spaced dark reddish-brown spots, confluent with the darker color of the sides and of upper surface. Posteriorly these spots are connected with much broken bands of the same color. General color of head cinnamon brown. Labials, loreals, nasals and rostral yellow green, irregularly spotted with fine brown spots, confluent along the joinings of labial scales. A narrow line of the green from nostrils through the eye to angle of jaw. Another line just above this f[illegible]er of eye light olive brown, fo[illegible]to ge[illegible] body color. A dar[illegible]n prefrontals, extending t[illegible] anterior portion of frontal.

Coll. No. 608: Kartabo, Color Plate 333, fig. a, March 10, 1922, total length 810 mm. Head above olive green, sides paler. Neck when distended and flattened with a central solid patch of bright grenadine pink, surrounded at a distance by a larger, diamond-shaped band of the same color. This in turn is framed in a large patch of dark olive green. The extreme edges of the flattened nuchal hood are bright lemon yellow. Body generally deep olive green, with indistinct cross bands and diagonal markings of every conceivable kind, olive brown becoming darker toward the short tail. Lower labials and chin olive buff. Ventrals olive buff with irregular cross bands of light gray. Iris buffy brown with dark stippling toward the outer edge.

Coll. No. 3132: Kartabo, June 6, 1920, total length 1031 mm., fully adult snake. General color dark reddish-pink, shading to rich rufous on the tail, where there are large blotches of black.

Coll. No. 3133: Kartabo, October 2, 1920, total length 1503 mm., above blue black, with numerous, irregularly scattered scales of grass green. Ventral surface grass green.

Coll. No. 77: Kartabo, June 3, 1919, total length 1530 mm. (5 feet, 2 inches), body width 50 mm., weight 1245 grams (2¾ pounds). The largest of this species taken. Above dark olive buff, under surface straw yellow. Iris buckthorn brown.

Food: (1) Caught near laboratory attacking a small domestic chicken, while it had just swallowed a small marine toad. (2) Just caught a marine toad, 130 mm. long, still alive. Partly digested was a large frog buried in a mass of round worms. (3) 1 grasshopper, 1 *Atta* soldier, 2 large black ants, 1 small spider, 2 leaves. (4) 2 large *Leptodactylus* frogs, 1 *Ameiva*. (5) Small *Ameiva*.

Family Elapidae.

Coral snakes, while claiming close ki[illegible] with forms such as the common and [illegible] cobras and krait[illegible]re far less dan[illegible]

because of their small size and relatively short fangs. Most are characterized by brilliancy of coloring such as many successive bands of red, black and yellow. They are closely mimicked by several unrelated, harmless snakes.

They are burrowers and usually nocturnal, and feed on small lizards, frogs and insects. In the localities under consideration I found only two species although locally these snakes were almost abundant.

Micrurus lemniscatus (Linnaeus, 1758).

(Plate XII, Figs. 53).

Names: Tricolored Coral Snake. Hot Bead Snake (Creole). Koo-mung, "one who lives in the ground" (Akawai Indian).

Range: Northern and central South America.

General Account: Locally abundant at Kartabo, but in general, both there and at Caripito found only occasionally. About 35 were collected in all. Those snakes not actually dug up were found as they crawled slowly through the jungle, usually on overcast days.

The typical color pattern of the common Kartabo coral snake is a black snout, white loreal band and a broad scarlet complete band on the back of the head and nape. These are followed by the first of 14 to 17 body and tail pattern sequences, a large black area trisected by two narrow bands of white, followed in turn by a second scarlet interspace. The scarlet occasionally has the scales tipped with black, producing a dulling of the color, or very rarely there is a tinge of yellow on the white bands, but in no coral snake from British Guiana did I see true yellow bands. Considerable variation occurs in the pattern of the extreme head and tail, but it is always a regular carrying out and continuation of the somatic pattern sequence.

Measurements of three coral snakes of varying lengths are as follows: Coll. No. 825, total length 245 mm.; No. 236a, length 630; and No. 3552, length 900 mm. Tail respectively 20.7, 55 and 80 mm., ventrals 228, 254 and 226, subcaudals 34, 36 and 33, weights 3, 19.8 and 75 grams.

Color in Life: Among the 17 snakes taken from a single field there were only two noticeable variations. In one individual all the white bands were themselves bisected or split with narrow lines of black.

Coll. No. 230; March 27, 1919, total length 555 mm. Very aberrant in pattern, for while the white bands are very wide and conspicuous ventrally, they are almost absent on the back. The exact opposite is true of the red bands which are deep in color, with considerable black edging to the scales, yet below there is hardly a trace of this. Hence this individual is black above with strong red bands at wide intervals. Beneath it is black with twice as many broad white bands.

Coll. No. 3552: male, 900 mm. total length, June 30, 1924. This snake showed only ten sets of patterns on both body and tail, all the bands red, black and white being of unusual width and the white very heavily edged with black. Twenty-two years later in the dried, well-preserved skin all the whites are changed to bright yellow, the scarlet and black being unaltered.

Of the 35 specimens taken at Kartabo, 17 were captured in a single marshy field of some three acres extent, all within eleven days, from March 20 to April 1, 1919. Others were taken in the same field on May 20 of the same year. They were all uncovered while the field was being hoed. In total length the first 17 coral snakes measured from 241 mm. (9.5 inches), to 787.4 mm. (31 inches), the average being 577 mm. (22.5 inches). I also counted the scarlet bands on these snakes, including that on the head and that near the tip of the tail. Of two snakes with 14 red bands the average length was 591 mm. (23.25 inches). Seven with 15 bands averaged 628 mm. (24.7 inches), 3 with 16 bands averaged 530 mm. (20.8 inches), and 4 specimens with 17 red bands showed an average length of 534 mm. (21 inches). So age has nothing to do with the number of pattern series.

We found coral snakes much more violent and aggressive than we had been led to expect. When captured they twisted and fought and struck, until allowed to bury themselves in débris in vivariums. The tail seemed to have the ability to flatten itself slightly and when excited was often held upright and twisted about in its own orbit.

Micrurus psyches (Daudin, 1803).

(Plate XII, Figs. 54 and 55).

Name: Bicolored Coral Snake.

Range: Guianas and northeastern Venezuela.

General Account: This snake is found occasionally both at Kartabo and Caripito. About a dozen specimens were taken at the former place, none of which were associated with the concentrations of *Micrurus lemniscatus*. Without exception this species seemed more quiet and less aggressive than the congeneric form, almost never making any resistance at capture.

As will be seen from the various descriptions, the pattern shows considerable variation, the two most common phases being black above, with many pale yellow, narrow rings, or alternate broad bands of dark red and black throughout body and tail.

Measurements and Color in Life: Coll. No. 633, Kartabo, July 10, 1922, total length 250 mm., weight 4.5 grams. Black with 51

narrow white bands completely around body, and 5 wider ones on tail.

Coll. No. 2660: March 25, 1924, total length 295 mm., tail 35.8, eye 1.5 mm., ventrals 195, subcaudals 49, weight 6.2 grams.

Coll. No. 30,105: Caripito, May 17, 1942, total length 390 mm., tail 48 mm. On the body are 35 complete black bands, averaging three scales in width, bounded dorsally by single scale lines of white. The black bands are separated at equal distances by broad bands of pale red much dulled by black on the distal half of each scale, producing a checkered appearance. The black spots die out at the edge of the pale salmon ventrals. The red interspaces are about three times the width of the black bands.

Coll. No. 3263: Kartabo, March 16, 1921, total length 400 mm., tail 60 mm. Latero-ventral head band red, then a black nuchal band, next the first somatic red, black-tipped band. Twenty-four black bands on body separated by red interspaces, each of the latter four times as wide as the black. No segregation into pairs is observable. The red is very much dimmed by the half black scales. Ventrally, the red interspaces are immaculate. The tail has a wholly different pattern, being black above with eight pairs of single scale width, broken pink lines. Ventrally these widen, and broad, black subcaudal bands alternate with red spaces, with a mottling of black in the center of the latter.

Coll. No. 640: June 30, 1922, Color Plate 416, total length 425 mm., tail 40 mm., ventrals 213, subcaudals 32, weight 11 grams. This specimen has 35 red bands on the dorsal surface and an equal number of dark red ones.

Coll. No. 2735: April 4, 1924, total length 453 mm., tail 41, head length 12, eye 2.3 mm., ventrals 200, subcaudals 30, weight 15.5 grams. Black above with faint blue sheen and slight iridescence all over in the sunlight. There are 58 narrow rings of dull white, grouped in pairs on each side of interspaces which are narrower and darker than the spaces between the pairs. These rings are broken above, but form wider, well defined bands across the ventral surface. A broad band of pale yellowish-white diagonally forward across side of face. Four of the rings which occur on the tail have a yellowish tinge and are wider than the somatic white rings.

Coll. No. 3265: June 15, 1922, total length 465 mm., tail 63 mm. The pale body rings are very narrow and broken above, widening below where they can be observed to form rather indefinite pairs, covering one or two ventrals as compared with three or four ventrals between. The usual latero-ventral cephalic band. The first body pair of white lines, while very narrow above, are wide and actually fuse below, and the second pair almost joins ventrally. Altogether the 66 rings on body form 30 pairs. There are nine wide, unpaired white rings on the tail.

Coll. No. 634: September 10, 1919, total length 480 mm., tail 40 mm. Above iridescent dark steely blue, with about a dozen narrow, very faint cross bands on the anterior third of the body. From here back none are visible. Below we find the same iridescence, with 59 more or less regular cross bands of creamy white, usually covering half of two [redacted] ventrals. The bands occur on [redacted] the anterior ten [redacted] an area of 37 scales. A 60th band is found on the side of the head, beginning behind the eye and extending down across both jaws. The eye is small but well developed, the iris being dark brown.

Coll. No. 632: March 10, 1921, Color Plate 464, total length 400 mm., tail 50 mm. This specimen is unique in its pattern which closely resembles that of *Micrurus lemniscatus* although the coloring is quite different. The head is black except for a broad post-ocular, complete band of buffy yellow. There follows a wide area of black, trisected with two narrow, white lines. This black, white and yellow pattern is repeated ten times on the body and tail.

Food: The following are the contents of three stomachs: (1) Insect remains and a few quartz crystals. (2) A small snake. (3) Two small lizards, probably *Anolis*.

Breeding: The body of coral snake No. 640 was slightly enlarged posteriorly, and when it died two days after capture on June 22nd, two eggs were found, shell-less but almost full sized, elongate, measuring 7 by 25 mm.

Family Viperidae.

Lachesis muta (Linnaeus, 1758).

(Plate XII, Fig. 56).

Names: Bushmaster. Coonocooshe (Creole). Pah-tie-ee-sack (Awakai Indian).

Range: From Panama throughout northern and central South America.

General Account: The bushmaster is not rare at Kartabo but much less common than the fer-de-lance, whereas the opposite is true at Caripito where one encounters many more of the present species than fer-de-lance snakes. We seldom found a bushmaster in motion, but always coiled in a tight mat in a game trail. One of the first found was also the largest, No. 199, measuring 2596 mm., or eight feet, six inches over all. I have given an account of the capture of this giant in "Jungle Peace," pp. 188 to 195. It was sent north alive to the New York Zoological Park on April 10, 1916.

In the case both of the bushmaster the fer-de-lance [redacted] ondered why o[redacted]

were so often drawn to the coiled serpent before we were near enough to step on it. Experimenting with freshly caught specimens of both species I found that when I was tightly blind-folded I was aware of a distinct odor, even when six to ten feet away. This was especially true of the bushmaster, the odor being musky and very unpleasant. Unless we stopped and consciously sniffed, when our eyes were open other interfering sense impressions reduced the olfactory ones to a subconscious effect. While in the [illegible] masters closely associated with [illegible]mes in spiny palm scrub. [illegible]ping)

Measurements and Color in Life: Coll. No. 199, eight feet, six inches over all, Color Plate 181, fig. b, had more lilac and violet in its coloring than usual, and the iris was straw yellow instead of reddish. The large dorsal markings were dark lilac with black borders and outer frames of pale violet.

Coll. No. 3275: A male, July 24, 1920, Plate 181, fig. a. Total length 1038 mm. (45 inches), tail 92, head length 46, eye 4.5, body width 30, body height 27 mm., ventrals 220, subcaudals 40, weight one pound. The top of head was seal brown, mottled with paler. Body with wide diamond-shaped markings beginning at back of neck. Black lateral cephalic band running into a curved band from eye almost to first ventral. Above this a band of light brown, then a narrow, broken line of black. Tawny olive on upper neck. Upper labials and side of face pale buff, deepening to buffy brown on snout. Lower labials and throat white tinged with pinkish-buff. Iris flame scarlet, coarsely blotched and mottled with dark brown toward the outer rim, leaving a wide area immaculate around pupil. Pupil a rather wide vertical ellipse.

Coll. No. 656: Kartabo, July 7, 1922, Color Plate 421. Total length 1070 mm. (five feet, seven inches), tail 165, head length 70, head width 48, eye 6, body width 50, body height 45 mm., weight four and a half pounds. This was essentially a yellow brown phase and complete with the pattern of jungle débris when coiled as we first found it. The eye was scarlet, the head and much of the sides of the body pale wood brown. The postocular black band was very strongly marked. The dorsal diamonds were almost solid black, with a few rufous scales at their center, and each banded with a narrow frame of pale buff. The ventrals were yellowish-brown, and the dorsal markings became very irregular and whitish on the tail.

Food: Spiny rats seem to be the favorite diet of bushmasters both at Kartabo and Caripito. Five individuals were found feeding on these rodents.

Breeding: One female taken at Kartabo on April 6 contained seven nearly formed eggs, each three inches in length, and another snake captured on May 19 at Caripito had a 2½-inch shell-less yolk.

Bothrops atrox (Linnaeus, 1758).

(Plate XII, Figs. 57, 58 and 59).

Names: Fer-de-lance. Labaria (Creole). Sah-ru-rima (Akawai Indian).

Range: Mexico south to northern and central South America. Martinique and Tobago.

General Account: The fer-de-lance is a common snake at Kartabo but rather rare at Caripito. Between forty and fifty were taken alive and sent north or preserved. Young ones were frequently found in the bamboo clumps near the Kartabo laboratory and the larger ones on the deeper jungle floor. The fer-de-lance is nocturnal, but occasionally is active on overcast days. A full time embryo measured 10½ inches and the largest snake we saw, a female, was a little more than 4 feet, 3 inches over all.

Boulenger's color descriptions (Catalogue of Snakes of British Museum) are usually from preserved specimens, and wholly unlike those of living snakes, but the following characterization of this species is perfect: "Coloration very variable; gray, brown, yellow, olive or reddish above, uniform, or with more less distinct dark spots or crossbands, or with dark triangles on the sides inclosing pale rhombs. Lower parts yellowish, uniform or powdered or spotted with brown, or brown with light spots."

The only two really characteristic patterns which seem always to be present, are the dark band extending on the side of the head from the eye to the gape, and the conspicuous whitish or lemon yellow color of the tail.

Comparative measurements of 11 individuals, from 268 to 1290 mm. total length, are as follows:

Coll. No.	221a	3134	2762	2794	3531	2988	2788	221	3255	613	3121
Total length (mm.)	268	320	346	422	557	1040	1110	1120	1159	1228	1290
Tail (mm.)	38	42	46	62	72	153	150	120	159	168	165
Eye diameter (mm.)	3	3	3.5	3.5	3.9	5	5	5	5	5	6
Ventrals	204	201	200	191	207	205	203	196	204	195	206
Subcaudals	69	65	64	65	73	70	64	62	67	70	66
[illegible]ht (grams)	3.3	8.5	10.2	21	25	342	380	292	370	384	373

The head length in the two extremes of the embryo and the 1290 mm. specimen are 10 and 41 mm. The weight of the unborn embryo when the yolk sac is included, is increased from 3.3 to 10 grams.

Color in Life: Coll. No. 221a, Kartabo, nearly born embryo, length 268 mm., Color Plate 234, September 25, 1920. This one of eight nearly full-developed embryos was the offspring of No. 221. It was very active, dragging about its yolk-sac which weighed three times as much as itself. It showed two shades of lilac, very pale and darker, the two being arranged in a series of equally wide bands down the back. The characteristic dark eye to gape band, and the pale tail are both in evidence. The iris is much darker than in the usual fer-de-lance, and the wide pupil is vertical, not directed slightly forward as in older snakes.

Coll. No. 3100: young snake of 305 mm. length, June 14, 1919. Strong reddish-brown above with cross bands of dark olive, each constricted at mid-back. Whitish below, thickly checkered with pinkish-brown. Iris golden yellow, covered with a vertically striated mesh of black.

Coll. No. 2794: length 422 mm., May 11, 1924. Looked down upon as on a flat skin, the pattern is of a series of transverse, broad, hour-glass figures separated by narrow diamond interspaces. The boundaries are formed by narrow, yellowish-white lines. The anterior half of the body is of a general pale brown, the posterior half being much darker with a thick scattering of round, blackish-brown spots. Black, lateral head line and pale yellow tail as usual. Ventrals dominately black with many yellow spots.

Coll. No. 2827: length 465 mm., May 16, 1924. Similar to No. 2794, except that throughout, the hour-glass pattern is very dark, and the ventrals dominately yellow with dark lateral checkers.

Coll. No. 3258: length 615 mm., Color Plates 97 and 111, August 12, 1919. An extremely dark phase. Dark purplish-brown above, coarsely mottled with black. Tail very conspicuously lemon yellow, and ventrals bright salmon red, checkered with black. Head dark brown above, black on sides and below, with large patches of pink-bounded gray in the centers of 6 upper and 5 lower labials. Loreal scales pink, and iris pale gold with three broad antero-posterior bands of pinkish-red. Pupil, as in all fer-de-lance of this length and larger, tipped obliquely forward about twenty degrees.

Coll. No. 2788: female breeding, May 6, 1924, Color Plate 731, length 1110 mm. General color above hair brown with the typical *Bothrops atrox* markings showing as rhomboidal patches of dark brown, enclosing the lighter tone. These markings however are very faint. The top of the head has a faint greenish tinge. The labial region is light olive buff with very dark lateral facial line of broken streaks, which occur strongly on the keels of the scales, running from the eye back and obliquely downward. Ventrals cream buff shading to olive toward tail, and with touches of carnelian red on sides of the first few ventrals. Ventrals mottled, strongly toward tail, with light gray.

Coll. No. 221: female breeding (parent of No. 221a), length 1120 mm., Color plate 234, September [redacted] gray, paler at [redacted] at snout. Sides [redacted] purple, all labials thickly mottled with dark brown, and the usual lateral dark line. Body purplish-gray with dark, transverse triangular markings of dark lilac, edged with smoke gray. Chin light buff tinged with purplish, ventrals naples yellow, upper edges with touches of pink, fading to cream color, and mottled more and more thickly with bluish-gray toward tail. Iris warm yellow with dense flecking of dark gray and brown all over, except for pupil rim.

Coll. No. 613: length 1228 mm., Color Plate 400, June 14, 1922. General color of head and back hair brown, entire length with evenly spaced transverse bands of dark olive, over an inch in width at mid-body, all widely edged and blotched with black. The interspaces are edged with light grayish-olive and have a large, indistinct central diamond patch and lateral shading of brownish-black. Sides of head and lower labials bluish-gray with black loreal streak, and a few irregular black spots. Chin smoke gray anteriorly, becoming lighter under neck and merging into the general bright naples yellow of the ventral ground color. On the lateral portion of the ventrals is a series of large, irregular, roundish black spots, each separated by about two ventrals. Tail dull lemon yellow, inconspicuous. Iris ground color maize yellow, very heavily streaked and stippled with black, with a faint streak of red through the obliquely vertical pupil and a touch of red about the pupil rim.

Coll. No. 3121: length 1290 mm., Color Plate 180, July 25, 1920. Top of head brownish-black with supraoculars and keels of scales mouse gray. Loreals pink. Side of face antimony yellow, with three perpendicular marks on upper labials of black. Broad oblique band extending from eye almost to fourth ventral black. Body above with broad transverse bands of dusky violet edged narrowly with brown. Ventrals amber yellow deepening to apricot yellow on upper edges, mottled more and more thickly toward tail with black. Pupil a moderately wide, oblique ellipse. Iris pale yellow gold flecke[d] with ochraceous orange, with three zon[es]

mottling of dark brown, one at either end of pupil, and a broad band horizontally across the middle.

Food: Seven stomach contents were as follows: (1) A large *Leptodactylus pentadactylus*. (2) Remains of two mice. (3) In this snake, 887 mm. over all, was a spiny rat 410 mm. in length. (4) Two medium Ameivas. (5) 2 young spiny rats. (6) Unidentified lizard, small snake and the fur of some small mammal. (7) Shot while stalking a manakin.

Breeding: [redacted]tabo, 1110 mm. [redacted]ined 16 eggs about hali[redacted]2988, Kartabo, 1040 mm., taken on [redacted]19, 9 large eggs almost ready for deposition, measuring 20 by 30 mm. No. 221, Kartabo, 1120 mm. total length, captured on September 25, contained 8 young snakes almost ready for birth; No. 221a, 268 mm. long is one of these. No. 3249, Kartabo, 1140 mm., taken October 20, contained 11 large embryos.

Bothrops bilineatus (Wied, 1825).

(Plate XIII, Figs. 60 and 61).

Names: Tree Fer-de-lance, Green Fer-de-lance. Green Labaria (Creole). Eye-dee-ah-mo (Akawai Indian).

Range: Guianas, Brazil, Peru, Bolivia and Ecuador.

General Account: A rare snake at Karlabo, only three specimens being taken. It may well be more common than we think, owing to the difficulty of detecting it among the same colored jungle foliage. Except for the general green color it differs little from *atrox*, having even the lateral facial oblique band and the conspicuous, self-colored tail. It is pale leaf green above, uniform or sparsely spotted with darker, and yellow below. In the late *atrox* embryo the tail is 14 per cent. of the total length, and in the largest *atrox* taken it is 12 per cent. In the present species the tail is slightly longer, 15 to 16 per cent. of the length.

All three specimens were taken among the branches of low jungle shrubs. No. 354 was only five feet from the ground. I walked within a foot of the snake, and it made an abortive attempt at my face, striking the rim of my hat before I saw it and broke its back with my gun barrel.

Measurements and Color in Life: Coll. No. 345, Kartabo, April 4, 1920. Total length 540 mm., tail 80, head length 18, width 12, eye diameter 3, body width 12, body height 13 mm., rows of scales 33, ventrals 202, subcaudals 76, weight 38.2 grams. General color above lichen green, shading to grass green toward tail, which changes abruptly to pale pinkish-buff near the tip. Lateral [redacted]on side of head and about 40 sets of [redacted]ating, irregulars na[redacted] transverse dorsal marks light cadmium yellow, edged with black. Side of head greenish-yellow, shading into a wide patch of pieric yellow on the side of the neck, which in turn merges into the lateral body line of straw deepening to citron toward the tail. Ventrals pale lumiere green lighter toward tail, touched with lighter greenish-yellow on the lateral edges of the ventrals. Iris light yellow green flecked with darker green, paler toward pupil. The character of this marking is of a maze of indistinct fibers, extending more or less up and down. Pupil is an oblique vertical wide slit.

Coll. No. 2671: Kartabo, April 3, 1924, Color Plates 675 and 676. Total length 752 mm., tail 115, head length 26, eye 4, mm., rows of scales 31, ventrals 208, subcaudals 77, weight 39.4 grams. General color of head and back leaf green, dulled on head and anterior body by fine black dots which are larger and closer on the head. A lateral body stripe of chalcedony yellow extends along the outermost row of scales formed by the solid color of these scales and a small triangle at the edge of the ventrals. This yellow line is edged below by a narrow line of dark green along the ventrals. A band of ochraceous orange with faint black streaks extends from the eye to angle of mouth. This streak is broken in this individual snake on the left side by the intrusion of a single green scale. A few small markings of the same orange color occur at intervals along each side of the mid-back. Upper labials and a slight shading on the lower, lime green with scattered black dots. The remainder of the labials and chin pale lemon yellow which joins a lateral line on the side of the neck. Ventrals primrose yellow, paler toward tail, the tip of which for an inch is solid purplish-pink. Iris chalcedony yellow with fine stippling of jade green everywhere except at the top.

In 22 years this snake has changed to grayish-blue above, and the ventral yellow has become straw.

Coll. No. 267: Kartabo, November 5, 1920, Color Plate 262, total length 424 mm. Head above and back pale turquoise green with many irregular short markings down each upper side, each of which is orange framed with black dots and dashes. Scales of supra- and preocular areas of head pale greenish dotted with large black spots. Labials pale buffy yellow with considerable blotching of rich green. Postocular oblique band orange, spotted with black. Iris a maze of dark green fibrous markings. Chin and throat yellowish-white changing gradually into the general ventral color of immaculate pale blue green.

Food: No. 345 had swalowed a large *Hyla maxima*, 180 mm. over all. No. 267 had made

a meal of four large Hylas and two anolid lizards.

FAMILY CROTALIDAE.

Crotalus durissus terrificus (Laurenti, 1768).

(Plate XIII, Figs. 62 and 63).

Names: Green Rattlesnake. Jungle Rattlesnake. Cascabel (Spanish). Sak-kah-sak (Akawai Indian).

Range: Guianas, Venezuela and Colombia, to northern Argentine. Paraguay and south Brazil.

General Account: Very rare in the jungle at Kartabo where only three specimens were seen or taken during eight seasons. At Caripito not rare in the open llanos or savannas. One Kartabo snake had swallowed a large spiny rat.

Coll. No. 556: Kartabo, April 29, 1922, Color Plate 548. This was taken at night while crawling along a jungle trail near the laboratory. The tail was injured and there were only six remaining rattles. Like the other Kartabo specimens this rattler was green in general coloring, with variegated shades from pale to deep forest green, with irregular dorsal markings of black. The eyes were connected by a black band, and from the eyes back, two broad bands of dark brown extended along the body for some distance. The iris was green with two large vertical patches of brown mottling on the central three-fifths. The rather narrow pupil was vertical, not oblique as in the fer-de-lance. Below, the ventrals were creamy white, anteriorly deepening into greenish posteriorly.

Coll. No. 30058: Caripito, taken on the open savanna. It measured 740 mm. over all and was found on April 20, 1942. This and five others seen or taken were wholly brown of varying [illegible] black markings. The head [illegible] ish-black band [illegible] over the mid-crown on t[illegible] two indistinct bands of dull reddish extended from the lateral head along the back. A postocular band of black extended back to the gape, then turned forward along the line of the mouth, covering first the lower labials and then passing on to the upper ones, and swinging up and back to the anterior aspect of the eye. It actually joined the postocular streak by a broad central brown band across the iris itself. The rest of the iris was deep orange. A series of very distinct black diamonds, bounded with pale buff, extended down the back, with irregular lateral streaks posteriorly along the sides. The ventral surfaces were pale brown.

EXPLANATION OF THE PLATES.

(The black-and-white figures in the Plates are reproductions of color paintings by Isabel Cooper and Helen Tee-Van. Photographs are by William Beebe and John Tee-Van).

PLATE I.

Leptotyphlops septemstriata

Fig. 1. Life size photograph.

[illegible]tus

Fig. 3. *[illegible]*

Inilius [illegible]ale

Fig. 4. Head and fore body.
Fig. 5. Mounted skin. Photograph.

PLATE II.

Boa canina

Fig. 6. Boa in tree. Photograph.
Fig. 7. Head. Photograph.

PLATE III.

Constrictor c. constrictor

Fig. 8. Head of adult.
Fig. 9. Entire snake.
Fig. 10. Twelve-foot boa on ground. Photograph.

PLATE IV.

Epicrates c. cenchris

Fig. 11. Head.
Fig. 12. Entire snake.
Fig. 13. Boa constricting on arm.

PLATE V.

Eunectes gigas

Fig. 14. Entire snake.
Fig. 15. Head of adult.
Fig. 16. External hind claw.

PLATE VI.

Atractus trilineatus

Fig. 17. Head.
Fig. 18. Entire snake.

Chironius fuscus

Fig. 19. Head.

Clelia c. clelia

Fig. 20. Head.

Dipsas catesbyi

Fig. 21. Entire snake.

PLATE VII.

Dipsas indica

Fig. 22. Head and fore body.
Fig. 23. Entire snake.

Dipsas variegata

Fig. 24. Head.
Fig. 25. Entire snake.

Dryadophis b. boddaerti

Fig. 26. Head.
Fig. 27. Head of young snake.

PLATE VIII.

Drymarchon c. corais

Fig. 28. Entire snake.
Fig. 29. Head.

[illegible]

Erythrolamprus aesculapii

Fig. 30. Head and fore body.
Fig. 31. Entire snake.
Fig. 32. Entire snake, variation.

Imantodes cenchoa

Fig. 33. Head.
Fig. 34. Entire snake.

PLATE IX.

Leimadophis reginae

Fig. 35. Head.

Leptodeira a. annulata

Fig. 36. Head.

Leptophis a. ahaetulla

Fig. 37. Head.

Oxybelis a. aeneus

Fig. 38. Head.
Fig. 39. Entire snake.

Oxybelis fulgidus

Fig. 40. Head.

PLATE X.

Pseustes poecilonotus polylepis

Fig. 41. Head.
Fig. 42. Head and fore body.
Fig. 43. Snake mimicking liana.

Pseustes s. sulphureus

Fig. 44. Snake puffing, side view.
Fig. 45. Snake puffing, front view.

Spilotes p. pullatus

Fig. 46. Head.

Tantilla melanocephala

Fig. 47. Head.

Trypanurgos compressus

Fig. 48. Head.

PLATE XI.

Xenodon colubrinus

Fig. 49. Head.

Xenodon severus

Fig. 50. Entire snake.
Fig. 51. Snake flattening head and neck.

Micrurus lemniscatus

Fig. 52. Head.
Fig. 53. Entire snake.

PLATE XII.

Micrurus psyches

Fig. 54. Head.
Fig. 55. Entire snake.

Lachesis muta

Fig. 56. Head.

Bothrops atrox

Fig. 57. Head, adult male.
Fig. 58. Head, adult female.
Fig. 59. Heads and coiled embryos.

PLATE XIII.

Bothrops bilineatus

Fig. 60. Head.
Fig. 61. Entire snake.

Crotalus durissus terrificus

Fig. 62. Entire snake.
Fig. 63. Head.

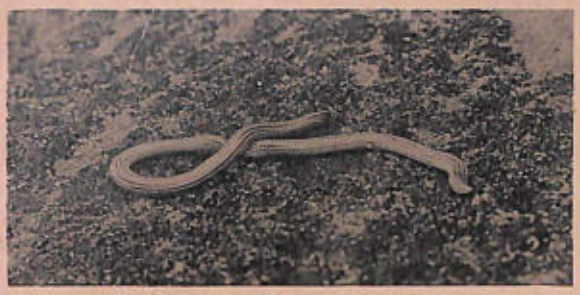


FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

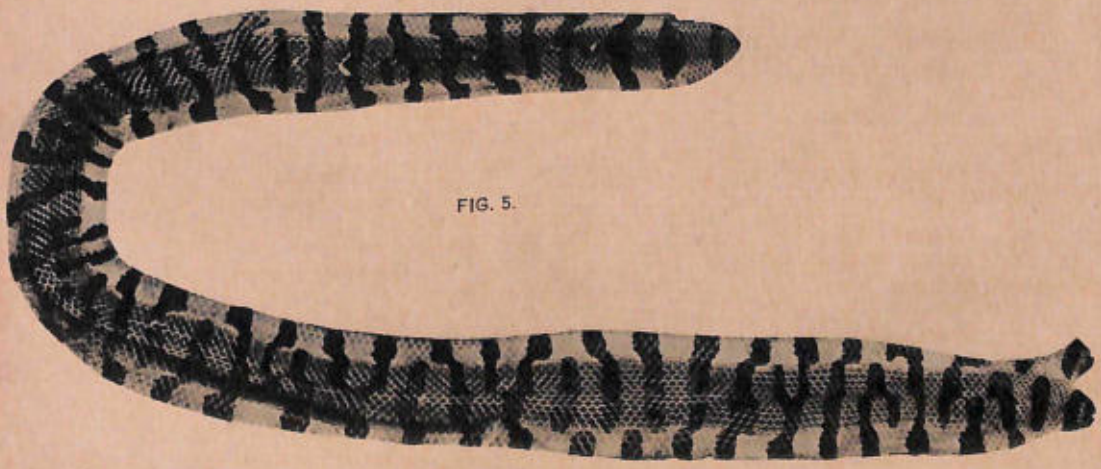


FIG. 5.

FIELD NOTES ON THE SNAKES OF KARTABO, BRITISH GUIANA, AND CARIPITO, VENEZUELA.

FIG. 6.

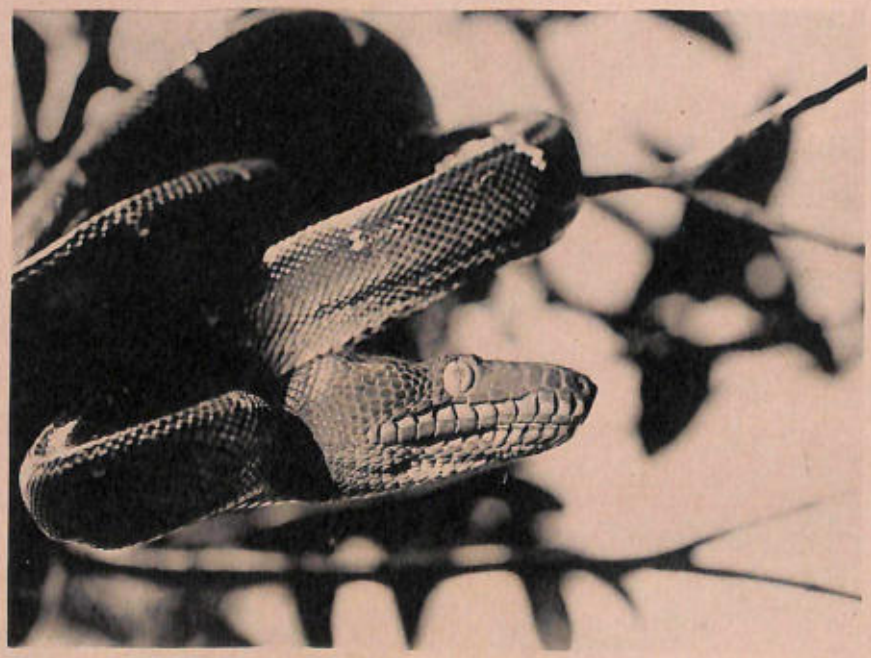


FIG. 7.

FIELD NOTES ON THE SNAKES OF KARTABO, BRITISH GUIANA, AND CARIPITO, VENEZUELA.

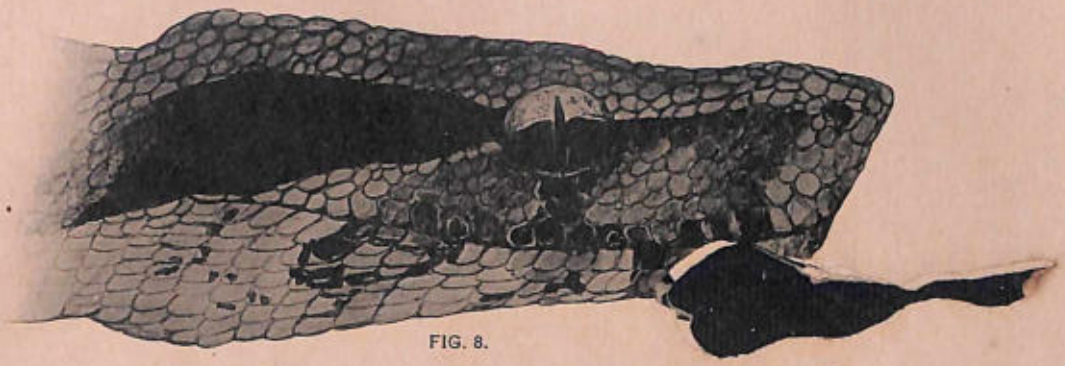


FIG. 8.

FIG. 9.

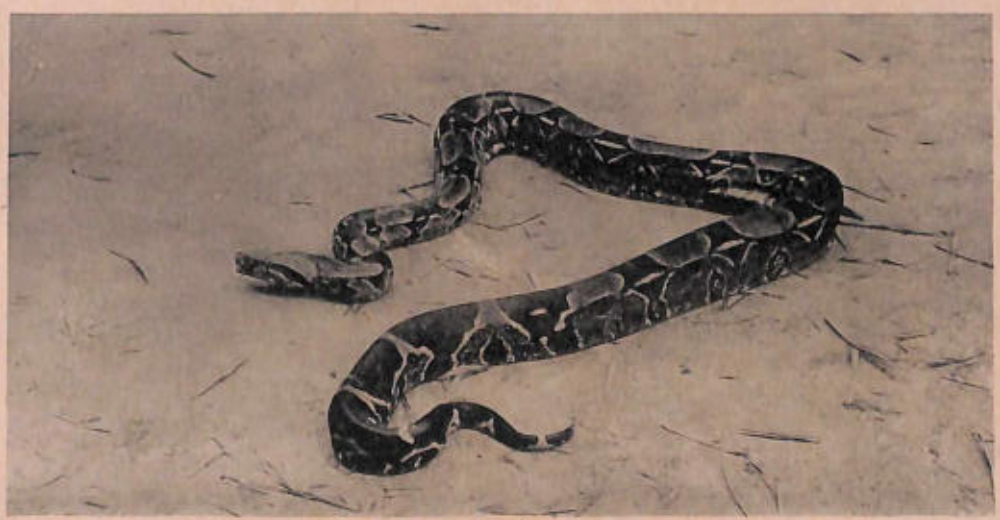


FIG. 10.

FIELD NOTES ON THE SNAKES OF KARTABO, BRITISH GU
AND CARIPITO, VENEZUELA.

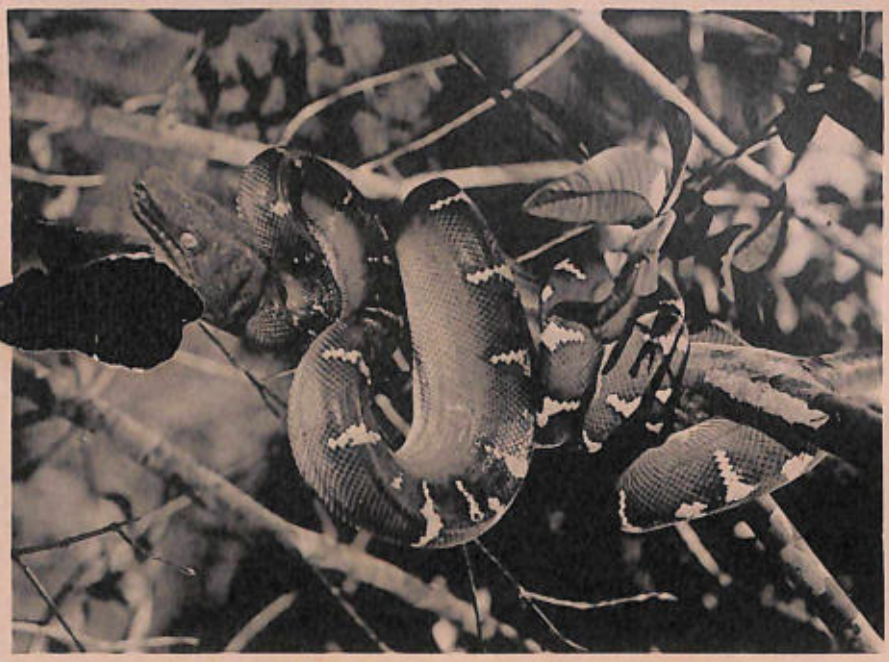


FIG. 6.

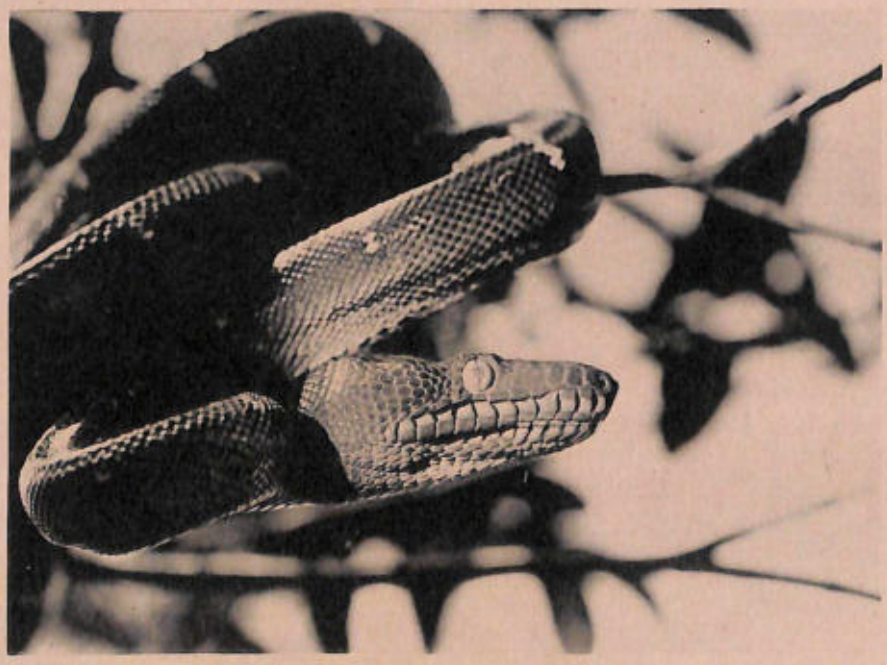


FIG. 7.

FIELD NOTES ON THE SNAKES OF KARTABO, BRITISH GUIANA, AND CARIPITO, VENEZUELA.

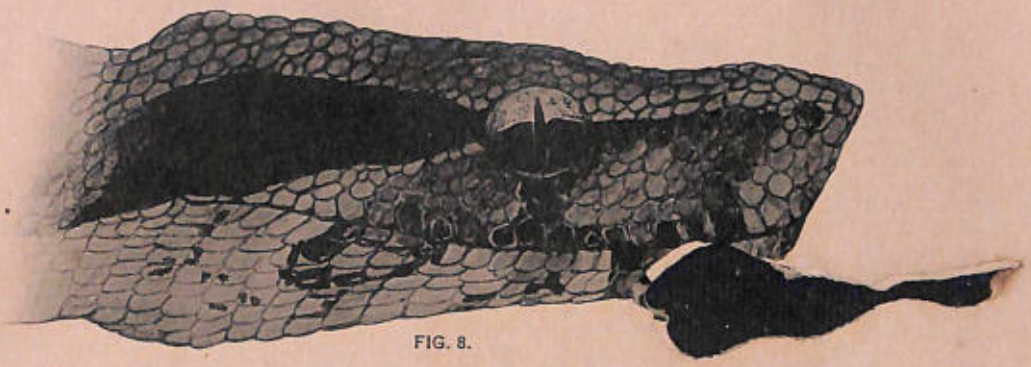


FIG. 8.

FIG. 9.

FIG. 10.

FIG. 11.

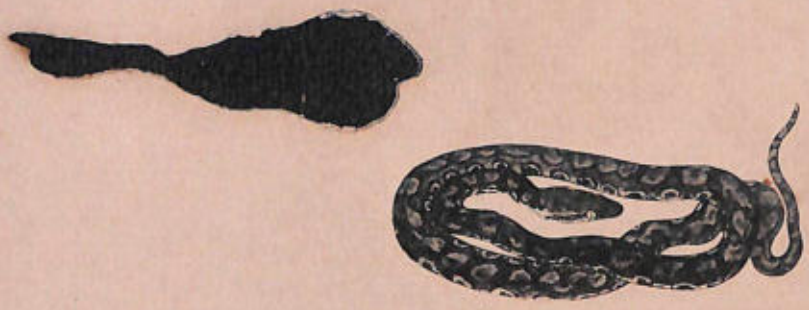


FIG. 12.

FIG. 13.

FIELD NOTES ON THE SNAKES OF KARTABO, BRITISH GUIANA, AND CARIPITO, VENEZUELA.

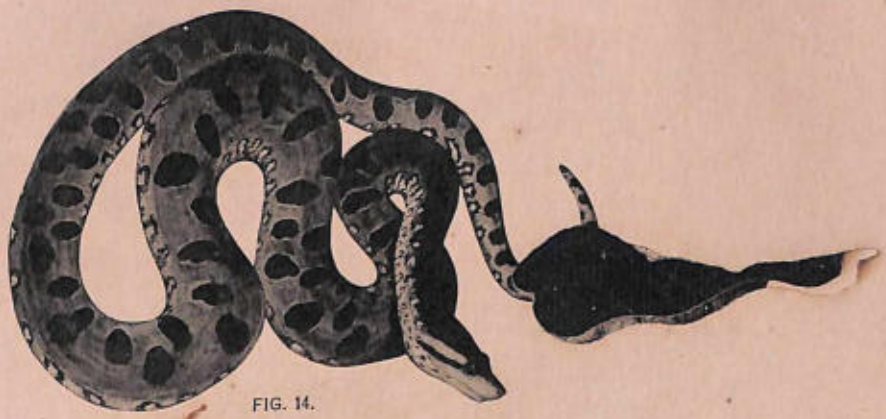


FIG. 14.

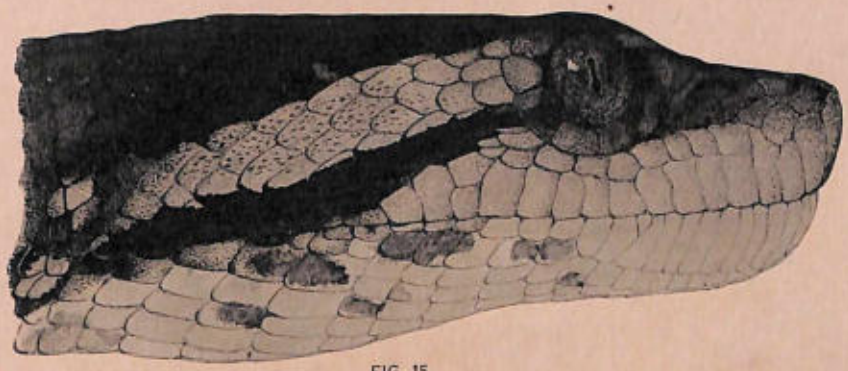


FIG. 15.

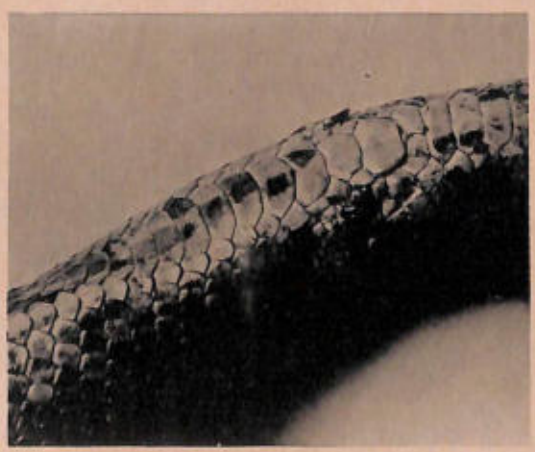


FIG. 16.

FIELD NOTES ON THE SNAKES OF KARTABO, BRITISH GUIANA, AND CARIPITO, VENEZUELA.

FIG. 17.

FIG. 18.

FIG. 19.

FIG. 20.

FIG. 21.

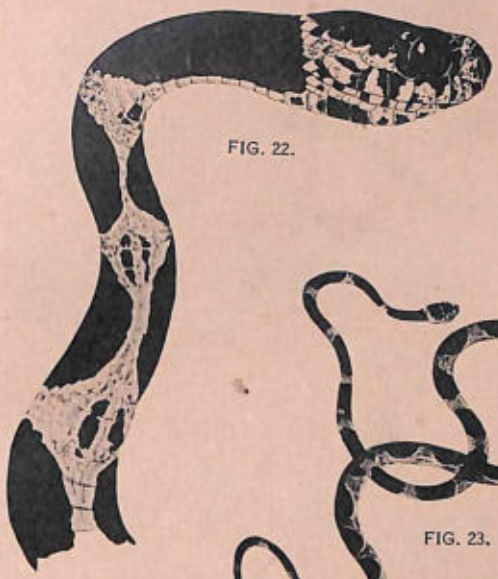


FIG. 22.

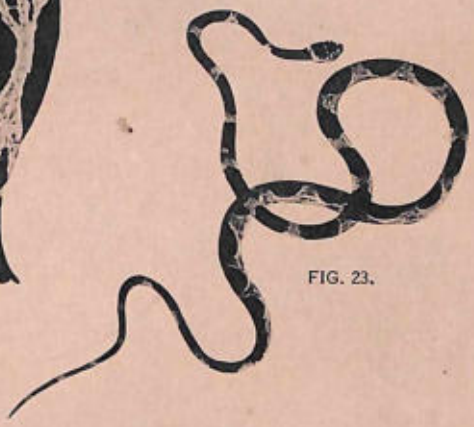


FIG. 23.

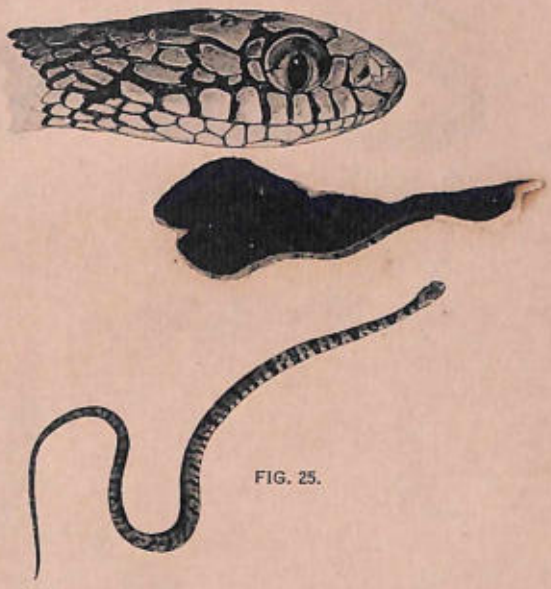


FIG. 25.

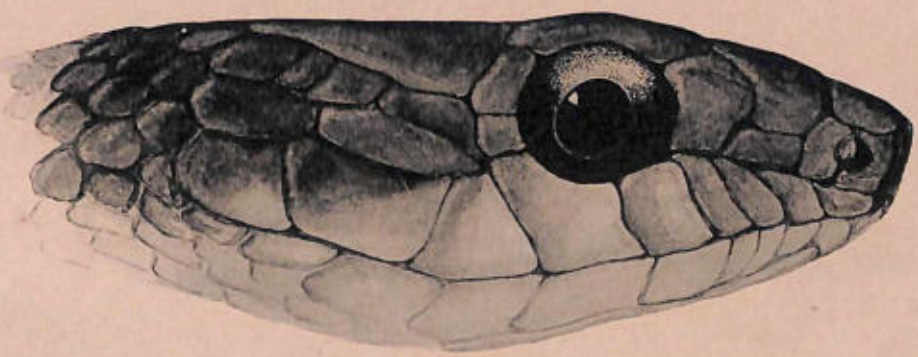


FIG. 26.

FIELD NOTES ON THE SNAKE[illegible]RTABO, BRITISH GUIANA,
AND CARIP[illegible]EZUELA.

FIG. 28.

FIG. 29.

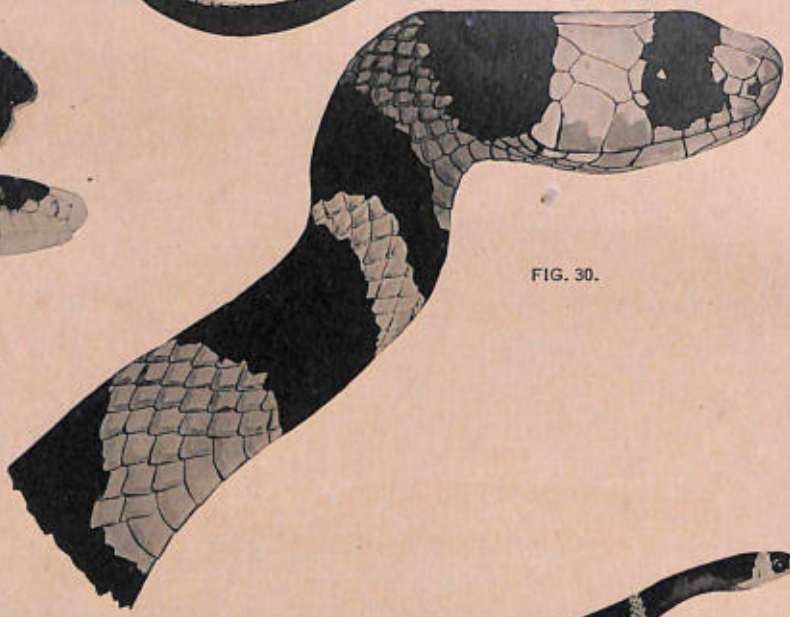


FIG. 30.

FIG. 31.

FIG. 33.

FIG. 32.

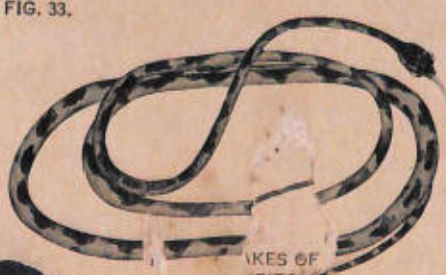


FIG. I.

FIELD NOTES ON THE SNAKES OF KARTABO, BRITISH GUIANA, AND CARIPITO, VENEZUELA.

FIG. 35.

FIG. 36.

FIG. 37.

FIG. 38.

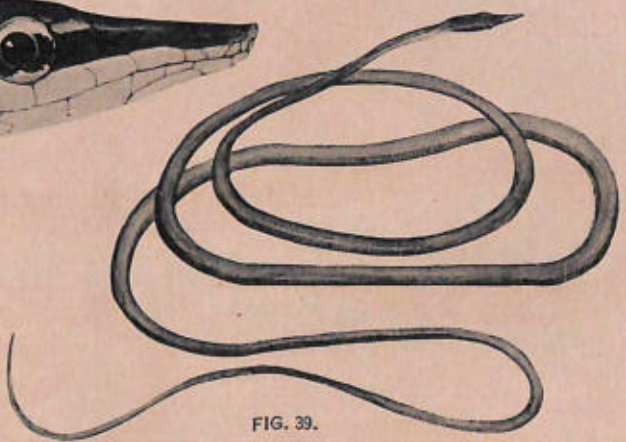


FIG. 39.

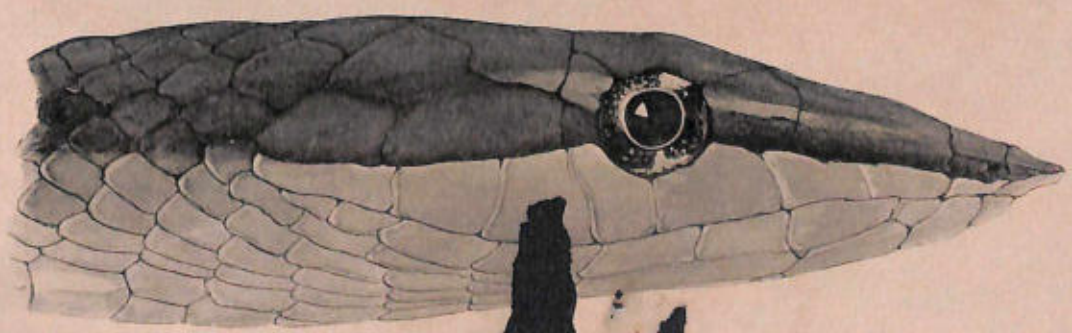


FIG. 41.

FIG. 42.

FIG. 43.

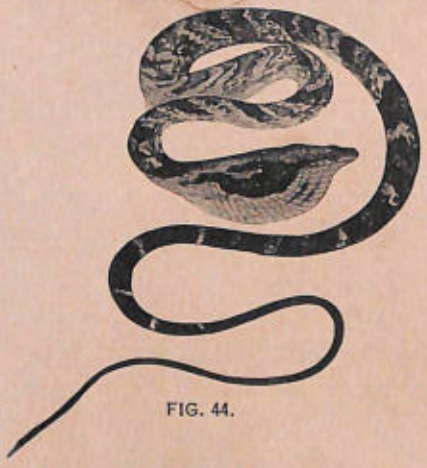


FIG. 44.

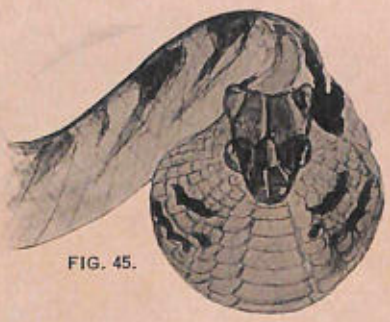


FIG. 45.

FIG. 46.

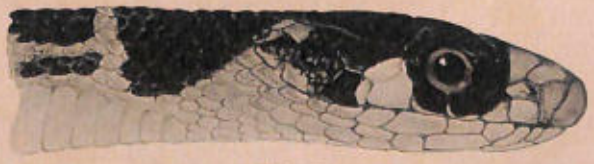


FIG. 47.

FIG.

FIELD NOTES O[illegible] TABO, BRITISH GUIANA,
[illegible] ZUELA.

[illegible] OTES ON

FIG. 49.

FIG. 50.

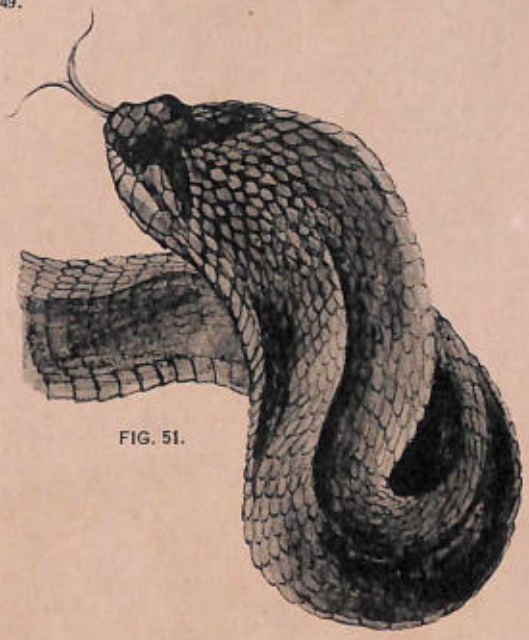


FIG. 51.

FIG. 52.

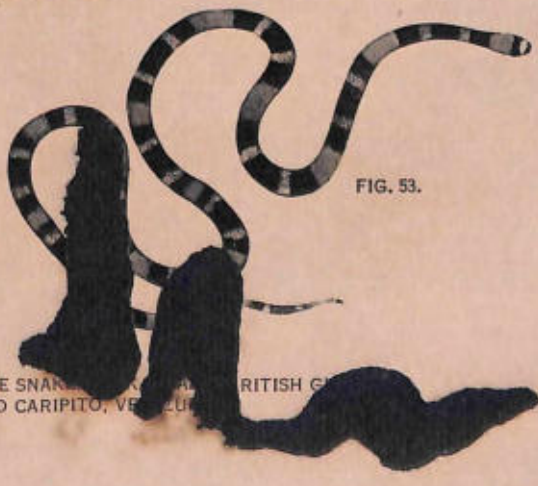


FIG. 53.

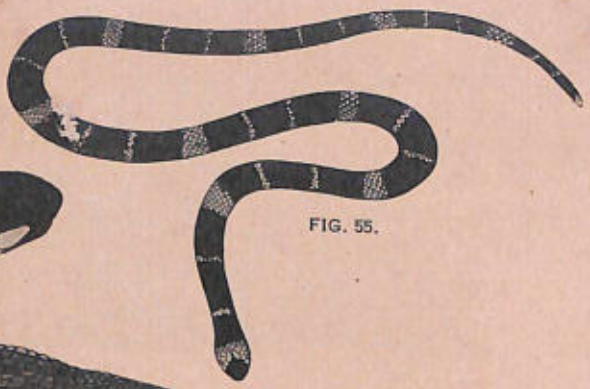


FIG. 55.

FIG. 54.

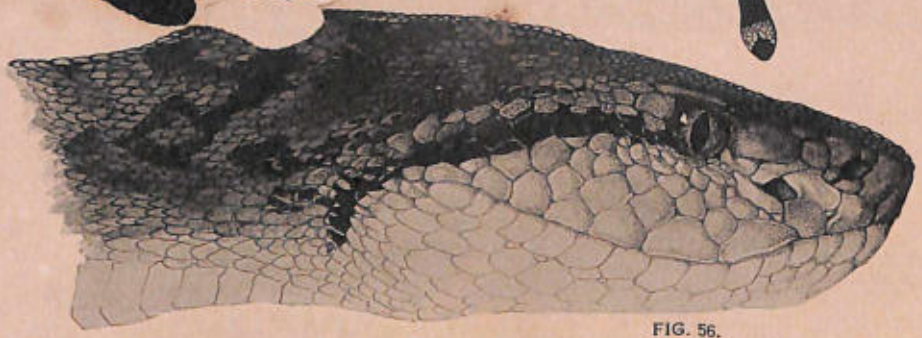


FIG. 56.

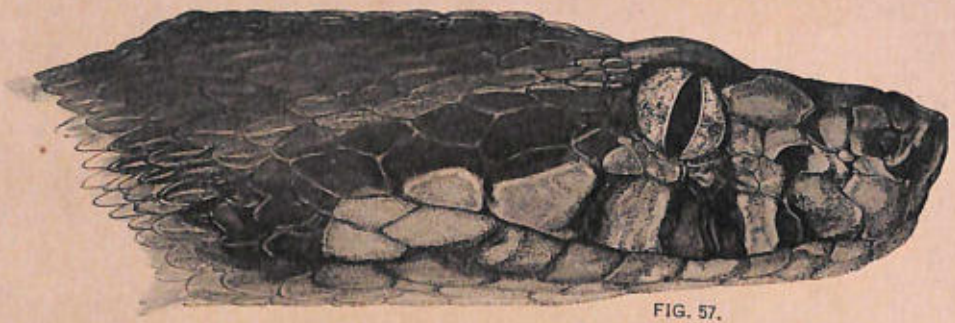
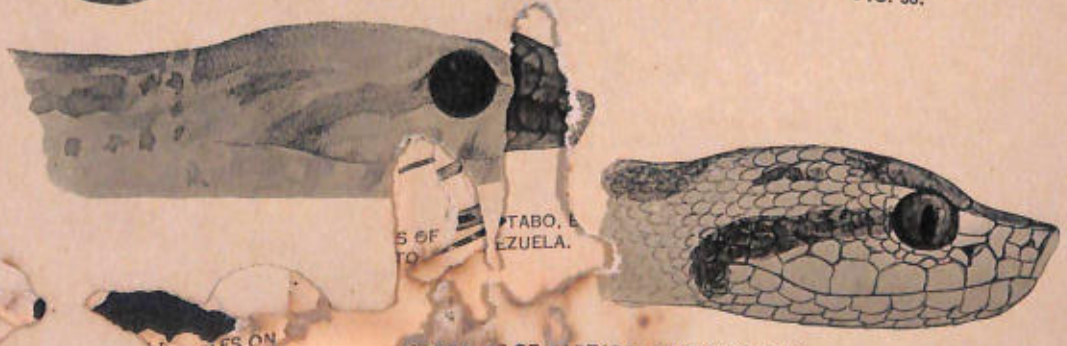


FIG. 57.

FIG. 58.

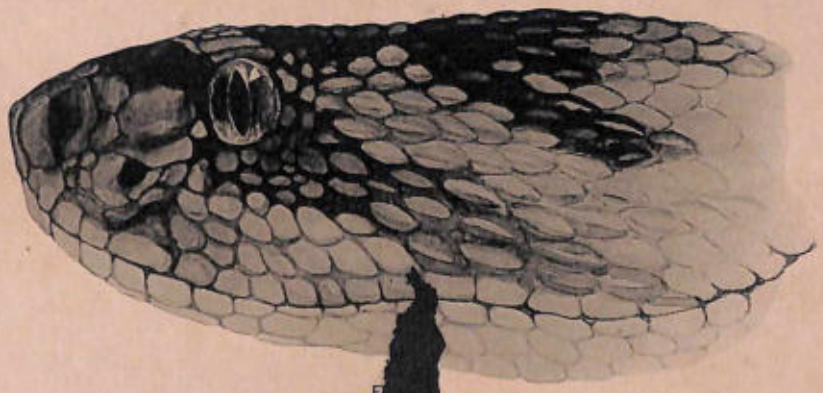


THE SNAKES OF KARTABO, BRITISH GUIANA, AND CARIPITO, VENEZUELA.

FIG. 60.

FIG. 61.

FIG. 62.



F

FIELD NOTES ON THE S F KARTABO, BRITISH GUIANA,
AND C VENEZUELA.

5.

Eastern Pacific Expeditions of the New York Zoological Society. XXXIV. Mollusks from the West Coast of Mexico and Central America. Part III.[1]

LEO GEORGE HERTLEIN & A. M. STRONG.

(Plate I).

[This is the thirty-fourth of a series of papers dealing with the collections of the Eastern Pacific Expeditions of the New York Zoological Society made under the direction of William Beebe. The present paper is concerned with specimens taken on the Templeton Crocker Expedition (1936) and the Eastern Pacific *Zaca* Expedition (1937-1938). For data on localities, dates, dredges, etc., refer to *Zoologica*, Vol. XXII, No. 2, pp. 33-46, and Vol. XXIII, No. 14, pp. 287-298.]

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INTRODUCTION.

This is the third of a series of papers dealing with collections of mollusks taken on the Templeton Crocker Expedition (1936) and the Eastern Pacific *Zaca* Expedition (1937-1938). The general plan of presentation followed in the present contribution is that mentioned in Part II of this series of papers[2]. Formal headings and keys are given only for the species collected by the Expeditions of 1936 and 1937-1938.

[1] Contribution No. 737, Department of Tropical Research, New York Zoological Society.

[2] Hertlein, L. G., and Strong, A. M. Eastern Pacific Expeditions of the New York Zoological Society. XXXII. Mollusks from the West Coast of Mexico and Central America, Part II. *Zoologica*, New York Zool. Soc., Vol. 28, Pt. 3, December 6, 1943, pp. 149-168, pl. 1.

Acknowledgment is due Dr. G. D. Hanna, Curator, department of Paleontology of the California Academy of Sciences, for assistance and suggestions. Acknowledgment is also due Dr. A. Myra Keen of Stanford University, Mr. A. G. Smith, Berkeley, California, Mr. George Willett of the Los Angeles County Museum of History, Science and Art, and Mr. C. G. Abbott, director of the San Diego Society of Natural History. The preparation of photographs by Mr. Frank L. Rogers is here acknowledged: his work was accomplished during the course of Federal Works Progress Administration Project Number 8569.

CLASS PELECYPODA.

Order Prionodesmacea.

Superfamily Ostracea.

FAMILY OSTREIDAE.

Genus **Ostrea** Linnaeus.

Key to the species of *Ostrea*.

A. Margin with denticles or transverse striae
  a. Margin plicated
    b. Upper valve flat, fitting into the lower ..... *palmula*
    bb. Upper valve arched, interlocking with the lower
      c. Shape arcuate, with 4 or 5 large corrugations; denticles along dorsal half of margin.... *megodon*
      cc. Shape round or subrounded; transverse striae on margin just below hinge..... *fisheri*
  aa. Margin usually not plicated; interior iridescent, burnished bronze, or white ..... *iridescens*
B. Margin without denticles or transverse striae ..... *columbiensis*

Ostrea columbiensis Hanley.

Ostrea columbiensis Hanley, *Proc. Zool. Soc. London*, for 1845 (issued February, 1846), p. 107. "Hab. St. Elena, West Columbia, adhering to the rocks at half-tide (Cuming)".—Sowerby, Conch. Icon., Vol. 18, *Ostraea*, January, 1871, species 10, pl. 7, figs. 10a, b. "St. Helena, Cuming. Mazatlan. Lower California".

Type Locality: Santa Elena, Ecuador, adhering to rocks at half-tide.

Range: San Bartolome [Turtle] Bay, Lower California, and the Gulf of California, to Coquimbo, Chile.

Collecting Station: Nicaragua: Isla Encantada, Corinto.

Description: Shell varying in shape from suborbicular to oblong, often about 3 inches long; lower valve usually attached by its entire lower surface; the upper valve fits into the lower and is continued by lamellae to the margin which often expands into wavy foliations; upper surface often rayed with purple on a white ground; the interior of the valves white; margin not dentate; scar reniform in shape; the margin as well as the muscle scar is usually colored purple.

Ostrea columbiensis never attains the size or thickness of *O. chilensis* Philippi. It also differs in the purple margin and in the presence of yellow or purple rays ornamenting the upper valve.

Distribution: This species occurs from Lower California to Chile and is usually found adhering to rocks or mangroves. It is gathered and sold for food in the markets of Peru.

Ostrea fisheri Dall.

Ostrea jacobaea Rochebrune, *Bull. Mus. Nat. Hist. Nat. Paris*, Vol. 1, 1895, p. 241. "Iles de la Baie de la Paz."—Contreras, *An. Inst. de Biologia*, Vol. 3, No. 3, 1932, p. 210, figs. 22 and 23. Islands of San Jose and Espiritu Santo, Gulf of California.

Ostrea fisheri Dall, *Nautilus*, Vol. 28, No. 1, May, 1914, p. 1. "Gulf of California." New name for *Ostrea jacobaea* Rochebrune, not *O. jacobaea* Linnaeus.

Type Locality: Islands in the Bay of La Paz, Lower California.

Range: San Luis Gonzaga Bay, Gulf of California, to Panama and the Galápagos Islands.

Collecting Station: Mexico: Santa Inez Bay, Gulf of California.

Description: Subcircular or rounded in outline, thick, valves gently arched, externally colored blackish-purple or dark red; margin often but not always with 6 to 8 plications which in some specimens give rise to irregular hollow tubercles; margin without denticles; ligamentary pit triangular and small in proportion to the size of the shell; transverse striations occur along the margin just below the ligamentary pit; interiorly the margin and the muscle scar are colored purple and in some specimens nearly all the interior is colored blackish-purple but in others the earlier portion is white. A large specimen from La Paz, Lower California, in the collections of the California Academy of Sciences, measures approximately 172 mm. from beak to base.

Ostrea fisheri bears a resemblance to *O. hyotis* Linnaeus, an Indo-Pacific species, and also to *O. sinensis* Gmelin, described from China. It also resembles *O. thomasi* McLean,[3] a species living off Florida, and *O. tamiamiensis* Mansfield from the Pliocene of Florida.

Distribution: *Ostrea fisheri* occurs at

[3] *Ostrea (Ostrea) thomasi* McLean, *Not. Nat. of Acad. Nat. Sci. Philadelphia*, No. 67, January 14, 1941, p. 7, pl. 3, figs. 1, 2, pl. 4, figs. 1, 2. The type was "dredged off Palm Beach, Florida, in 300 feet of water. It was firmly attached to a piece of coral. . . ."

various localities from the Gulf of California to the Galápagos Islands but so far as known it appears to be abundant only in the southern part of the Gulf of California. It is known to occur from Pliocene to Recent.

Ostrea iridescens Gray in Hanley.

Ostrea iridescens Gray, M.S. in Hanley, Conch. Miscell., *Ostrea*, 1854, pl. 2, figs. 6 and 7—Contreras, *An. Inst. de Biologia*, Vol. 3, No. 3, 1932, p. 194, figs. 1 and 2. San Lucas; Mazatlan to Panama. [Not all the synonymy. Not the record "la costa occidental de Africa."]

Ostraea spathulata Lamarck, Sowerby, Conch. Icon., Vol. 18, *Ostraea*, 1871, species 13, pl. 8, fig. 13. "Guacomayo, Co. of America".

Not *Ostrea spathulata* Lamarck, *Hist. Nat. Anim. s. Vert.*, Vol. 6, 1819, p. 206.

Type Locality: Reef at Panama City, Panama (here designated).

Range: La Paz, Lower California, to Panama.

Collecting Stations: Mexico: Banderas Bay, shore; Tenacatita Bay, shore; Port Guatulco, shore; Santa Cruz Bay, shore; Tangola-Tangola Bay, shore; El Salvador: Conchaguita Island, Gulf of Fonseca; Nicaragua: Potosi and Monypenny Point, Gulf of Fonseca; Costa Rica: Gulf of Dulce; Port Culebra.

Description: Shell elongately rectangular, with laminated structure, hinge long and square; large denticles occur along the margin below the hinge, and these fit in corresponding sockets in the opposite valve; the color of the interior is sometimes white but is usually beautifully iridescent and often of a brownish metallic luster; the muscle scar is large, reniform and variable.

This species has sometimes been cited under the name of *Ostrea prismatica* Gray, a South African species.

Distribution: *Ostrea iridescens* occurs from the Gulf of California to Panama and is often observed on rocks exposed between tides. The species is known to occur in the Pleistocene of Mexico and Ecuador and it probably occurs in the Pliocene of Peru.

Ostrea megodon Hanley.

Ostrea megodon Hanley, *Proc. Zool. Soc. London*, Pt. 13, for 1845 (issued February, 1846), p. 106. "Hab. Peru (Cuming). Mus. Cuming."—Sowerby, Conch. Icon., Vol. 18, *Ostraea*, 1871, species 24, pl. 12, figs. 24a, 24b. Peru.

Type Locality: Peru.

Range: Scammon Lagoon, Lower California, and the Gulf of California, to Paita, Peru.

Collecting Station: Costa Rica: 14 miles S.E. of Judas Point (214-D-1-4), 42-61 fathoms, mud, shell, rocks.

Description: Shell arcuate, usually attached by the tip of the umbo; margin folded into 4 or 5 large rounded plications and occasionally with additional smaller folds posteriorly; a row of denticles usually occurs along the margin from the hinge to about half the length of the shell; interior white with green or whitish-green margin.

Related species occur in the Miocene of the Caribbean region.

Distribution: This species occurs from Lower California to Peru. It usually occurs in fairly shallow water. The specimens in the present collection were dredged in 42-61 fathoms. The species is known from Pliocene to Recent.

Ostrea palmula Carpenter.

Plate I, Figure 14.

Ostrea ? conchaphila, var. *palmula* Carpenter, Cat. Mazatlan Shells, March, 1856, pp. 163, 550. "Mazatlan; extremely rare; L'pool Col. S. W. Mexico, P. P. C.—Upper California, Nuttall."

Ostraea mexicana Sowerby, Conch. Icon., Vol. 18, *Ostraea*, 1871, species 35, pl. 16, figs. 35a, b, c. "Tehauntepec, Mexico."

Type Locality: Mazatlan, Mexico.

Range: San Ignacio Lagoon, Lower California, and the Gulf of California, to Tumaco, Colombia, and the Galápagos Islands.

Collecting Stations: Mexico: Concepcion Bay, Lower California, 2½ to 4 fathoms, attached to calcareous material; Port Guatulco; Nicaragua: San Juan del Sur; Costa Rica: Port Parker; Colombia: Gorgona Island.

Description: Attached by the lower valve which turns up forming a cup-shaped depression; upper valve nearly flat and fitting into the upturned lower valve; margin usually plicated, sometimes with as many as 15 foliaceous plications; the exterior is usually some shade of green or purplish-blue; interiorly the margin is ornamented by a row of fine denticles which fit into corresponding sockets in the opposite valve; the margin is colored a dark purplish-blue, the muscle scar may be dark bluish-purple or light olive in color and the remainder of the interior may be white, olive, or bluish in color.

Ostrea palmula is a variable species and has been described under several different specific names in the literature. It is characterized by the flattish upper valve which fits into the plicate lower valve, and by the purplish-blue dentate margin. The form cited under this name from California and Washington can be referred to *Ostrea lurida laticaudata* Carpenter.

Distribution: *Ostrea palmula* occurs abundantly between tides at many localities from Lower California to Panama and the Galápagos Islands. It is usually attached to rocks or to mangroves and occurs abundantly on reefs exposed to the surf. It is known to

occur in the Pleistocene and probably occurs from Pliocene to Recent in the Gulf of California region.

Superfamily Pectinacea.

FAMILY PECTINIDAE.

Genus **Pecten** Müller.

Key to the subgenera of the Pectinidae.

A. Right valve arched, left valve flat or nearly so ..... *Pecten* s.s.
B. Both valves convex
  a. Shell corrugated, usually thick, strongly sculptured, usually brightly colored
    b. Ribs and interspaces strongly radially striated
      c. Shell large, very thick, ribs 9-12, often noded ..... *Lyropecten*
      cc. Shell smaller, thinner, ribs 5-7, not noded ..... *Mesopeplum*
    bb. Ribs and interspaces without strong radial striae
      d. Ears nearly equal in length
        e. Shell small, oblique, thin ..... *Leptopecten*
        ee. Shell large, less oblique, thick, very convex ... *Plagioctenium*
      dd. Ears unequal in length, the right markedly the longer ... *Chlamys*
  aa. Shell not corrugated, very thin, glassy, delicate sculpture, colored wholly or partly white
    f. Both valves with radial or reticulate sculpture ..... *Delectopecten*
    ff. Right valve with concentric, the left with radial, sculpture *Cyclopecten*

Subgenus **Pecten** s.s.

Key to the species of *Pecten* s.s.

A. Right valve very highly arched; about 19-20 low rounded ribs ..... *vogdesi*
B. Right valve gently arched; about 22-23 radial ribs
  a. Ribs high, squarish, interspaces flat-bottomed ..... *diegensis*
  aa. Ribs lower, broader, and these as well as bottoms of interspaces often somewhat triangular in cross section ..... *sericeus*

Pecten (Pecten) diegensis Dall.

Pecten floridus Hinds, Zool. Voy. *Sulphur*, Moll., Pt. 3, 1844 (dated January, 1845, on cover of Pt. 3), p. 60, pl. 17, figs. 6, 6a. "Inhab. San Diego, California. In five fathoms, among mud."

Not *Ostrea* [=*Pecten*] *florida* Gmelin, 1790.

Pecten (Pecten) diegensis Dall, *Trans. Wagner Free Inst. Sci.*, Vol. 3, Pt. 4, April, 1898, p. 710. "Pleistocene of San Diego; Hemphill. Living on the adjacent shores from Monterey, California, southward." ... new name for *Pecten floridus* Hinds, 1844, not *Ostrea* [=*Pecten*] *florida* Gmelin, 1790. —Arnold, U. S. Geol. Surv., Prof. Paper 47, 1906, p. 127, pl. 51, figs. 1, 1a, 1b. Monterey to San Diego, and in the Pleistocene of San Diego, California.

Type Locality: San Diego, California, in 5 fathoms, mud.

Range: Cordell Bank, California, to Gorda Banks, off Cape San Lucas, Lower California.

Collecting Stations: Mexico: East of Cedros Island (126-D-3, 10, 11, 12), 40-60 fathoms, mud, crushed shell, eel grass; Gorda Banks (150-D-2), 75 fathoms, sand.

Description: Right valve convex, ornamented by 22 or 23 flat-topped ribs which are generally longitudinally ridged or sulcated on top. Left valve flat or nearly so, and ornamented by 21 or 22 prominent, narrow, convex-topped ribs.

Distribution: This species is often dredged off southern California in 10 to 30 fathoms. It apparently occurs in deeper water further south. The present record of specimens dredged on Gorda Banks in 75 fathoms is an extension south in the known range of the species. It is known to occur north to Cordell Bank, California.

Pecten (Pecten) sericeus Hinds.

Pecten sericeus Hinds, Zool. Voy. *Sulphur*, Moll., Pt. 3, 1844 (dated January, 1845, on cover of Pt. 3), p. 60, pl. 17, figs. 1, 1a. "Inhab. Bay of Panama. In fifty-three fathoms, on a muddy floor".

Pecten (Pecten) sericeus Hinds, Hertlein, *Proc. Calif. Acad. Sci.*, Ser. 4, Vol. 21, No. 25, 1935, p. 303, pl. 18, figs. 14, 15; pl. 19, figs. 3 and 4. Various localities cited, from east of San Jose del Cabo, Lower California, to Panama.

Type Locality: Bay of Panama, in 53 fathoms, muddy bottom.

Range: Santa Inez Bay, Gulf of California, to Panama. Also Maria Madre Island, Clarion Island, and Cocos Island.

Collecting Stations: Mexico: Arena Bank, Gulf of California (136-D-1, 4, 26, 27, 31), 35-50 fathoms, mud, *Arca* conglomerates, sand, crushed shell, calcareous algae, rock; Santa Inez Bay (147-D-2), 60 fathoms, mud, crushed shell; Gorda Banks (150-D-9), 50-60 fathoms, muddy sand; 3 miles off Pyramid Rock, Clarion Island (163-D-2), 55 fathoms, rock, coral; Costa Rica: Port Parker (203-D-3), 12 fathoms, shelly mud; Panama: Hannibal Bank west of Coiba Island, 35 fathoms, rocks, mud, coral.

Description: Right valve gently arched, the ribs are lower, broader, and are separated by slightly wider interspaces than are those of *P. diegensis*. Some of the large specimens reveal the presence of shallow

grooves separating three minor riblets on top of each rib, the middle riblet the highest of the three. In some cases a single riblet occurs directly in the center of the rib. The ribs on the flattened left valve are less prominent and wider spaced than are those of *P. diegensis*. On the ventral portion of some large left valves a faint riblet occurs in the interspaces between the ribs. The largest specimen of *Pecten sericeus* in the present collection measures 63 mm. from beak to base. On one of the specimens a *Capulus californicus* Dall is attached to the anterior side of the umbo of the right valve in exactly the same position as it occurs on some specimens of *Pecten diegensis*.

Distribution: This species occurs from the southern part of the Gulf of California to Panama, and off Maria Madre Island, Clarion Island and Cocos Island.

Pecten (Pecten) vogdesi Arnold.

Pecten (Pecten) vogdesi Arnold, U. S. Geol. Surv., Prof. Paper 47, 1906, p. 100, pl. 33, figs. 1, 1a; pl. 34, fig. 1. "The type of this species (a right valve) is from the upper San Pedro formation at San Pedro," California, Pleistocene. Also other localities. —Hertlein, *Proc. Calif. Acad. Sci.*, Ser. 4, Vol. 21, No. 25, 1935, p. 304, pl. 19, figs. 16 and 17. Various localities from Magdalena Bay, Lower California, and the Gulf of California, south to Paita, Peru. Pliocene and Pleistocene of California and Lower California.

Type Locality: Upper San Pedro formation (Pleistocene), San Pedro, California.

Range: Magdalena Bay, Lower California, and the Gulf of California, to Paita, Peru.

Collecting Stations: Mexico: Arena Bank (136-D-13, 28, 30), 35-85 fathoms, mud, sand, *Arca* conglomerate, weed; Ceralbo Island; Ceralbo Channel (137-D-30), 46 fathoms, rock; Santa Inez Bay (141-D-2, 3, 4,), 10-20 fathoms, sand, crushed shell, weed, also on shore; Arena Point area; Gorda Banks (150-D-6), 60 fathoms, muddy sand, rocks; Manzanillo (184-D-1, 2), 25-30 fathoms, sand; Tenacatita Bay; Port Guatulco (195-D-19-20), 17-23 fathoms, gravel, mud, crushed shell; Costa Rica: Port Parker (203-D-1-2-3) 10-15 fathoms, sand, mud, crushed shell; Port Culebra; Golfito, Gulf of Dulce; Panama: Gulf of Chiriqui, David Bay and Isla Parida to Bahia Honda (221-D-1-5), 35-40 fathoms, sandy mud.

Description: Right valve highly arched and ornamented by 19 to 20 low rounded ribs. Left valve gently concave, and ornamented by about 22 low, square ribs. The color of the shell is usually light brown or reddish-brown.

This species has also been recorded in west American literature under the names of *Pecten dentatus* G. B. Sowerby, *Pecten excavatus* Anton and *Pecten cataractes* Dall.

Distribution: This species occurs fairly commonly from Magdalena Bay, Lower California, to Peru, from near shore to 50 fathoms. The deepest occurrence in the present dredgings was at 85 fathoms. *Pecten vogdesi* also occurs in the Pliocene and Pleistocene of California and Lower California.

Subgenus **Chlamys** Bolten.

Pecten (Chlamys) lowei Hertlein.

Pecten (Chlamys) lowei Hertlein, *Proc. Calif. Acad. Sci.*, Ser. 4, Vol. 21, No. 25, September 26, 1935, p. 308, pl. 19, figs. 1, 2, 7, 8. "From Carmen Island, Gulf of California, from a depth of 20 fathoms."

Type Locality: Carmen Island, Gulf of California, in 20 fathoms.

Range: Carmen Island, Gulf of California, and Clarion Island, to Panama and the Galápagos Islands. ?Santa Catalina Island, California.

Collecting Stations: Mexico: Arena Bank (136-D-4, 22), 45-55 fathoms, mud; 3 mi. off Pyramid Rock, Clarion Island (163-D-2), 55 fathoms, rock, coral; Manzanillo (184-D-2), 30 fathoms, gravelly sand; Costa Rica: Golfito, Gulf of Dulce (218); Panama: Hannibal Bank (224), 35-40 fathoms, rocks, coral, sand, shells, mud.

Description: Right valve with a well developed byssal notch under the right auricle. The valves are ornamented by 20 to 22 rounded triangular ribs upon which spinose riblets occur and a spinose riblet occurs in each interspace. The color is white or gray flecked with brown or on some specimens the greater part is orange or reddish-brown. One of the largest specimens in the present collection measures approximately 18.5 mm. from beak to base.

Distribution: This species is known from Carmen Island, Angel de la Guardia Island, and Arena Bank in the Gulf of California, off Cape San Lucas, Lower California, Manzanillo, Mexico, Gulf of Dulce, Costa Rica, Hannibal Bank, Panama, and the Galápagos Islands. A specimen possibly of this species was dredged off Catalina Island, California, but the occurrence of the species there is not positively known.

Subgenus **Plagioctenium** Dall.

Pecten (Plagioctenium) circularis Sowerby.

Pecten circularis Sowerby, *Proc. Zool. Soc. London*, October 9, 1835, p. 110. "Hab. ad Sinum Californiae. (Guaymas)". "Found in sandy mud at a depth of seven fathoms."

Pecten (Plagioctenium) circularis Sowerby, Arnold, U. S. Geol. Surv., Prof. Paper 47, 1906, p. 125, pl. 42, figs. 3, 4, 5, 6; pl. 44, figs. 6, 6a, 6b, 7. Pliocene and Pleistocene. Recent from the Gulf of California to Santa Elena, Ecuador.

Type Locality: Guaymas, Mexico, 7 fathoms, sandy mud.

Range: Cedros Island, Lower California, and the Gulf of California, to Paita, Peru.

Collecting Stations: Mexico: East of Cedros Island (126-D-2), 38 fathoms, mud; Arena Bank (136-D-18), 40 fathoms, mud; Santa Inez Bay (143-D-3, also beach), 35 fathoms, mud, crushed shell; (145-D-1, 3,), 4-13 fathoms, sand; Concepcion Bay, anchorage 1 mile south of San Domingo Point; Arena Point area; Gulf of California; Cape San Lucas; Banderas Bay; Chamela Bay; Tenacatita Bay (183-D-2, also beach), 30 fathoms, sandy mud; Manzanillo (184-D-1, 2), 25-30 fathoms, sand, gravelly sand; Port Guatulco (195-D-2, 9, 17, 19, 20, 21, also beach), 3-23 fathoms, sand, gravelly sand, crushed shell, mud; Tangola-Tangola Bay (196-D-6, 7, 8, 14, also beach), 5-9 fathoms, sand, crushed shell; Nicaragua: Corinto (200-D-1, 3, 16, 17, 19, also beach), 2-13 fathoms, mangrove leaves; Costa Rica: Port Parker (203-D-1, 2, 3, also beach), 10-15 fathoms, sandy mud, crushed shell, algae; Culebra Bay; Port Culebra (206-D-1, 2, 3, also beach), 14 fathoms, sandy mud; Piedra Blanca Bay (208-D-1-10), 2-6 fathoms, rocks, sand, algae; Cedro Island, Gulf of Nicoya (213-D-1-10), 8-10 fathoms, mud, sand, crushed shell; Golfito, Gulf of Dulce (218); Panama: Gulf of Chiriqui (221-D-1-5), 35-40 fathoms, sandy mud.

Description: Both valves strongly arched; ornamented by 19 to 21 ribs, those on the right valve squarish, close-set, smooth, and those on the left narrower, flat-topped and with sloping sides; color light to dark brownish-red. The coloration of *P. circularis* is much more vivid than the more northern subspecies *aequisulcatus* which reaches a larger size when adult, has a thinner and flatter shell and narrower ribs. The subspecies is often colored with some pattern of brown while *circularis* is often ornamented with some pattern of red coloration.

Distribution: *Pecten circularis* was taken at many localities from Cedros Island to Panama, on the beach and at depths of 2 to 40 fathoms.

Subgenus **Lyropecten** Conrad.

Key to the species of *Lyropecten*.

A. Right valve with 11 or 12 ribs, left with 10 or 11 ..... *subnodosus*

B. Right valve with 10 ribs, left with 9; lighter colored ..... *intermedius*

Pecten (Lyropecten) subnodosus Sowerby.

Pecten subnodosus Sowerby, *Proc. Zool. Soc. London*, October 9, 1835, p. 109. "Found in sandy mud and coral sand in from ten to seventeen fathoms." Three varieties; brownish-red with white striae, "ad Sinum Californiae"; var. variegated with brown and white patches, "ad Insulam Platae, Columbiae Occidentalis;" var. with more depressed shell of a bright orange color, "ad Sinum Tehuantepec, Mexicanorum."—Reeve, Conch. Icon., Vol. 8, *Pecten*, 1852, species 20, pl. 4, fig. 20. Mexico and west Colombia, in sandy mud and coral sand, at a depth of 10 to 17 fathoms.

Type Locality: Island of La Plata, Ecuador.

Range: Tres Marias Islands, Mexico, to Negritos, Peru.

Collecting Stations: Mexico: Banderas Bay; Chamela Bay, Passavera Island; Costa Rica: Port Parker; Culebra Bay; Panama: Bahia Honda, beach; Hannibal Bank, 35-40 fathoms, rocks, sand, coral, shells, mud, algae.

Description: Shell large, coarse, thick, right valve usually ornamented with 11 striated ribs, the left with 10, and occasionally there are 12 on the right valve and 11 on the left; the ribs are often nodose especially on the earlier part of the shell.

Distribution: This species occurs at various localities from the Tres Marias Islands to Paita, Peru. The exact northern limit is not known. It may occur in the Gulf of California but the form found there often has one less rib and is lighter colored.

Pecten (Lyropecten) subnodosus intermedius Conrad.

Lyropecten intermedius Conrad, *Amer. Jour. Conch.*, Vol. 3, Pt. 1, April 4, 1867, p. 7. "Cape St. Lucas, California."

Pecten (Lyropecten) subnodosus Sowerby, Arnold, U. S. Geol. Surv., Prof. Paper 47, 1906, p. 128, pl. 52, fig. 1; pl. 53, figs. 1, 1a. West coast of Mexico.

Pecten (Lyropecten) nodosus (Linnaeus) variety *intermedius* (Conrad), Grant and Gale, *Mem. San Diego Soc. Nat. Hist.*, Vol. 1, 1931, p. 181. Pliocene to Recent in the Gulf of California region.

Type Locality: Cape San Lucas, Lower California, Mexico.

Range: Scammon Lagoon to Cape San Lucas, and the Gulf of California; Clarion Island.

Collecting Stations: Mexico: Santa Inez Bay, beach; Arena Bank (136-D-6, 30), 35 fathoms, sand, weed; 3 miles off Pyramid Rock, Clarion Island (163-D-2), 55 fathoms, rock, coral.

Description: Shell usually with one rib less than that of *Pecten subnodosus*, lighter colored and often larger. There is some doubt as to the validity of this subspecies because the number of ribs is not constantly different from that of *P. subnodosus*. In general, however, the specimens from the west coast of Lower California and the Gulf of California show the features mentioned and for this reason the subspe-

cific name *intermedius* is retained at least for the present. A large specimen in the collections of the California Academy of Sciences from Scammon Lagoon, Lower California, measures 150 mm. from beak to base.

Distribution: This subspecies occurs at Scammon Lagoon, Cedros Island, Magdalena Bay and at Cape San Lucas, Lower California, as well as at many localities in the Gulf of California. The exact southern range is not known but it is known to occur as far south as Clarion Island and perhaps along the coast of Mexico some distance south of the Gulf of California. It occurs in shallow water.

Subgenus **Mesopeplum** Iredale.

Pecten (Mesopeplum) fasciculatus Hinds.

Pecten fasciculatus Hinds, Zool. Voy. *Sulphur*, Moll., Pt. 3, 1844 (date on cover of Pt. 3, January, 1845), p. 61, pl. 17, fig. 4. "West coast of Veragua. In seventeen fathoms among sandy mud."

Pecten (Pallium) miser Dall, *Bull. Mus. Comp. Zool.*, Vol. 43, No. 6, October, 1908, p. 401, pl. 8, fig. 6. "Gulf of Panama, in 182 fathoms, mud, bottom temperature 54°.1 F."

Pecten (Decadopecten) fasciculatus Hinds, Hertlein, *Proc. Calif. Acad. Sci.*, Ser. 4, Vol. 21, No. 25, September 26, 1935, p. 318, pl. 18, figs 1, 2. Earlier records cited.

Type Locality: West coast of Veragua, Panama, 17 fathoms, in sandy mud.

Range: Arena Bank, Gulf of California, to Panama.

Collecting Stations: Mexico: Arena Bank, Gulf of California (136-D-27, 28, 31) 35-85 fathoms, sand, muddy sand, rock, calcareous algae, weed; Gorda Banks, Gulf of California (150-D-4, 6, 16, 18, 23), 45-75 fathoms, muddy sand, sand, rocks, calcareous algae; Panama: Hannibal Bank (224), 35-40 fathoms, rocks, coral, sand, shells, algae.

Description: Shell with about a half dozen rounded ribs ornamenting each valve; ribs and interspaces ornamented by fine radial riblets, which are covered with fine concentric imbrications. In some specimens the ribs are flatter than in others. Color brownish-pink exactly as shown on the original illustration. Interiorly most of the specimens show vertical grooving along the hinge line and large specimens have well developed, grooved, cardinal crura. Irregular radial rounded riblets occur along the interior ventral margin. This margin is turned up especially in the right valve but sometimes that of the left is turned down to meet the right. The largest specimen at hand measures approximately 31.4 mm. from beak to base.

A study of these specimens leaves no doubt that the species described by Dall as *Pecten miser* is identical with *P. fasciculatus*.

The features of *Pecten fasciculatus* so closely resemble illustrations of *Mesopeplum caroli* Iredale,[4] the type of *Mesopeplum*, that we have referred it to that subgenus. It also closely resembles *Notochlamys anguineus* Finlay, the type of *Notochlamys*, which is said to differ from *Mesopeplum* only in lacking concentric sculpture.

Distribution: The present record of the occurrence of this species in the Gulf of California furnishes a long extension north in the range. It has been recorded as occurring in depths from 17 to 182 fathoms.

Subgenus **Leptopecten** Verrill.

Key to the species of *Leptopecten*.

A. Every third rib (especially on the left valve) raised above the others
  a. Ribs 16 ..... *velero*
  aa. Ribs 12 ..... *biolleyi*
B. Ribs of about equal elevation
  a. Ribs square or subangular
    b. Shell moderately thick, ears squarely offset from submargins ..... *tumbezensis*
    bb. Shell thin, areas joining ears and submargins rounded ..... *latiauratus*
  aa. Ribs 12-16 rounded corrugations of the shell ..... *monotimeris*

Pecten (Leptopecten) latiauratus Conrad.

Pecten latiauratus Conrad, *Jour. Acad. Nat. Sci. Philadelphia*, Vol. 7, 1837, p. 238, pl. 18, fig. 9. "Inhabits below the efflux of the tide near Sta. Diego and Sta. Barbara."

Pecten (Chlamys) latiauritus Conrad, Arnold, U. S. Geol. Surv., Prof. Paper 47, 1906, p. 115, pl. 46, figs. 2, 2a, 3, 3a. Monterey to San Diego, California. Also Pliocene and Pleistocene.

Type Locality: San Diego, California (according to I. S. Oldroyd, 1924).

Range: Off Point Reyes, California, to Cape San Lucas, Lower California.

Collecting Stations: Mexico: 5 miles west of San Jose Point, Lower California (175-D-1), 45 fathoms, slabs of slaty rock; east of Cedros Island (126-D-8, 9, 10, 11, 12, 15), 42-60 fathoms, mud, crushed shell and eel grass; also (127-D-1), 38 fathoms, mud.

Description: Shell small, thin, 12 to 16 square ribs; hinge line long, oblique; ears acutely pointed at termination of hinge line.

Distribution: This little pecten was dredged west of San Jose Point, at several localities east of Cedros Island, and a few were collected at Cape San Lucas, Lower California.

[4] *Mesopeplum caroli* Iredale, *Rec. Australian Mus.*, Vol. 17, No. 4, September 4, 1929, p. 162, pl. 38, figs. 7-9. "Type trawled in 55-60 fathoms off Montague Island, New South Wales."

Pecten (Leptopecten) latiauratus monotimeris Conrad.

Pecten monotimeris Conrad, *Jour. Acad. Nat. Sci. Philadelphia*, Vol. 7, 1837, p. 238, pl. 18, fig. 10. "Inhabits with the preceding" [=Inhabits below the efflux of the tide near Sta. Diego and Sta. Barbara]. "The young occasionally found attached to *Fuci* by a slender byssus."

Pecten (Chlamys) latiauritus var. *monotimeris* Conrad, Arnold, U. S. Geol. Surv., Prof. Paper 47, 1906, p. 131, pl. 46, figs. 4, 5, 5a. San Francisco and Santa Barbara to San Diego, California, Recent; also Pleistocene.

Type Locality: San Diego, California (according to I. S. Oldroyd, 1924).

Range: Monterey Bay, California, to Cape San Lucas, Lower California.

Collecting Stations: Mexico: East of Cedros Island (126-D-10), 60 fathoms, crushed shell and eel grass; Capé San Lucas.

Description: The rounded ribs which form broad corrugations of the shell, and the less acutely pointed ears, distinguish this subspecies from *P. latiauratus*.

Distribution: One specimen of *Pecten latiauratus monotimeris* was dredged east of Cedros Island and six typical specimens of this little kelp pecten were collected at Cape San Lucas, Lower California.

Pecten (Leptopecten) tumbezensis d'Orbigny.

Pecten tumbezensis d'Orbigny, Voy. Amér. Mérid., Vol. 5, 1846, p. 663. Tumbez, Peru. New name for *Pecten aspersus* Sowerby, not *P. aspersus* Lamarck.

Pecten (Leptopecten) tumbezensis d'Orbigny, Hertlein, *Proc. Calif. Acad. Sci.*, Ser. 4, Vol. 21, No. 25, September 26, 1935, p. 314, pl. 19, figs. 11, 12. Gulf of California to Tumbez and Paita, Peru. Also Quaternary of Peru.

Type Locality: Tumbez, Peru.

Range: Gulf of California, to Paita, Peru.

Collecting Stations: Mexico: Manzanillo (184-D-2), 30 fathoms, gravelly sand; Santa Cruz Bay (195-D-21), 18 fathoms, mud; Tangola-Tangola Bay (196-D-17), 23 fathoms, mud; Guatemala: 7 miles west of Champerico (197-D-1-2), 14 fathoms, mud; El Salvador: La Libertad (198-D-1-2), 13-14 fathoms, mud; Meanguera Island, Gulf of Fonseca (199-D-1), 16 fathoms, sand, mud, crushed shell; Nicaragua: Corinto (200-D-19), 12-13 fathoms, mangrove leaves; Monypenny Point, Gulf of Fonseca; Costa Rica: 14 miles S.E. of Judas Point (214-D-1-4), 42-61 fathoms, mud, shell, rocks; Panama: Gulf of Chiriqui (221-D-1-5), 35-40 fathoms, sandy mud.

Description: Shell fairly thick in proportion to the size, usually somewhat expanded posteriorly; ornamented by about 14 square ribs. The right valve is usually at least partly white in color but the left valve is usually ornamented by a sprinkling of light bluish dots on a slate-colored or brown background. A large valve from Monypenny Point, Nicaragua, in the Gulf of Fonseca, measures 31.2 mm. from beak to base and 33.9 mm. in length.

Distribution: This species was dredged at a number of localities from off Manzanillo, Mexico, to Panama, in depths from 12 to 61 fathoms. It ranges south to Peru.

Pecten (Leptopecten) velero Hertlein.

Pecten (Leptopecten) velero Hertlein, *Proc. Calif. Acad. Sci.*, Ser. 4, Vol. 21, No. 25, September 26, 1935, p. 316, pl. 19, figs. 13, 14. "Bahia Honda, Veragua, Panama, in three to nine fathoms."

Type Locality: Bahia Honda, Veragua, Panama, in 3 to 9 fathoms.

Range: Off Mazatlan, Mexico, to Panama.

Collecting Stations: Mexico: Manzanillo (184-D-2), 30 fathoms, gravelly sand; El Salvador: Meanguera Island, Gulf of Fonseca (199-D-1), 16 fathoms, sand, mud, crushed shell; Nicaragua: Corinto (200-D-1, 19), 6.5-13 fathoms, mangrove leaves.

Description: Shell small, ornamented by 16 ribs of which every third one is raised above the others, this is especially noticeable on the left valve. Toward the ventral margin of the right valve some specimens have well developed interribs and occasionally these also are present on the left valve.

Distribution: This species is known to occur off Mazatlan, Manzanillo, and Tres Marias Islands, Mexico, Meanguera Island, Gulf of Fonseca, El Salvador, Corinto, Nicaragua, and at Bahia Honda, Panama. It has been dredged in waters to a depth of 30 fathoms.

Pecten (Leptopecten) velero biolleyi

Hertlein and Strong, subsp. nov.

Plate I, Figure 6.

Shell small, rather thin, hinge long; color white and brown roughly arranged in concentric bands; anterior ear of right valve with large byssal notch and ctenolium, ornamented by three ribs; ventral margin broadly rounded; left ear large and broadly notched, ornamented by about four ribs; valve ornamented by about 12 to 13 rather high sharply triangular ribs which are separated by considerably wider interspaces, ribs and interspaces with strong, dense, fringing imbricating lamellae; when slightly worn the tops of the ribs are smooth; the ribs near the anterior and posterior margins are somewhat higher than the others and sometimes every third rib or pair of ribs is slightly raised; left valve similar to right except that it lacks the large byssal notch and the right ear is ornamented by about 4 or 5 ribs and the left ear is orna-

mented by 5 or 6 ribs; on some left valves every third rib is raised higher than the intervening ones. Length, 6.9 mm.; height, 6.6 mm.

Holotype, right valve, and paratypes (Calif. Acad. Sci. Paleo. Coll.), from Station 203-D-3, dredged in 12 fathoms (22 meters) in Lat. 10°55'45"N., Long. 85°49'05" W., Port Parker, Costa Rica, on bottom of sandy mud and crushed shells. Several small specimens were dredged near the same locality at Station 203-D-1.

This form is described as a subspecies of *Pecten velero* Hertlein because occasional left valves have every third rib raised similar to that species. The new subspecies differs from *Pecten velero* in possessing fewer, stronger ribs, 12 as compared to 16, and in that every third rib is less strongly raised in relation to the others. *Pecten velero biolleyi* resembles *P. bellilamellatus* Arnold[5] a species described as a fossil from the Pliocene of California, but differs in possessing fewer ribs, only 12 or 13 as compared to 15 or 16. Our specimens bear a remarkable resemblance to Arnold's illustrations of *P. bellilamellatus* and possibly this new subspecies might be considered to be a living representative of that species. Arnold's species however, was described as possessing about 16 ribs whereas the present form is constant in its small size and in its ornamentation of 12 or occasionally 13 ribs. Compared to *Pecten latiauratus delosi* Arnold,[6] the new subspecies has fewer, wider spaced ribs.

This new subspecies is named for Paul Biolley, former professor of Natural History at San Jose de Costa Rica.

Subgenus **Delectopecten** Stewart.

Pecten (Delectopecten) arces Dall.

Pecten (*Pseudamusium*) *arces* Dall, *Proc. U. S. Nat. Mus.*, Vol. 45, June 11, 1913, p. 592. "Off Santa Barbara, California, in over 500 fathoms, muddy bottom."

Pseudamusium arces Dall, Dall, *Proc. U. S. Nat. Mus.*, Vol. 66, Art. 17, 1925, p. 24, pl. 27, fig. 4. "Off Santa Cruz Island, Calif., in 534 fathoms."

Type Locality: Off Santa Barbara, California, in over 500 fathoms, mud.

Range: Off Santa Cruz Island, California, to off Cedros Island, Lower California.

Collecting Station: Mexico: East of Cedros Island (126-D-12), 45 fathoms, crushed shell, mud.

Description: Shell small, thin, ornamented by reticulated radial and concentric sculpture which where crossing forms a tiny spinule. The posterior ear forms an oblique angle with the hinge line similar to that of *Pecten randolphi* Dall rather than a nearly square angle as is the case in *P. vancouverensis*. Two left valves in the present collection appear to be the young of this species.

Distribution: This species has been recorded from off Santa Cruz Island and San Nicolas Island, California. The present specimens extend the known range of the species south to Cedros Island, Lower California.

Subgenus **Cyclopecten** Verrill.

Key to the species of *Cyclopecten*.

A. Right ear of each valve with fine reticulate sculpture ..... *pernomus*

B. Right ear of each valve without reticulate sculpture ..... *catalinensis*

Pecten (Cyclopecten) catalinensis Willett.

Pecten (*Cyclopecten*) *catalinensis* Willett, *Nautilus*, Vol. 45, No. 2, October, 1931, p. 65, pl. 4, figs. 1 and 2. "Taken by the writer in 100 fathoms off White's Landing, north side of Catalina Island, California."

Type Locality: Off White's Landing, Catalina Island, California, in 100 fathoms.

Range: Catalina Island, California, to Cedros Island, Lower California.

Collecting Station: Mexico: East of Cedros Island (126-D-10), 60 fathoms, crushed shell and eel grass.

Description: Shell small, shining transparent, very fragile; right valve white, ornamented only by fine concentric lines of growth; the left valve with lines of growth which are crossed in the umbonal region by very fine wavy striae, also ornamented by irregular brown radial rays, in the type specimen about 20, in the present specimen about 15; ears on both valves nearly equal in size and ornamented by concentric lines of growth. A single small left valve in the present collection appears to be referable to this species.

The shell of *Pecten catalinensis* has more nearly equal ears, lacks the posterior sulcation and has different color markings from that of *P. cocosensis* Dall. Characters which assist in separating *P. catalinensis* from *P. pernomus* are the concentric rather than reticulate sculpture of the right ear of each valve, also the faint rather than well developed radial sculpture of the left valve.

Distribution: One valve of *Pecten catalinensis* was dredged by the Expedition east of Cedros Island, Lower California, in 60 fathoms. This is an extension south in the known range of the species.

Pecten (Cyclopecten) pernomus Hertlein.

Pecten (*Cyclopecten*) *rotundus* Dall, *Bull.*

[5] *Pecten* (*Chlamys*) *bellilamellatus* Arnold, U. S. Geol. Surv., Prof. Paper 47, 1906, p. 108, pl. 41, figs. 6, 6a, 7, 7a. "San Diego formation (Pliocene), Pacific Beach, San Diego County, Cal."

[6] *Pecten* (*Chlamys*) *latiauritus* Conrad var. *delosi* Arnold, U. S. Geol. Surv., Prof. Paper 47, 1906, p. 130, pl. 46, figs. 9, 9a, 10, 10a. "San Pedro formation (lower portion), Pleistocene, Deadman Island, near San Pedro, Los Angeles County, Cal." Also Recent.

Mus. Comp. Zool., Vol. 43, No. 6, October, 1908, p. 404. "Panama Bay, in 29½ fathoms; also at station 2784, in 194 fathoms, mud, bottom temperature 51°. 9 F."

Pecten (Cyclopecten) pernomus Hertlein, *Proc. Calif. Acad. Sci.*, Ser. 4, Vol. 21, No. 25, September 26, 1935, p. 320, pl. 18, figs. 11, 12, 13. New name for *Pecten (Cyclopecten) rotundus* Dall, not *P. rotundus* von Hagenow.

Type Locality: Panama Bay, in 29½ fathoms, mud.

Range: Cedros Island, Lower California, to Panama.

Collecting Stations: Mexico: East of Cedros Island (126-D-10, 12), 45-60 fathoms, crushed shell, eel grass, mud; Arena Bank (136-D-29), 70 fathoms, rock, weed; Manzanillo (184-D-2), 30 fathoms, gravelly sand; Port Guatulco (195-D-19), 17 fathoms, green mud, crushed shell; Costa Rica: Port Parker (203-D-1, 3), 12-15 fathoms, sandy mud, crushed shell, shelly mud.

Description: The shell of this species is small, thin, suborbicular, with sub-equal ears. The right valve is ornamented by concentric striations; the anterior ear is ornamented by fine reticulate sculpture, a byssal notch is present, the posterior ear smooth; valve colored white or ornamented by small white and brown spots. The left valve is radially striated, the striae bifurcating toward the ventral margin; the ears are subequal, the left the larger of the two, both finely radially striated and crossed by fine concentric sculpture; color white and often ornamented by brownish spots or by large V-shaped brownish areas pointing toward the beaks.

A study of the specimens in the present collection and of those collected by George Willett from off western Mexico has convinced us that these should be referred to *Pecten pernomus* Hertlein. The records from California Academy of Sciences localities numbers 23,779, 23,804, 25,527 27,581, 27,584, 27,587, cited by Hertlein (1935) under *Pecten (Cyclopecten) cocosensis* Dall, can be referred to *P. pernomus*. The suborbicular shape and absence of the posterior sulcation as well as the larger ears and strong radial ornamentation of the left valve all serve to separate this species from *P. cocosensis* Dall.

Distribution: This species occurs fairly abundantly at some localities off southern Mexico and off Nicaragua. It occurs as far north as Cedros Island and south to the bay of Panama. Dall mentioned that a single valve from near the Straits of Magellan was apparently identical with *Pecten rotundus* Dall [=*pernomus*]. We have not seen specimens from that region but it seems unlikely that the species occurs that far south.

FAMILY SPONDYLIDAE.

Key to the genera of the Spondylidae.

A. Shell with auricular areas each side of umbo ..... *Spondylus*

B. Shell without auricular areas each side of umbo ..... *Plicatula*

Genus **Spondylus** Linnaeus.

Spondylus princeps Broderip.

Spondylus princeps Broderip, *Proc. Zool. Soc. London*, May 17, 1833, p. 4. "Hab. ad Insulam Platam Columbiae Occidentalis." "Found attached to coral rocks at the depth of seventeen fathoms."—Reeve, Conch. Icon., Vol. 9, *Spondylus*, 1856, species 9, pl. 2, fig. 9. Original locality cited.

Spondylus leucacantha Broderip, *Proc. Zool. Soc. London*, May 17, 1833, p. 5. "Hab. ad Insulam Platam."—Reeve, Conch. Icon., Vol. 9, *Spondylus*, 1856, species 6, pl. 2, fig. 6. Original locality cited.

Type Locality: Island of Plata, Ecuador, in 17 fathoms, attached to coral rocks.

Range: Scammon Lagoon, and the Gulf of California, to Negritos, Peru.

Collecting Stations: Mexico: Arena Bank (136-D-2, 4, 11), 30-45 fathoms, mud, *Arca* conglomerate, rock; Santa Inez Bay; Costa Rica: Port Culebra; Piedra Blanca; Panama: Bahia Honda; Colombia: Gorgona Island.

Description: Shell with radial rows of long spines; color white with red near the umbos, orange, or entirely red, interior white, border sometimes red or orange.

There is some doubt as to the earliest correct name for this species. It has generally been attributed to *Spondylus crassi-squama* Lamarck[7]. Lamarck referred to Recent specimens stated to occur in "les mers de l'Inde" and to fossil forms from "Fossil à Carthagène d'Amérique." Favre[8], who has given illustrations of Lamarck's fossil specimens, stated that Lamarck's Recent specimens can be referred to *S. pictorum* Chemnitz but that the name *crassi-squama* should apparently be restricted to the fossil form from Colombia. *Spondylus pictorum* Chemnitz[9] has been considered by some authors to be the earliest name for the Recent west American form but the type locality of the species is given as the Mediterranean Sea and the Aegean

[7] *Spondylus crassi-squama* Lamarck, Hist. Nat. Anim. s. Vert., Vol. 6, February-June, 1819, p. 191. "Habite les mers de l'Inde." Also "On le trouve fossile à Carthagène d'Amérique." References to "Rumph. Mus. t.48. fig.1." and "Encyclop. pl.192. f.2." Also "[b] *Squamis palmatis*. Seba, Mus. 3. t.88. f.10."

[8] Favre, J., Mus. d'Hist. Nat. Genève Cat. Illustr. Coll. Lamarck, Conch. Monomyaires foss. 1918, II Sec., pl. 12, figs. 39a, 39b, 39c. "Le *S. pictorum* semble être une mutation plus ornamentée du S. *crassi-squama* fossile, et il parait indiqué de restreindre au type éteint le nom que Lamarck avait appliqué indistinctement aux deux formes parentes."

[9] *Spondylus pictorum* Chemnitz, Neus Syst. Conch.-Cab., Bd. 7, 1784, p. 94, suppl. pl. 69, figs. E. F. "Sie wohnet im mittelländischen Meere, und vorzüglich nach Aristotelis Aussage im ägeischen Meere, welches heut zu Tage der griechische Archipelagus heist."

Sea. Pfeiffer[10] referred Chemnitz's figures "E." and "F." of *Spondylus pictorum* to *Spondylus gaederopus* of Gmelin. Some writers do not accept as valid the names of species proposed by Chemnitz.* However, his names appear to deserve acceptance far more than those of some authors whose names have been accepted but whose strict use of binomial nomenclature may be open to question. In any case the name *Spondylus princeps* Broderip without doubt was applied to the Recent west American *Spondylus* which also has been cited in the literature as *S. dubius* Broderip and *S. leucacantha* Broderip. D'Orbigny (1846) considered *S. leucacantha* to be only an adult variety of *S. princeps*. *Spondylus limbatus* Sowerby, erroneously cited from the Gulf of California by some authors, was originally described from the Persian Gulf.

Spondylus calcifer Carpenter[11], the only other species of *Spondylus* living in west American waters, possesses a very thick shell which is less coarsely spinose than that of *S. princeps*, and is colored along the interior margin by a deep reddish-purple band. It has been reported to range from Concepcion Bay in the Gulf of California to Panama. It is sometimes burned for lime in regions where it is abundant.

Distribution: *Spondylus princeps* occurs at various localities from Scammon Lagoon, Lower California, to Peru. Most of the specimens in the present collection were worn beach specimens or imperfect dredged specimens.

Genus ***Plicatula*** Lamarck.

Key to the species of *Plicatula*.

A. Shell small, thin, finely radially ribbed ..... *penicillata*

B. Shell large, thick, coarsely radially plaited ..... *spondylopsis*

Plicatula penicillata Carpenter.

Plicatula penicillata Carpenter, Cat. Mazatlan Shells, February, 1856, p. 155. "Hab. —Bay of Fonseca, Cuming.—Mazatlan; extremely rare, on shells."—Sowerby, Conch. Icon., Vol. 19, *Plicatula*, 1873, species 3, pl. 1, fig. 3. North America.

Type Locality: Mazatlan, Mexico (here designated). Gulf of Fonseca also originally cited.

Range: Gulf of California to Panama.

Collecting Stations: Mexico: Port Guatulco (195-D-9), 7 fathoms, sand, crushed shell; Nicaragua: Corinto (200-D-19), 12-13 fathoms, mangrove leaves.

Description: Shell small, suborbicular or irregular in shape, thin, finely ribbed or sculptured by fine radial rows of hollow spines; some specimens are ornamented exteriorly by small brown spots; the interior of the shell is often colored by dark brown spots or stripes especially around the margin, which is denticulated. A large specimen measures approximately 15 mm. from beak to base.

Distribution: This species has been recorded between Cape Pulmo and Cape San Lucas, Lower California, Mazatlan, Mexico, Nicaragua, and Panama. Specimens in the present collection were dredged at depths of 7 to 13 fathoms.

Plicatula spondylopsis Rochebrune.

Plate I, Figures 15 and 16.

Plicatula spondylopsis Rochebrune, *Bull. Mus. Nat. Hist. Nat. Paris*, Vol. 1, 1895, p. 242. "Lagunes des îsles de San Jose." Gulf of California.—Lamy, *Jour. de Conchyl.*, Vol. 83, No. 1, 1939, p. 23. Lower California.

Type Locality: San Jose Island, Gulf of California, in lagoon.

Range: San Jose Island, Gulf of California, to Ecuador, and the Galápagos Islands.

Collecting Stations: Arena Bank (136-D-5, 26), 33-45 fathoms, sand, weed, crushed shell; Gulf of California.

Description: Shell roughly trigonal in shape, thick, ornamented by coarse radial plaited sculpture, which however may be partially or almost wholly absent on some specimens; two hinge teeth in each valve. In perfect shells the exterior is colored purple and the interior white, with dark spots around the corrugated margin. Muscle scar nearer the posterior margin. A very narrow space between the valves is occupied by the animal.

Plicatula ostreivaga Rochebrune is a synonym.

This species has been cited from west American waters under the name *Plicatula dubia* Hanley. At the time of original description *Plicatula dubia*[12] was cited from both the Philippine Islands and from the

[10] Pfeiffer, L., Kritisches Register zu Martini und Chemnitz's Syst. Konch.-Kab., p. 73, (Kassel), 1840.

* Since this paper was submitted for publication the International Commission on Zoological Nomenclature has ruled against acceptance of the specific and subspecific names in Volumes 1-11 of Martini and Chemnitz, Neues Systematisches Conchylien-Cabinet, Nürnberg, 1769-1795. (See "Opinions and Declarations rendered by the International Commission on Zoological Nomenclature", Vol. 3, Pt. 3, Opinion 184. Summary, p. 27. "No new specific or subspecific trivial name published in these volumes has any status in nomenclature." Also p. 34. Issued October 17, 1944).

[11] *Spondylus calcifer* Carpenter, Cat. Mazatlan Shells, February, 1856, p. 152. "Hab.—Bay of Panama, in a few fathoms of water, Cuming; C. B. Adams.—La Paz; Lieut. Green.—Mazatlan; not uncommon."

This species appears to be the one illustrated by Reeve under the name *Spondylus radula* (Conch. Icon., Vol. 9, *Spondylus*, May, 1856, species 52, pl. 14, fig. 52. "Hab. Tehuantepec, West Mexico; Captain Dare.") The combination of names *Spondylus radula* was used by Lamarck in 1806, therefore Reeve's species was renamed *Spondylus smithi* by Fulton (*Journ. Conch.*, Vol. 14, No. 12, October 1, 1915, p. 357).

[12] *Plicatula dubia* Hanley in Sowerby, Thes. Conch., Vol. 1, p. 437, pl. 90, fig. 12?; pl. 91, fig. 19, 1847. "Collected by Mr. Cuming at the Island of Samar, and at the Island of Cana, West Colombia."

Island of "Cana," west Colombia. Later writers including Hanley[13], Sowerby[14], Hidalgo[15], and Lamy considered it to be a Philippine species. Lamy[16] pointed out that an island of the name of "Cana" occurs in the Philippine Archipelago but that no island of that name is known from western South America. There is, however, an island of "Cano" in the Gulf of Nicoya and another island of the same name in the Gulf of Dulce, Costa Rica. It is uncertain whether either of these may have been the island to which Hanley referred. It appears then that the correct name for the west American species considered here is *Plicatula spondylopsis* Rochebrune.

Plicatula spondyloidea Meuschen[17], a Caribbean species, is very similar to the west American form.

Distribution: *Plicatula spondylopsis* occurs from the Gulf of California to Ecuador and the Galápagos Islands, in rather shallow water. It also occurs from Pliocene to Recent in the same region.

FAMILY DIMYIDAE.

Genus **Dimya** Rouault.

Dimya Rouault, *Mem. Soc. Geol. France*, Ser. 2, Vol. 3, Pt. 2, 1848, p. 470 (Mem. No. 7, p. 14). Sole species, "*Dimya Deshayesiana*, Nob.", p. 471 (Mem. No. 7, p. 15), pl. 15 (Mem. No. 7, pl. B), figs. 3, 3a, 3b. "Bos d'Arros," France, Eocene.—Stoliczka, *Mem. Geol. Surv. India. Palaeont. Indica*, Ser. 6, Cret. Fauna South. India, Vol. 3, 1871, pp. XXII, 397. "Type, *D. Deshayesiana* Rouault, from Eocene beds at Bos d'Arros, France." —Dall, *Bull. Mus. Comp. Zool.*, Vol. 12, No. 6, 1886, p. 227. "Type *Dimya Deshayesiana* Rouault."

Not *Dimya* Menke, Syn. Meth. Moll., 1830, p. 101. "Subordo 2. Dimya. (Dimyaires, Fér.)." Not *Dimya* F. Moore, 1881. Lep. Noctuid.

Margariona (Dall MS), Kobelt, *Nachrichtsbl. Malakozool. Gesell.*, Vol. 14, Nos. 11 and 12, November-December, 1882, p. 186. [No species cited, but it was placed in the synonmy of *Dimya* by Dall in 1886].

Deuteromya Cossmann, *Rev. Crit. de Paleozool.*, Vol. 7, 1903, p. 68. A new name for *Dimya* Rouault, not *Dimya* Menke.—Cossmann and Peyrot, *Act. Soc. Linn. Bordeaux*, Vol. 68, 1914, p. 409. "(G.-T.: *Dimya Deshayesiana* Rouault, Eoc.)"

Type (by monotypy): *Dimya deshayesiana* Rouault. Eocene of France. Illustrated by Rouault, 1848, pl. 15, figs. 3, 3a, 3b. Also, Tryon, Struct. and Syst. Conch., Vol. 3, 1884, p. 281, pl. 132, figs. 80 and 81. Eocene; Pau.—Fischer, Man. de Conchyl., 1886, p. 936, fig. 704.

Shell small, irregularly orbicular, adhering by the right valve which is larger than the left, compressed, externally nacreous, internally porcellanous; umbones slightly projecting, subcentral; surface smooth or with fine radial ornamentation or sculptured similar to the object to which it adheres; external ligament slender, linear; interior ligament in a small triangular pit. Interior white; anterior and posterior muscle scars present, the posterior one larger and double; pallial line simple; inner margin radiately wrinkled.

We have used the genus name *Dimya* Rouault although the name *Dimya* was also used by Menke in 1830 as a name for a suborder as follows: "Subordo 2. Dimya. (Dimyaires, Fér.)." If *Dimya* is not available as a generic name then the name *Margariona* Dall in Kobelt is applicable. Kobelt in 1882 mentioned that Dall intended to name a genus *Margariona* for a species of Dimyidae dredged in the Caribbean region. No species was cited by Kobelt and *Margariona* was thus originally a genus without species. In 1886 Dall placed *Margariona* in the synonymy of *Dimya* whose type was cited as *Dimya deshayesiana* Rouault. If *Dimya* Rouault proves to be invalid, Dall's action would make *Margariona* Dall in Kobelt a valid genus with the same type, *Dimya deshayesiana* Rouault. Cossmann in 1903 proposed *Deuteromya* as a new name for *Dimya* Rouault (not *Dimya* Menke). There is also a *Dimya* F. Moore, 1881, in Lepidoptera. *Dimyarina* Iredale has been proposed with the type, *Dimya corrugata* Hedley, a Recent species from Australia.

Species referred to the genus *Dimya* have been described from beds of Cretaceous age in Africa and in Mexico. Probably most of the forms which have been attributed to *Dimya* in the earlier Mesozoic belong to other genera such as *Dimyodon* Munier-Chalmas, the type of which is *D. schlumbergeri* Munier-Chalmas. That genus as pointed out by Dall "is characterized chiefly by its undivided posterior adductor scar, the tooth-like crura being present though feeble in the typical *Dimya*." *Dimyopsis* Bittner with the type *Dimyodon intusstriata* Emmrich is a related genus in the Triassic.

Species of *Dimya* have been described from the Tertiary of Australia, New Zealand, East Indies and Europe. The genus is represented at the present time in the waters of Australia, New Zealand, East Indies, Philippine Islands, Japan, Hawaii, southern California and northern Mexico, and the Caribbean Sea.

[13] Hanley, S., Cat. Rec. Biv. Shells, 1856, p. 289. "Philippines."

[14] Sowerby, G. B., Conch. Icon., Vol. 19, *Plicatula*, 1873, species 13, pl. 4, fig. 13. "Hab. Isl. Samar, Philippines."

[15] Hidalgo, J. G., Cat. Mol. Test. Islas Filipinas, 1904-1905, p. 385.

[16] Lamy, E., *Journ. de Conchyl.*, Vol. 83, No. 1, 1939, p. 17.

[17] See Lamy, E., *Journ. de Conchyl.*, Vol. 83, No. 1, 1939, p. 19.

Dimya californiana Berry.

Plate I, Figure 17.

Dimya californiana Berry, *Proc. Malac. Soc. London*, Vol. 22, Pt. 3, November 14, 1936, p. 126, pl. 13B, figs. 1, 2, 3, 4. "100 fathoms, off Santa Monica, California; specimen obtained from a stone taken by fishermen (W. H. Golisch, summer 1918)."

Type Locality: Off Santa Monica, California, in 100 fathoms, on a stone.

Range: Santa Monica, California, to Ceralbo channel, Gulf of California.

Collecting Station: Mexico: Ceralbo channel, Gulf of California (137-D-2), 46 fathoms, rock.

Description: Shell small, suborbicular, rather flat, outer surface irregularly laminated somewhat like mica; cardinal crura continuous above a small, roundly-triangular pit-like socket for the resilium; a line of denticles occurs just inside of where the valves impinge upon each other.

A single left valve of a *Dimya* dredged in Ceralbo channel in the Gulf of California agrees with the description and illustrations of *Dimya californiana* Berry. Somewhat similar species are *Dimya filipina* Bartsch and *D. lima* Bartsch, from the Philippine Islands, and *D. mimula* Dall, Bartsch & Rehder, from the Hawaiian Islands. Berry has recently described *Dimya coralliotis* from southern California (*Proc. Malacol. Soc. London*, Vol. 26, Pt. 1, May 4, 1944, p. 25, figs. 1-4).

Distribution: The single specimen of this species dredged in 46 fathoms in Ceralbo channel in the Gulf of California is the only record of this species from Mexican waters.

FAMILY LIMIDAE.

Genus **Lima** Cuvier.

Key to the species of *Lima*.

A. Shell large, thick, with coarse radial ribs ..... *tetrica*

B. Shell small, thin, with fine radial ribs

a. Shell with a central longitudinal sulcus ..... *subauriculata*

aa. Shell without a central longitudinal sulcus

b. Shell narrowly elongate, slightly convex, widely gaping on both sides ..... *pacifica*

bb. Shell ovately elongate, decidedly convex, gaping wider anteriorly than posteriorly

c. Widest part of shell at about the middle of the anterior margin ..... *orbignyi*

cc. Widest part of shell above the middle of the anterior margin ..... *hemphilli*

Subgenus **Lima** s.s.

Lima (Lima) tetrica Gould.

Lima tetrica Gould, *Proc. Boston Soc. Nat. Hist.*, Vol. 4, November, 1851, p. 93. "Gulf of California, La Paz. Maj. Rich."—Gould, *Boston Jour. Nat. Hist.*, Vol. 6, 1857, p. 405, pl. 16, fig. 6. La Paz, Gulf of California.

Type Locality: La Paz, Lower California, Mexico.

Range: Espiritu Santo Island, in the Gulf of California, to Gorgona Island, Colombia.

Collecting Stations: Mexico: Port Guatulco (195-D-9), 7 fathoms, gravel, sand and crushed shell; Tangola-Tangola Bay (196-D-14, 15), 5 fathoms, crushed shell; Costa Rica: 14 miles S. × E. of Judas Point (214-D-1-4), 42-61 fathoms, mud, shell, rock.

Description: Shell obliquely ovate, triangular, thick, dull white, with eighteen radiating ribs covered with long, semi-erect, muricated scales, longest at the posterior margin. The muscle scar is nearer the posterior margin. The shell attains a height of at least 50 mm.

Lima tetrica belongs to a group of species which occur in the warm marine waters of the world. This group is typified by *Lima lima*, the type of the genus which is probably a Mediterranean species.

Distribution: *Lima tetrica* occurs in comparatively shallow water, from the Gulf of California to Colombia. It is also known to occur in the Pleistocene of Oaxaca, Mexico.

Subgenus **Promantellum** Iredale.

Promantellum Iredale, Brit. Mus. (Nat. Hist.) Great Barrier Reef Exped. 1928-1929. Sci. Repts., Vol. 5, No. 6, Moll., Pt. 1, February 25, 1939, p. 385. "Type: *P. parafragile* sp. nov.," p. 386, pl. 6, figs. 10, 10a. "Low Isles," Great Barrier Reef, Australia.

Type (by original designation): *Promantellum parafragile* Iredale.

Shell very thin and oblique, flattened, equivalve, inequilateral, widely gaping both anteriorly and posteriorly, hinge line oblique and short, ears small, the anterior the larger and pointed; sculpture of low, sharp, slightly scaly, radial ribs which are separated by wider interspaces; ligament short and broad; free swimming. Exteriorly the general characters of the shells of *Promantellum* are somewhat like those of *Limatulella* Sacco[18], but the valves gape widely while those of *Limatulella*, which is typified by *Lima loscombi* Leach in Sowerby, gape only slightly along the upper anterior dorsal margin.

[18] *Limatulella* Sacco, Moll. Piemonte e Liguria, Pt. 25, August, 1898, p. 16. "(tipo *L. Loscombii* (Sow.))." ["*Lima Loscombi*, Leach," G. B. Sowerby, Gen. Shells, Vol. 1, 1823, *Lima*, pl. 99, fig. 4 (cited on plate as *L. loscombii*). Coast of Devonshire, England. Also illustrated by Forbes & Hanley, Hist. Brit. Moll., Vol. 2, 1853, p. 265, pl. 53, figs. 1, 2, 3. Various localities about Gt. Britain. Ranges throughout the European seas.]

Lima (Promantellum) pacifica d'Orbigny.

Lima arcuata Sowerby, Thes. Conch., Vol. 1, 1843, p. 86, pl. 22, figs. 41 and 42. [The date on the title page is 1842, but according to Sherborn this part was issued prior to June 23, 1843]. "at Panama in sandy mud; at Guayaquil Bay; at Guacomayo, under stones, etc. by Mr. Cuming." [Not the record "Found at Lord Hood's Island, under coral rocks," but it does occur at Hood Island, Galápagos group].

Not *Lima arcuata* Geinitz, 1840.

Lima pacifica d'Orbigny, Voy. Amér. Mérid., Vol. 5, 1846, p. 654. "M. Cuming l'a rencontrée près de Guayaquil, république de l'Équateur, et à Panama." New name for *Lima arcuata* Sowerby, not *Lima arcuata* Geinitz.

Type Locality: Panama, in sandy mud (here designated as type locality). Bay of Guayaquil, Ecuador, Guacomayo, and Lord Hood's Island also cited originally.

Range: Punta Penasco, Sonora, Mexico, to Negritos, Peru, and the Galápagos Islands.

Collecting Station: Costa Rica: Piedra Blanca.

Description: Shell thin, rather narrowly elongate, and somewhat expanded ventrally, widely gaping, the valves in contact only along the hinge and base; ornamented by about 30 to 35 fine, slightly wavy, radial ribs which bear very fine scales; the ribs become finer and more closely spaced anteriorly and posteriorly. A fairly large valve measures approximately: height 27 mm., length 17 mm., convexity (one valve) 5 mm.

Lima galapagensis Pilsbry and Vanatta[19] appears to be identical with this species.

Distribution: *Lima pacifica* is found occasionally from the Gulf of California to Peru and the Galápagos Islands. It occurs under rocks at extreme low tide.

Subgenus ***Limaria*** Link.

Limaria Link, *Beschreib. Nat.-Samml. Univ. Rostock*, Abt. 3, May 17, 1807, p. 157. —Winckworth, *Proc. Malacol. Soc. London*, Vol. 19, Pt. 3, November, 1930, p. 116. "I here choose *inflata* as type . . . "

Type (by subsequent designation): *Limaria inflata* of Link founded on Chemnitz, Conchyl.-Cab., Bd. 7, 1784, pl. 68, fig. 649*a* [cited as 641*a* by Link]. From the "Küste von Guinea und an den Stranden der westindischen Zuckerinsuln."

Shell moderately thin, oblique, somewhat produced anteriorly toward the ventral margin, submargins not impressed, usually somewhat inflated and gaping; ornamented by rather fine ribs of variable strength, often scaly; ligament pit broadly triangular; foot without byssus or retractor.

Limaria is available for most of the species formerly attributed to *Mantellum* Mörch which is not available due to earlier use of that name by Bolten.

Winckworth designated *Lima inflata* of Link as type, based on fig. 649*a* [cited as 641*a* by Link] of Chemnitz. Iredale rejected this selection, stating that *vulgaris* of Link (based on fig. 651 of Chemnitz, and under which Link included as a synonym *Ostrea lima* Linnaeus) should be the type by tautonomy, thus making *Limaria* a synonym of *Lima*. However, according to the rules of the International Commission on Zoological Nomenclature (Article 30(m)) it is recommended that names such as *vulgaris*, *communis*, etc., in the original list of species accompanying a genus, should be given preference but it is not stated that they must be selected as type.

Ostrea lima Linnaeus is cited in the synonymy of *vulgaris* Link, but the specific name *lima* is not absolutely tautonymous with *Limaria* but only virtually tautonymous. According to the rules of nomenclature a type by subsequent designation takes precedence over designation by virtual tautonomy. For these reasons we have retained *Limaria* with the type *inflata* based on Chemnitz's figure 649*a* as designated by Winckworth.

Iredale pointed out that *Lima inflata* of Gmelin, based on Chemnitz's figure 649*b*, represents a different species (*bullata* Born).

Species of *Limaria* have been recorded from the Neocomian, lower Cretaceous, to Recent. At the present time species occur at various depths in the waters of the temperate and tropical latitudes.

Lima (Limaria) hemphilli

Hertlein & Strong, sp. nov.

Plate I, Figures 3 and 4.

Lima dehiscens Conrad cited in west American records. Not *Lima dehiscens* Conrad, 1837. Island of Fayal, Azores.

Description: Shell obliquely elliptical, equivalve, inequilateral, moderately convex, broadly gaping especially along the anterior dorsal margin, posteriorly narrowly gaping; hinge short, anterior ear the larger, pointed, and beneath which a notch is present; the maximum width of the anterior margin is above the middle of the shell; between the widest portion and the hinge the margin shows two vague angulations; ventral margin elliptical, posterior margin very gently rounded; the anterior umbonal slope of the valves is gentle, the posterior slope is rather abrupt; valves ornamented by fine irregular radial ribs which are crossed by very

[19] *Lima galapagensis* Pilsbry & Vanatta, *Proc. Washington Acad. Sci.*, Vol. 4, September 30, 1902, p. 556, pl. 35, fig. 4. "Tagus Cove, Albemarle" Island, Galápagos Islands.

fine imbricating lirae; anterior and posterior submargins smooth. Height 23 mm., length 16.4 mm., convexity (both valves) approximately 12 mm.

Holotype and paratype (Calif. Acad. Sci. Paleo. Type Coll.) from Loc. 5955 (C.A.S.), San Diego, California; Henry Hemphill collector.

This species has been cited in the west American records as *Lima dehiscens* Conrad[20], a species originally described from the island of Fayal in the Azores. Sowerby[21] later considered Conrad's species to be synonymous with *Lima fragilis* Chemnitz[22] which was described originally from the coast of Nicobar.

Carpenter[23] in 1864 cited *Lima orientalis* Adams and Reeve from California and cited Cooper as authority that the species was identical with *Lima dehiscens*. *Lima orientalis* Adams and Reeve[24] was originally described from the Philippine Islands and is a distinct species.

From a consideration of the facts it appears to us that the west American species is without a valid name. It is here named in honor of Henry Hemphill who made extensive collections of mollusks in western North America.

Lima hemphilli greatly resembles the east American species generally referred to *Lima inflata* Lamarck[25]. The west American form appears to be wider in proportion to the length in comparison with the east coast specimens which we have seen, but they are very similar.

Compared to *Lima hians*, the width of *L. hemphilli* is proportionally greater, the widest part of the shell is somewhat farther above the middle and there are two vague angulations along the anterior dorsal outline rather than a correspondingly straight marginal outline in *L. hians*. Furthermore the anterior slope in *L. hemphilli* is steeper than that of *L. hians*.

Compared to *Lima hemphilli* the shell of *L. hirasei* Pilsbry[26] is flatter, the radial sculpture is finer, and the anterior and posterior dorsal margins are flattened and gently upturned. Thiele[27] considered *L. hirasei* to be only a variety of the West American species.

Range: Monterey, California, to Acapulco, Mexico.

Distribution: *Lima hemphilli* occurs from Monterey, California, to off western Mexico in waters from 10 to 50 fathoms and perhaps at greater depths. A single specimen of this species was dredged by the Crocker-Beebe expedition southeast of Cedros Island, in the channel, (126-D-19), in 25 fathoms, rocks, algae. It is also known from Pliocene to Recent and a similar or identical form has been recorded from the upper Miocene of southern California.

Lima (Limaria) orbignyi Lamy.

Lima angulata Sowerby, Thes. Conch., Vol. 1, 1843, p. 86, pl. 22, figs. 39, 40. [The date on the title page is 1842 but according to Sherborn this part was issued prior to June 23, 1843]. "Found by Mr. Cuming at Panama and the Bay of Caracas, in sandy mud, 10 to 12 fathoms."—Prashad, Siboga Exped., Monogr. 53c, Lamell., 1932, pp. 125-126 (in text), pl. 3, figs. 34, 35. Panama.

Not *Lima angulata* Münster, 1841.

Lima (Mantellum) orbignyi Lamy, *Jour. de Conchyl.*, Vol. 74, No. 3, November 29, 1930, p. 180. New name for *Lima angulata* Sowerby, not *L. angulata* Münster.

Type Locality: Panama, in 10 to 12 fathoms, sandy mud (here designated). Bay of Caraccas, Ecuador, also cited originally.

Range: Punta Penasco, Sonora, Mexico, to Juan Fernandez Island, and the Galápagos Islands.

Collecting Stations: El Salvador: La Union, Gulf of Fonseca (199-D-8, 22), 3-6 fathoms, mud, mangrove leaves on bottom; Nicaragua: Monypenny Point, Gulf of Fonseca (199-D-6), 4 fathoms, mud; Potosi Island; Costa Rica: Port Parker (203-D-3), 12 fathoms, shelly mud.

Description: Thin, striated, ventricose, slightly gaping on both sides, obliquely oval, with a posterior angle between the lateral and ventral margin, hinge narrow, auricles small, nearly equal (Sowerby). The valves gape widest along the dorsal portion of the anterior margin.

A large specimen of this species from Panama in the collection of Stanford University measures approximately 32 mm. in altitude and 24 mm. in width.

Lima orbignyi in some cases has been cited from west American waters under the name of *Lima orientalis* Adams and Reeve. The species described by Adams and Reeve

[20] *Lima dehiscens* Conrad, *Jour. Acad. Nat. Sci. Philadelphia*, Vol. 7, 1837, p. 247, pl. 19, fig. 7. "Inhabits the rocky coast of the island of Fayal; rare."

[21] Sowerby, Jun., G. B., Thes. Conch., Vol. 1, *Lima*, 1843, p. 86.

[22] *Pecten fragilis*, Chemnitz, Conchyl.-Cab., Vol. 7, 1784, p. 349, pl. 68, fig. 650. "Diese seltene Muschel ist an den Nicobarischen Stranden gefunden worden."

[23] Carpenter, P. P., Rept. Brit. Assoc. Adv. Sci. for 1863 (issued August, 1864), pp. 612, 645. Reprint in Smithson. Miscell. Coll., No. 252, 1872, pp. 98, 131.

[24] *Lima orientalis* Adams and Reeve, Zool. Voy. Samarang, August, 1850, Moll., p. 75, pl. 21, fig. 7. "Hab. Philippine Archipelago."

[25] See Perry, L. M., *Bull. Amer. Paleo.*, Vol. 26, No. 95, August 12, 1940, p. 44, pl. 6, fig. 31. Florida.

[26] *Lima hirasei* Pilsbry, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 53, May 7, 1901, p. 209. "Hirado, prov. Hizen, Kiusiu, Japan (Mr. Hirase)."—Pilsbry, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 53, p. 402, pl. 19, fig. 12 (as *Lima hians* Gmelin var. *hirasei* Pilsbry).

[27] Thiele, J., Martini—Chemnitz Conchyl.-Cab., Bd. 7, Abt. 2a, Heft 22, 1920, Limidae, p. 32, pl. 5, fig. 4. Pacific Ocean (Kiusiu, Japan).

occurs in the East Indies and is distinct from the west American shell.

Distribution: This species occurs from the Gulf of California to Juan Fernandez Island. Specimens in the present collection were dredged from depths of 3 to 13 fathoms and some were found along the beach.

Subgenus ***Limatula*** Wood.

Lima (Limatula) subauriculata Montagu.

Pecten subauriculata Montagu, Suppl. to Test. Brittanica [Vol. 3], 1808, p. 63, Tab. 29, fig. 2. On the coast of Devon, in deep water.

Lima subauriculata Montagu, Forbes & Hanley, Hist. Brit. Moll., Vol. 2, 1853, p. 263, pl. 53, figs. 4 and 5. Numerous localities cited in British Isles. Also said to range along all the coasts of Europe.

Type Locality: On the coast of Devon, England, in deep water.

Range: Izhut Bay, Afognak Island, Alaska, to Cape San Lucas, Lower California; northern Europe; North Atlantic; in West Atlantic south to Porto Rico; White Sea; circumboreal.

Collecting Stations: Mexico: east of Cedros Island (126-D-9,12), 45-56 fathoms, crushed shell, mud; Cape San Lucas.

Description: Shell ovate-oblong, pellucid, white, equilateral, equivalve, furnished with small, equal, angular projections, or subauricles, and wrought with numerous longitudinal striae that slightly crenulate the margin; along the middle are two striae that appear more conspicuous than the rest by being opaque and are equally evident on the inside; a character constant in several specimens examined. Length a quarter of an inch; breadth half its length (Montagu).

The two prominent riblets ornamenting the center of the valves of *Lima subauriculata* border a sulcus visible both exteriorly and interiorly. On the species described as *L. attenuata* by Dall, a sulcus is said to show only on the inside of the valves, while *L. similis* Dall is said to lack a sulcus.

Distribution: The distribution of *Lima subauriculata* is very wide. It is circumboreal and occurs in both the North Atlantic and Pacific waters. Woodring[28] has questioned the identity of the species cited under this name from western North America. Carpenter[29], however, stated that a specimen from California "Exactly agrees with British specimens," and Dall and others have considered the west American shells to be identical with those from northern European waters. It has been recorded from various localities from later Tertiary to Recent.

[28] Woodring, W. P., U. S. Geol. Surv., Prof. Paper 190, 1938, pp. 49-50.

[29] Carpenter, P. P., Rept. Brit. Assoc. Adv. Sci. for 1863 (issued August, 1864), p. 612. Reprint in Smithson. Miscell. Coll., No. 252, 1872, p. 98.

Superfamily Anomiacea.

FAMILY ANOMIIDAE.

Key to the genera of the Anomiidae.

A. Hinge with cardinal crura ..... *Placunanomia*

B. Hinge without cardinal crura

a. Imperforate valve with 1 large and two small muscle scars ..... *Anomia*

aa. Imperforate valve with 1 large and 1 small muscle scar ..... *Pododesmus*

Genus ***Anomia*** Linnaeus.

Anomia peruviana d'Orbigny.

Anomia peruviana d'Orbigny, Voy. Amér. Mérid., Vol. 5, 1846, p. 673. "environs de Payta (Pérou)," Recent.—Philippi, Abbild. u. Beschreib. Conchyl., Bd. 3, Heft 8, 1850, p. 131, *Anomia*, Tab. 1, figs. 2 and 3. Peru. —Grant and Gale, *Mem. San Diego Soc. Nat. Hist.*, Vol. 1, 1931, p. 240, pl. 12, figs. 2 and 5. Earlier records cited. Pliocene to Recent.

Type Locality: Paita, Peru.

Range: Monterey Bay, California, to Paita, Peru, and the Galápagos Islands.

Collecting Stations: Mexico: Santa Inez Bay (143-D-1, also beach; 144-D-2; 145-D-1, 3; 147-D-2), 2½-60 fathoms, mud, crushed shell, weed, sand, rocks; Cape San Lucas; Chamela Bay; Tenacatita Bay; Nicaragua: Monypenny Point, Gulf of Fonseca (199-D-1, 12, 22, also beach), 3-29 fathoms, sand, mud, crushed shell, mangrove leaves; Corinto (200-D-19) 12-13 fathoms, mangrove leaves; Panama: Gulf of Chiriqui (221-D-1-5), 35-40 fathoms, sandy mud.

Description: Shell variable in shape due to situs, generally fairly thin, partly translucent, smooth, radiately costate, or with irregular sculpture, often colored orange or yellowish-green, attached by a byssus which passes through a notch in the right valve; in the interior of the left valve there is a large scar below which there are two subequal scars, one just below the large upper scar, the other farther out and offset.

A number of species described by Gray, such as *Anomia alectus*, *A. fidenas*, *A. hamillus*, *A. lampe*, *A. larbas*, and *A. pacilus*, are now considered to be identical with *A. peruviana*. *Anomia simplex* Rochebrune is another synonym.

Distribution: This is a common species and ranges from Monterey Bay, California, to Paita, Peru. It occurs between tides or in shallow water attached to rocks or other objects. It is also known to occur from Pliocene to Recent in Southern California, Lower California, Panama, and in northern South America.

Genus ***Pododesmus*** Philippi.

Pododesmus macrochismus Deshayes.

Anomia macrochisma Deshayes, *Rev. Zool. Soc. Cuvierienne*, December, 1839, p. 359.

"Kamtschatka."—Deshayes, *Guerin's Mag. Zool.*, 1841, pl. 34.

Placunanomia macrochisma Deshayes, Reeve, Conch. Icon., Vol. 11, *Placunanomia*, 1859, species 7, pl. 2, fig. 7. "Hab. Onalaska; Cuming. Kamtschatka; Deshayes."

Pododesmus macroschismus Deshayes, Grant and Gale, *Mem. San Diego Soc. Nat. Hist.*, Vol. 1, 1931, p. 241, pl. 12, figs. 3, 4a, 4b. Earlier records cited. Pliocene to Recent.

Type Locality: Kamchatka.

Range: Kamchatka to Cape San Lucas and Santa Inez Bay in the Gulf of California. Also to Japan.

Collecting Stations: Mexico: Arena Bank (136-D-4, 5, 6, 30), 33-55 fathoms, mud, sand, weed; Arena Point area; Santa Inez Bay (141-D-1-4) 7-20 fathoms, sand, sandy mud, crushed shell, weed, calcareous algae.

Description: Shell ovate, rather solid, somewhat pearly, ornamented by rude, irregular, radiating ribs; colored yellowish or greenish-white, inner surface green; upper valve with one large scar, sometimes striated, which is in contact with a smaller, lower, offset scar; lower valve with a large byssal orifice. Large specimens attain an altitude of about 100 mm.

Pododesmus macrochismus differs from the generally more southern *P. foliatus* Broderip[30], in the coarser ribbing and in that the color of the interior is green rather than brown.

Distribution: This species occurs from Kamchatka to Santa Inez Bay in the Gulf of California and west to Japan. It occurs between tides or in shallow water attached to rocks or other objects. It is also known to occur from Pliocene to Recent in California.

Genus *Placunanomia* Broderip.

Placunanomia cumingii Broderip.

Placunanomia cumingii Broderip, *Proc. Zool. Soc. London*, April 21, 1832, p. 29. "Hab. ad oras Americae Centralis. (Gulf of Dulce, Province of Costa Rico)." "Dredged from a muddy bottom, at a depth of eleven fathoms, attached to dead bivalve shells and dead coral."—Reeve, Conch. Icon., Vol. 11, *Placunanomia*, 1859, species 3, pl. 1, figs. 3a, 3b. original locality cited.

Type Locality: Gulf of Dulce, Costa Rica, in 11 fathoms, attached to shells and corals on a muddy bottom.

Range: Carmen Island, Gulf of California, to Ecuador.

Collecting Stations: Mexico: Arena Bank (136-D-5, 6, 30), 33-35 fathoms, sand, weed, mud; Santa Inez Bay (141-D-1-4, also on shore), 7-20 fathoms, sand, sandy mud, crushed shell, weed, calcareous algae; Arena Point area; Costa Rica: Port Parker (203-D-3), 12 fathoms, shelly mud.

Description: Shell smooth, somewhat pearly, folded into three or four subangular plications which extend about two-thirds the distance to the beaks; color olive-white, especially interiorly; right valve with subcentral adductor scar and above this the closed (in adult) byssal scar; two prominent elevated ridges converge at the cardinal margin of the valve, these fit into a corresponding bipartite socket in the left valve; left valve with prominent byssal and adductor scars.

Placunanomia plicata Tuomey and Holmes described from the Miocene of South Carolina and *P. panamensis* Olsson[31] from the Pliocene of Panama are similar species.

Distribution: This species is found occasionally in comparatively shallow water from the Gulf of California to Ecuador, and it may occur as far south as Peru. It is also known to occur in the Pliocene and Pleistocene of the Tres Marias Islands, Mexico, and of Ecuador, and in the Pleistocene of Peru.

Superfamily Mytilacea.

FAMILY MYTILIDAE.

Key to the genera of the Mytilidae.

A. Teeth on anterior part of hinge; beaks terminal or nearly so
  a. Shell with internal deck below beaks ..... *Septifer*
  aa. Shell without internal deck below beaks
    b. Shell not over 3 mm. from beak to base; oval, with fine divaricate sculpture ..... *Crenella*
    bb. Shell large, over 3 mm. from beak to base.
      c. Shell with crenellated margin posterior to the ligament; radial sculpture ..... *Brachidontes*
      cc. Shell without crenellated margin posterior to the ligament ..... *Mytilus*

B. Without teeth on anterior part of hinge; beaks not terminal
  a. Shell subcylindrical or rhombic in cross-section
    b. Posterior end attenuated and wedge-shaped ..... *Lithophaga*
    bb. Posterior end not wedged-shaped ..... *Botula*

[30] *Placunanomia foliata* Broderip, *Proc. Zool. Soc. London*, May 14, 1834, p. 2. "Hab. in sinu Guayaquil Columbiae Occidentalis. (Isle of Muerte)." "Dredged up attached to a dead *Pinna* from a bottom of sandy mud, at the depth of eleven fathoms."—Reeve, Conch. Icon., Vol. 11, *Placunanomia*, August, 1859, species 5, pl. 1, fig. 5. Original locality cited.

[31] *Placunanomia panamensis* Olsson, *Bull. Amer. Paleo.*, Vol. 27, No. 106, December 25, 1942, p. 183 (31), pl. 14 (1), figs. 1, 4, 5. "Quebrada Rabo de Puerco," Panama. Pliocene.

occurs in the East Indies and is distinct from the west American shell.

Distribution: This species occurs from the Gulf of California to Juan Fernandez Island. Specimens in the present collection were dredged from depths of 3 to 13 fathoms and some were found along the beach.

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Lima (Limatula) subauriculata Montagu.

Pecten subauriculata Montagu, Suppl. to Test. Brittanica [Vol. 3], 1808, p. 63, Tab. 29, fig. 2. On the coast of Devon, in deep water.

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Type Locality: On the coast of Devon, England, in deep water.

Range: Izhut Bay, Afognak Island, Alaska, to Cape San Lucas, Lower California; northern Europe; North Atlantic; in West Atlantic south to Porto Rico; White Sea; circumboreal.

Collecting Stations: Mexico: east of Cedros Island (126-D-9,12), 45-56 fathoms, crushed shell, mud; Cape San Lucas.

Description: Shell ovate-oblong, pellucid, white, equilateral, equivalve, furnished with small, equal, angular projections, or subauricles, and wrought with numerous longitudinal striae that slightly crenulate the margin; along the middle are two striae that appear more conspicuous than the rest by being opaque and are equally evident on the inside; a character constant in several specimens examined. Length a quarter of an inch; breadth half its length (Montagu).

The two prominent riblets ornamenting the center of the valves of *Lima subauriculata* border a sulcus visible both exteriorly and interiorly. On the species described as *L. attenuata* by Dall, a sulcus is said to show only on the inside of the valves, while *L. similis* Dall is said to lack a sulcus.

Distribution: The distribution of *Lima subauriculata* is very wide. It is circumboreal and occurs in both the North Atlantic and Pacific waters. Woodring[28] has questioned the identity of the species cited under this name from western North America. Carpenter[29], however, stated that a specimen from California "Exactly agrees with British specimens," and Dall and others have considered the west American shells to be identical with those from northern European waters. It has been recorded from various localities from later Tertiary to Recent.

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Superfamily Anomiacea.

FAMILY ANOMIIDAE.

Key to the genera of the Anomiidae.

A. Hinge with cardinal crura ..... *Placunanomia*

B. Hinge without cardinal crura

a. Imperforate valve with 1 large and two small muscle scars ..... *Anomia*

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Genus ***Anomia*** Linnaeus.

Anomia peruviana d'Orbigny.

Anomia peruviana d'Orbigny, Voy. Amér. Mérid., Vol. 5, 1846, p. 673. "environs de Payta (Pérou)," Recent.—Philippi, Abbild. u. Beschreib. Conchyl., Bd. 3, Heft 8, 1850, p. 131, *Anomia*, Tab. 1, figs. 2 and 3. Peru. —Grant and Gale, *Mem. San Diego Soc. Nat. Hist.*, Vol. 1, 1931, p. 240, pl. 12, figs. 2 and 5. Earlier records cited. Pliocene to Recent.

Type Locality: Paita, Peru.

Range: Monterey Bay, California, to Paita, Peru, and the Galápagos Islands.

Collecting Stations: Mexico: Santa Inez Bay (143-D-1, also beach; 144-D-2; 145-D-1, 3; 147-D-2), 2½-60 fathoms, mud, crushed shell, weed, sand, rocks; Cape San Lucas; Chamela Bay; Tenacatita Bay; Nicaragua: Monypenny Point, Gulf of Fonseca (199-D-1, 12, 22, also beach), 3-29 fathoms, sand, mud, crushed shell, mangrove leaves; Corinto (200-D-19) 12-13 fathoms, mangrove leaves; Panama: Gulf of Chiriqui (221-D-1-5), 35-40 fathoms, sandy mud.

Description: Shell variable in shape due to situs, generally fairly thin, partly translucent, smooth, radiately costate, or with irregular sculpture, often colored orange or yellowish-green, attached by a byssus which passes through a notch in the right valve; in the interior of the left valve there is a large scar below which there are two subequal scars, one just below the large upper scar, the other farther out and offset.

A number of species described by Gray, such as *Anomia alectus, A. fidenas, A. hamillus, A. lampe, A. larbas,* and *A. pacilus,* are now considered to be identical with *A. peruviana. Anomia simplex* Rochebrune is another synonym.

Distribution: This is a common species and ranges from Monterey Bay, California, to Paita, Peru. It occurs between tides or in shallow water attached to rocks or other objects. It is also known to occur from Pliocene to Recent in Southern California, Lower California, Panama, and in northern South America.

Genus ***Pododesmus*** Philippi.

Pododesmus macrochismus Deshayes.

Anomia macrochisma Deshayes, *Rev. Zool. Soc. Cuvierienne,* December, 1839, p. 359.

"Kamtschatka."—Deshayes, *Guerin's Mag. Zool.*, 1841, pl. 34.

Placunanomia macrochisma Deshayes, Reeve, Conch. Icon., Vol. 11, *Placunanomia*, 1859, species 7, pl. 2, fig. 7. "Hab. Onalaska; Cuming. Kamtschatka; Deshayes."

Pododesmus macroschismus Deshayes, Grant and Gale, *Mem. San Diego Soc. Nat. Hist.*, Vol. 1, 1931, p. 241, pl. 12, figs. 3, 4a, 4b. Earlier records cited. Pliocene to Recent.

Type Locality: Kamchatka.

Range: Kamchatka to Cape San Lucas and Santa Inez Bay in the Gulf of California. Also to Japan.

Collecting Stations: Mexico: Arena Bank (136-D-4, 5, 6, 30), 33-55 fathoms, mud, sand, weed; Arena Point area; Santa Inez Bay (141-D-1-4) 7-20 fathoms, sand, sandy mud, crushed shell, weed, calcareous algae.

Description: Shell ovate, rather solid, somewhat pearly, ornamented by rude, irregular, radiating ribs; colored yellowish or greenish-white, inner surface green; upper valve with one large scar, sometimes striated, which is in contact with a smaller, lower, offset scar; lower valve with a large byssal orifice. Large specimens attain an altitude of about 100 mm.

Pododesmus macrochismus differs from the generally more southern *P. foliatus* Broderip[30], in the coarser ribbing and in that the color of the interior is green rather than brown.

Distribution: This species occurs from Kamchatka to Santa Inez Bay in the Gulf of California and west to Japan. It occurs between tides or in shallow water attached to rocks or other objects. It is also known to occur from Pliocene to Recent in California.

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Placunanomia cumingii Broderip.

Placunanomia cumingii Broderip, *Proc. Zool. Soc. London*, April 21, 1832, p. 29. "Hab. ad oras Americae Centralis. (Gulf of Dulce, Province of Costa Rico)." "Dredged from a muddy bottom, at a depth of eleven fathoms, attached to dead bivalve shells and dead coral."—Reeve, Conch. Icon., Vol. 11, *Placunanomia*, 1859, species 3, pl. 1, figs. 3a, 3b. original locality cited.

Type Locality: Gulf of Dulce, Costa Rica, in 11 fathoms, attached to shells and corals on a muddy bottom.

Range: Carmen Island, Gulf of California, to Ecuador.

Collecting Stations: Mexico: Arena Bank (136-D-5, 6, 30), 33-35 fathoms, sand, weed, mud; Santa Inez Bay (141-D-1-4, also on shore), 7-20 fathoms, sand, sandy mud, crushed shell, weed, calcareous algae; Arena Point area; Costa Rica: Port Parker (203-D-3), 12 fathoms, shelly mud.

Description: Shell smooth, somewhat pearly, folded into three or four subangular plications which extend about two-thirds the distance to the beaks; color olive-white, especially interiorly; right valve with subcentral adductor scar and above this the closed (in adult) byssal scar; two prominent elevated ridges converge at the cardinal margin of the valve, these fit into a corresponding bipartite socket in the left valve; left valve with prominent byssal and adductor scars.

Placunanomia plicata Tuomey and Holmes described from the Miocene of South Carolina and *P. panamensis* Olsson[31] from the Pliocene of Panama are similar species.

Distribution: This species is found occasionally in comparatively shallow water from the Gulf of California to Ecuador, and it may occur as far south as Peru. It is also known to occur in the Pliocene and Pleistocene of the Tres Marias Islands, Mexico, and of Ecuador, and in the Pleistocene of Peru.

Superfamily Mytilacea.

FAMILY MYTILIDAE.

Key to the genera of the Mytilidae.

A. Teeth on anterior part of hinge; beaks terminal or nearly so
  a. Shell with internal deck below beaks ..... *Septifer*
  aa. Shell without internal deck below beaks
    b. Shell not over 3 mm. from beak to base; oval, with fine divaricate sculpture ..... *Crenella*
    bb. Shell large, over 3 mm. from beak to base.
      c. Shell with crenellated margin posterior to the ligament; radial sculpture ..... *Brachidontes*
      cc. Shell without crenellated margin posterior to the ligament ..... *Mytilus*

B. Without teeth on anterior part of hinge; beaks not terminal
  a. Shell subcylindrical or rhombic in cross-section
    b. Posterior end attenuated and wedge-shaped ..... *Lithophaga*
    bb. Posterior end not wedged-shaped ..... *Botula*

[30] *Placunanomia foliata* Broderip, *Proc. Zool. Soc. London*, May 14, 1834, p. 2. "Hab. in sinu Guayaquil Columbiae Occidentalis. (Isle of Muerte)." "Dredged up attached to a dead *Pinna* from a bottom of sandy mud, at the depth of eleven fathoms."—Reeve, Conch. Icon., Vol. 11, *Placunanomia*, August, 1859, species 5, pl. 1, fig. 5. Original locality cited.

[31] *Placunanomia panamensis* Olsson, *Bull. Amer. Paleo.*, Vol. 27, No. 106, December 25, 1942, p. 183 (31), pl. 14 (1), figs. 1, 4, 5. "Quebrada Rabo de Puerco," Panama. Pliocene.

aa. Shell obliquely oblong; strong umbonal inflation and often compressed dorsally ..... *Volsella*

Genus **Mytilus** Linnaeus.

Key to the subgenera of *Mytilus*.

A. Anterior ventral margin strongly incurved forming a shelf in adult; no anterior adductor muscle scar ..... *Chloromya*

B. Anterior ventral margin not incurved to form a shelf; anterior adductor scar present ..... *Mytilus* s. s.

Subgenus **Mytilus** s.s.

Mytilus (Mytilus) californianus Conrad.

Mytilus californianus Conrad, *Jour. Acad. Nat Sci. Philadelphia*, Vol. 7, 1837, p. 242, pl. 18, fig. 15. "Inhabits on rocks, near Sta. Diego and Sta. Barbara, as well as at Monterrey," California.—I. S. Oldroyd, *Stanford Univ. Publ. Univ. Ser. Geol. Sci.*, Vol. 1, 1924, p. 66, pl. 27, fig. 2. Unalaska, Aleutian Islands, to Socorro Island, Mexico. Also Pliocene and Pleistocene of southern California.

Type Locality: San Diego, California. [Stated to be the type locality by I. S. Oldroyd, 1924, and accepted as such by the present writers.]

Range: Unalaska, Aleutian Islands, Alaska, to Socorro Island, Mexico.

Collecting Station: Mexico: Middle San Benito Island, Lower California.

Description: Shell large, thick ovately elongated, inflated; ventral margin nearly straight; ornamented by a few (sometimes a dozen) fairly broad, subdued radial ribs which occur on the median portion of the shell.

Distribution: This species occurs commonly from Alaska to Lower California, Mexico. It is found abundantly between tides attached to rocks or other objects. It is also known to occur in the Pliocene and Pleistocene of southern California.

Subgenus **Chloromya** Mörch.

Mytilus (Chloromya) palliopunctatus Dunker.

Mytilus palliopunctatus Dunker, in Carpenter, Cat. Mazatlan Shells, December, 1855, p. 118. "Mazatlan," Mexico.—Reeve, Conch. Icon., Vol. 10, *Mytilus*, 1857, species 19, pl. 5, fig. 19. Mazatlan. [Not the record "California," but it does occur in Lower California.]

Type Locality: Mazatlan, Mexico.

Range: Magdalena Bay, Lower California, to Corinto, Nicaragua.

Collecting Stations: Mexico: Cape San Lucas, Lower California; Chamela Bay; Tenacatita Bay.

Description: Shell elongately ovate, pointed anteriorly and usually rubbed at various angles; incurved along anterior ventral margin; periostracum dark, shell light purple in color, and with very fine radial striations; interior purple but white near the beak, and much of the surface finely punctate.

Distribution: This species is known to occur from Lower California to Nicaragua. It occurs between tides attached to rocks or other objects.

Genus **Brachidontes** Swainson.

Key to the subgenera of *Brachidontes*.

A. Dorsal margin angulated ..... *Brachidontes* s.s.

B. Dorsal margin rounded ..... *Hormomya*

Subgenus **Hormomya** Mörch.

Brachidontes (Hormomya) adamsianus Dunker.

Mytilus adamsianus Dunker, *Proc. Zool. Soc. London*, 1856 (issued May 8, 1857), p. 360. "Hab. ad Isthmum Panamense (Cuming)."—Reeve, Conch. Icon., Vol. 10, *Mytilus*, January, 1858, species 55, pl. 11, fig. 55. Panama.

Type Locality: Isthmus of Panama.

Range: Santa Barbara, California, to Panama, and the Galápagos Islands.

Collecting Station: Costa Rica: Piedra Blanca, beach.

Description: Shell small for the genus, externally similar to *Septifer bifurcatus;* sloping steeply dorsally from the umbo; ornamented on the umbo by coarse radial bifurcating ribs and along the ventral margin by finer ribs. The shape and ribbing of this species is extremely variable. It may be narrow or wide and the ribbing may be coarse or fine and in some specimens coarse radial ornamentation changes abruptly to fine.

Mytilus stearnsi Pilsbry and Raymond[32] was described from San Diego, California. There do not appear to be any constant characters by which the form from southern California can be distinguished from the form described as *Mytilus adamsianus*.

There has been confusion regarding the identification of *Brachidontes adamsianus* and the species described as *Mytilus multiformis* Carpenter; in fact, Carpenter (1864) believed the two were identical. *Mytilus multiformis* Carpenter[33] was described from Mazatlan, Mexico, in 1855. A study of specimens from Mazatlan, as well as Carpenter's original description has led us to consider *Mytilus multiformis* to be a distinct species

[32] *Mytilus stearnsi* Pilsbry & Raymond, *Nautilus*, Vol. 12, No. 6, October, 1898, p. 70, pl. 4, figs. 1-3. Type from "San Diego," California.

[33] *Mytilus multiformis* Carpenter, Cat. Mazatlan Shells, December, 1855, p. 118. "Mazatlan; jun. abundant, rare adult, among sea weeds on Chamae, Spondyli, Ostreae, Patellae, etc., or in the cavities of dead Lithophagi or Balani."

characterized by its smaller size, *Volsella*-like shape, usually smooth umbos and with very fine ribbing. Furthermore it occurs in mats of moss on rocks while *adamsianus* usually occurs in crevices in rocks or on the under sides of rocks. Haas[34] and Chace[35] have recently discussed these two species.

Distribution: *Brachidontes* (*Hormomya*) *adamsianus* occurs from southern California to Panama and the Galápagos Islands. It is often found between tides occurring in crevices or attached to the under sides of rocks, where only the end of the shell is exposed to the waves.

Genus **Septifer** Recluz.

Septifer Recluz, *Rev. Zool. Soc. Cuvierienne*, 1848, Vol. 11, p. 277.—Stoliczka, *Mem. Geol. Surv. India. Palaeont. Indica.* Ser. 6, Cret. Fauna South. India, Vol. 3, 1871, pp. XXI, 366. "Type, *S. bilocularis*, Linn."—Grant and Gale, *Mem. San Diego Soc. Nat. Hist.*, Vol. 1, 1931, p. 247. Type: *Mytilus bilocularis* Linnaeus.—Lamy, *Journ. de Conchyl.*, Vol. 80, No. 3, September 1, 1936, p. 239.

Type (designated by Stoliczka): *Septifer bilocularis* Linnaeus [Syst. Nat., ed. 10, Vol. 1, 1758, p. 705. "Habitat in O. Indico." Illustrated by Chemnitz, Conchyl.-Cab., Bd. 8, 1785, p. 155, pl. 82, figs. 736a, 736b (as *Mytilus nicobaricus*) and p. 157, pl. 82, fig. 737 (Nos. 1, 2, 3) (as "Varietas mytili Nicobarici viridescentis"). Nicobar Islands.—Prashad, Siboga Exped., Monogr. 53c, Lamell., 1932, p. 69, pl. 2, figs. 21-24. East Indies.]

The shell of *Septifer* may be separated from those of *Mytilus* or of *Brachidontes* by the presence of a small deck in the anterior end of the shell just below the hinge. The genus *Septifer* has been recorded from upper Cretaceous to Recent. Lamy[36] has given a discussion of a number of Recent species of *Septifer*.

Septifer zetekl Hertlein and Strong, sp. nov.

Plate I, Figures 1 and 2.

Septifer cumingii Recluz, cited from west American localities. Not *Septifer cumingii* Recluz from the island of Annaa.

Mytilus cumingianus cited from west American localities. Not *Mytilus cumingianus* Reeve.

Description: Shell small, subtriangular in outline, inflated, expanded posteriorly, colored green; umbos small, anterior dorsal margin nearly straight, posterior margin rounded, the upper part broadly, the ventral part less so, ventral margin slightly impressed and gaping toward the anterior end, a light brown colored byssus projects through the opening; the ventral part of the valve slopes steeply from the umbonal ridge but the dorsal part slopes more gently; surface of shell ornamented by fine radial ribs which in many cases become divaricate toward the posterior, the ribs are finely decussated by impressed concentric lines of growth; a septum is present interiorly just below the beaks, and is nearly straight across at the free end; the margin of the shell is crenulated; the interior of the shell is bluish colored or tinged with green. Length 6.8 mm., greatest height 4.1 mm., convexity (both valves) 3.5 mm.

Holotype and two paratypes (Calif. Acad. Sci. Paleo. Type Coll.) from off Taboga Island, Panama, in 25 fathoms, dredged by James Zetek. Paratype from Station 195-D-9, Port Guatulco, Mexico, dredged in 7 fathoms.

Range: Gulf of California to Panama and the Galápagos Islands.

Collecting Station: Mexico: Port Guatulco (195-D-9), in 7 fathoms, green sand and crushed shell.

This species has been cited from west American localities under the name of *Septifer cumingii* Recluz,[37] a species originally described from "les côtes de l'île Annaa (près le détroit de Panama), dans l'océan Pacifique." Reeve later described and illustrated a species under the name of *Mytilus cumingianus*[38] and cited the locality as Panama, and indicated that the specimen was collected by Cuming. The citation of this locality by Reeve probably influenced authors in accepting the name *Septifer cumingii* for a west American species.

E. A. Smith[39] later considered the problem of the identification of *Septifer cumingii* and stated that there was no reason to doubt the original locality of Recluz cited as the Island of Annaa, in Polynesia, and pointed out that Cuming collected at that island.

He also pointed out that Reeve was mistaken in his reference, orthography of the specific name, and the locality. After a comparison of the type of *Septifer cumingii* with specimens of *S. bilocularis* Linnaeus, the type of the genus, he concluded that there were no grounds for separating them.

After a consideration of the facts we have concluded that it is necessary to assign a new name to the west American form. The species is named in honor of Dr. James Zetek, Balboa, Canal Zone, Panama.

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[34] Haas, F., *Nautilus*, Vol. 56, No. 1, July, 1942, pp. 31-32.—Haas, *Field Mus. Nat. Hist.*, Zool. Ser., Vol. 29, No. 1, 1943, pp. 16-17.

[35] Chace, E. P., *Nautilus*, Vol. 56, No. 2, October, 1942, p. 43.

[36] Lamy, E., *Journ. de Conchyl.*, Vol. 80, No. 3, 1936, pp. 239-252.

[37] *Septifer cumingii* Recluz, *Rec. Zool. Mag. Guérin*, Ser. 2, Vol. 1, 1849, p. 132.

[38] *Mytilus cumingianus* Recluz, MS., Reeve, Conch. Icon., Vol. 10, *Mytilus*, January, 1858, species 52, pl. 11, fig. 52. "Hab. Panama."

[39] Smith, E. A., Rept. Sci. Res. Voy. *Challenger*, Zool., Vol. 13, 1885, p. 271.

Septifer zeteki resembles *S. bilocularis*, the type of the genus, but never attains the size of that species. It also somewhat resembles *Septifer bryani* Pilsbry,[40] originally described from the Hawaiian Islands, but the ribs appear to be coarser and less numerous than those of the Hawaiian species.

Genus **Volsella** Scopoli [=**Modiolus** Lamarck].

Key to the subgenera of *Volsella*.

A. Shell inflated, posterior dorsal area without zigzag markings ..... *Volsella* s.s.

B. Shell weakly inflated, narrow, posterior area with zigzag markings ..... *Amygdalum*

Subgenus **Volsella** s.s.

Key to the species of *Volsella* s.s.

A. Shell arcuate, narrow ..... *arciformis*

B. Shell not arcuate, broad

a. Shell with raised concentric sculpture especially posteriorly ..... *guyanensis*

aa. Shell with fine equal concentric lines of growth

b. Posterior end subquadrate ..... *salvadorica*

bb. Posterior end gently truncated and roundly attenuated ..... *capax*

Volsella (Volsella) arciformis Dall.

Plate I, Figure 5.

Modiolus arciformis Dall, *Proc. U. S. Nat. Mus.*, Vol. 37, 1909, pp. 152, 258, pl. 28, fig. 2. "Huaquilla on the Ecuador border; apparently from a shellheap."

Type Locality: Huaquilla, Ecuador, apparently from a shellheap.

Range: La Union, El Salvador, to Huaquilla, Ecuador.

Collecting Stations: El Salvador: La Union, Gulf of Fonseca (199-D-16), 6 fathoms, mud; Nicaragua: Monypenny Point, Gulf of Fonseca.

Description: Shell rather narrow and decidedly arcuate in outline after attaining a length of 40 mm. This feature is not pronounced in young specimens. A decided umbonal ridge is present, due to the compressed character of the ventral part of the shell. The interior of the shell is pearly and of a purplish color.

Distribution: The discovery of the occurrence of this species in the Gulf of Fonseca, extends the known range north to El Salvador.

Volsella (Volsella) capax Conrad.

Modiola capax Conrad, *Journ. Acad. Nat. Sci. Philadelphia*, Vol. 7, 1837, p. 242. "Inhabits marshes and muddy shores about Sta. Diego." [California]. — Reeve, Conch. Icon., Vol. 10, *Modiola*, 1857, species 11, pl. 3, fig. 11. "Hab. Galapagos Islands; Cuming. California; Nuttall. Mazatlan; Carpenter."

Type Locality: San Diego, California, in marshes and on muddy shores.

Range: Santa Cruz, California, to Paita, Peru.

Collecting Stations: Mexico: Santa Inez Bay, east coast of Lower California, beach; Cape San Lucas, beach; Chamela Bay, beach; Costa Riea: Port Parker, beach; Cedro Island, Gulf of Nicoya, beach.

Description: This species is easily recognized in the southern fauna by the large, thick shell and by the brick red color which is often present on worn surfaces.

Volsella capax differs from the generally more northern *V. modiolus* in possessing a heavier, more inflated shell which has a more depressed area between the umbos.

Distribution: This species occurs quite commonly from southern California to Peru.

Volsella (Volsella) guyanensis Lamarck.

Modiola guyanensis Lamarck, Anim. s. Vert., Vol. 6, February-June, 1819, p. 112. "Habite les mers de la Guyane."—Delessert, Rec. Coq. décrites par Lamarck et non encore figurées, 1841, pl. 13, fig. 9. Original locality cited.

Modiola brasiliensis Chemnitz, Reeve, Conch. Icon., Vol. 10, *Modiola*, August, 1857, species 17, pl. 4, fig. 17, Guayaquil; pl. 6, fig. 31. Brazil.

Type Locality: Guiana.

Range: San Ignacio Lagoon, Lower California, and the Gulf of California, to Paita, Peru. Also from Trinidad to Brazil on the Atlantic coast.

Collecting Stations: Nicaragua: Potosi and Monypenny Point; Isla Encantada, Corinto; Costa Rica: Ballenas Bay.

Description: This handsome shell is ornamented by well developed raised concentric growth lines which are especially pronounced posteriorly. The anterior part of the shell is usually colored some shade of brown while the posterior part is green, blackish-green, or in some cases the entire shell may be colored brownish-black.

Carpenter described *"Modiola ?Brasiliensis*, var. *mutabilis"*[41] from Mazatlan, Mexico. He considered it as possibly representing a rough water form of *brasiliensis*. The margins of this form were described as less straight and angular and the diagonal keel less impressed than that of the typical species. This subspecies is of doubtful value.

[40] See Dall, W. H., Bartsch, P., and Rehder, H. A., *Bernice P. Bishop Mus., Bull.* 153, July 25, 1938, p. 51, pl. 9, figs. 1-4. Cited from various localities in the Hawaiian Islands.

[41] *Modiola ?Brasiliensis*, var. *mutabilis* Carpenter, Cat. Mazatlan Shells, January, 1856, p. 122. "Mazatlan," Mexico.

Volsella guyanensis (=*Volsella brasiliensis* Chemnitz) is one of the species which occurs in both east and west American waters and there seems to be no positive method by which specimens from the two regions can be separated. A certain amount of variation might be expected in a species occurring over such a wide range.

Distribution: This species has a wide distribution. It occurs in shallow water from the Gulf of California to Peru and on the Atlantic coast from Trinidad to Brazil.

Volsella (Volsella) salvadorica

Hertlein and Strong, sp. nov.

Plate I, Figures 7 and 11.

Shell thin, subquadrate, moderately inflated, smooth; hinge line almost straight, with the beaks at about one-fourth the distance from the anterior end; beaks pointing forward and almost resting on the hinge; dorsal margin nearly straight; ventral margin with a slight concavity in the middle; anterior end rounded; posterior end sloping obliquely from the dorsal margin and rounded at the dorsal and ventral margins; umbonal ridge well developed; a slight convexity anterior to the ridge begins on the beaks and continues to the ventral margin; the dorsal posterior part of the valve is subalate; color of exterior of shell grading from light to chocolate brown, interior light purple and somewhat iridescent. Length 23.6 mm., height 13.9 mm., diameter (one valve) 5.8 mm.

Holotype, left valve (Calif. Acad. Sci. Paleo. Type Coll.), from Station 198-D-2, Lat. 13°27'20"N., Long. 89°19'20"W., dredged in 14 fathoms (25 meters) off La Libertad, El Salvador. Paratype, right valve, from Station 199-D-6, Lat. 13°02'30"N., Long. 87°29'30"W., dredged in 4 fathoms (7.2 meters) off Monypenny Point, Gulf of Fonseca, Nicaragua. One small specimen from Station 199-D-1, Lat. 13°08'N., Long. 87°43'W., dredged in 16 fathoms (29 meters), off Meanguera Island, Gulf of Fonseca, El Salvador.

Volsella salvadorica sp. nov. differs from *V. capax* in the straighter, longer hinge line, and much more quadrate shape.

Subgenus ***Amygdalum*** Megerle von Mühlfeld.

Key to the species of *Amygdalum*.

A. Posterior end of shell evenly rounded, colored yellowish-white ..... *pallidula*

B. Posterior end of shell obliquely truncated, colored yellowish-green ..... *speciosa*

Volsella (Amygdalum) pallidula Dall.

Modiolus (*?politus* Verrill var.) *pallidulus* Dall, *Proc. U. S. Nat. Mus.*, Vol. 52, December 27, 1916, p. 404. "Off San Luis Obispo Bay, in 77 fathoms."

Type Locality: Off San Luis Obispo Bay, California, in 77 fathoms.

Range: Bodega Head, California, to Acapulco, Mexico.

Collecting Station: Mexico: East of Cedros Island (126-D-10, 12), 45-60 fathoms, crushed shell, eel grass, mud.

Description: Shell small, thin, brilliantly polished, a large translucent dorsal area with whitish colored zigzag reticulations, and a smaller, opaque, white ventral area.

Volsella polita Verrill and Smith,[42] from the Atlantic and *V. sagittata* Rehder[43] from the Gulf of Mexico are similar species, as is *V. peasei* Newcomb[44] from the Hawaiian Islands.

Distribution: This species is known to occur from Bodega Head, California, to Acapulco, Mexico. It has been dredged usually in depths of 45 to 75 fathoms, or or even in deeper water.

Volsella (Amygdalum) speciosa Dunker.

Modiola speciosa Dunker in Reeve, Conch. Icon., Vol. 10, *Modiola*, October, 1857, species 35, pl. 7, fig. 35. "Hab. Tumbez, Peru; Cuming."

Type Locality: Tumbez, Peru.

Range: Magdalena Bay, Lower California, to Paita, Peru.

Collecting Station: Nicaragua: Monypenny Point, Gulf of Fonseca (199-D-3, 4, 5), 6-7 fathoms, mud.

Description: Shell elongate, slender, smooth; the periostracum of the anterior ventral region is light brown in color and the dorsal posterior portion is ornamented with fine dashes and zigzag brown lines which are separated upon a bright green ground color. The largest specimen in the present collection measures approximately 56.9 mm. in length.

Compared to *Volsella speciosa*, *V. tumbezensis* Pilsbry and Olsson,[45] also described from Peru, is said to possess a smaller shell which is wider posteriorly.

Distribution: *Volsella speciosa* is not a common species but is found occasionally from Magdalena Bay, Lower California, to Paita, Peru.

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[42] *Modiola polita* Verrill and Smith, *Amer. Jour. Sci.*, Ser. 3, Vol. 20, November, 1880, p. 400. From Lat. 39°56' 30"N., Long. 70°59'45"W., in 238 fathoms.—Verrill, *Trans. Connecticut Acad. Sci.*, Vol. 6, 1884, p. 281, pl. 30, fig. 12 (as *Modiolaria polita*).

[43] *Modiolus* (*Amygdalum*) *sagittatus* Rehder, *Nautilus*, Vol. 48, No. 4, April, 1935, p. 127, pl. 7, figs. 11, 12. Type "from the Gulf of Mexico, off Cape San Blas, Florida." Also from off Cape Florida.

[44] *Volsella* (*Amygdalum*) *peasei* Newcomb, Dall, Bartsch and Rehder, *Bernice P. Bishop Mus., Bull.* 153, 1938, p. 45, pl. 8, figs. 11-14. Cited from various localities off the Hawaiian Islands, in 4 to 50 fathoms.

[45] *Modiolus* (*Modiolus*) *tumbezensis* Pilsbry and Olsson, *Nautilus*, Vol. 49, No. 1, July, 1935, p. 16, pl. 1, fig. 5. "Beach at Puerto Pizarro, northern Peru."

Genus **Botula** Mörch.

Key to the subgenera of *Botula*.

A. Beaks subterminal; posterior umbonal area rounded ..... *Botula* s.s.
B. Beaks between center and anterior end; posterior umbonal area angulated ..... *Adula*

Subgenus **Adula** H. & A. Adams.

Botula (Adula) falcata Gould.

Lithodomus falcatus Gould, *Proc. Boston Soc. Nat. Hist.*, Vol. 4, November, 1851, p. 92. "Monterey, in indurated marly clay."—Gould, *Boston Journ. Nat. Hist.*, Vol. 6, October, 1853, p. 403, pl. 16, fig. 9. Original locality record cited.

Botula falcata Gould, I. S. Oldroyd, *Stanford Univ. Publ. Univ. Ser. Geol. Sci.*, Vol. 1, 1924, p. 71, pl. 21, figs. 8, 9. Coos Bay, Oregon, to San Diego, California.

Type Locality: Monterey Bay, California, in indurated marly clay.

Range: Coos Bay, Oregon, to Cape San Lucas, Lower California.

Collecting Station: Mexico: Cape San Lucas, Lower California.

Description: Shell subcylindrical, falcate, fragile, beaks about one eighth the length from the anterior end; a strongly marked angle occurs from the beaks to the base of the posterior extremity; ornamented by vertical wrinkles posteriorly, and these are somewhat divaricate anteriorly; periostracum thick, chestnut colored.

The vertical sculpture, larger and more elongate valves, are characters which serve to separate *Botula falcata* from *B. californiensis* Philippi.

Distribution: The discovery of the occurrence of *Botula falcata* at Cape San Lucas, Lower California, is an extension southward in the known range. It bores into rocks and attaches itself by a byssus to the sides of the burrow.

Genus **Lithophaga** Bolten.

Key to the subgenera of *Lithophaga*.

A. Calcareous prolongations of shell crossed at posterior end ..... *Myoforceps*
B. Calcareous prolongations of shell not crossed at posterior end
  a. Calcareous incrustation of shell smooth ..... *Labis*
  aa. Calcareous incrustation with divaricate plumose pattern posteriorly ..... *Diberus*

Subgenus **Myoforceps** Fischer.

Lithophaga (Myoforceps) aristata Dillwyn.

Mytilus aristatus Dillwyn, Descript. Cat. Rec. Shells, Vol. 1, 1817, p. 303. "Inhabits the coasts of Senegal burrowed in the shells of Balani. Adanson. In calcareous rocks. Sowerby." Reference to Adanson, Hist. Nat. Senegal, 1757, p. 267, pl. 19, fig. 2; Encycl. Meth., pl. 221, fig. 8; Linn. Trans., Vol. 8, pl. 6, fig. 2.

Lithophaga aristata Dillwyn, I. S. Oldroyd, *Stanford Univ. Publ. Univ. Ser. Geol. Sci.*, Vol. 1, 1924, p. 73, pl. 39, fig. 2. La Jolla, California, to Peru. Also Atlantic.

Type Locality: Coast of Senegal, Africa, in shells of Balani, also in calcareous rocks.

Range: La Jolla, California, to Peru. Also in the Atlantic; world wide.

Collecting Stations: Mexico: Punta Arena area; Pulmo Reef; Port Guatulco (195-D-15), 1.5 fathoms, coral; Acapulco; Tangola-Tangola Bay, on beach; Costa Rica: Port Parker, on beach; Cedro Island, Gulf of Nicoya (213-D-4-15), 5-40 fathoms, mud; Colombia: Gorgona Island.

Description: Shell subcylindrical, fairly straight, smooth, thin; a whitish calcareous coating usually covers the yellowish periostracum at the posterior end and extends beyond the shell in two narrow beak-like prolongations which cross as in the blades of a pair of scissors. Lamy has discussed this species and its synonymy (*Journ. de Conchyl.*, Vol. 81, 1937, pp. 169-174).

Distribution: This species is found from southern California to Peru, in holes which it has bored into rocks. It also occurs in the Atlantic and world wide in tropical seas. Dall recorded the species from the lower Miocene of Ballast Point, Tampa Bay, Florida, and the present authors recorded its occurrence in the Pleistocene of the Galápagos Islands.

Subgenus **Labis** Dall.

Lithophaga (Labis) attenuata Deshayes.

Modiola attenuata Deshayes, Lamarck's Anim. s. Vert., Vol. 7, 1836, p. 28. "Habite au Pérou, au Chile, dans les pierres." Ref. to "*Lithodomus caudigerus* var.," Sowerby, Gen. Shells, [Vol. 2, pl. 135] fig. 3.—Philippi, Abbild. u. Beschreib. Conchyl., Bd. 2, Heft 5, *Modiola*, October, 1846, p. 148 (2), tab. 1, fig. 6. "Patria: Litus Peruviae et Chili."

Lithophaga attenuata Deshayes, I. S. Oldroyd, *Stanford Univ. Publ. Univ. Ser. Geol. Sci.*, Vol. 1, 1924, p. 73, pl. 39, fig. 10. Lower California.

Type Locality: Peru and Chile.

Range: San Ignacio Lagoon, Lower California, to Chile.

Collecting Station: Costa Rica: Port Parker.

Description: Shell characterized by its slender produced form. The beaks are appressed, smooth, and the entire inner surface is hollow. This species is the type of the subgenus *Labis* Dall, which "has on each valve a semicylindrical smooth appendage of which the distal end is internally flattened and somewhat separated from the

appendage of the opposite valve, the ends being rounded."

Distribution: This species has been cited as occurring as far south as southern Chile. We have not seen specimens from north of San Ignacio Lagoon, Lower California. Like others of the genus it bores into rocks.

Subgenus ***Diberus*** Dall.

Lithophaga (Diberus) plumula Hanley.

Plate I, Figure 10.

Lithodomus plumula Hanley, *Proc. Zool. Soc. London*, July, 1844, p. 17. "Hab. Panama, in *Spondyli*."—Reeve, Conch. Icon., Vol. 10, *Lithodomus*, 1857, species 23, pl. 4, fig. 23. Original locality cited.

Modiola (Lithodomus) plumula Hanley, Hanley, Cat. Rec. Bivalve shells, pl. 24, fig. 23, 1856. [Not the record p. 240, "Philippines"].

Lithophagus calyculatus Carpenter, Cat. Mazatlan Shells, January, 1856, p. 124. "Hab.—Mazatlan; 1 sp. in *Spondylus calcifer*."

Type Locality: Panama, in *Spondyli*.

Range: San Ignacio Lagoon, Lower California, to Peru.

Collecting Stations: Mexico: Pulmo Reef, Arena Point, Lower California; Costa Rica: Port Parker; Colombia: Gorgona Island.

Description: The characteristic features of this species were mentioned by Hanley as follows: "The calcareous cellular coating of the umbonal ridge, resembling a ruffled feather in its arrangement, being composed of elevated thin ridges which slope anteriorly and diverge from their point of junction, one half to the anterior dorsal, the other to the ventral margin."

Carpenter's description of *Lithophaga calyculata* agrees exactly with that of Hanley for *L. plumula* and is therefore placed in the synonymy of Hanley's species in the present paper.

Specimens from San Diego and north to Duxbury Reef, Mendocino county, California, which have been referred to *Lithophaga plumula*, usually differ from typical forms of that species in that the calcareous incrustation usually lacks the definite arrowhead pattern of a central ridge from which lines point toward the vertex of the triangle of incrustation (see Plate I, Figures 8 and 9). For the California form we propose the subspecific name ***Lithophaga plumula kelseyi***, (Calif. Acad. Sci. Paleo. Type Coll.) from Loc. 5865 (C. A. S. Coll. H. Hemphill collector), San Diego, California.

Distribution: *Lithophaga plumula* occurs fairly commonly at certain localities along the west coast from Mexico to Peru where it is found between tides in rocks into which it has bored.

Genus ***Crenella*** Brown.

Crenella divaricata d'Orbigny.

Plate I, Figures 12 and 13.

Nuculocardia divaricata d'Orbigny, in Sagra, Hist. Cuba, Moll., Vol. 2, 1845, p. 311, atlas, pl. 27, figs. 56, 57, 58, 59. "Se trouve dans presque toutes les Antilles; au moins l'avons-nous de la Martinique, de la Guadeloupe, de la Jamaïque et de Cuba."—Chenu, Man. de Conchyl., Vol. 2, 1862, p. 154, fig. 754.

Crenella divaricata d'Orbigny, Maury, *Bull. Amer. Paleo.*, Vol. 10, Bull. 42, 1925, p. 247(95), pl. 29 (18), fig. 13. Springvale, Trinidad. Miocene.

Type Locality: Cuba (here designated). Martinique, Guadeloupe, Jamaica and Antilles also cited originally.

Range: Guadalupe Island, off Lower California, Mexico, and the Gulf of California, to Ecuador. Also Atlantic, from North Carolina to Venezuela.

Collecting Stations: Mexico: Santa Inez Bay (145-D-1, 3), 4-13 fathoms, sand; Manzanillo (184-D-2), 30 fathoms, gravelly sand; Port Guatulco (195-D-9), 7 fathoms, green sand, crushed shell; Costa Rica: Port Parker (203-D-1, 3), 12-15 fathoms, sandy mud, crushed shell, shelly mud.

Description: Shell small, elongately oval in shape, colored yellowish-white, ornamented by fine radial divaricate striations which are decussated by concentric sculpture; margins crenellated; a single strong crenellated denticle is present on the hinge.

A study of the literature and of the museum material available has led us to accept the conclusion of Dall that these tropical west American specimens can be referred to d'Orbigny's species *Crenella divaricata* which was originally described from the Caribbean region. The species has been cited from various geologic formations back to the Miocene.

Crenella ecuadoriana Pilsbry and Olsson,[46] described from the Pliocene of Ecuador, appears to be identical except for the slightly larger size of the fossil form.

Another name for the Recent species is *Crenella inflata* Carpenter,[47] originally described from Cape San Lucas, Lower California.

We have not noticed any occurrence of *Crenella divaricata* north of Mexico. Specimens which we have studied from southern California are referable to *Crenella decussata* Montagu and appear to be identical with specimens from England and from the

[46] *Crenella ecuadoriana* Pilsbry and Olsson, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 93, September 9, 1941, p. 55, pl. 18, figs. 2 and 3. "Canoa formation, Punta Blanca," Ecuador, Pliocene.

[47] ?*Crenella inflata* Carpenter, *Ann and Mag. Nat. Hist.*, Ser. 3, Vol. 13, April, 1864, p. 313. "Cape St. Lucas," Lower California. Reprint in *Smithson. Miscell. Coll.*, No. 252, 1872, p. 211.

Not *Crenella inflata* Müller, Holzapfel, *Palaeontographica*, Bd. 35 (Moll. Aachner Kreide, Abt. 2), 1889, p. 220, pl. 25, figs. 17, 18. Cretaceous of Germany. [Originally described as *Mytilus inflatus*].

Atlantic coast of the United States. The shells of *Crenella divaricata* are more inflated, more elongately oval in outline, and the hinge is more strongly developed in comparison with that of *C. decussata*.

Crenella megas Dall[48] described from Panama possesses a larger, thinner, delicately ornamented shell which is more pointed posteriorly in comparison with that of *C. divaricata*.

Distribution: *Crenella divaricata* occurs fairly commonly in west American waters at depths of 5 to 50 fathoms from Guadalupe Island, Mexico, to Ecuador, and along the Atlantic coast from North Carolina to the West Indies. It has been recorded from Miocene to Recent in the Caribbean region and is at present known from Pliocene to Recent on the Pacific coast.

EXPLANATION OF THE PLATE.

PLATE I.

Fig. 1. *Septifer zeteki* Hertlein & Strong, sp. nov. Paratype, right valve, from Station 195-D-9, dredged in Lat. 15°44'28"N., Long. 96°07'51"W., off Port Guatulco, Mexico, in 7 fathoms (12.6 meters). Length (beak to base) 6 mm. P. 71.

Fig. 2. *Septifer zeteki* Hertlein & Strong, sp. nov. View of the interior of the specimen shown in Figure 1.

Fig. 3. *Lima hemphilli* Hertlein & Strong, sp. nov. Holotype, left valve, from Loc. 5955 (Calif. Acad. Sci.), San Diego, California, Henry Hemphill collector. Altitude 23 mm., length 16.4 mm. P. 66.

Fig. 4. *Lima hemphilli* Hertlein & Strong, sp. nov. Holotype, right valve. View of interior of right valve of specimen shown in Figure 3.

Fig. 5. *Volsella* (*Volsella*) *arciformis* Dall. Hypotype, right valve, from Monypenny Point, Nicaragua. Length 41 mm., greatest width approximately 16.5 mm. P. 72.

Fig. 6. *Pecten* (*Leptopecten*) *velero biolleyi* Hertlein & Strong, subsp. nov. Holotype, right valve, from Station 203-D-3, dredged in Lat. 10°55'45"N., Long. 85°49'05"W., near Port Parker, Costa Rica, in 12 fathoms (22 meters). Length 6.9 mm., altitude 6.6 mm. P. 60.

Fig. 7. *Volsella* (*Volsella*) *salvadorica* Hertlein & Strong, sp. nov. Holotype, left valve, from Station 198-D-2, dredged in Lat. 13°27'20"N., Long. 89°19'20" W., off La Libertad, El Salvador, in 14 fathoms (25 meters). Length 23.6 mm., height 13.9 mm. P. 73.

Fig. 8. *Lithophaga plumula kelseyi* Hertlein & Strong, subsp. nov. Holotype, from Loc. 5865 (Calif. Acad. Sci.), San Diego, Calfornia, Henry Hemphill collector. Length 57.2 mm., greatest height approximately 14 mm. P. 75.

Fig. 9. *Lithophaga plumula kelseyi* Hertlein & Strong, subsp. nov. Side view of left valve of specimen shown in Figure 8.

Fig. 10. *Lithophaga* (*Diberus*) *plumula* Hanley. Hypotype, right valve, from Port Parker, Costa Rica. Length 48.2 mm., height 14 mm., convexity (both valves) 14.3 mm. View of exterior of right valve. P. 75.

Fig. 11. *Volsella* (*Volsella*) *salvadorica* Hertlein & Strong, sp. nov. View of interior of specimen shown in Figure 7.

Fig. 12. *Crenella divaricata* d'Orbigny. Hypotype, left valve, from Station 145-D-1, dredged in Lat. 26°52'N., Long. 111°53'W., Santa Inez Bay, east coast of Lower California, in 13 fathoms (24 meters). Height (beak to base) approximately 3 mm., length approximately 2 mm. P. 75.

Fig. 13. *Crenella divaricata* d'Orbigny. View of the interior of the specimen shown in Figure 12.

Fig. 14. *Ostrea palmula* Carpenter. View of interior of upper valve of holotype from Mazatlan, Mexico. Original measurements given as "*Long.* 2.3, *lat.* 1.6, *alt.* .54" poll. Carpenter at the time of descriptions of species in 1865 (*Journ. de Conchyl.*, Vol. 12 (Ser. 3, Vol. 5), April, 1865, p. 133 (footnote). Reprint in *Smithson. Miscell. Coll.*, No. 252, 1872, p. 301) stated that the unit "poll." used in the descriptions was 2.53 cm. in length. Dr. Teng-Chien Yen who, while at the British Museum of Natural History, investigated this unit of measurement, stated that the length of a pollex is approximately 2 cm.

This photograph was obtained from authorities of the British Museum of Natural History by Dr. U. S. Grant, IV, who kindly permitted us to use it to illustrate the species. P. 55.

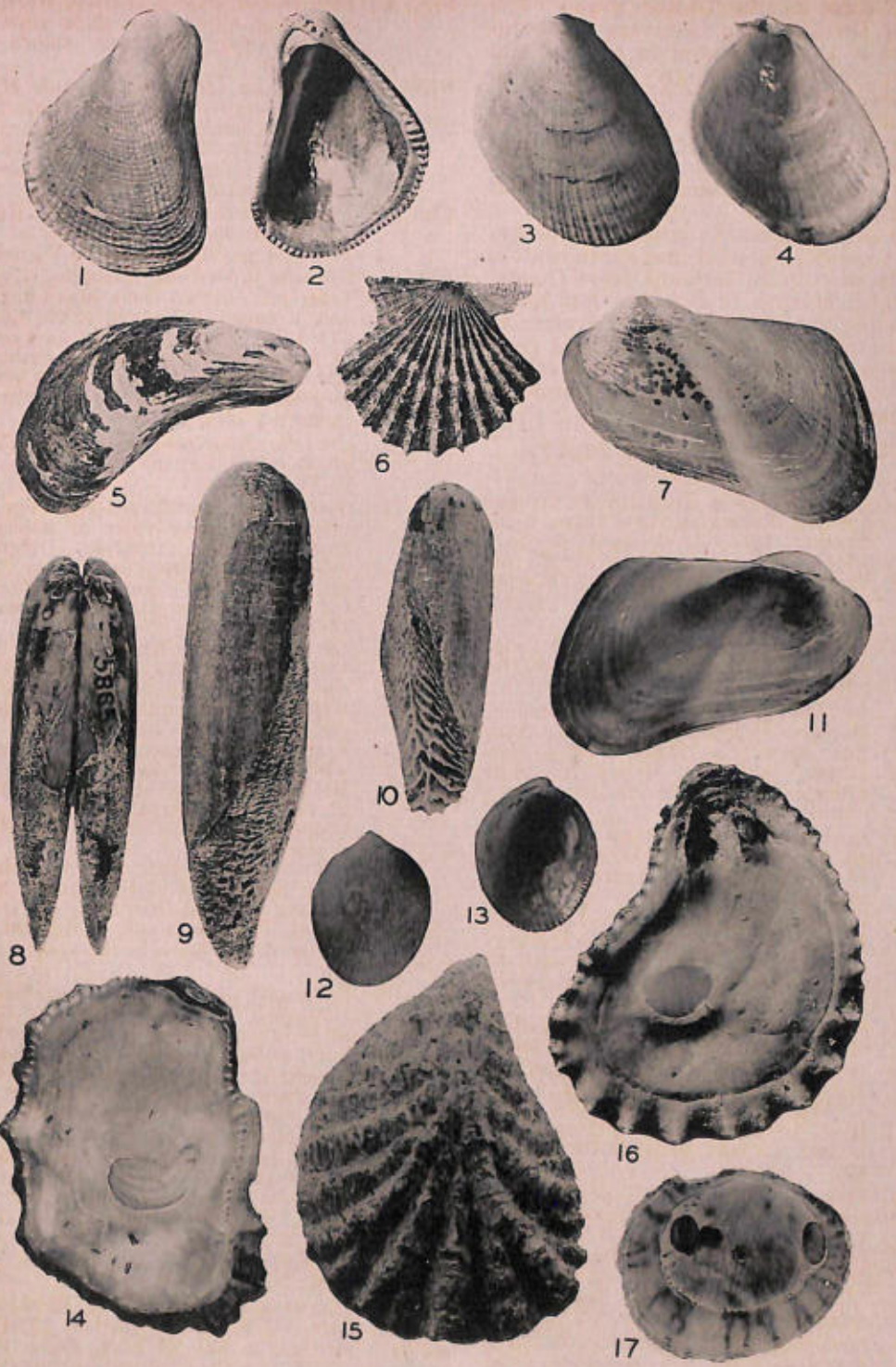
Fig. 15. *Plicatula spondylopsis* Rochebrune. Hypotype, left valve, from the Gulf of California, without exact locality but probably from Arena Bank. Height (beak to base) approximately 52.6 mm., length approximately 38 mm., convexity (both valves) approximately 25 mm. P. 63.

Fig. 16. *Plicatula spondylopsis* Rochebrune. Hypotype, left valve, from station 136-D-26, dredged in Lat. 23°27'N., Long. 103°24'W., Gorda Bank, Gulf of California, in 45 fathoms (82 meters). Height (beak to base) 53.6 mm., length 40.5 mm. P. 63.

Fig. 17. *Dimya californiana* Berry. Hypotype, left valve, from Station 137-D-2, dredged in Lat. 24°11'N., Long. 109° 59'W., Ceralbo Channel, Gulf of California, in 46 fathoms (84 meters). Length 10.8 mm., height (beak to base) 8.7 mm., convexity (one valve) approximately 1.8 mm. P. 65.

All the specimens illustrated on this Plate are in the type collection of the Department of Paleontology of the California Academy of Sciences.

[48] *Crenella megas* Dall, *Proc. U. S. Nat. Mus.*, Vol. 24, March 31, 1902, p. 559. "Dredged at station 2795, in Panama Bay, at a depth of 33 fathoms, sand, bottom temperature 64 F."—Dall, *Proc. U. S. Nat. Mus.*, Vol. 26, 1903, p. 950, pl. 62, fig. 4.



MOLLUSKS FROM THE WEST COAST OF MEXICO AND CENTRAL AMERICA.

6.

Introgressive Hybridization in Domesticated Fishes. I. The Behavior of Comet A *Platypoecilus maculatus* Gene in *Xiphophorus hellerii*.

MYRON GORDON.[1]
New York Aquarium, New York Zoological Society.

(Plates I-III).

The platyfish's comet gene P^{Co} was found in 1932 among the wild population of *Platypoecilus maculatus* in a tiny pool within the bed of a tributary stream of the Rio Tonto in the State of Oaxaca, Mexico. In 1939 two more populations containing the P^{Co} gene were found in the Rio Jamapa, Veracruz, and in several of the Rio Papaloapan tributaries in Oaxaca. The comet is one of a galaxy of genes in the natural populations of the platyfish, the most variable vertebrate, with respect to color pattern polymorphism, in North America. The comet gene P^{Co} belongs to an autosomal series of seven, dominant, multiple alleles, which include onespot, P^{O}; moon, P^{M}; moon complete with satellites, P^{Mc}; crescent, P^{C}; crescent complete, P^{Cc}; twinspot, P^{T}; and the universal recessive +.

During the study of this series of wild alleles, the comet-marked platyfish was mated in some instances to members of its own wild population and then, in contrast, to a number of domesticated breeds of the same species. A comparison of the results of these two types of matings was quite startling and unexpected. An entirely new pattern was created, known popularly among fish fanciers as the *black wagtail*. It resembles the color scheme in the Himalayan rabbit and Siamese cat, in which the extremities are much darker than other parts of the body.

Owing to the ease in which *P. maculatus* hybridizes with *Xiphophorus hellerii*, a mating between a wild comet platyfish and a wild swordtail was attempted and accomplished. As a result, the hybrids carrying the comet gene showed up with the same wagtail response. By repeated backcrosses of the wagtail platy-swordtail hybrid to the swordtail, a stock was developed indistinguishable from the *X. hellerii* configuration but containing the P^{Co} gene of *P. maculatus*. The wagtail swordtail so produced is now well established in the trade devoted to aquarium fishes.

Every step in the production of this new wagtail swordtail is known in this instance, and this will be described in detail. There are many colorful swordtails on the aquarium fish market most of which, if all the facts were known, could be traced back to one or more wild platyfish genes introduced into the swordtail by the process of introgression. This type of hybridization is the basis, also, for the development of melanomas in platyfish-swordtail combinations. Essentially the malignant tumors depend upon the interactions of the platyfish genes for macromelanophores *Sp* or *N* in association with a number of swordtail genes. With every backcross of the melanotic hybrid to the swordtail, the characteristic contours of the swordfish are more closely approached, while at the same time the severity of the melanoma is enhanced.

The process of introgression is often reversed; that is, a few swordtail genes may modify the basic platyfish genes. This is probably the explanation for the wagtail platyfish and for a number of the brilliant red, black and other domesticated varieties of the platyfish.

THE COMET PATTERN.

The comet is a simple pattern in wild platyfish. It consists of two straight black lines, one on the upper and one on the lower border of the tail fin. These dual black streaks are not parallel but flare slightly in conforming to the broadening of the caudal fin. This has the appearance of a conventionalized comet's train. A microscopic examination of the black lines of the comet reveals that they are composed of hundreds of tiny pigmented cells or micromelanophores concentrated along the upper and lower margins of the tail fin. The rest of the fin, in contrast, is transparent although there are scattered micromelanophores over all of it. The pigmented cells of the comet,

[1] Aided in part by a grant from the Anna Fuller Fund and by the facilities of the American Museum of Natural History.

of the tail fin proper, and of the body proper are similar morphologically. These micromelanophores are similar, too, to the pigmented cells which compose the other six patterns of the tail and caudal peduncle. When the micromelanophores are scattered, they produce an olive gray appearance; when concentrated they produce a jet black effect.

The Comet Reaction in Wild Populations.

Two distinct geographical populations of *P. maculatus* containing the comet platy were tested. The Rio Tonto population belongs to the Rio Papaloapan drainage system and in this system the comet gene is present in 8% of all platyfish. The second group belongs to the Rio Jamapa system, being collected at Plaza de Agua near El Tejar, a few miles west of the city of Veracruz. This area marks the most northern limit of the species as far as known; here 5% of the platyfish population carry the gene P^{Co}. The same species is known from two other great river systems, the Rio Coatzacoalcos and the Rio Usumacinta, but no comets have been reported, as yet, from them. An analysis of speciation in this fish by the use of pattern gene frequencies, including P^{Co}, is being prepared by Gordon (1946a).

In the paper just mentioned genetic evidence will be presented showing the relation of the P^{Co} gene to the others of its allelic series. When a comet platy is mated to any other member of its wild population, their offspring will display the comet pattern unchanged, regardless of the presence of any of the other markings. Natural combinations such as $P^{Co}P^{O}$, $P^{Co}P^{M}$, $P^{Co}P^{Mc}$, $P^{Co}P^{C}$, $P^{Co}P^{Co}$ and $P^{Co}P^{T}$ have been observed. In addition, single and duplex combinations have been seen with the sex-linked genes: *Sp*, *Sr*, *Sd* and *N* in more complex arrangements of patterns. However, no matter what other wild patterns a platyfish may have, the comet, if present, is visible and remains phenotypically unchanged.

The Comet Reaction in Domesticated Populations.

When a wild platyfish carrying the comet gene was mated to several different domesticated breeds of the same species, the F_1 hybrids carrying P^{Co} showed an entirely new phenotypic expression of it. When quite young the comet hybrids appeared in their conventional pattern, but as they continued their growth, the intensity of the black pigmentation of the upper and lower margins of the tail fin spread to the intermediate regions of that fin. At the same time the dorsal, the anal, the ventral and even the pectoral fins became darker too. Finally when the hybrid fish reached maturity, the micromelanophores in great concentrations blackened all the fins, and in addition they darkened the upper and lower jaws and the edges of the operculum. Expressing this reaction in short: all extremities were darkened. The resulting pattern is somewhat similar to the color scheme seen in Siamese cats, Himalayan rabbits, great Dane dogs, Dorset sheep and others in which the exposed parts, the muzzle, the ears, the digitory areas and the tail are strikingly darker than the rest of the body.

The action of the gene P^{Co} for comet was apparently modified in F_1 hybrids by a gene or genes contributed to the hybrid by the domesticated platyfish. The reaction of the comet with its modifier was first detected when the comet fishes of the Rio Papaloapan system were mated to the aquarium-bred variety known as the goldplaty. Later the same reaction was rediscovered when a wild comet platy from the Rio Jamapa was mated to several domesticated varieties.

The Genetic Nature of the Comet Modifier.

In *P. maculatus*, prior to the discovery of the P^{Co} modifier gene, *E*, three linkage groups were known: a sex-linked group with seven dominant genes, an autosomal allelic series with seven dominant genes and another autosomal group containing the one "domesticated" recessive golden, *st*. This platy has 24 haploid chromosomes according to Ralston (1934) and Friedman and Gordon (1935).

The following is an analysis of the genetic association of the *E* gene. The presentation of the following data and their analyses are not necessarily given in the chronological order in which the experiments were conducted.

	"Domesticated" ♀		"Wild" ♂
1.	$\frac{Dr}{+}\ \frac{st}{st}\ \frac{+}{+}\ \frac{E}{E}$	×	$\frac{+}{+}\ \frac{+}{+}\ \frac{P^{Co}}{P^{Co}}\ \frac{+}{+}$

In the above and succeeding formulae of genetic constitutions, *Dr* represents the gene for a red-dorsal fin, shown by Kosswig (1931) to be dominant and sex-linked. This was confirmed independently by Gordon (1931) who at one time used the symbol *Rf* for this gene. In domesticated females its chromosome associations are (Z)*Dr* (W)+.

The recessive *st* represents few or no micromelanophores and the absence of these black cells reveals the many underlying xanthophores which give this fish variety its golden coloring.

P^{Co} represents the comet pattern and *E* refers to its specific modifier which, as will be seen, is present in most domesticated stocks in a homozygous state. The + refers to universal recessive of the allelic series and to the "neutral wild type."

Together with this first mating, two others may be presented and discussed at the same

time because in each case the female parents had the same genotypes, and the males, too, were for the most part similar genetically for the characters under analysis. The second male differed only in that the P^{Co} gene was associated with another one of the dominant alleles, the gene P^{O} for onespot while the third male had the allele P^{C} for crescent as its P^{Co} associate. Their genotypes are given below:

	Females		Males
2.	$\frac{Dr}{+}\ \frac{st}{st}\ \frac{+}{+}\ \frac{E}{E}$	×	$\frac{+}{+}\ \frac{+}{+}\ \frac{P^{Co}}{P^{O}}\ \frac{+}{+}$
	Females		**Males**
3.	$\frac{Dr}{+}\ \frac{st}{st}\ \frac{+}{+}\ \frac{E}{E}$	×	$\frac{+}{+}\ \frac{+}{+}\ \frac{P^{Co}}{P^{C}}\ \frac{+}{+}$

It is clear from the results indicated in Table I that the sex-linked factor *Dr* was transmitted from the mothers to all their sons in the conventional manner according to (Z)*Dr* (W) + chromosome sex-determining mechanism. But Gordon (1946c) has indicated that the wild platyfish male has the XY chromosome arrangement. Thus it may seem from these experiments that among the F_1, (X)+ (W)+ and (Y)+ (W)+ are female while (Z)*Dr* (X)+ and (Z)*Dr* (Y)+ are male. A further discussion of this phase of the problem in matings of "wild" and "domesticated" platyfish is treated in another paper by Gordon (1946b).

All the F_1 of the three matings were olive gray, showing complete and uniform dominance of the "wild" *St* (or +) over the recessive "domesticated" golden gene *st*.

The first "wild" male comet platy (1-38) was apparently homozygous for P^{Co} as all of the F_1 had this factor but its phenotype expression modified by extensor gene *E* was changed into the wagtail pattern.

The offspring of the second (1-39) and the third (1-40) males show that the presumed modifier *E* acts on P^{Co} but not on P^{O} or P^{C}, and we have additional data at this time showing that *E* does not act on P^{Cc}, P^{M}, P^{Mc} or P^{T}, the remaining members of the series, and *E* has no discernible phenotype by itself. Only the combination P^{Co} *E* produced the wagtail reaction.

Matings 1, 2 and 3, taken individually or together, clearly show that *E* is not sex-linked, for while *Dr* is transmitted from the mother to her sons only the wagtail reaction P^{Co} *E* is visible in the sons and daughters.

Further evidence of the autosomal nature of the P^{Co} modifier may be seen in matings listed in Table II. In mating 4 the broods of two genetically similar females were pooled, and the observed results are apparently consistent with the theoretical values expected if *E* is considered independent of the two known autosomal factors in the mating, P^{Co} and *St*. Previous work (Gordon, 1927) has shown that the number of golden *st* is usually deficient, the deficiency being due to differential viability of *st* in contrast with the wild allele *St*. If *E* were linked to P^{Co} we might have expected that the ratio between P^{Co} *E* and *E* would have been less than 3:1, since linkage, if it existed, would have been in the repulsion series; actually the number of P^{Co} *E* was slightly greater than expected on the basis of a 3:1 ratio.

The independence of *E* and P^{Co} with respect to their linkage relations is clearly demonstrated in mating 5. Here approximately equal numbers of modified comets P^{Co} *E*, and non-comets, + *E*, (20:15) were found, whereas if *E* were linked with P^{Co},

TABLE I.

Mating No.	1		2		3	
Culture No.	31		32		33	
P_1 Pedigree No. P_1 Phenotypes	♀ 9A1 Dr st+E	♂ 1–38 ++P^{Co}+	♀ 9A2 Dr st+E	♂ 1–39 ++$P^{Co}P^{O}$+	♀ 9A3 Dr st+E	♂ 1–40 ++$P^{Co}P^{C}$+
F. Phenotypes	♀	♂	♀	♂	♀	♂
Dr+P^{Co} E	0	12	0	5	0	14
++P^{Co} E	9	0	6	0	10	0
Dr+P^{o} E			0	7		
++P^{o} E			8	0		
Dr+P^{C} E					0	10
++P^{C} E					15	0
Totals	9	12	14	12	25	24
χ^2 values	0.428		0.768		1.693	

TABLE II.

Mating	4		5		6		7	
Culture No.	53		59		55		54	
P_1 Pedigree No. P_1 Phenotypes	♀ 31–1, 2 ++P^{Co}E	♂ 31–11 Dr+P^{Co}E	♀ 9A²–1 Dr st+E	♂ 31–11 Dr+P^{Co}E	♀ 31–3, 4 +P^{Co}E	♂ 12–11 +++	♀ 53–1 st P^{Co}E	♂ 53–11 st P^{Co}E
F_1 Phenotypes	♀	♂	♀	♂	♀	♂	♀	♂
Dr + P^{Co}E	14	8	3	6				
+ + P^{Co}E	13	12	4		14	11		
Dr st P^{Co}E	3	2	2	4				
+ st P^{Co}E	2	1	1				14	18
Dr + P^{Co}	4	5						
+ + P^{Co}	4	3			11	8		
Dr st P^{Co}	1	0						
+ st P^{Co}	0	1					4	6
Dr + + +	6	8	2	5				
+ + + +	3	2	4		28	24		
Dr st + +	2	1	1	3				
+ st + +	1	0	0				8	8
Totals	53	43	17	18	53	43	26	32
χ^2 values	12.764		8.267		1.417		0.237	

then one might have expected only one P^{Co} *E* in four individuals (1:3). Independence of these genes is fully substantiated by the results of mating 6, where the male parent, being a "wild" individual and presumably homozygous recessive for the P^{Co} modifier *e*, produced when mated to an F_1 P^{Co} *E* approximately equal numbers of P^{Co} *E* and P^{Co} +. If P^{Co} were closely linked to *E*, no P^{Co} *E* would have been expected; if linked but separated moderately, a few P^{Co} *E* might have been expected as crossovers; but the data (25:19) indicate independence. The results shown in mating 7, where golden wagtails (P^{Co} *E*) were inbred, indicate a similar conclusion.

The data presented in Table III indicate further evidence that domesticated stocks of *P. maculatus* carry *E* (the dominant modifier of P^{Co}), in a homozygous state. All four golden platyfish of culture 9A listed in Table II were of this type; and the spotted female, 8 C1, and golden male, 9A21, listed in Table III, were homozygous for *E* too. In mating 8, the spotted female carried the pattern gene on its W chromosome, (Z)+ (W)*Sp*. This accounts for the mother-to-daughter type of inheritance of the *Sp* gene. (Again although XY represents the P_1 wild male (No. 1-39), in the F_1, XW and YW apparently determine femaleness and ZX and ZY determine maleness). Again, *E* apparently has no effect on the phenotypic expression of the allele P^{O}.

Further consideration of the sex-linked factors *Sp* and *Dr* in linkage relations to *E* seem unnecessary. Additional data are available of the linkage independence of *E* with respect to *St* and P^{Co}. In matings listed under No. 9 representing broods 46, 47 and 48, there were 146 P^{Co} *E*, 41 P^{Co} +, and 55 ++. The theoretical expectancy if P^{Co} and *E* are independent is as follows: 125 P^{Co} *E*, 45 P^{Co} +, and 60 ++, which is a significantly good fit. The X^2 value in this mating results with regard to *st*, P^{Co} and *E* is P = 31.

The results of mating 9 show that it is not likely that *E* is linked to *St* for when P^{Co} *E* was crossed with + P^{Co} *E*, 12 were *st* P^{Co} out of 242 offspring. On the basis of three independent factors 11.4 or 3/64 of the total were expected theoretically. All the other phenotypes appear in proportions appropriate to the theoretical values expected upon the same basis.

Further confirmation of the independence of *St*, P^{Co} and *E* is presented in the results from matings 10 and 11. If P^{Co} and P^{O} were linked to *E*, one ought *not* to get any P^{Co} P^{O} *E* in mating 11, yet 19 were observed; and 17 would be expected on the three independent factor basis. If *E* were linked to *St*, no *st* P^{Co} or P^{Co} P^{O} *E* would be expected, yet both types were present.

The Distribution of the *E* Gene in Xiphophorin Species.

Tests for the presence of the *E* gene in some of the wild xiphophorin species were

TABLE III.

Mating No.	8		9		10		11	
Culture No.	44		46–47–48		49–50		51–52	
Pedigree No. Genotypes	♀ 8C1 Sp st+E + st+E	♂ 1–39 ++P^{Co}+ ++P^{O}+	♀ 44-1,2,3 +P^{Co} E st + +	♂ 44-11,12 +P^{Co} E st + +	♀ 44–4, 5 +P^{Co} E st + +	♂ 9A21 ++E ++E	♀ 44–6, 7 +P^{O} E st + +	♂ 44–13 +P^{Co} E st + +
F. Phenotypes	♀	♂	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.
Sp+P^{Co} E	7	0						
++P^{Co} E	0	7						
Sp+P^{O} E	6	0						
++P^{O} E	0	9						
+P^{Co} E			121	101.8	28	22.8	14	12.6
st P^{Co} E			25	34.2	21	22.8	3	4.2
+P^{Co} +			29	34.2			5	4.2
st P^{Co} +			12	11.4			2	1.4
++			42	45.4	24	22.8	15	16.8
st +			13	15.2	18	22.8	4	5.6
+P^{Co} P^{O} E							17	12.6
st P^{Co} P^{O} E							2	4.2
+P^{Co} P^{O} +							2	4.2
st P^{Co} P^{O} +							1	1.4
+ P^{O}							20	16.8
st P^{O}							5	5.6
Total	13	16	242	242.2	91	91.2	90	89.6
X^2 values	0.812		7.163		1.265		5.583	

made by mating wild comet-carrying *P. maculatus* to *Xiphophorus hellerii*, *P. xiphidium* and *P. couchianus*. Tests were made also in three domesticated varieties of the swordtail: the albino, the red, and the golden tuxedo.

In Table IV the various interspecific matings are listed. The first-generation hybrids between *X. hellerii* and *P. maculatus* are designated as *XP*. When this hybrid is backcrossed to *X. hellerii*, the offspring are indicated as *XPX*, and when *XPX* is backcrossed again to *X. hellerii*, their offspring are designated as *XPXX*. The *XPXX* hybrids are not all alike, nor would they all pass as swordtails (see discussion). In 12 to 15, the results of crossing four wild *P. maculatus* comets, P^{Co}, with two albinos, one red and one wild female *X. hellerii*, show that the *E* modifier was present in a homozygous state in all of the swordtails, since the wagtail reaction rather than the unmodified comet pattern appeared in half of the hybrids. When the hybrids of mating 12 were inbred (mating 16), the number of wagtails (P^{Co} *E*), comets (P^{Co}), and neutrals (+) showed up approximately in the ratio of 9:3:4. This ratio represented the distribution of the three phenotypes in matings 16 and 17, too. Summing matings 16 through 18, there were 70 P^{Co} *E*, 15 P^{Co}, and 37+, while the expected ratio was 68.4 P^{Co} *E*, 23 P^{Co}, and 30.4 +. This summary does not, of course, include a number of presumably P^{Co} *E*, P^{Co}, and + in combination with the homozygous recessive *ii* for albinism, because the melanin pigment inhibitor *i* suppresses all melanic patterns. The fact that the albinos appear in far fewer numbers than the theoretical expectancy, has previously been noted by Gordon (1942).

When the species hybrids were backcrossed to the swordtail in an effort to recreate the body configuration of the swordtail and at the same time to retain the wagtail pattern (matings 19 through 23, and 25), all the domesticated and wild *X. hellerii* used proved to be homozygous for the *E* modifier in the backcross generation. When, however, the F_1 hybrid was backcrossed to a wild *P. maculatus* which introduced the non-modifier (mating 24), an 8 P^{Co} *E* to 4 P^{Co} to 10 + ratio was observed, and 5.5 to 5.5 to 11.0 ratio was expected on the basis of 1:1:2 ratio and 22 individuals.

With each backcross of the wagtail platy-swordtail hybrid to the *X. hellerii*, the resulting broods contains individuals that approach the swordtail more perfectly in body type, but there are many swordtail-platyfish

TABLE IV.

	P_1 FEMALES			P_1 MALES			F_1								
No.	SPECIES	PEDIGREE	TYPE	SPECIES	PEDIGREE	TYPE	CULTURE	$P^{Co}E$	$P^{Co}+$	++	P^{O}	P^{C}	i	TOTAL	χ^2 values
12	Xh	10A1	i E	Pm	1–39	$P^{Co}P^{O}$	71	19			16			35	0.25
13	Xh	10A2	i E	Pm	1–31	P^{Co}	72	15		8				23	2.13
14	Xh	10C1	R E	Pm	1–40	$P^{Co}P^{C}$	73	38				31		69	0.71
15	Xh	$3B^2$–2	+ E	Pm	1–41	P^{Co}	74	9	6	14				29	0.65
16	XP	71–1	$P^{Co}E+$	XP	71–11	$P^{Co}E+$	75	28	8	16			12	64	2.48
17	XP	72–21	$P^{Co}E+$	XP	72–11	+ E+	81	31	5	16			8	60	7.95
18	XP	72–22	$P^{Co}E+$	XP	72–12	$P^{Co}E+$	82	11	2	5			4	22	1.29
19	Xh	10A2	+ E i	XP	72–12	$P^{Co}E+$	84	10		12			4	26	12.77
20	Xh	70–41	+ E st	XP	72–12	$P^{Co}E+$	83	10		11				21	0.05
21	Xh	77a–27	+ E i	XP	72–41	$P^{Co}E+$	79	21		19			8	48	21.50
22	XP	74B1	$P^{Co}E$	Xh	10A11	i	115	33		34				67	0.02
23	XP	74B2	$P^{Co}E$	Xh	10A12	i	116	125		122				247	0.04
24	XP	74B3	$P^{Co}E$	Pm	22–11	+	117	8	4	10				22	1.62
25	XP	74B4	$P^{Co}E$	Xh	$3B^3$–11	+	118	63		56				119	0.41
26	Xh	10F1	+	XPX	115–11	$P^{Co}E$	146	9		16				25	1.96
27	Xh	124–1	st	XPX	146–11	$P^{Co}E$	147	116		109				225	0.21
28	Xh	124–2	st	XPX	146–11	$P^{Co}E$	148	22		23				45	0.02
29	Xh	89–1	R	XPXX	147–11	$P^{Co}E$	149	93		102				195	0.42
30	Xh	10–R i	R i	XPXX	147–11	$P^{Co}E$	169	24		22				46	0.09
31	Xh	124–Dt	st	XPX	118–11	$P^{Co}E$	151	69		79				148	0.68
32	XPXX	151–1	$P^{Co}E$	XPXX	151–11	$P^{Co}E$	153a	47		17				64	1.95
33	Xh	150–3	+	XPXX	151–11	$P^{Co}E$	153b	32		32				64	0.00
34	XPXX	151–2	$P^{Co}E$	XPXX	151–11	$P^{Co}E$	212	35		12				47	0.01
														1711	

hybrids in the *XPXX* category that have many combinations of hereditary factors; some of them indeed may be compared to the F_1 or *XP*.

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Wild swordtails are quite uniform with respect to color patterns whereas wild platyfish are extremely variable. In over 10,000 specimens of both species taken over their entire range in southern Veracruz and Oaxaca in Mexico and in British Honduras and Guatemala, not a single hybrid was found, yet at eight localities in this range the two species may be found side by side. Some of the isolating mechanisms such as psychological and ecological have been suggested previously by Gordon (1943, 1946a) to account for lack of natural hybridization. In the laboratory or home aquaria these barriers to hybridization are easily overcome. In a historical account of the early domestication of these species Gordon (1934) has found that the platy was first imported, probably from the Rio Coatzacoalcos, in 1907, and the swordtail followed in 1909, propably from the same river. Only two years later, 1911, hybrids between the species were recorded by aquarists writing in the *Blätter* and in the *Wochenschrift für Aquarien und Terrarienkunde*.

At present the tropical-fish dealers' catalogues list a dozen or more color varieties of the swordtail, only one of which, the albino, may have definitely arisen by the process of mutation. The other domesticated varieties, including such types as golden, red, black, tuxedo, "montezuma helleri" and their combinations, may be traced to introgressive hybridization of the many individual types of platyfish with the swordtail. Since the wagtail swordtail was produced in the laboratory, every step in its development has been recorded. Evidence of the origin of many other domesticated swordtails is now available also and will be presented in a series of papers.

The introgressive process is much clearer in the development of domesticated swordtails than in domesticated platyfish, but the same process has been going on in both. It seems to be clearest in the production of the wagtail platy. Since wild *P. maculatus* do not carry the *E* factor and wild *X. hellerii* do, it is likely that *E* was transferred to domesticated platies during the many matings made between these species.

An alternative suggestion may be made in accounting for the presence of the *E* factor in domesticated stocks. The early importations of platyfish were probably made from the Rio Coatzacoalcos, according to the analysis made by Gordon (1946a). The P^{Co} factor does not occur (as far as our data show) in the platyfish population of this river but the *E* factor may be present and it may have been transmitted in domesticated stocks generation after generation from 1907 to the present time. The former suggestion seems more plausible at this time.

Modifying Factors and Quantitative Characters.

From his analyses of natural fish hybrids and particularly from his laboratory studies of species hybrids in *Mollienisia* and related forms, Hubbs (1940) has become convinced that in species hybrids systematic characters of fishes generally show blending inheritance and that simple Mendelian segregation very seldom results; and this seems to apply to hybrids of subspecies and races. Hubbs finds that the characters which distinguish species and subspecies behave in hybridization experiments "in such strict conformance with the Galtonian scheme of inheritance that one can, for instance, compute rather precisely the number of dorsal rays in the final multiple hybrid by striking theoretical averages through the complex mating chart, starting only with the known average value of each form as it is introduced into the multiple matings. Such characters as position of fins, form of body and coloration appear to show a similar type of inheritance."

Kosswig (1931-39) and Gordon (1931-37) have long held that multiple genetic factors may account for the striking modifications in coloration in species hybrids between a particular *P. maculatus* and *X. hellerii*. Gordon (1937), for instance, suggested that the swordtail carries two sets of dominant modifying factors which act upon the spotting (*Sp*) gene of the platyfish. *Sp* is the gene that governs the development of specific pigment cells, the *macromelanophores*, which produce an irregular spotted pattern—a normal condition found in wild stocks as well as in domesticated ones. Thus the following formulae were used to represent the species:

Swordtail × Platyfish
++ AA BB × SpSp ++ ++

The first generation hybrids are all *Sp*+ *A*+ *B*+. The interaction of *A* and *B* with *Sp* produces a state of melanosis which frequently is so intense that it leads directly to the development of melanomas.

The reality of these modifiers *A* and *B* may be evaluated in the two opposing types

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The reality of these modifiers *A* and *B* may be evaluated in the two opposing types

of backcrosses, one to the platyfish, the other to the swordtail:

BACKCROSS OF F_1 HYBRIDS.
To the Platyfish

Spotted platyfish × Melanotic hybrid
Sp+ ++ ++ × *Sp*+ *A*+ *B*+

Backcross hybrids

NORMALS	MELANOTIC
SpSp ++ ++	SpSp A+ B+ (2)
Sp+ ++ ++	Sp+ A+ B+ (2)
++ A+ B+	SpSp A+ ++ (1)
++ A+ ++	Sp+ A+ ++ (1)
++ ++ B+	SpSp ++ B+ (1)
++ ++ ++	Sp+ ++ B+ (1)

BACKCROSS OF F_1 HYBRIDS.
To the Swordtail

Melanotic hybrid × Normal swordtail
Sp+ *A*+ *B*+ × ++ *AA BB*

Backcross hybrids

NORMALS	MELANOTIC
++ AA BB	Sp+ AA BB (4)
++ A+ BB	Sp+ AA B+ (3)
++ AA B+	Sp+ A+ BB (3)
++ A+ B+	Sp+ A+ B+ (2)

Assuming that each dominant intensifying factor of the swordtail has the value of *one* (1) the degree of melanosis, or shift of the normal spotted pigment pattern to an intense blackening, is indicated by the values within the parentheses: *A* or *B* equals 1, together *A* and *B* equal 2, and so on.

When the melanotic (*Sp A B*) hybrid is backcrossed to the spotted platyfish (*Sp*++), the darkest backcross hybrids are rarely blacker than their melanotic parent which have an intensity value of *two* (2). There are four genotypic hybrids which have a melanotic intensity value of *one* (1), while two spotted genotypes have the normal pattern; these are listed under *normals*.

In the backcross to the swordtail, the severity of melanosis is enhanced in some backcross hybrids owing to intensity factors which reach the value of *four* (4) in 12½% of the brood; the value of *three* (3) in 25%; and the value of *two* (2) in 12½%. Fifty per cent. or remainder of the brood are normal, for they do not carry the essential *Sp* gene.

When the backcross hybrid members of this brood are again backcrossed to the swordtail, the results depend upon the specific genotype of the particular hybrid used. Hybrid *Sp*+ *AA BB* by a ++ *AA BB* swordtail produces black offspring essentially of the same intensity as its hybrid parent. Hybrid *Sp*+ *AA B*+ by ++ *AA BB* swordtail produces two grades of melanotic offspring while hybrid *Sp*+ *A*+ *B*+ by a ++ *AA BB* swordtail produces three grades of melanotic offspring. In this analysis it has been assumed that *A* has the same value as *B*. If modifying factors *A* and *B* had different values, or if there were more than two modifiers involved, far more divergent groups of hybrids might be expected.

In some of the matings between two swordtail species the degree of diversity in the coloration of various types of hybrids closely resembles, particularly in the first generation, the type of "blending" mentioned for "good" systematic characters. It was found that when the wild spotted type of *Xiphophorus montezumae* was mated with the wild *X. hellerii*, the degree of spotting in the hybrids fell to about 50% of normal; but when the weakly spotted hybrid was backcrossed to *X. hellerii*, the backcross offspring had hardly any spots at all. (These statements are based on Gordon's unpublished data.)

ORIGIN OF RED SWORDTAIL; A STUDY IN INTROGRESSION.

The example given by Hubbs (1940) to illustrate the distinction "between the systematic characters showing blending inheritance on one hand and the phase characters with a simple genetic basis on the other," concerns the origin of the red swordtail. (Incidentally, this is another good example of introgressive hybridization under domestication). According to Hubbs, "no red phase of the swordtail genus *Xiphophorus* [*hellerii*] has been taken in nature and none seems to have originated by mutation in captivity, but the red phase does occur in the related genus *Platypoecilus* [*maculatus*], which hybridizes rather freely with *Xiphophorus*. The hybrids produced by mating a *Xiphophorus* with a red *Platypoecilus* are, in part, of an undiluted red, though intermediate in the ordinary systematic characters, such as form, number of rays, and structure of the gonopodium. Red hybrids mating back to *Xiphophorus* produce three-quarter hybrids of which, however, a certain proportion is red. One or two backcrossings then reconstruct the swordtail, in all respects other than the red clothing."

First the comments concerning the coloration of the wild swordtail and wild platyfish may be discussed because subsequent color responses in their hybrids depend upon the interaction of *all* the color and color modifying genes involved (and possibly some of these genes may be linked to those affecting systematic characters). The wild swordtail has some red coloring of its own: a strong row of erythrophores runs along its lateral line in a zigzagging pattern. Also many red patches of grouped red cells are scattered in the dorsal fin. The red zigzag row of chromatophores of the wild *X. hellerii* is subject to modification; for instance, it may be intensified in a species hybrid by

genes contributed to the hybrid by a non-red species, *X. montezumae*.

Some wild platyfish may have light orange-red dorsal fins; some have brighter coloration about their throat and belly regions. But the reddest of the wild platyfish could not match the brilliant over-all red coloration of the commercially cultivated red platy. We must first explain the process by which the domesticated red platy got so red. The detailed explanation cannot be given adequately on this occasion, but briefly stated, there has been a reciprocal interchange of modifying genes—an example of *reciprocal introgressive hybridization*. The red swordtail has the red gene or genes of the platyfish. *Dr* or *Rt* or both plus its own modifiers of *Dr* and *Rt*. The process involved is essentially the same as that given for the *Sp* gene in this discussion. The brilliant red platyfish of the aquarist has the swordtail gene modifiers of *Dr* or *Rt* plus its own red genes. This has been attained by selection of the desirable combination on the part of the fish fanciers.

The fact that the red phase may have a number of genetic modifiers does not make it any less Mendelian in its mode of inheritance. It does indicate that the red characteristic is as sensitive to quantitative expression (which is the basis of the apparent blending inheritance) as characters that are often used in taxonomy.

In actual practice many subspecies are more easily distinguished on the basis of their distinctive colorations or color patterns than by slight average differences of body proportions or of skeletal elements. In the speciation process at the lowermost level of differentiation (and perhaps at somewhat higher levels as well) the evaluation of the patterns formed by pigment cells may be compared upon equal terms, at least, with patterns formed by bone, muscle or other groups of cells.

Just as we find a number of genetical systems controlling chromatic patterns in hybrids (for instance, one factor for stippling, *St;* or for *one-spot, O;* or for cresent complete, *Cc;* and for some others; two factors, *Co* and *E* for wagtail; three, for intense melanosis, and each dominant factor has a specific value, *Sp AA BB*, etc.) so other body structures may each have a special genetic basis and in addition there may be interactions between the genes in these restricted systems. In illustration of this latter point, Gerschler (1912), in studying the inheritance of the length of sword in swordtail-platyfish hybrids, found that at least three dominant factors were required to account for the results he obtained: *AA BB CC* where *AA* have the value of 2. *BB* have the value of 4 and *CC* have the value of 6. In addition, Gerschler found that the platyfish carries dominant genes for some body features while the swordtail carries dominant genes for other groups of structures.

Other Instances of Introgression in Domesticated Fishes.

As indicated on several previous occasions, there are many good examples of introgressive hybridization in xiphophorin fishes—a complex of seven species. The papers of Kosswig (1929, 1937) and of his associate Breider (1937, 1938) contain detailed accounts of the behavior of specific genes of one species in the germ plasm of a related species. For the most part these are valid but many so-called *X. hellerii* genes such as *Mo*, *Rb* and *Sn* are all probably traceable to *P. maculatus*. Further discussion of these papers will be reserved for future occasions when related data on these specific color genes are presented. One comment may be made at this time: certain patterns of the platyfish have become associated so completely with the swordtail body form, and have been modified so thoroughly in the process, that part of their platyfish origin was not suspected. This is particularly true of the "*Mo*" character of the swordtail (*X. hellerii*) which now turns out to be due to the striped *Sr* pattern of wild platyfish. (This statement is based on unpublished data on the mating of wild platyfish of many different genotypes and wild swordtails.)

Introgression in General.

In his treatment of natural polymorphism in relation to geographical variation, Mayr (1942) discusses the apparent rapid spread of a black mutation from one population having a high concentration of that particular mutation to other nearby populations where that mutation had been rare or absent. He states that this phenomenon, which looks like introgressive hybridization in geographical races, may possibly be explained on the basis of the great phylogenetic antiquity of certain alleles in related groups and species. In commenting upon the introgressive process, Mayr regards it as theoretical and unproved in animals. Anderson and Hubricht (1938) and other botanists have pointed out that introgressive hybridization is more likely to occur in localities which have come under man's management (or mismanagement) and in plants that may have escaped from cultivation. Dobzhansky (1941) states that while it is impossible to appraise the evolutionary role of introgressive hybridization, it may, in some organisms, result in the emergence of superior genotypes. For example of introgression in animals he cites the work of Boettger and of Franz on mollusks and that of Blair on toads and states that this phenomenon appears to be much more common in plants than in animals. It occurs

of backcrosses, one to the platyfish, the other to the swordtail:

BACKCROSS OF F_1 HYBRIDS.
To the Platyfish

Spotted platyfish × Melanotic hybrid
Sp+ ++ ++ × *Sp*+ *A*+ *B*+

Backcross hybrids

NORMALS	MELANOTIC
SpSp ++ ++	SpSp A+ B+ (2)
Sp+ ++ ++	Sp+ A+ B+ (2)
++ A+ B+	SpSp A+ ++ (1)
++ A+ ++	Sp+ A+ ++ (1)
++ ++ B+	SpSp ++ B+ (1)
++ ++ ++	Sp+ ++ B+ (1)

BACKCROSS OF F_1 HYBRIDS.
To the Swordtail

Melanotic hybrid × Normal swordtail
Sp+ *A*+ *B*+ × ++ *AA BB*

Backcross hybrids

NORMALS	MELANOTIC
++ AA BB	Sp+ AA BB (4)
++ A+ BB	Sp+ AA B+ (3)
++ AA B+	Sp+ A+ BB (3)
++ A+ B+	Sp+ A+ B+ (2)

Assuming that each dominant intensifying factor of the swordtail has the value of *one* (1) the degree of melanosis, or shift of the normal spotted pigment pattern to an intense blackening, is indicated by the values within the parentheses: *A* or *B* equals 1, together *A* and *B* equal 2, and so on.

When the melanotic (*Sp A B*) hybrid is backcrossed to the spotted platyfish (*Sp*++), the darkest backcross hybrids are rarely blacker than their melanotic parent which have an intensity value of *two* (2). There are four genotypic hybrids which have a melanotic intensity value of *one* (1), while two spotted genotypes have the normal pattern; these are listed under *normals*.

In the backcross to the swordtail, the severity of melanosis is enhanced in some backcross hybrids owing to intensity factors which reach the value of *four* (4) in 12½% of the brood; the value of *three* (3) in 25%; and the value of *two* (2) in 12½%. Fifty per cent. or remainder of the brood are normal, for they do not carry the essential *Sp* gene.

When the backcross hybrid members of this brood are again backcrossed to the swordtail, the results depend upon the specific genotype of the particular hybrid used. Hybrid *Sp*+ *AA BB* by a ++ *AA BB* swordtail produces black offspring essentially of the same intensity as its hybrid parent. Hybrid *Sp*+ *AA B*+ by ++ *AA BB* swordtail produces two grades of melanotic offspring while hybrid *Sp*+ *A*+ *B*+ by a ++ *AA BB* swordtail produces three grades of melanotic offspring. In this analysis it has been assumed that *A* has the same value as *B*. If modifying factors *A* and *B* had different values, or if there were more than two modifiers involved, far more divergent groups of hybrids might be expected.

In some of the matings between two swordtail species the degree of diversity in the coloration of various types of hybrids closely resembles, particularly in the first generation, the type of "blending" mentioned for "good" systematic characters. It was found that when the wild spotted type of *Xiphophorus montezumae* was mated with the wild *X. hellerii*, the degree of spotting in the hybrids fell to about 50% of normal; but when the weakly spotted hybrid was backcrossed to *X. hellerii*, the backcross offspring had hardly any spots at all. (These statements are based on Gordon's unpublished data.)

ORIGIN OF RED SWORDTAIL; A STUDY IN INTROGRESSION.

The example given by Hubbs (1940) to illustrate the distinction "between the systematic characters showing blending inheritance on one hand and the phase characters with a simple genetic basis on the other," concerns the origin of the red swordtail. (Incidentally, this is another good example of introgressive hybridization under domestication). According to Hubbs, "no red phase of the swordtail genus *Xiphophorus* [*hellerii*] has been taken in nature and none seems to have originated by mutation in captivity, but the red phase does occur in the related genus *Platypoecilus* [*maculatus*], which hybridizes rather freely with *Xiphophorus*. The hybrids produced by mating a *Xiphophorus* with a red *Platypoecilus* are, in part, of an undiluted red, though intermediate in the ordinary systematic characters, such as form, number of rays, and structure of the gonopodium. Red hybrids mating back to *Xiphophorus* produce three-quarter hybrids of which, however, a certain proportion is red. One or two backcrossings then reconstruct the swordtail, in all respects other than the red clothing."

First the comments concerning the coloration of the wild swordtail and wild platyfish may be discussed because subsequent color responses in their hybrids depend upon the interaction of *all* the color and color modifying genes involved (and possibly some of these genes may be linked to those affecting systematic characters). The wild swordtail has some red coloring of its own: a strong row of erythrophores runs along its lateral line in a zigzagging pattern. Also many red patches of grouped red cells are scattered in the dorsal fin. The red zigzag row of chromatophores of the wild *X. hellerii* is subject to modification; for instance, it may be intensified in a species hybrid by

genes contributed to the hybrid by a non-red species, *X. montezumae*.

Some wild platyfish may have light orange-red dorsal fins; some have brighter coloration about their throat and belly regions. But the reddest of the wild platyfish could not match the brilliant over-all red coloration of the commercially cultivated red platy. We must first explain the process by which the domesticated red platy got so red. The detailed explanation cannot be given adequately on this occasion, but briefly stated, there has been a reciprocal interchange of modifying genes—an example of *reciprocal introgressive hybridization*. The red swordtail has the red gene or genes of the platyfish. *Dr* or *Rt* or both plus its own modifiers of *Dr* and *Rt*. The process involved is essentially the same as that given for the *Sp* gene in this discussion. The brilliant red platyfish of the aquarist has the swordtail gene modifiers of *Dr* or *Rt* plus its own red genes. This has been attained by selection of the desirable combination on the part of the fish fanciers.

The fact that the red phase may have a number of genetic modifiers does not make it any less Mendelian in its mode of inheritance. It does indicate that the red characteristic is as sensitive to quantitative expression (which is the basis of the apparent blending inheritance) as characters that are often used in taxonomy.

In actual practice many subspecies are more easily distinguished on the basis of their distinctive colorations or color patterns than by slight average differences of body proportions or of skeletal elements. In the speciation process at the lowermost level of differentiation (and perhaps at somewhat higher levels as well) the evaluation of the patterns formed by pigment cells may be compared upon equal terms, at least, with patterns formed by bone, muscle or other groups of cells.

Just as we find a number of genetical systems controlling chromatic patterns in hybrids (for instance, one factor for stippling, *St;* or for *one-spot, O;* or for cresent complete, *Cc;* and for some others; two factors, *Co* and *E* for wagtail; three, for intense melanosis, and each dominant factor has a specific value, *Sp AA BB*, etc.) so other body structures may each have a special genetic basis and in addition there may be interactions between the genes in these restricted systems. In illustration of this latter point, Gerschler (1912), in studying the inheritance of the length of sword in swordtail-platyfish hybrids, found that at least three dominant factors were required to account for the results he obtained: *AA BB CC* where *AA* have the value of 2, *BB* have the value of 4 and *CC* have the value of 6. In addition, Gerschler found that the platyfish carries dominant genes for some body features while the swordtail carries dominant genes for other groups of structures.

Other Instances of Introgression in Domesticated Fishes.

As indicated on several previous occasions, there are many good examples of introgressive hybridization in xiphophorin fishes—a complex of seven species. The papers of Kosswig (1929, 1937) and of his associate Breider (1937, 1938) contain detailed accounts of the behavior of specific genes of one species in the germ plasm of a related species. For the most part these are valid but many so-called *X. hellerii* genes such as *Mo*, *Rb* and *Sn* are all probably traceable to *P. maculatus*. Further discussion of these papers will be reserved for future occasions when related data on these specific color genes are presented. One comment may be made at this time: certain patterns of the platyfish have become associated so completely with the swordtail body form, and have been modified so thoroughly in the process, that part of their platyfish origin was not suspected. This is particularly true of the "*Mo*" character of the swordtail (*X. hellerii*) which now turns out to be due to the striped *Sr* pattern of wild platyfish. (This statement is based on unpublished data on the mating of wild platyfish of many different genotypes and wild swordtails.)

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to me that if the origin of our domesticated animals were more precisely known many additional examples might be put forward in this group of organisms.

Fishes and Cotton Plants.

Genetic conditions somewhat similar to those reported in this paper for xiphophorin fishes may be found among the species of cottons, studies upon which have been under way for many years by Harland (1936, 1939) and associated workers of the Imperial Cotton Growing Corporation, Hutchinson, Silow and Stephens. By planned hybridization between *Gossypium barbadense* and *G. hirsutum* and backcrossing of the hybrids to the original species, they have extracted hybrid compounds having predominantly the gene system of *G. barbadense* with a few genes of *G. hirsutum*, or conditions may be reversed. In the practical application of genetic research, plant and animal breeders are constantly trying to combine the desirable features of one organism with those of another. In some instances a high yielding plant is subject to a specific disease. A search is made among its wild relatives to find a disease-resistant strain and attempts are then made to combine the high yielding qualities of one with the disease-resisting qualities of the other. In effect, this, too, is introgression—if it is shown that the traits combined have a hereditory basis and separate origins.

Genes and the Rate of Development.

Changes in developmental rates by regulation of the external temperatures during specific periods of embryonic growth have altered the attainment of the usual number of vertebrae (and possibly dorsal fin-ray counts) in fishes. Hubbs and others have discovered this phenomenon; recently Gabriel (1944) has demonstrated it experimentally in developing *Fundulus*, and Gordon and Benzer (1945) have reviewed its significance in problems of speciation in xiphophorin fishes. Gabriel found that some strains of *Fundulus* were temperature labile, while others were genetically unalterable with regard to the number of vertebrae they attain.

In this connection, the work of Ford and Huxley (1929) on the attainment of definitive eye colors in *Gammarus* is suggestive. (A comprehensive discussion on the subject has recently been presented by Huxley, 1944). The eyes of the shrimp are usually black but mutants with eye colors of red, brown and dark brown are known. The eyes of the young stages of the normal shrimp are red but they gradually become darker. In the red-eyed mutant adult they never get darker; in other mutants they stop at the brown or darker stages. Huxley believes that genes produce their effect by influencing the rate of development of various substances involved in pigment formation. This interpretation may be applied to the possible manner in which the modifying genes *A* and *B* of *X. hellerii* act upon the *Sp* gene of *P. maculatus* to produce melanosis in the F_1 hybrids (*Sp*+ *A*+ *B*+) and to produce severe melanosis in the backcross (to *X. hellerii*) hybrids (*Sp*+ *AA BB*). In the latter, the degree of melanosis which is usually attained by the F_1 hybrid in adult life is attained, according to Gordon (1937), in the backcross hybrid on the day of birth. A reversal of this trend may be seen in the inhibitory action of *X. hellerii* factors on the macromelanophore gene of *X. montezumae*.

The concept of the influence of genes on the rate of development has been used by Goldschmidt for the interpretation of sex attainment and other features. It may also apply, possibly, to vertebrae number, fin-ray count and other "taxonomic" characters.

Summary.

1. The Mexican platyfish gene P^{Co}, one of seven dominant, multiple, autosomal alleles, produces a simple comet-like pattern in the tail fin in wild *Platypoecilus maculatus*. Representatives of the comet gene P^{Co} are found in natural populations of the platyfish in the Rio Jamapa and Rio Papaloapan but not in the Rio Coatacoalcos and the Rio Usumacinta.

2. When a "wild" *P. maculatus* carrying P^{Co} is mated with "domesticated" platyfish or with "wild" *Xiphophorus hellerii* the phenotype of the hybrids show *all* the fins considerably darker, producing a new variety termed the *wagtail*. The modified effect of P^{Co} from the comet to the wagtail is due to a specific factor *E* which has no visible effect of its own. *E* is autosomal and independent of the P^{O}, P^{M}, P^{Mc}, P^{Co}, P^{C}, P^{Ce}, P^{T} series and of *st*.

3. It is suggested that "domesticated" stock of *P. maculatus* acquired the *E* factor by a process of introgression.

4. The Platyfish gene P^{Co} was transferred by hybridization to platyfish-swordtail hybrids. By a series of backcrosses of the hybrids to the swordtail, fish were bred having the configuration of *Xiphophorus hellerii* but containing P^{Co} of *Platypoecilus maculatus*. This new variety is called the wagtail swordtail among fish fanciers. The establishment of this new stock is an example of introgressive hybridization under conditions of domestication. Hybridization under natural conditions has not been known to take place.

5. The domesticated red swordtail of aquarists is considered and its origin is traced to "red" gene of *P. maculatus* modified by intensification by at least two *X. hellerii* genes. These effects resemble the behavior of taxonomic characters in species crosses. Taxonomic characters at the lower-

most levels, sub-species and perhaps species, are compared genetically with color pattern characters.

6. A number of genetic similarities and parallelisms of introgressive hybridization in cotton plants and xiphophorin fishes are indicated.

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EXPLANATION OF THE PLATES.

Plate I.

Fig. 1. *The wild color types in natural populations.*

There are many pools in Mexico, particularly in the Rio Papaloapan drainage area, in which most or all of the color types shown here may be found living side by side.

The first column represents the two forms of the swordtail (*Xiphophorus hellerii*). The upper one represents a weakly spotted type which is very rare, occurring in wild populations in a frequency of less than one-half of one per cent.

The second column represents the tail markings of the platyfish (*Platypoecilus maculatus*). These form a series of autosomal, dominant, multiple alleles. Reading from top to bottom: one-spot, P^{O}; twin-spot, P^{T}; single crescent, P^{C}; complete crescent, P^{Cc}; moon, P^{M}; moon complete, P^{Mc}; and comet, P^{Co}. There is a universal recessive shown at the top of the next column, usually referred to as the + gene. Of all the seven dominant alleles, only the comet, P^{Co}, reacts to the presence of the *E* modifier.

The third column shows, in addition to the universal recessive, on top, the five sex-linked patterns: striped-sided, spot-sided, spotted dor-

sal, black-bottomed and the black-banded. These patterns are formed by macromelanophores. The series in the column to the left are formed by micromelanophores.

The fourth column shows the three red colored varieties: the red-dorsal, the red anal-fin and the bleeding heart. These are sex-linked and are formed by erythrophores.

Fig. 2. *The Introgression of the Platyfish Gene Comet (Co) Into the Germ Plasm of the Swordtail.*

The series of matings shown in this chart begins in the upper left hand corner. A wild swordtail (*Xiphophorus hellerii*) is mated with a wild comet-marked platyfish (*Platypoecilus maculatus*). The mating of these distinct species is effective under conditions of domestication in an aquarium where one female and one male are placed in a single container. Under conditions in nature, these two species, which are often found living side by side, apparently do not hybridize. In more than 10,000 specimens caught in nature, and examined, no hybrids were found between them.

The "domesticated" hybrids are shown in the lower left. The comet pattern of the platyfish is transformed into the wagtail; note the shortening of the sword compared with its normal length in male wild swordtails shown elsewhere in the chart. There is a blend of body configurations and some color patterns in the hybrids.

If one of the wagtail platyfish-swordtail hybrids is selected and mated to a pure wild swordtail male as indicated in the pair in the lower right hand corner, the body contours, the length of the tail and other features *in some of the resulting offspring* resemble that of the wild swordtail, but the wagtail pattern in their makeup is a sign of the fact that at least one gene, the comet gene (*Co*) of the platyfish, is present in the domesticated and reconstructed swordtail. Thus the presence of a platyfish gene in the germ plasm of the swordtail is a result of *introgressive hybridization.*

Plate II.

Fig. 3. *The Development of the Golden Wagtail Platyfish.*

The golden wagtail platyfish was developed by mating a domesticated golden platyfish with a wild, gray-green comet. In the first generation all the offspring were gray-green, owing to the fact that the wild type gene *St* for micromelanophores is dominant to the golden, or non-micromelanophore type. The wagtail reaction is evident in the F_1 owing to the interaction of the wild comet gene (*Co*) with its modifier *E*. When the gray-green wagtail F_1 are inbred, six phenotypes appear in the next generation. Reading down by columns, the column on the extreme left: gray, comet; gray; golden, comet. The second column: gray, wagtail; golden; golden, wagtail. The third and fourth columns represent the males and the number of phenotypes in them is the same as in the females just enumerated.

When two golden wagtails are selected from the second generation offspring and mated, if by chance these individuals were homozygous for the comet (*Co*) and for the extensor of comet gene (*E*), then a pure breeding line of golden wagtail platyfish may be established as indicated in the chart.

The presence of the modified gene *E* in domesticated platyfish may be explained by suggesting that *E* is found in natural populations of the related species, the swordtail (*Xiphophorus hellerii*), and it has infiltrated by introgressive hybridization into the germ plasm of the domesticated platyfish (*Platypoecilus maculatus*).

Plate III.

Fig. 4. *The Early and the Perfected Wagtail Platyfish.*

In some of the early matings between the "wild" comet platyfish (*Platypoecilus maculatus*) with the "domesticated" strains, the red, black-spotted type of female was used. In some instances the *R* and *Sp* genes were carried by the W chromosomes, thus producing red, black-spotted daughters and recessive, gray sons. One of the spotted daughters and one of the gray males are shown in this plate facing to the right; both of them carry the modified form of the comet pattern known as wagtail. The fish facing to the left was obtained by use of the golden domesticated strain and a wild comet platy. It represents one of the second generation young, in which the color is bright yellow, but the fins are blackened by the interaction of the comet gene (*Co*) with a modifier, *E*, the extensor of the comet.

The wagtail pigmentation reaction involves more than the deepening color of the fins: the snout and parts of the operculum are blackened by small melanophores. These pigmented cells are found in the integumentary tissues surrounding the region of the premaxillaries; they are found in the tissues surrounding the region of the dentary and continue from this point caudally along a line formed by the ventral margin of the articular, quadrate and preopercular; then the line forms an upwardly directed angle following the posterior margin of the preopercular. Photographs by S. C. Dunton.

Fig. 5. *Wagtail Swordtails.*

This pair of swordtails have all the external attributes of swordtails, *Xiphophorus hellerii*, except for the black coloring of the fins. This color pattern is the result of the interaction of a platyfish gene comet (*Co*) with a specific modifier (*E*). These swordtails are the product of introgressive hybridization. In the course of their genetic history, a *Platypoecilus maculatus* gene, *Co*, has been incorporated into the germ plasm of the swordtail. Photographs by S. C. Dunton.

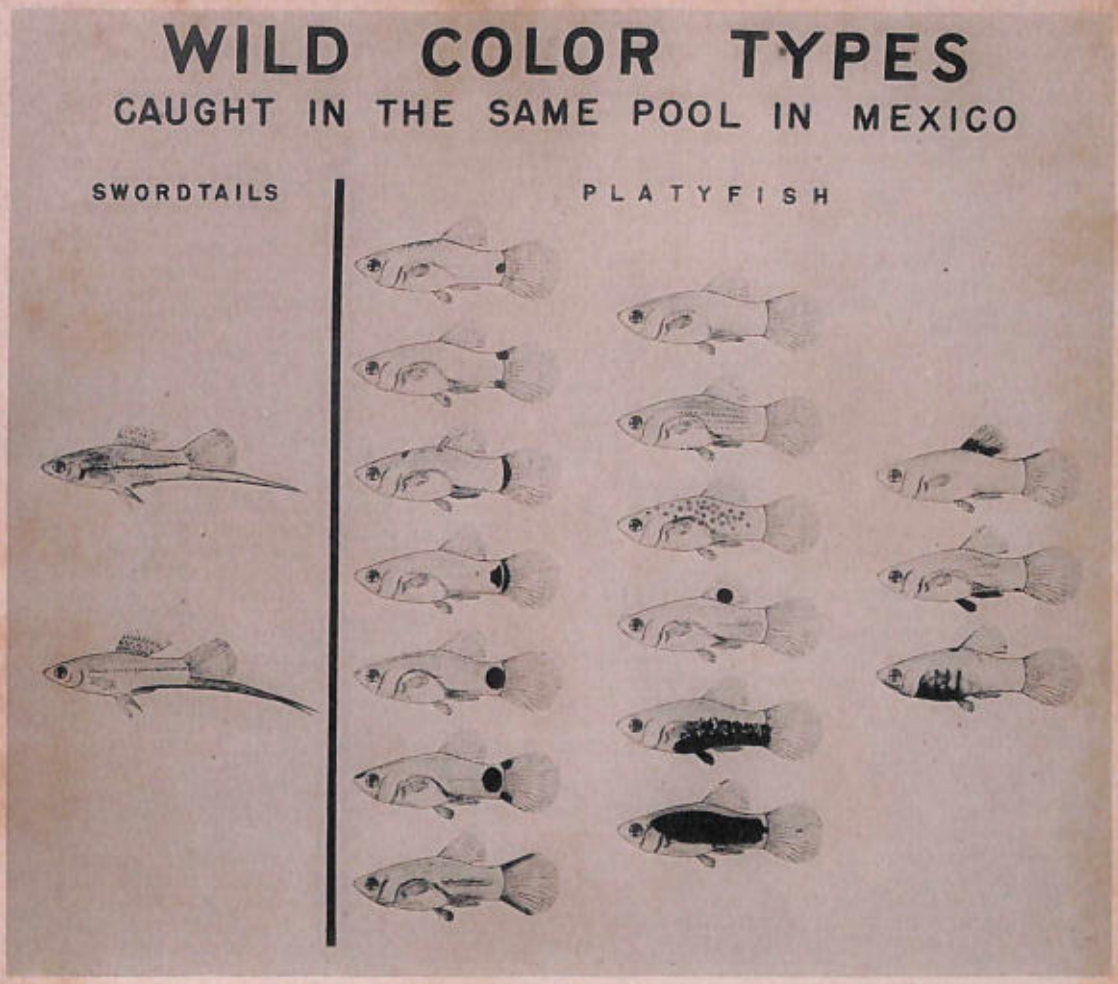

FIG. 1.

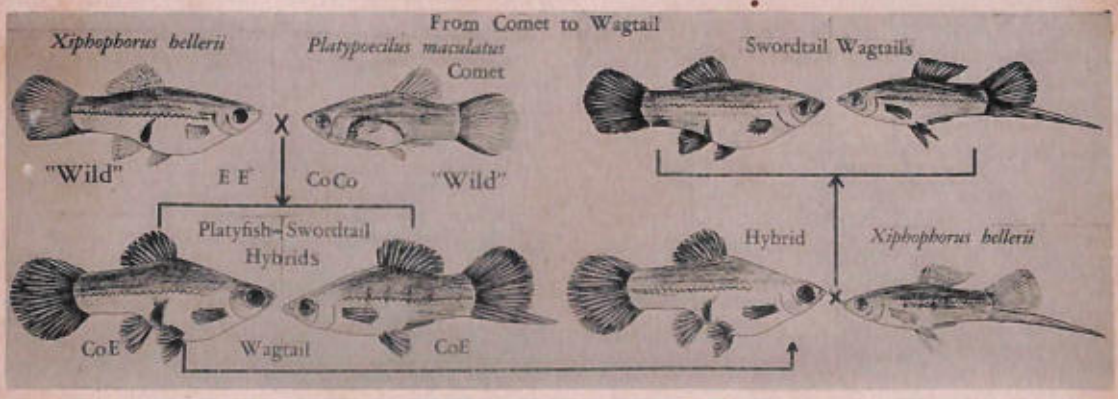

FIG. 2.

INTROGRESSIVE HYBRIDIZATION IN DOMESTICATED FISHES.
I. THE BEHAVIOR OF COMET—A PLATYPOECILUS MACULATUS GENE IN XIPHOPHORUS HELLERII.

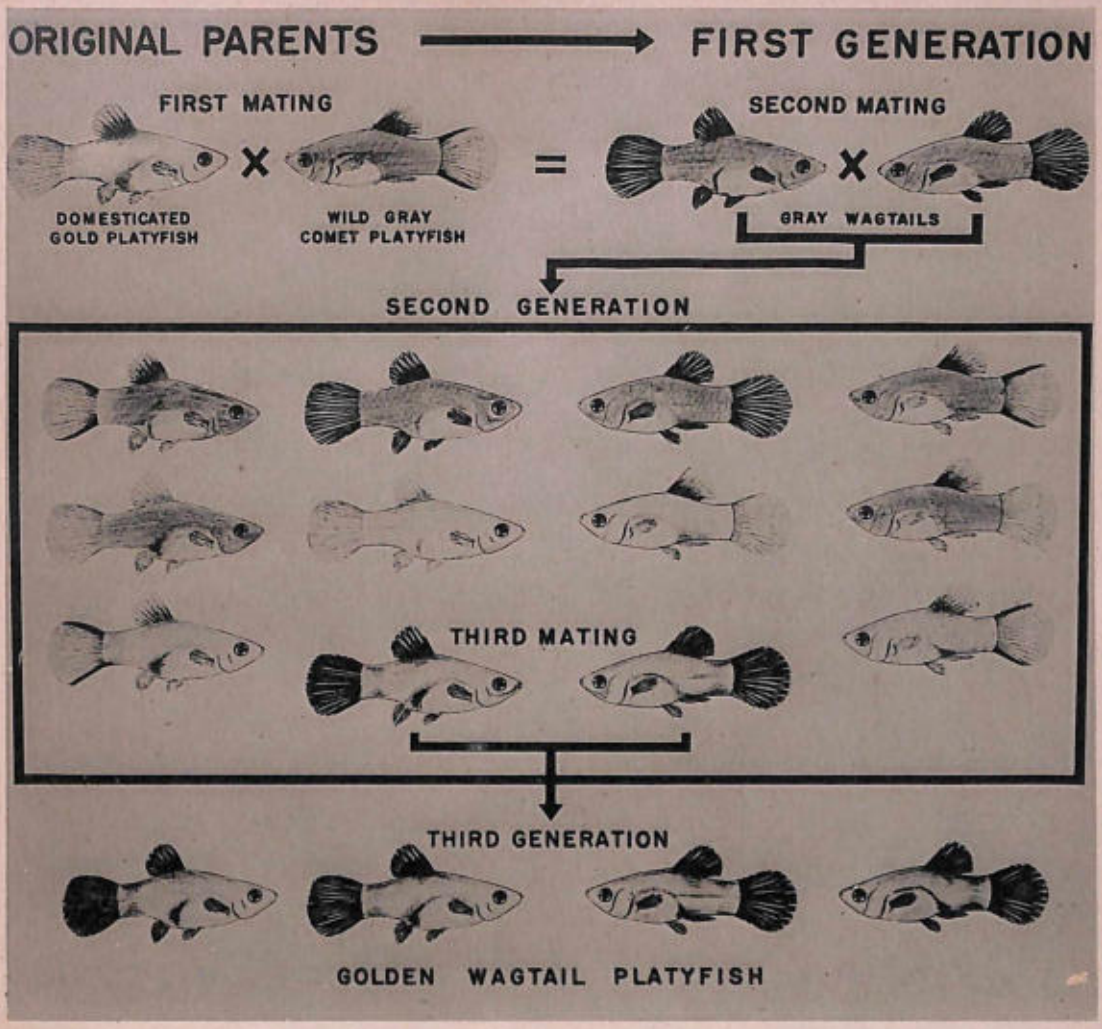

FIG. 3.

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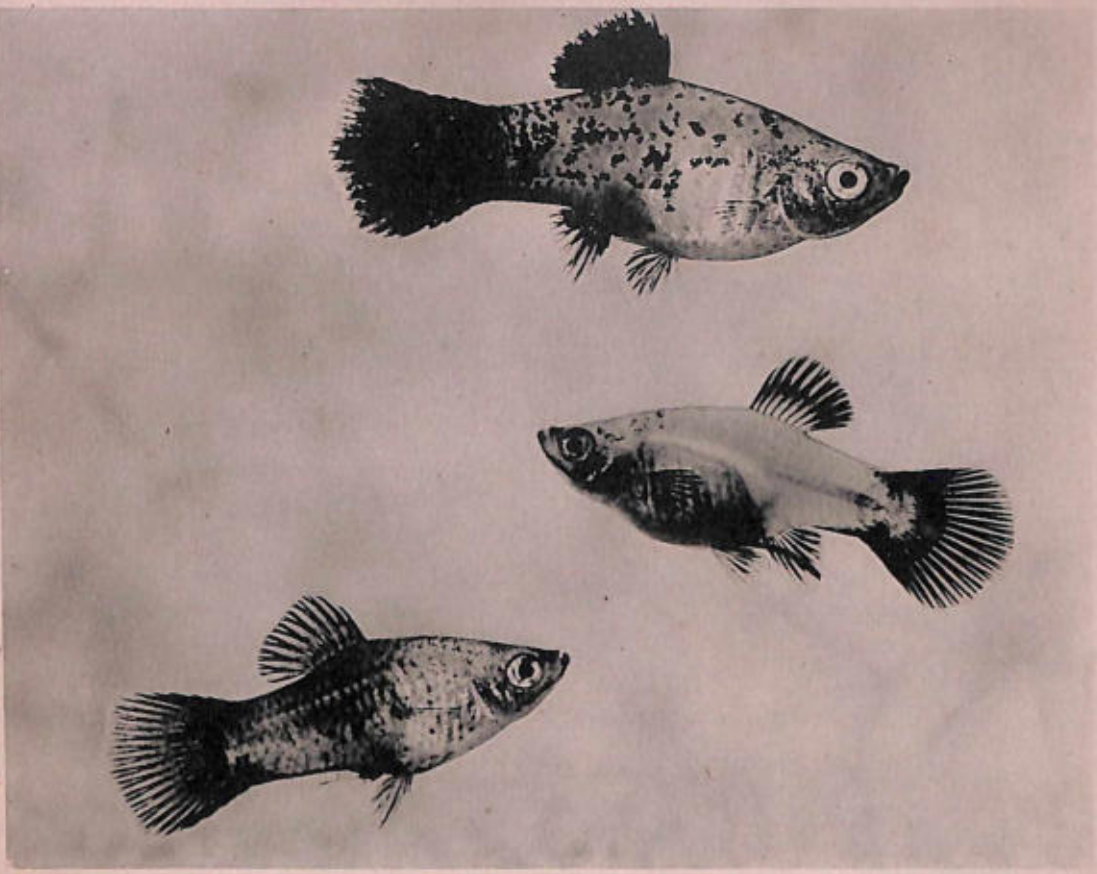

FIG. 4.

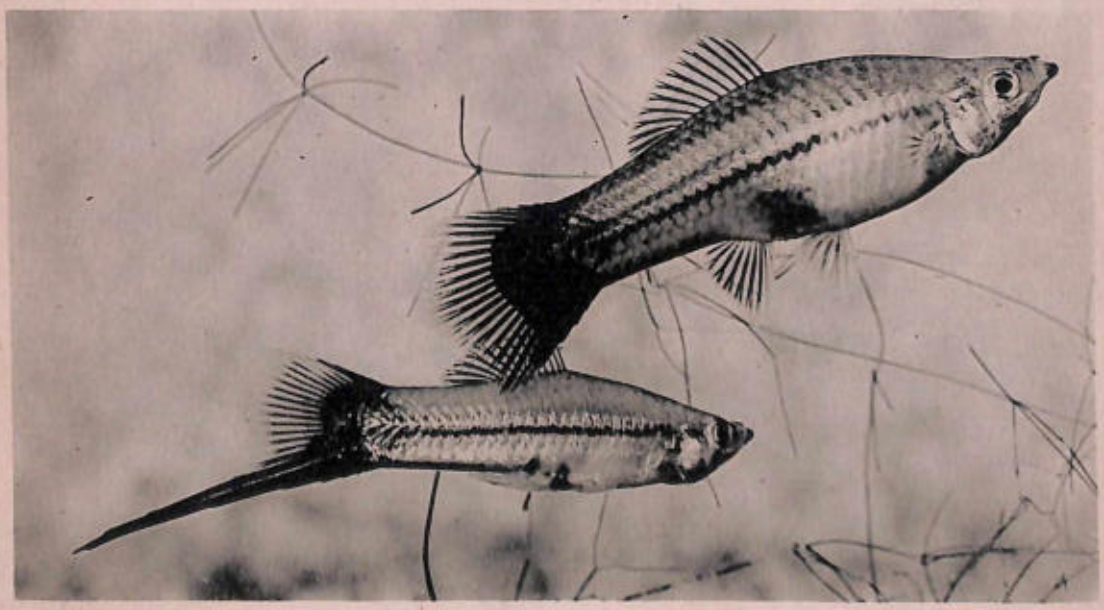

FIG. 5.

INTROGRESSIVE HYBRIDIZATION IN DOMESTICATED FISHES.
I. THE BEHAVIOR OF COMET—A PLATYPOECILUS MACULATUS GENE IN XIPHOPHORUS HELLERII.

7.

Spontaneous Neoplasms in Fishes. I. Osteochondroma in the Jewelfish, *Hemichromis bimaculatus*.[1]

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Plates I-V; Text-figures 1 & 2.

INTRODUCTION.

Only a few chondromas and related tumors have been reported, all in European-bred fishes. Fiebiger (1909) described a massive osteochondroma on a carp (*Cyprinus*) which grew into the cranial cavity, causing the brain to be compressed and laminated. Although no functional disturbances were noted in the live fish, Fiebiger reported that the olfactory lobes, certain cranial nerves and hypophysis were missing. A chondroma, also in a carp, was reported and figured (credited to Muslow) by Plehn (1924). A longitudinal section of the head showed the tumor extending ventrally over the roof of the mouth and posteriorly against the brain, causing it to be deflected upward and at right angles to the brain stem. Thomas (1931), in his excellent review on fish tumors, recorded two cases described by Surbeck in 1917 and 1921. The first was an enchondroma which developed in a barbel (*Barbus*) as a bilobed structure between the maxilla and the right operculum. The second was a chondrofibroma which was attached to the belly of a pike. This growth was a massive, pediculated, saccular tumor larger than two fists and weighing 800 grams.

No detailed histological or cytological descriptions were given of the tumors reported above. Neither was there any information given as to the possible cause or causes of the growths. The present contribution is concerned with gross and histological descriptions of an osteochondroma on the operculum and adjacent structures of an aquarium-bred African jewelfish, *Hemichromis bimaculatus*. This fish was found among about 100 normal jewelfish in a 150 gallon aquarium in the Department of Animal Behavior of the American Museum of Natural History. We are indebted to Dr. Lester R. Aronson for this specimen.

[1] This work was supported in part by grants from the Anna Fuller Fund and The American Cancer Society, on the recommendation of the Committee on Growth of the National Research Council.

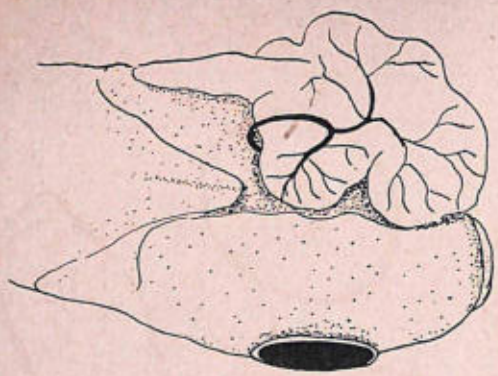
GROSS DESCRIPTION OF THE TUMOR.

When the tumor was first observed it appeared as a small swelling at the anterior edge of the right operculum. The growth was comparatively rapid, for within two months it attained the large size shown in Text-figure 1 and Plate I, Figure 1. The fish was a male and measured 52 mm. in standard length; the tumor mass measured 13 mm. long, 6 mm. at its widest part and from 3 to 4 mm. high. When examined with the low power binocular, the surface of the growth was more or less smooth and richly supplied with branches of the right first afferent artery (Text-figure 1). The structures involved were the opercle, subopercle, peropercle, interopercle, brachiostegals, inferior parts of the maxillary and cheek bones. The anterior-most gill-raker of the first gill arch also had a smaller but separate cartilaginous nodule, which measured about 3 mm. in diameter. It was uncertain whether this separate growth arose *de novo* or whether some infiltration had taken place, either directly or through the blood stream.

HISTOLOGICAL DESCRIPTION OF THE TUMOR.

The tumor, together with the adjacent structures, was extirpated and pieces were fixed in Zenker's. They were embedded in paraffin, sectioned at four microns and stained with iron-hematoxylin with and without eosin, Delafield's hematoxylin with eosin, Mallory's triple stain, Giemsa's stain, and with methylene blue.

The tumor was an osteochondroma, the major part of which consisted of hyalin cartilage arranged in a more or less irregular pattern. (Plates I-V). The typical arrangement of cartilage cells with opposed surfaces was not evident. Some tranformation into osteoid tissue had taken place (Plate II, Figure 6). The tissue was well supplied with nourishment from the numerous blood vessels which accompanied its fibrous stroma (Plate IV, Figure 9). The



TEXT-FIGURE 1. Sketch of the ventral-lateral aspect of the head of the jewelfish showing the blood vessels on the surface of the osteochondroma. The main branch emerging from the branchial region is derived from the right first afferent artery. Enlarged about 4 ×.

intercellular substance was variable, being very dense in some areas and light in others (Plate I, Figure 3). In regions where the cartilage cells appeared to be dividing rapidly, there was little intercellular material and the isogenic groups of tumor cells were closer (Plate II, Figures 5 and 6). Both interstitial and appositional growth took place to form the tumor.

The epithelium overlying the growth was still intact, slightly thickened in some areas, but otherwise normal in appearance (Plate I, Figure 2). The corial layer was edematous and contained only a few melanophores.

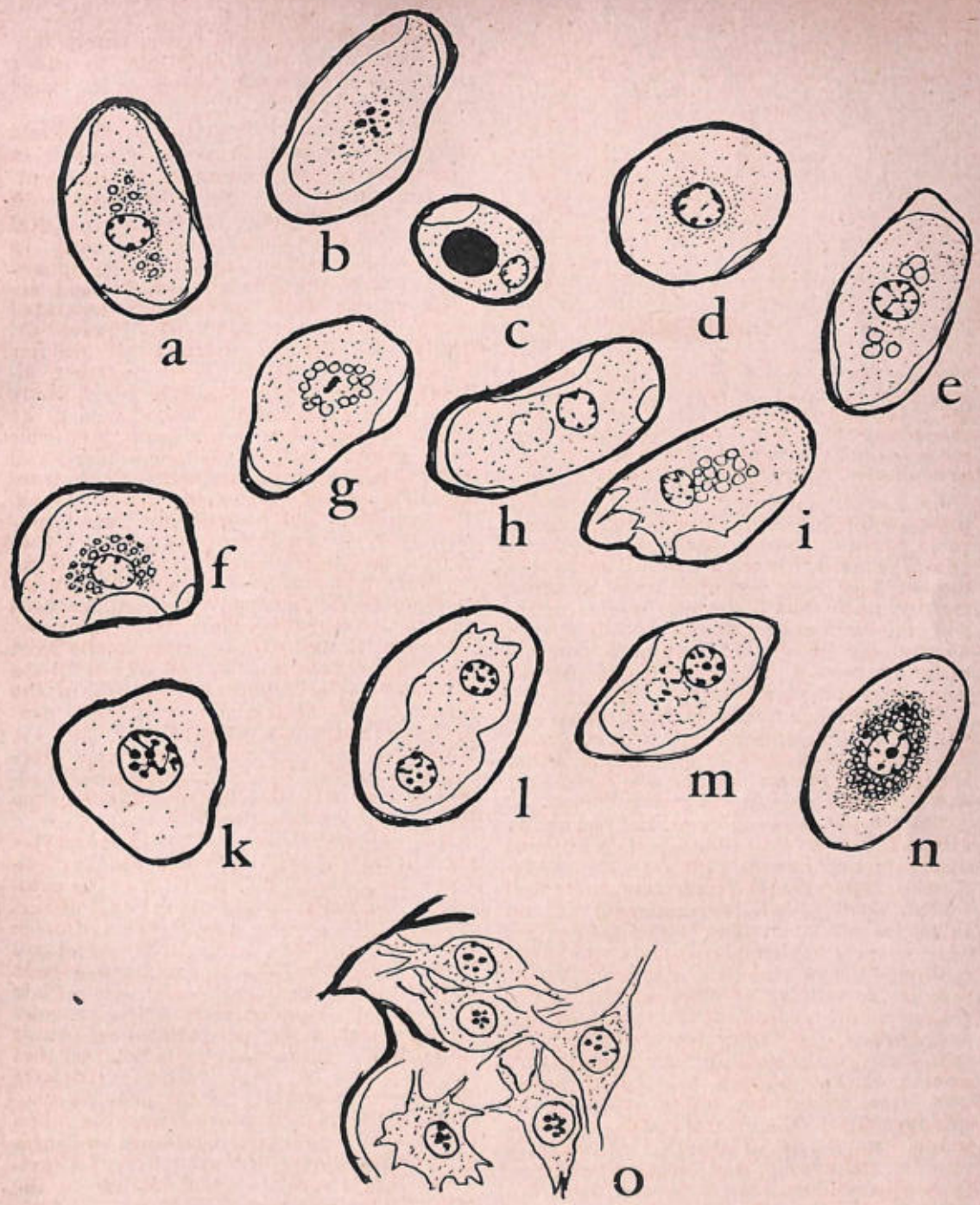
The thickened periosteum was basophilic (Plate I, Figure 2) while the subperiosteum was mainly acidophilic (Plate II, Figure 4). Numerous large and small, thin and thick walled blood vessels were present in the subperiosteal layer. The vessels, however, were never completely engorged and often contained granular debris. The transformation of the cellular elements of the subperiosteum into typical chondrocytes at the periphery of the tumor was evident. Such cells were responsible for the appositional growth. In some regions the gradual transition from collagenous fibers, made up of spindle-shaped cells (fibroblasts), into cartilage was visible (Plate IV, Figure 10). In other and more highly vascularized areas the various cellular stages in bone formation were found. The elements involved in the process were stellate-shaped (osteoblasts) which passed from the subperiosteal layer into the tumor mass. These cells (Text-figure 2, n; Plate V, Figures 11 and 12), interconnected by their dendritic processes, formed a network. They laid down a hyalin-like ground substance, which, however, was not calcified. (Such tissue is referred to as osteoid. In fishes osteoid tissue enters into the composition of scales and in other structures of the head, including the operculum).

The fully developed cartilage cells (Plate II, Figures 5 and 6) were irregular in shape, size and in their mass arrangement. In some areas the cells were large with clearly defined capsules and had a great deal of intercellular substance between them. In other areas, particularly at the periphery of the tumor, the cells were smaller and isogenic groups were more clearly separated from each other (Plate II, Figure 6). There was marked evidence of cellular activity (interstitial tissue growth), although no mitotic figures were noted. Many cells were binucleated (Text-figure 2, k) and in some cases two or even three cells were present within the same territorial matrix. Although the majority of cells were spherical many variations were found. Those toward the periphery of the tumor were more or less flattened in a plane parallel with the surface. On the borderline of the cartilage and periosteum there were intermediate forms between the cartilage cells and the fibroblasts (Plate III, Figure 8). The body of the cartilage cells, in the fixed and stained sections, did not always fill the cartilage cavity which it occupied in the interstitial substance. A few cells had dendritic processes (Text-figure 2, i; Plate IV, Figure 9) but whether or not these processes extended into the interstitial substance was not determined, although the indication was that they did.

The nuclei of the mature chondrocytes were comparatively large and usually vesicular (Text-figure 2; Plates I-V). The cytoplasm was granular and in the region surrounding the nucleus was denser and often contained minute vacuole-like structures which in some cells were small and numerous and in others larger and few (Plate II, Figure 5; Text-figure 2). These vacuoles were present in all preparations, regardless of fixative or stain used. It is believed that the presence of these vacuoles indicates the secretory activity of the cell, the contents of the vacuole passing into the interstitial area. Other cells contained comparatively large concretions (chondrin?) (Text-figure 2, c) which stained similar to the intercellular material.

DISCUSSION.

The osteochondroma of the jewelfish is strikingly similar histologically to comparable growths in man (see Ewing, 1940). The cause of the tumor on the fish was not determined. It was the only abnormal specimen in about a hundred of the same species



TEXT-FIGURE 2. Figures **a-i** inclusive are chondrocytes stained with Giemsa's stain: **a**, **e** and **f-i** show different manifestations of the nucleus together with the vacuole-like structures around it; **b**, cell with basophilic staining granules which may be chromatin; **c**, cell with concretion (chondrin?) that stains like the intercellular substance. Figures **k-n** inclusive were stained with iron-hematoxylin: **k**, a typical chondrocyte; **l**, binucleate cell within the same capsule; **m**, cell with five vacuole-like structures in the region of the nucleus; **n**, cell with dense cytoplasm, containing many minute vacuole-like structures, surrounding the nucleus. Figure **o**, a group of osteoblast cells. Note the beginning of bone formation. About 800 ×.

and strain that were kept in a 150 gallon aquarium at the Department of Animal Behavior of the American Museum of Natural History. In all other respects the fish appeared to be in good health; the gills and internal organs showed no obvious disturbances. There was no evidence that heredity, hormonal disturbance, nutritional deficiency, virus, bacteria or other plant and animal parasites were involved as possible causative agents of this osteochondroma. However, the tumor may have resulted from traumatic response following an injury to the fish's operculum earlier in life. Periosteum is readily capable of producing cartilage whenever new formation of this tissue is required, and cartilaginous tumors might possibly arise from cells which produce bone by way of cartilage.

SUMMARY.

A spontaneous osteochondroma on the right operculum and associated structures of a jewelfish, *Hemichromis bimaculatus*, was composed of irregularly arranged hyalin cartilage and osteoid tissue. It was well supplied with blood vessels. Both interstitial and appositional cell growth were responsible for the increase in size of the tumor. The transformation of the cellular elements of the connective tissue in the subperiosteal region into chondrocytes at the periphery of the tumor was clearly evident. In several regions stellate-shaped cells (osteoblasts) passed into the mass of the tumor from the subperiosteal layer and formed a network around which hyalin-like osteoid material was deposited. The major part of the tumor consisted of hyalin cartilage. Cytological details of the chondrocytes were given. The causative agent of the osteochondroma was not determined but it may have resulted from a fractured operculum in early life.

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EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. Osteochondroma on the right side of the head of a live aquarium-bred male jewelfish, *Hemichromis bimaculatus*. Enlarged about one-third. Photograph by S. C. Dunton, New York Zoological Society.

Fig. 2. Photomicrograph showing section of the osteochondroma taken through the operculum. Note the thickened band of periosteal (**p**) material growing out from the surfaces of this structure. The epithelium (**e**) varies in thickness but otherwise is normal in appearance. The corial (**c**) layer is edematous and shows no melanophores. The chondrocytes (**Cc**) show an irregular pattern and the amount of intercellular substance varies considerably in density. Delafield's hematoxylin-eosin. About 75 ×.

Fig. 3. Section stained with Giemsa's. Note the varying density of intercellular material. **P**, Periosteum; **i**, intercellular material. About 75 ×.

PLATE II.

Fig. 4. Section through the subperiosteal region showing blood vessels and fibrous material. Note the granular debris within the larger blood vessel. Mallory's Triple stain. About 160 ×.

Fig. 5. A group of cells from the osteochondroma. Vacuole-like cytoplasmic structures are present similar to those shown in Text-figure 2. Giemsa's stain. About 335 ×.

Fig. 6. Iron - hematoxylin treated section showing osteoid tissue staining black. Smaller isogenic groups of cartilage cells may be seen at the periphery. About 75×.

PLATE III.

Fig. 7. Note the variability in size and shape in the structure of the chondrocytes. Giemsa's stain. 675 ×.

Fig. 8. Region of periosteum and subperiosteum. Transformation of the fibroblastic-like cells into chondrocytes is taking place, producing growth by apposition. Hematoxylin-eosin. 675 ×.

PLATE IV.

Fig. 9. Connective tissue layer extending into the tumor forming the supporting stroma which provides the pathway for the blood vessels and other cellular elements. Giemsa's stain. 675 ×.

Fig. 10. Periphery of tumor showing collagenous fibers with spindle-shaped cells. Note transformation into chondrocytes. Giemsa's stain. About 675 ×.

PLATE V.

Fig. 11. Osteoid tissue. Note the network of osteoblasts around the periphery of this tissue. Delafield's hematoxylin. About 675 ×.

Fig. 12. Same as Figure 11, showing details of osteoid formation. Delafield's hematoxylin. About 675 ×.

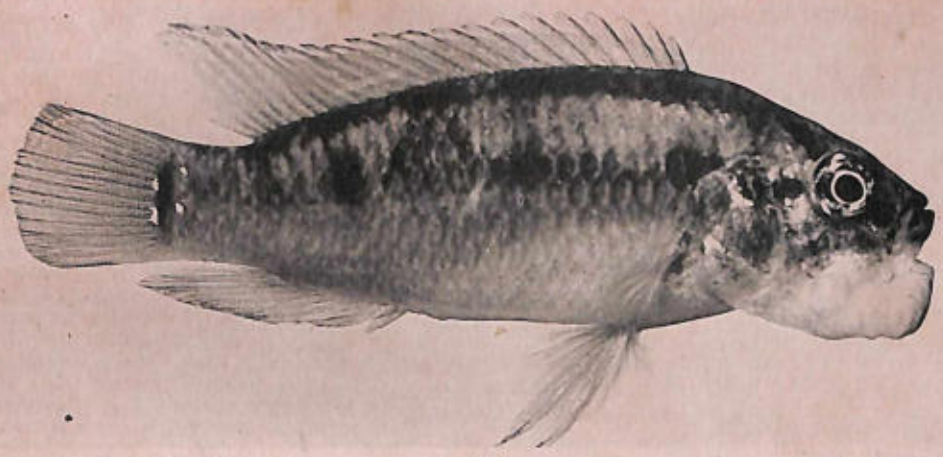

FIG. 1.

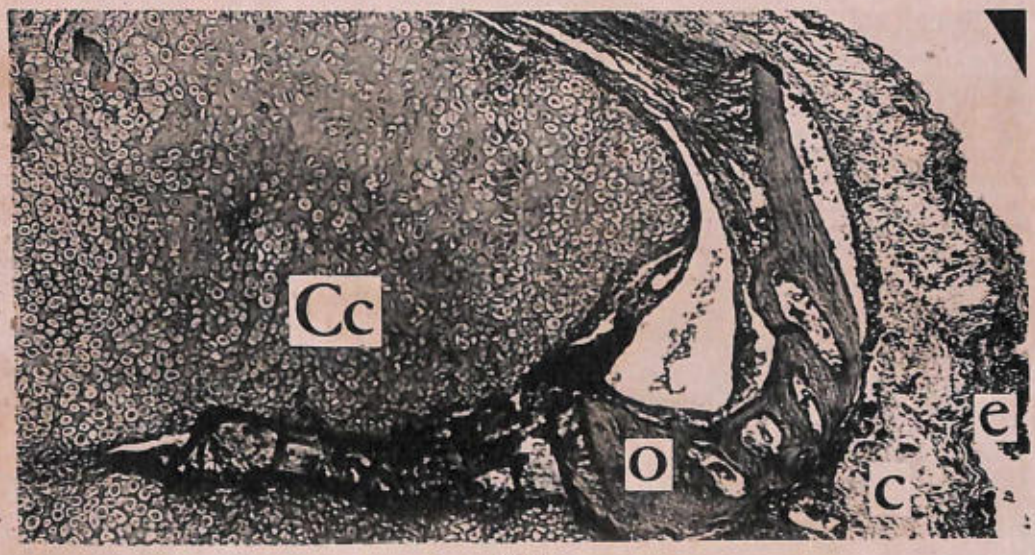

FIG. 2.

FIG. 3.

SPONTANEOUS NEOPLASMS IN FISHES. I. OSTEOCHONDROMA IN THE JEWELFISH, HEMICHROMIS BIMACULATUS.

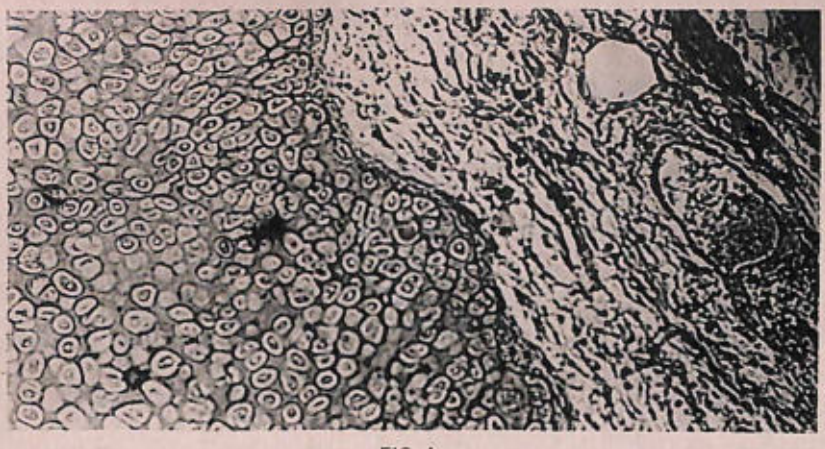

FIG. 4.

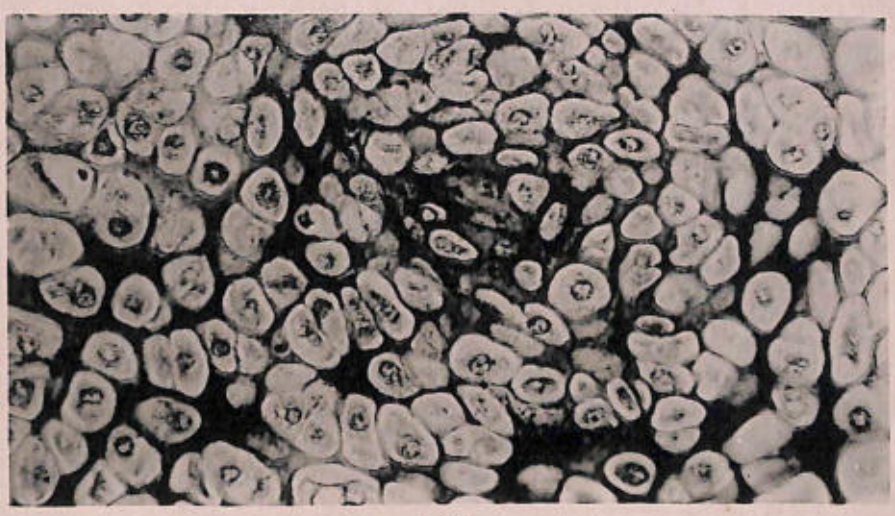

FIG. 5.

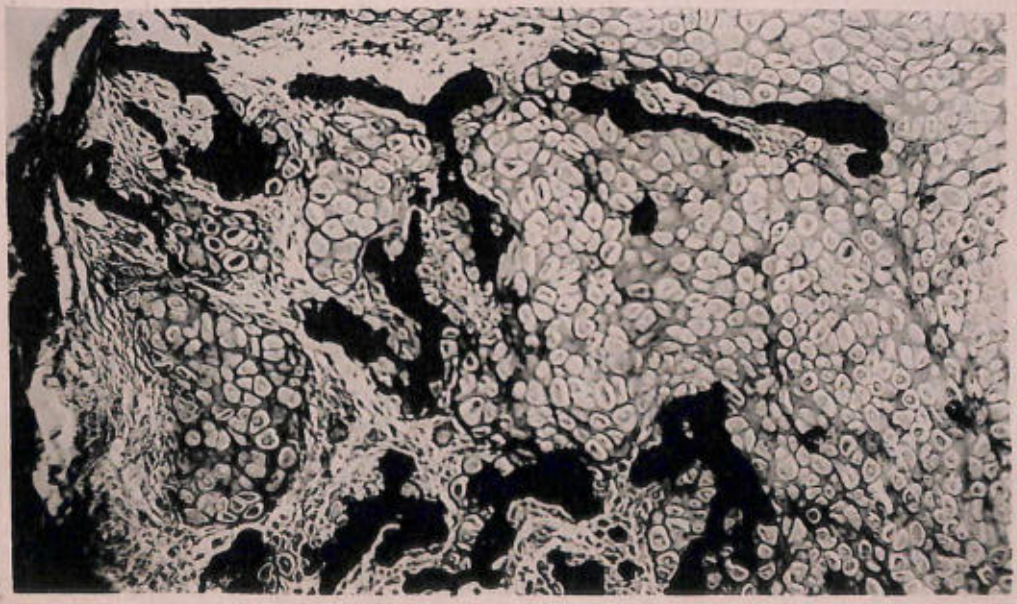

FIG. 6.

SPONTANEOUS NEOPLASMS IN FISHES. I. OSTEOCHONDROMA IN THE JEWELFISH, HEMICHROMIS BIMACULATUS.

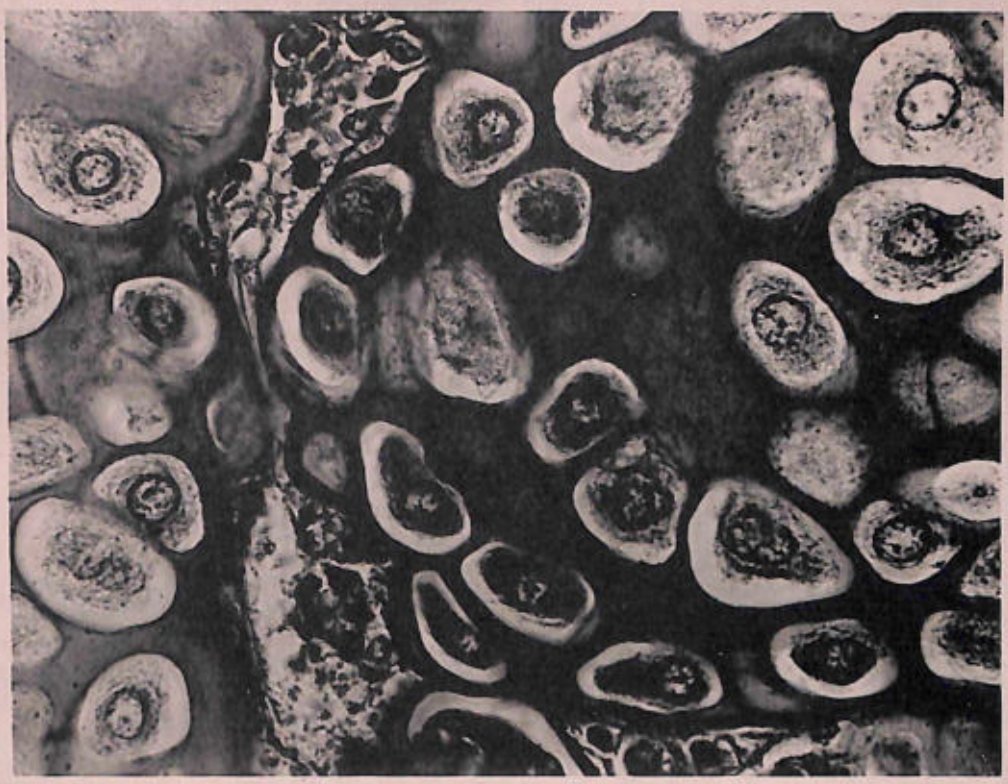

FIG. 7.

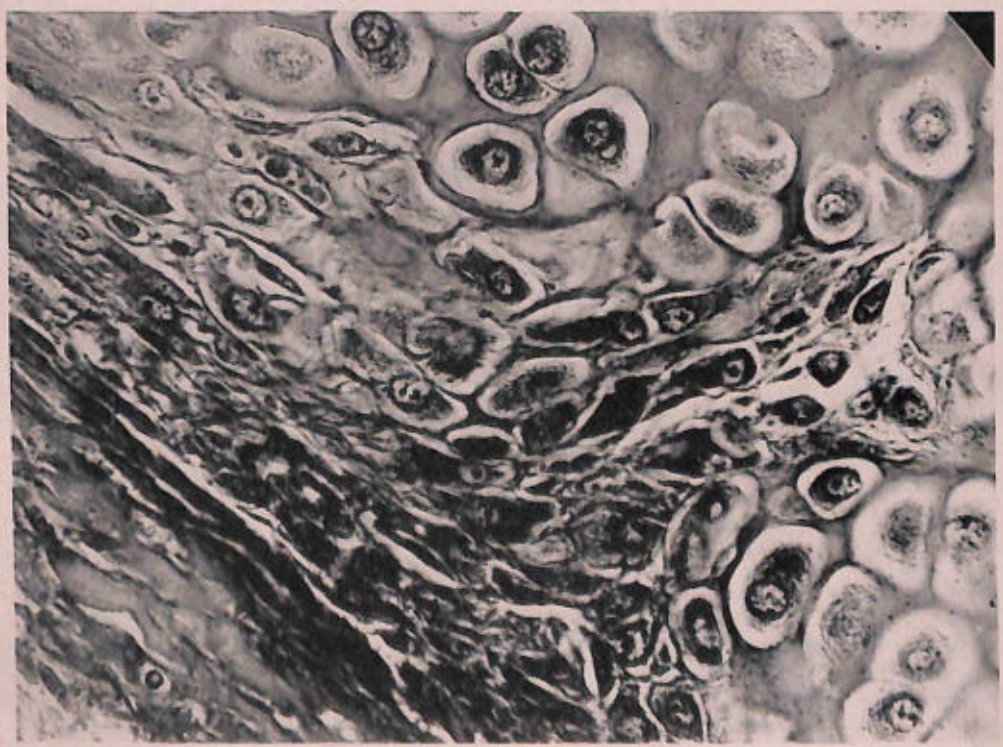

FIG. 8.

SPONTANEOUS NEOPLASMS IN FISHES. I. OSTEOCHONDROMA IN THE JEWELFISH, HEMICHROMIS BIMACULATUS.

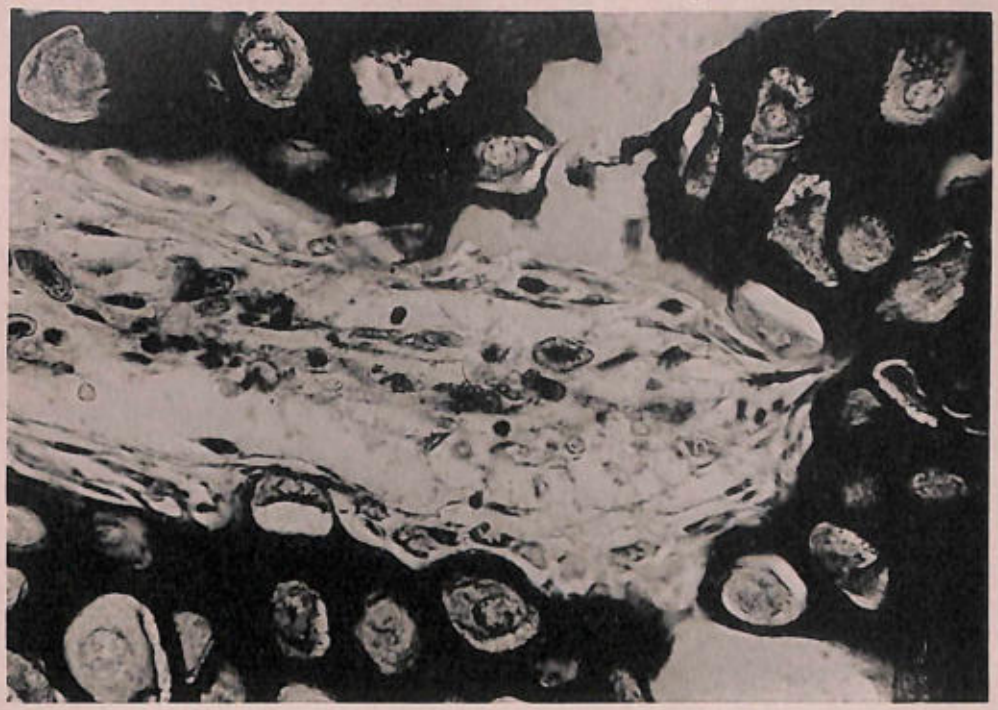

FIG. 9.

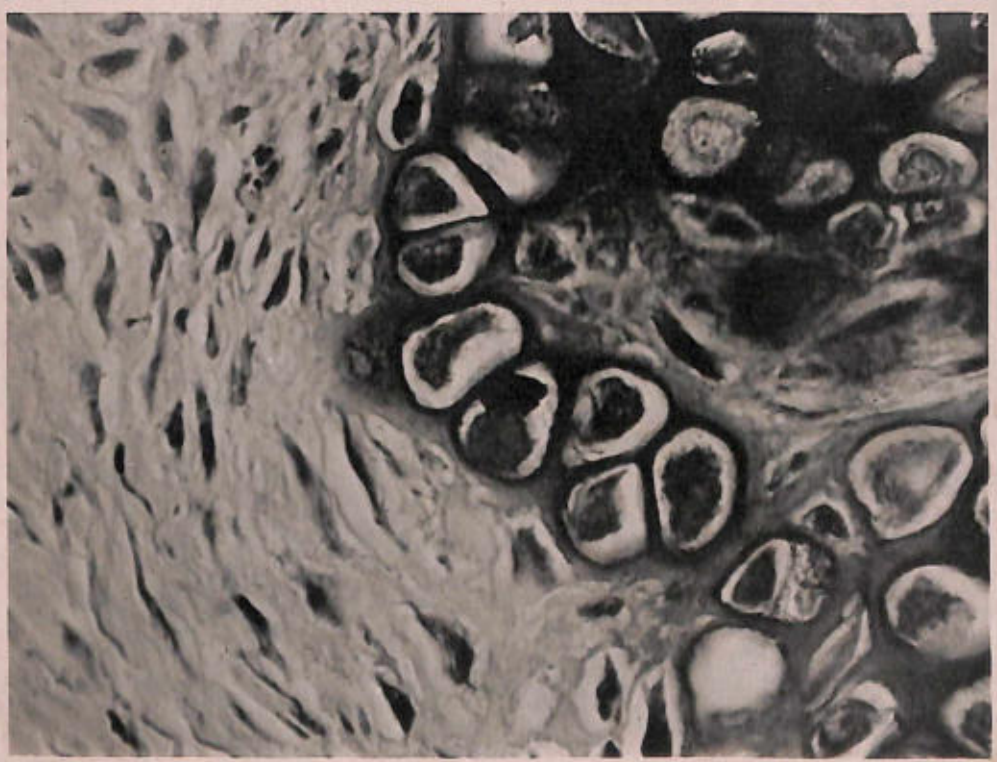

FIG. 10.

SPONTANEOUS NEOPLASMS IN FISHES. I. OSTEOCHONDROMA IN THE JEWELFISH, HEMICHROMIS BIMACULATUS.

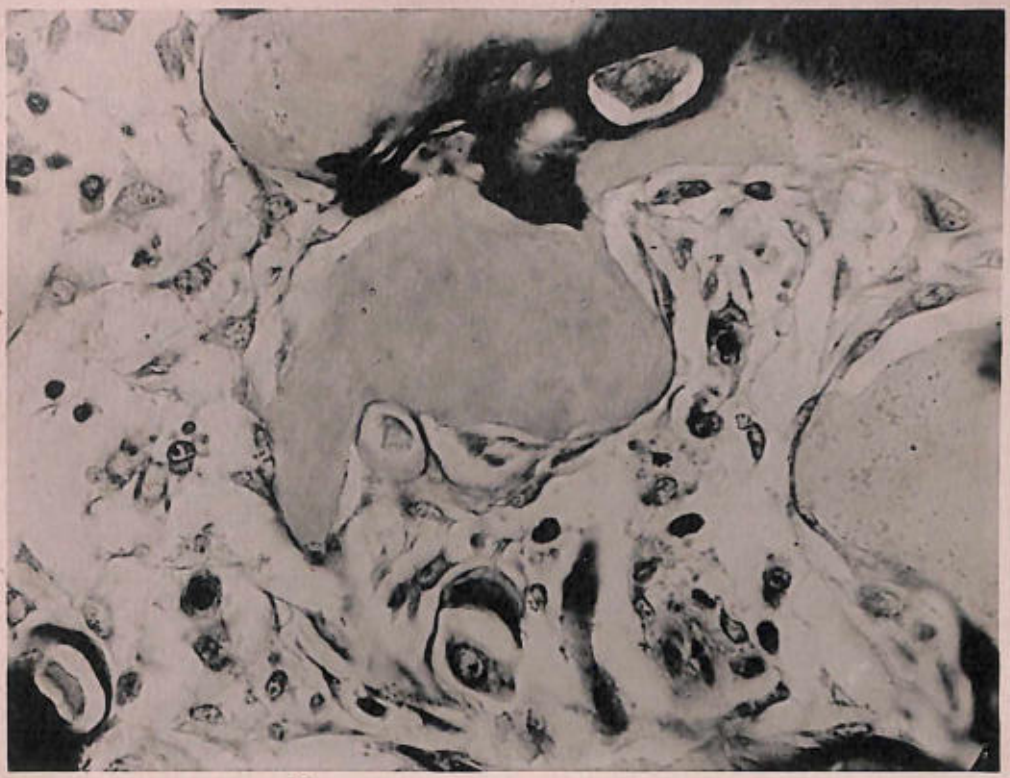

FIG. 11.

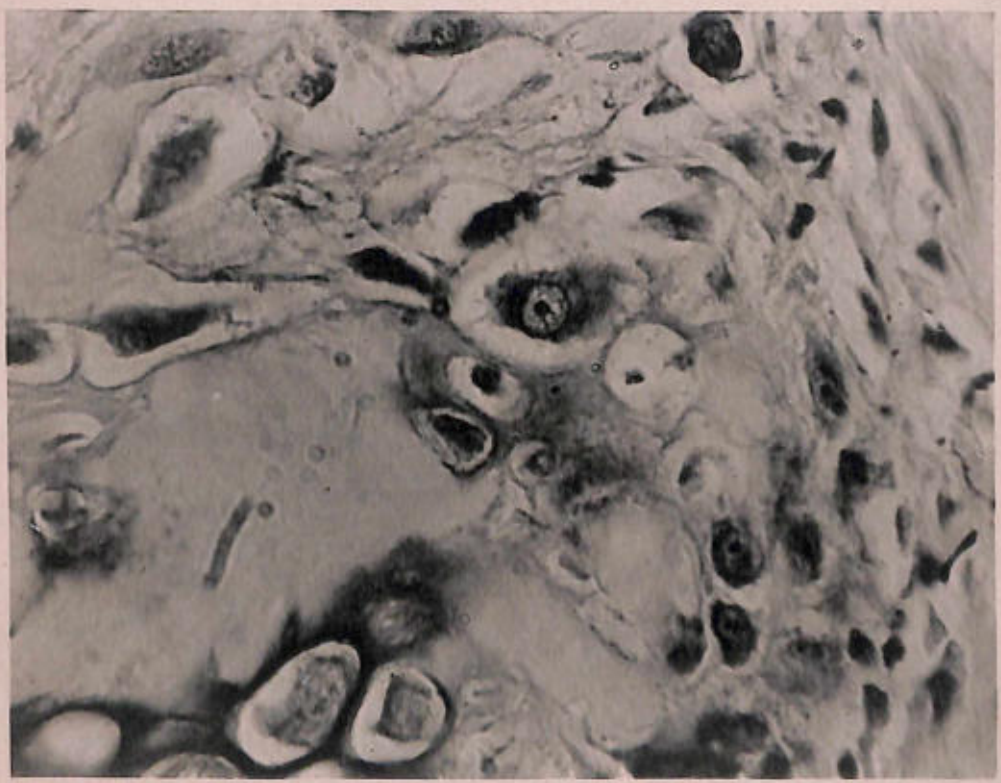

FIG. 12.

SPONTANEOUS NEOPLASMS IN FISHES. I. OSTEOCHONDROMA IN THE JEWELFISH, HEMICHROMIS BIMACULATUS.

8.

Eastern Pacific Expeditions of the New York Zoological Society. XXXV. Mollusks from the West Coast of Mexico and Central America. Part IV.[1]

LEO GEORGE HERTLEIN & A. M. STRONG.
California Academy of Sciences.

(Plate I).

[This is the thirty-fifth of a series of papers dealing with the collections of the Eastern Pacific Expeditions of the New York Zoological Society made under the direction of William Beebe. The present paper is concerned with specimens taken on the Templeton Crocker Expedition (1936) and the Eastern Pacific *Zaca* Expedition (1937-1938). For data on localities, dates, dredges, etc., refer to *Zoologica*, Vol. XXII. No. 2, pp. 33-46, and Vol. XXIII, No. 14, pp. 287-298.]

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[1] Contribution No. 743, Department of Tropical Research, New York Zoological Society.

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INTRODUCTION

This is the fourth of a series of papers dealing with collections of mollusks taken on the Templeton Crocker Expedition (1936) and the Eastern Pacific *Zaca* Expedition (1937-1938). The general plan of presentation followed in the present contribution is that mentioned in Part II of this series of papers[2]. Formal headings and keys are given only for the species collected by the Expeditions of 1936 and 1937-1938.

Acknowledgment is due Dr. G. D. Hanna, Curator, department of Paleontology of the California Academy of Sciences, for assistance and suggestions. Acknowledgment is also due Mr. A. G. Smith of Berkeley, California, Dr. A. Myra Keen of Stanford University and Mr. George Willett of the Los Angeles Museum of History, Science and Art for assistance in various ways. The preparation of most of the photographs by Mr. Frank L. Rogers is here acknowledged; his work was accomplished during the course of Federal Works Progress Administration Project Number 8569. We also wish to express our appreciation to Mr. Cecil Tose for the photographs of the new species of *Periploma*.

CLASS PELECYPODA.

Order Anomalodesmacea.

Superfamily Laternulacea.

FAMILY PERIPLOMATIDAE.

Genus *Periploma* Schumacher.

Key to the species of *Periploma*.

A. Beaks central or nearer the posterior end
  a. Beaks nearly central ..... *discus*
  aa. Beaks nearer the posterior end
    b. Shell orbicular ..... *stearnsii*
    bb. Shell elongately oval ..... *teevani*
B. Beaks nearer the anterior end; rostrum only slightly marked off from the disk ..... *carpenteri*

Periploma carpenteri Dall.

Periploma carpenteri Dall, *Proc. U. S. Nat. Mus.*, Vol. 18, April 23, 1896, p. 20. Dredged "in 210 fathoms, mud, in the Gulf of Panama."—Dall, *Bull. Mus. Comp. Zool.*, Vol. 43, No. 6, October, 1908, p. 426, pl. 16, fig. 8. Same locality record as originally cited.

Type Locality: Gulf of Panama, in 210 fathoms, mud.

Range: La Union, El Salvador, to Panama.

Collecting Station: El Salvador: La Union, Gulf of Fonseca (199-D-22), 3 fathoms, mud, mangrove leaves on bottom.

Description: Shell suborbicular, thin, pearly, beaks slightly nearer the anterior end; surface ornamented by fine crowded granules which on some parts of the shell are arranged in extremely fine radial rows. The present specimen measures 21.5 mm. in length and 19 mm. in height.

The more anteriorly situated beaks, the lack of or very fine radial arrangement of the crowded granules, larger pallial sinus and the fact that the rostrum is less distinctly marked off from the arch of the base, all serve to separate *Periploma carpenteri* from *P. stearnsii* Dall.

It is possible that the specimen here referred to *Periploma carpenteri* may be a young form of *Periploma alta* Adams,[3] a species originally described from Panama, the type specimen of which has not been illustrated. Adams' species is said to be similar to *Periploma discus* but differing in the outline of the posterior portion of the shell.

Distribution: A single right valve of *Periploma carpenteri* was dredged in the Gulf of Fonseca. This furnishes an extension northward of the known range of the species.

Periploma discus Stearns.

Periploma discus Stearns, *Proc. U. S. Nat. Mus.*, Vol. 13, September 16, 1890, p. 222, pl. 16, figs. 1 and 2. "San Pedro, Long Beach, etc., Los Angeles County, California."—I. S. Oldroyd, *Stanford Univ. Publ. Univ. Ser. Geol. Sci.*, Vol. 1, 1924, p. 82, pl. 43, figs. 1 and 3. San Pedro to San Diego, California.

Type Locality: Long Beach, California (cited as type locality by I. S. Oldroyd and accepted as such by the present authors).

Range: Monterey Bay, California, to La Union, El Salvador.

Collecting Station: El Salvador: La Union, Gulf of Fonseca (199-D-11), 5 fathoms, mud.

Description: One small specimen measuring approximately 16 mm. from beak to base is in general features similar to *Periploma discus*. It is slightly less circular in outline than adult specimens but this feature seems to be characteristic of young forms of this species. A narrow and well marked rostrum is present. The valves are ornamented by fine granular sculpture which on some parts of the shell is arranged in fine radial rows. Pallial sinus short and rather narrow.

[2] Hertlein, L. G., and Strong, A. M. Eastern Pacific Expeditions of the New York Zoological Society. XXXII. Mollusks from the West Coast of Mexico and Central America. Part II. *Zoologica*, New York Zool. Soc., Vol. 28, Pt. 3, December 6, 1943, pp. 149-169, pl. 1.

[3] *Anatina alta* C. B. Adams, *Ann. Lyceum Nat. Hist. New York*, Vol. 5, July, 1852, pp. 518, 547 (separate pp. 294, 323). "Panama".
Periploma alta C. B. Adams, Pilsbry & Lowe, *Nautilus*, Vol. 47, No. 3, 1934, p. 85.

Distribution: The present record of *Periploma discus* from the Gulf of Fonseca is an extension southward in the known range. Pilsbry and Lowe have cited the species from La Paz, Lower California, Mexico. It is known to occur north to Monterey Bay, California.

Periploma stearnsii Dall.

Periploma stearnsii Dall, *Proc. U. S. Nat. Mus.*, Vol. 18, April 23, 1896, p. 19. Dredged "in 24 fathoms, mud; off Point Fermin, at the head of the Gulf of California."—Dall, *Bull. Mus. Comp. Zool.*, Vol. 43, No. 6, 1908, p. 426, pl. 16, fig. 5. Original locality cited.

Type Locality: Off Point Fermin, head of the Gulf of California, in 24 fathoms, mud.

Range: Head of the Gulf of California to San Lucas Bay, Lower California.

Collecting Station: Mexico: San Lucas Bay (135-D-2), 8-16 fathoms, sand.

Description: Shell orbicular, thin, pearly, beaks nearer the posterior end; rostrum rather wide and well marked off by a groove; surface ornamented by fine radial rows of granules separated from each other by a clear space. A right valve in the present collection measures approximately 34.8 mm. in length and 29.6 mm. in height.

The shell of *Periploma stearnsii* differs from that of *P. discus* in the more compressed form, wider rostrum, wider pallial sinus, and in that the beaks are more posteriorly situated.

Distribution: *Periploma stearnsii* heretofore has been known only from the head of the Gulf of California and the present record extends the known range south to Cape San Lucas Bay at the southern end of the Gulf of California.

Periploma teevani Hertlein & Strong, sp. nov.

Plate I, Figures 2 and 6.

Shell elongately roundly oval, thin, fragile, pearly, valves gently convex and gaping posteriorly; beaks nearer the posterior end, opisthogyrate, acutely pointed, fissured; anterior dorsal margin gently rounded, sloping and merging into the rounded anterior end, ventral margin gently rounded, posterior dorsal margin nearly straight sloping gently down to the subtruncated and nearly straight steeply sloping posterior end of the shell; surface of shell covered by fine concentric lines of growth, the basal half sculptured by fine, weak, radial rows of pustules; on the rostrum these are developed into fine but strong dense closely spaced radial rows; a narrow shallow groove runs from the beak to the anterior basal margin; internally the chondrophore is directed slightly anteriorly, and posteriorly is supported by a thin rounded buttress; a lithodesma is present anterior to the chondrophore; faint radial lines show through on the interior of the shell; pallial sinus short (about one-fourth the length of the shell) not reaching a vertical with the hinge. Length, 23 mm.; height, 19 mm.; convexity (both valves), 10 mm.

Holotype, from Station 196-D-19, Lat. 15°44'N., Long. 96°05'W., Tangola-Tangola Bay, Oaxaca, Mexico, dredged in 30 fathoms (55 meters), mud.

Compared to *Periploma planiuscula* Sowerby[4], a species which ranges from Point Concepcion, California, to Negritos, Peru, the new species is comparatively higher in proportion to the length, the rostrum is shorter and wider and the shell is ornamented by radial rows of pustules which in Sowerby's species are irregularly arranged. These same characters serve to separate it fom *Periploma venezuelana wiedenmayeri* H. K. Hodson[5] from the Miocene of Venezuela.

This species is named for Mr. John Tee-Van, a member of the scientific staff on the *Zaca* during the eastern Pacific Expeditions.

FAMILY THRACIIDAE.

Key to the genera of the Thraciidae.

A. Shell ornamented by prominent oblique concentric undulations ..... *Cyathodonta*

B. Shell ornamented only by concentric lines of growth ..... *Thracia*

Genus **Thracia** Leach in Blainville.

Thracia curta Conrad.

Thracia curta Conrad, *Jour. Acad. Nat. Sci. Philadelphia*, Vol. 7, 1837, p. 248, pl. 19, fig. 8. "Inhabits the coast of California, near Sta. Barbara."—I. S. Oldroyd, *Stanford Univ. Publ. Univ. Ser. Geol. Sci.*, Vol. 1, 1924, p. 84, pl. 43, fig. 6. Icy Cape, Arctic Ocean, Bering Sea, to San Diego, California.

Type Locality: Near Santa Barbara, California.

Range: Icy Cape, Alaska, to Punta Penasco, Sonora, Mexico, in the Gulf of California, Mexico. To Ecuador (E. K. Jordan).

Collecting Station: Mexico: SE. of Cedros Island, in channel (126-D-19), 25 fathoms, rocks, algae.

Description: Shell roundly quadrate, anterior and ventral margins rounded, posterior end truncated; on large specimens a distinct carina marks off the rostrum from the remainder of the shell. A specimen collected at San Diego, California, by Henry Hemphill measures 42 mm. in length.

[4] *Periploma planiuscula* Sowerby, *Proc. Zool. Soc. London*, October 25, 1834, p. 87. "Hab. ad Sanctam Elenam."—Grant & Gale, *Mem. San Diego Soc. Nat. Hist.*, Vol. 1, 1931, p. 255, pl. 13, figs. 1a, 1b. [Not all of the synonymy.] Pliocene to Recent.

[5] *Periploma venezuelana wiedenmayeri* H. K. Hodson, *Bull. Amer. Paleo.*, Vol. 16, No. 59, October 1, 1931, p. 7, pl. 1, figs. 3, 5, 7. From "2 kilometers south and 600 meters east of La Compana, District of Democracia, State of Falcón. (La Compana is 11.5 kilometers east and 2 kilometers south of Urumaco.)" Venezuela. Lower middle Miocene.

The shell of this species is more roundly quadrate in outline and the rostrum is much less expanded in comparison to that of *Thracia trapezoides* Conrad.

Distribution: A single right valve of this species was dredged in the channel southeast of Cedros Island, Lower California. It has been recorded as occurring from Alaska to the Gulf of California and south to Ecuador. We have not seen specimens from south of Cape Lucas, Lower California.

Genus **Cyathodonta** Conrad.

Key to the species of *Cyathodonta*.

A. Shell ornamented by radiating rows of granules ..... *undulata*

B. Shell ornamented by granules arranged in irregular concentric lines

a. Shell elongately ovate; beaks decidedly nearer the posterior end ..... *lucasana*

aa. Shell higher; beaks only slightly nearer the posterior end ..... *dubiosa*

Cyathodonta dubiosa Dall.

Cyathodonta dubiosa Dall, *Proc. U. S. Nat. Mus.*, Vol. 49, November 27, 1915, p. 445. "Type locality, off La Paz." Range: San Pedro to San Diego, California, and to La Paz, Lower California.—I. S. Oldroyd, *Stanford Univ. Publ. Univ. Ser. Geol. Sci.*, Vol. 1, 1924, p. 86, pl. 9, fig. 5. Original locality records cited.

Type Locality: Off La Paz, Lower California, Mexico.

Range: San Pedro, California, to Champerico, Guatemala.

Collecting Station: Guatemala: 7 miles W. of Champerico (197-D-2), 14 fathoms, mud.

Description: The specimen which is here referred to *Cyathodonta dubiosa* differs from *C. undulata* in the character of ornamentation pointed out by Dall, "the granulation is in somewhat irregular concentric lines and not radially distributed." It measures 19.8 mm. in length and 16 mm. in height.

Distribution: A single left valve of *Cyathodonta dubiosa* was dredged off Champerico, Guatemala, in 14 fathoms. The species has also been reported as occurring in the Pleistocene of Lower California and Panama.

Cyathodonta lucasana Dall.

Plate I, Figures 4 and 9.

Cyathodonta lucasana Dall, *Proc. U. S. Nat. Mus.*, Vol. 49, November 27, 1915, p. 445. "Type locality, Cape St. Lucas, Lower California, Xantus."

Type Locality: Cape San Lucas, Lower California, Mexico.

Range: La Paz, Lower California, to Port Guatulco, Mexico.

Collecting Station: Mexico: Port Guatulco (195-D-9), 7 fathoms, green sand, crushed shell.

Description: A single left valve in the present collection dredged off Port Guatulco, Mexico, is identified as *Cyathodonta lucasana* Dall. It is elongately ovate in shape, the anterior end the longer. The plications are few and sparse. In the original description of the species Dall stated that no granulation was perceptible on the type specimen which was 7.5 mm. long and 5 mm. high. The present specimen shows only fine granulation toward the base at that size but after attaining a height of 8 mm. shows well developed irregular concentric granulations. It measures: length, 21 mm.; height, 14 mm.; convexity (one valve), 3.4 mm.

Distribution: The discovery of the occurrence of this species at Port Guatulco, Mexico, is an extension southward of the known range.

Cyathodonta undulata Conrad.

Cyathodonta undulata Conrad, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 4, 1849, p. 156. [Title of article states "Shells from the coasts of Lower California and Peru"].

Thracia plicata Deshayes, Reeve, Conch. Icon., Vol. 12, *Thracia*, November, 1859, species 7, pl. 2, figs. 7b, 7c. California. [Not *Thracia plicata* Deshayes, Reeve, pl. 2, fig. 7a].

Type Locality: East coast of Lower California, (here designated as type locality). Peru also cited originally.

Range: Gulf of California to Peru.

Collecting Stations: Mexico: Arena Bank (136-D-15), 40 fathoms, mud, crushed shell; Santa Inez Bay (145-D-1, 3), 4-13 fathoms, sand; anchorage 1 mile south of San Domingo Point, Concepcion Bay; Nicaragua: Corinto (200-D-4, 7), ½-2 fathoms, mangrove leaves; Costa Rica: Golfito, Gulf of Dulce.

Description: Shell elongate, ornamented by concentric ripples and by fine rows of granules radiating from the umbos. It attains a length of 50 mm. or more.

Cyathodonta magnifica Jonas, from the east coast of Honduras, is a similar species.

Distribution: *Cyathodonta undulata* has been recorded from a number of localities from the Gulf of California to Peru. It also has been reported from the Pliocene and Pleistocene of Lower California, and from the Pleistocene of southern California and Panama.

FAMILY PANDORIDAE.

Genus **Pandora** Hwass in Chemnitz.

Winckworth[6] has recently presented reasons for abandoning the genus name *Pandora* in favor of *Calpodium* Bolten[7]. The

[6] Winckworth, R., *Jour. Conch.*, Vol. 20, No. 2, 1934, pp. 52-53.

[7] Bolten, J. F., *Mus. Bolt.*, Pt. 2, 1798, p. 166.

latter name was proposed for *C. albidum* Bolten, in the synonymy of which was included *Tellina inaequivalvis* with a reference to Chemnitz, Conchyl.-Cab., Vol. 6, pl. 11, figs. 106a, b, c, d [=*Tellina inaequivalvis* Gmelin]. *Calpodium* is thus certainly available if *Pandora* is considered to be invalid. We have hesitated to make this change until it is certain that the well known name *Pandora* must be abandoned.

Key to the subgenera of **Pandora**.

A. Right valve with 2 cardinal teeth
  a. Left valve with 1 tooth or none
    b. Lithodesma present ..... *Kennerlia*
    bb. Lithodesma absent ... *Pandora s.s.*
  aa. Left valve with 3 cardinal teeth ..... *Foveadens*
B. Right valve with 3 cardinal teeth ..... *Clidiophora*

Subgenus **Pandora** s. s.

Pandora (Pandora) uncifera Pilsbry & Lowe.

Pandora uncifera Pilsbry & Lowe, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 84, May 21, 1932, p. 104, pl. 17, figs. 17, 18, 19. "Acapulco, 20 fathoms, type loc.," also from Manzanillo, Mexico, in 20 fathoms.

Type Locality: Acapulco, Mexico, in 20 fathoms.

Range: Gorda Banks off Cape San Lucas, Lower California, to Port Parker, Costa Rica.

Collecting Stations: Mexico: Gorda Banks (150-D-?); Port Guatulco (195-D-9), 7 fathoms, green sand, crushed shell; Tangola-Tangola Bay (196-D-6, 7, 14, 15) 5-7 fathoms, sand, crushed shell; Costa Rica: Port Parker (203-D-3), 12 fathoms, shelly mud.

Description: Shell elongate, small, of about the same size and general features of *Pandora brevifrons* Sowerby[8] but proportionately shorter. Furthermore the anterior dorsal margin of the shell is hooked, a feature entirely lacking in the species described by Sowerby. Length about 12.5 mm.

Distribution: *Pandora uncifera* was dredged abundantly off Port Guatulco, Mexico, in 7 fathoms. The present records of the species north to Gorda Banks in the Gulf of California and south to Port Parker, Costa Rica, are extensions of the known range.

Subgenus **Kennerlia** Carpenter.

Key to the species of *Kennerlia*.

A. Outline elongated; anterior area of left valve set off by an impressed line ..... *bilirata*
B. Outline semicircular; anterior area of left valve not, or only weakly, set off by an impressed line ..... *convexa*

Pandora (Kennerlia) bilirata Conrad.

Pandora bilirata Conrad, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 7, 1855, p. 267. California.—Conrad, *U. S. Pac. R. R. Repts.*, Vol. 6, 1857, *Geol. Rept.*, p. 73, pl. 5, fig. 25. "Santa Barbara, Cal."

Pandora (Kennerlia) bicarinata Carpenter, Arnold, *Mem. Calif. Acad. Sci.*, Vol. 3, 1903, p. 123, pl. 18 fig. 2. Lower San Pedro series of Deadman Island, San Pedro, California, Pleistocene. Also Recent.

Pandora (Kennerlia) bilirata Conrad, I. S. Oldroyd, *Stanford Univ. Publ. Univ. Ser. Geol. Sci.*, Vol. 1, No. 1, 1924, p. 89, pl. 53, figs. 8 and 9. Range, Forrester Island, Alaska, to Point Abreojos, Lower California.

Type Locality: California.

Range: Drier Bay, Prince William Sound, Alaska, to Point Abreojos, Lower California.

Collecting Station: Mexico: East of Cedros Island (126-D-10, 12), 45-60 fathoms, crushed shell, eel grass, mud.

Description: Right valve concave, left convex; anterior margin contracted in the middle, base convex; posterior end truncated; left valve with two carinated ribs radiating dorsally from the beak to the posterior margin, also ornamented by a few very fine and rather widely spaced raised lines extending to the ventral margin posterior to the anterior contraction. Length about 16 mm.

Distribution: This species is often dredged on muddy or on fine sandy bottoms from Alaska to Lower California.

Pandora (Kennerlia) convexa Dall.

Plate I, Figure 5.

Kennerlyia convexa Dall, *Proc. U. S. Nat. Mus.*, Vol. 49, November 27, 1915, p. 449. "Type locality, Ballenas Lagoon, Lower California, in 48 fathoms."

Type Locality: Ballenas Lagoon, Lower California, in 48 fathoms.

Range: Ballenas Lagoon to Cape San Lucas, Lower California, Mexico.

Collecting Station: Mexico: Cape San Lucas, Lower California.

Description: The single specimen in the present collection referred to *Pandora convexa* is approximately 13.5 mm. in length as compared to the unfigured type of the species which was 21 mm. long. Compared to *P. bilirata* Conrad the shell of Dall's species is more semicircular in outline and the anterior area of the left valve is less distinctly set off by an impressed line.

Distribution: The present record of *Pandora convexa* at Cape San Lucas, Lower California, is an extension south of the known range of the species.

[8] *Pandora brevifrons* Sowerby, *Proc. Zool. Soc. London*, September 25, 1835, p. 93. "Hab. apud Panamam." "Obtained from a sandy bottom, at the depth of ten fathoms." —Sowerby, Spec. Conch., Vol. 1, Pt. 2, 1855, *Pandora*, pl. [not numbered], figs. 25, 26. —Sowerby, Conch. Icon., Vol. 19, *Pandora*, 1874, species 12, pl. 2, fig. 12, "Hab.—?"

Subgenus **Clidiophora** Carpenter.

Pandora (Clidiophora) cristata Carpenter.

Clidiophora cristata Carpenter, *Proc. Zool. Soc. London*, November 22, 1864, p. 597. "Hab. in sinu Californiensi."

Pandora cristata Carpenter, Sowerby, Conch. Icon., Vol. 19, *Pandora*, 1874, species 1, pl. 1, fig. 1. "Hab.—?"

Type Locality: Gulf of California.

Range: Gulf of California to La Libertad, El Salvador.

Collecting Stations: Guatemala: 7 miles west of Champerico (197-D-1, 2), 13-14 fathoms, mud; El Salvador: La Libertad (198-D-1, 2), 13-14 fathoms, mud.

Description: The shell of this species may be distinguished from that of other similar forms of the genus by the presence of triangular serrations along the anterior dorsal margin. A large specimen measures approximately 26 mm. in length.

Distribution: The discovery of the occurrence of *Pandora cristata* as far south as La Libertad, El Salvador, is an extension of the known range of the species.

Subgenus **Foveadens** Dall.

Pandora (Foveadens) panamensis Dall.

Foveadens panamensis Dall, *Proc. U. S. Nat. Mus.*, Vol. 49, November 27, 1915, p. 451. "Type locality, beach at Old Panama."

Type Locality: Old Panama, on beach.

Range: El Salvador to Panama.

Collecting Station: El Salvador: Meanguera Island, Gulf of Fonseca (199-D-1), 16 fathoms, sand, mud, crushed shell.

Description: A single somewhat worn right valve dredged in the Gulf of Fonseca off El Salvador seems to fit the description given by Dall for *Pandora panamensis*. This flat, white, pearly valve is slightly concentrically undulated, and possesses two diverging teeth and a low ridge extending from the apex of the hinge to the anterior adductor scar. Length, 33.5 mm.

Distribution: The present record of this species in the Gulf of Fonseca is an extension north of the known range.

FAMILY LYONSIIDAE.

Genus **Lyonsia** Turton.

Key to the subgenera of *Lyonsia*.

A. Shell regular, not distorted; radial sculpture ..... *Lyonsia s.s.*

B. Shell irregular, distorted; smooth ..... *Entodesma*

Subgenus **Lyonsia** s. s.

Key to the species of *Lyonsia s.s.*

A. Umbos inflated; shell often arcuate ..... *californica*

B. Umbos only slightly inflated; shell smaller, less arcuate ..... *gouldii*

Lyonsia (Lyonsia) californica Conrad.

Lyonsia californica Conrad, *Jour. Acad. Nat. Sci. Philadelphia*, Vol. 7, 1837, p. 248, pl. 19, fig. 20 [erroneously cited in text as fig. 21]. "Inhabits the coast of California, near Sta. Barbara."—I. S. Oldroyd, *Stanford Univ. Publ. Univ. Ser. Geol. Sci.*, Vol. 1, 1924, p. 91, pl. 27, fig. 3. Type locality cited. Range, Puget Sound to Todos Santos Bay, Lower California.

Type Locality: Near Santa Barbara, California.

Range: Southeastern Alaska (Lat. 56°N.) to Lat. 24°S., Lower California.

Collecting Station: Mexico: East of Cedros Island (126-D-4), in 40 fathoms, mud.

Description: Shell elongate, thin, pearly, usually more or less arcuate, umbos inflated, ornamented by fine radial sculpture. Fresh specimens are always more or less covered with adhering sand grains.

The subspecies *Lyonsia californica haroldi* Dall, a generally larger shell from central California, is not arcuate and is nearly cylindrical in form. *Lyonsia californica nesiotes* Dall from southern California possesses a small, thin shell in which the beaks are much nearer the anterior end than in the typical species.

Distribution: A single specimen of *Lyonsia californica* was dredged in the channel east of Cedros Island, Lower California, in 40 fathoms. It is commonly found in the waters off California but is much less commonly found off Lower California.

Lyonsia (Lyonsia) gouldii Dall.

Osteodesma nitidum Gould, *Boston Jour. Nat. Hist.*, Vol. 6, April, 1852, p. 390, pl. 15, fig. 6. "Inhabits Santa Barbara."

Lyonsia gouldii Dall, *Proc. U. S. Nat. Mus.*, Vol. 49, November 27, 1915, p. 453. "San Francisco Bay, California, and south to Point Abreojos, Lower California." New name for *Osteodesma* [*Lyonsia*] *nitidum* Gould, 1851, not *Mya* [=*Lyonsia*] *nitida* Fabricus, 1798.

Type Locality: Santa Barbara, California.

Range: San Francisco Bay, California, to Acapulco, Mexico.

Collecting Stations: Mexico: Off Cedros Island; E. of Cedros Island (126-D-4), in 40 fathoms, mud; Santa Inez Bay, Gulf of California (145-D-1, 3), 4-13 fathoms, sand.

Description: Shell small, slender, pearly, umbos gently convex, ornamented by fine raised radial lines, posterior end truncated. Length about 16 mm.

The shell of *Lyonsia gouldii* is smaller, less arcuate in outline, and the umbos are much less inflated than those of *L. californica*.

Distribution: *Lyonsia gouldii* is said to range north to San Francisco Bay, California, but apparently it occurs more commonly

farther south off San Diego, California, and in west Mexican waters.

Subgenus ***Entodesma*** Philippi.

Lyonsia (Entodesma) inflata Conrad.

L [*yonsia*]. *inflata* Conrad, *Jour. Acad. Nat Sci. Philadelphia*, Vol. 7, 1837, p. 248, pl. 19, fig. 10. "Inhabits Guayaquil."—I. S. Oldroyd, *Stanford Univ. Publ. Univ. Ser. Geol. Sci.*, Vol. 1, 1924, p. 93. Type locality cited. Range, in sponges from Vancouver Island, British Columbia, to Guayaquil, Ecuador.

Type Locality: Guayaquil, Ecuador.

Range: Vancouver Island, British Columbia, to Guayaquil, Ecuador (Dall).

Collecting Station: Mexico: Santa Inez Bay, Gulf of California (144-D-2), 2½ fathoms, mud, crushed shell.

Description: Shell irregularly oval in shape, smooth, attaining a length of about 20 mm.; anterior end short.

There is some doubt as to whether *inflata* is the correct specific name to apply to the present specimens. They agree quite well with the general features of *Lyonsia inflata* shown in the original figure, but possess a more angulated anterior margin. In comparing *Lyonsia* (*Entodesma*) *chilense* Philippi with *L.* (*E.*) *inflata*, Dall[9] stated that "these mollusks are nestlers" but in the discussion of *L. inflata* he stated that it is "usually found living in sponges or the mass of compound ascidians, and they differ from the rock nestlers in their polished smooth surface and normal shape."

Lyonsia diaphana Carpenter[10] was originally described from Mazatlan, Mexico. In an early paper Dall[11] stated that Carpenter's specimens appeared to be quite different from the original figure of *L. inflata* given by Conrad but in a later paper (1915) he considered *L. diaphana* to be a young form of Conrad's species. The illustration of *"Mytilimeria" diaphana* given by Sowerby[12] is similar in general characters to that of the original figure of *Lyonsia inflata* except that it is narrower and more elongated. We have not seen convincing evidence that the specimens from the Gulf of California really differ from the more southern forms, hence we have applied the earlier name proposed by Conrad.

Distribution: *Lyonsia inflata* has been recorded as occurring from Forrester Island, Alaska, to Ecuador. The more northern part of the range may perhaps be open to question but the present record from the Gulf of California would appear to be well within the range of the species.

Superfamily Poromyacea.

FAMILY POROMYACIDAE.

Genus ***Poromya*** Forbes.

Poromya Forbes, 13th Rept. Brit. Assoc. Adv. Sci., (Cork, 1843), (issued 1844), pp. 143, 191. Sole species, *Poromya anatinoides* Forbes. "Asia Minor, Cyclades."

Type (by monotypy): *Poromya anatinoides* Forbes [=*Corbula granulata* Nyst & Westendorp. See illustration by Chenu, Man. de Conchyl., Vol. 2, 1862, p. 49, fig. 206].

Shell small, ovate, subequilateral; sculpture of fine granules in radial series; hinge of right valve with a strong cardinal tooth in front of a wide chondrophore; hinge of the left valve with a small cardinal tooth behind and above the chondrophore.

Questimya Iredale[13] is a similar genus.

Subgenus ***Dermatomya*** Dall.

Dermatomya Dall, *Bull. Mus. Comp. Zool.*, Vol. 18, May 20, 1889, pp. 448, 452. Sole species, *Poromya* (*Dermatomya*) *mactroides* Dall.

Type (by original designation): *Poromya* (*Dermatomya*) *mactroides* Dall. Illustrated in *Proc. U. S. Nat. Mus.*, Vol. 12, 1889, p. 291, pl. 8, fig. 8. West coast of Patagonia, in 122, 348 and 449 fathoms. Also off the coast of Ecuador.

The shell of *Dermatomya* differs from typical *Poromya* in the absence of superficial granulations, in the presence of a deep and strong pallial sinus, and in that the hinge is very coarse and strong.

Poromya (Dermatomya) tenuiconcha Dall.

Poromya (*Dermatomya*) *tenuiconcha* Dall, *Proc. U. S. Nat. Mus.*, Vol. 45, June 11, 1913, p. 596. "In deep water off Monterey Bay, California."

Dermatomya tenuiconcha Dall, Dall, *U. S. Nat. Mus., Bull.* 112, 1921, p. 27, pl. 3, fig. 10. Alaska Peninsula to Coronado Islands, in deep water [*Dermatomya* used as a subgenus of *Poromya*].

Type Locality: Off Monterey, California, in deep water.

Range: Alaska Peninsula to off San Jose Point, Lower California (Lat. 31° 25′ N.)

Collecting Station: Mexico: 5 miles W. of San Jose Point, Lower California (175-D-1), 45 fathoms, slabs of slaty rock.

Description: Shell small, thin, smooth, subtrigonal, umbos inflated, anterior end rounded, posterior end roundly truncated,

[9] Dall, W. H., *Proc. U. S. Nat. Mus.*, Vol. 49, 1915, p. 455.

[10] *Lyonsia* (*Osteodesma*) *diaphana* Carpenter, *Proc. Zool. Soc. London*, February 5, 1856, p. 228. "Hab. Mazatlan."

[11] Dall, W. H., *Amer. Jour. Conch.*, Vol. 7, Pt. 2, 1871, p. 143.

[12] Sowerby, G. B., Conch. Icon., Vol. 20, *Mytilimeria*, 1875, species 2, pl. 1, fig. 2. "California."

[13] *Questimya* Iredale, *Rec. Austral Mus.*, Vol. 17, No. 9, June 27, 1930, pp. 389, 406. "Type *Poromya undosa* Hedley and Petterd," *Rec. Austral Mus.*, Vol. 6, No. 3, June 19, 1906, p. 224, pl. 38, figs. 16, 17. "Two odd valves from two hundred and fifty fathoms, and fragments of larger specimens from three hundred fathoms," off Sydney, Australia.

the area set off by a low angulation anterior to which is a shallow groove; interior pearly; hinge of left valve with a small internal resilium on an inconspicuous oblique chondrophore, and immediately in front of this a small notch; fitting into this is a projecting denticle on the opposite valve. The present specimen measures approximately: length, 11.9 mm.; width, 9.8 mm.; convexity (both valves), 7.6 mm.

The shell of *Poromya tenuiconcha* differs from that of *P. trosti* Strong & Hertlein, in the more trigonal form and in that the posterior margin is more distinctly truncated.

Distribution: A single specimen of this species was dredged in 45 fathoms west of San Jose Point, Lower California.

FAMILY CUSPIDARIIDAE.

Key to the genera and subgenera of the Cuspidariidae.

A. Hinge with a posterior lateral tooth in right valve
  a. Surface smooth or with faint concentric sculpture ... *Cuspidaria s. s.*
  aa. Surface with radial ribs ... *Cardiomya*
B. Hinge with both posterior and anterior lateral tooth in right valve
  a. Surface granulated ... *Plectodon*
  aa. Surface smooth (or with concentric growth lines only) ... *Leiomya*

Genus **Cuspidaria** Nardo.

Subgenus **Cuspidaria** s. s.

Cuspidaria (Cuspidaria) apodema Dall.

Cuspidaria apodema Dall, *Proc. U. S. Nat. Mus.*, Vol. 52, No. 2183, December 27, 1916, p. 407. "Station 2859, southwest of Sitka Bay, Alaska, in 1,569 fathoms."—Dall, *U. S. Nat. Mus., Bull. 112*, 1921, p. 28. Off Sitka, Alaska, and south to Panama Bay, in deep water.

Type Locality: Southwest of Sitka, Alaska, in 1,569 fathoms.

Range: Sitka, Alaska, to Panama Bay, in deep water.

Collecting Station: Mexico: Cape San Lucas, Lower California.

Description: Shell small, white, umbos inflated, beaks about 5 mm. from the anterior end, hinge line nearly straight; anterior end rounding into the semicircular base which is suddenly constricted posteriorly at the rostrum; smooth except for incremental lines and wrinkles on the dorsal side of the rostrum.

A single worn specimen from Cape San Lucas, Lower California, in the present collection, approximately 12.6 mm. long and 7.5 mm. high, appears to be referable to *Cuspidaria apodema*. Dall stated that his species is similar to *C. obesa* Lovén, an Atlantic species. Our specimen does resemble somewhat the illustration of that species given by Sars[14].

Possibly the specimen from Cape San Lucas could be a worn valve of *Cuspidaria panamensis* Dall[15] but the smaller size and rather straight hinge line agree more nearly with Dall's description of *C. apodema*. Dall mentioned that the rostrum of *C. panamensis* is short and somewhat recurved and that the ligamentary nymph is very large and tooth like.

Distribution: Only a single valve of this species was taken by the expedition at Cape San Lucas, Lower California.

Subgenus **Cardiomya** A. Adams.

Key to the species of *Cardiomya*.

A. Right valve with about 8 ribs, these are partly twinned on the left valve ... *dulcis*
B. Right and left valves with about 12 to 15 ribs ... *pectinata*

Cuspidaria (Cardiomya) dulcis Pilsbry & Lowe.

Cuspidaria (Cardiomya) dulcis Pilsbry & Lowe, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 84, May 21, 1932, p. 104, pl. 17, figs. 20, 21, 22. "Mexico: Acapulco, in about 20 fathoms," type. Also San Juan del Sur, Nicaragua.

Type Locality: Acapulco, Mexico, in about 20 fathoms.

Range: Punta Penasco, Sonora, Mexico, to Taboga Island, Panama.

Collecting Stations: Mexico: Cape San Lucas; Santa Inez Bay, Lower California (145-D-1,3), 4-13 fathoms, sand; Manzanillo (184-D-2), 30 fathoms, gravelly sand; Port Guatulco (195-D-19), 17 fathoms, green mud, crushed shell; Costa Rica: Port Parker (203-D-1,3), 12-15 fathoms, sandy mud, crushed shell.

Description: Shell small, right valve ornamented by about 8 radiating, high, narrow ribs; on the left valve these are partly twinned; two weak radial threads occur on the rostrum but are often lacking on empty shells. Length about 8 mm.

The shell of *Cuspidaria dulcis* appears to differ from that of *C. costata* Sowerby[16] in the twinning of the ribs on the left valve and in the possession of two radial threads on the rostrum. Neither of these features is

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[14] See *Neaera obesa* Lovén, Sars, *Moll. Reg. Arct. Norvegiae*, 1878, p. 86, pl. 6, figs. 4a, b, c.

[15] *Cuspidaria panamensis* Dall, *Bull. Mus. Comp. Zool.*, Vol. 43, No. 6, October, 1908, p. 432, pl. 16, fig. 2. "U. S. S. 'Albatross,' station 3394, in the Gulf of Panama, in 511 fathoms, mud, bottom temperature, 41°.8 F. U. S. N. M. 122,937."

[16] *Anatina costata* Sowerby, *Proc. Zool. Soc. London*, October 25, 1834, p. 87. "Hab. ad Sanctam Elenam." "A single specimen was found in sandy mud at a depth of six fathoms."

mentioned in the original description of Sowerby's species.

Distribution: This species occurs from the Gulf of California to Panama. In the present collection it is represented most abundantly by specimens from Port Parker, Costa Rica, in 14 fathoms. It is also known to occur in the Pleistocene of Magdalena Bay, Lower California.

Cuspidaria (Cardiomya) pectinata Carpenter.

Neaera pectinata Carpenter, *Rept. Brit. Assoc. Adv. Sci.* for 1863 (issued August, 1864), pp. 602, 637. Puget Sound; Santa Barbara, and Santa Barbara Islands, California. Reprint in *Smithson. Miscell. Coll.*, No. 252, 1872, pp. 88, 123.—Carpenter, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 17, 1865, p. 54. "Hab. In sinu Pugetiano." Also "apud insulam catalinam et Sanct. Barbaram adultam piscavit Cooper."—Arnold, *Mem. Calif. Acad. Sci.*, Vol. 3, 1903, p. 181, pl. 18, fig. 11. Lower San Pedro Series at Deadman Island, San Pedro, California, Pleistocene.

Type Locality: Puget Sound, Washington (cited as type locality by I. S. Oldroyd, 1924, and accepted as such by the present authors).

Range: Puget Sound to [?] Panama.

Collecting Station: Mexico: East of Cedros Island (126-D-12), 45 fathoms, crushed shell and mud.

Description: Shell with about 12 to 15 sharp radiating ribs which vary in size. The rostrum was originally described as lacking radial sculpture; this feature however, appears to be variable. Length about 8 to 11 mm.

The type of this species appears to have come from Puget Sound. Carpenter considered shells from Santa Catalina Island, California, to be identical with those from Puget Sound. Specimens from Puget Sound in the collection at Stanford University are fully twice as large as those from off California. Other than size there is no apparent difference. The ribs vary considerably, depending on the size of the shell.

Cuspidaria californica Dall,[17] described from Catalina Island, California, was described as differing from *C. pectinata* in possessing a smaller and proportionally longer and less inflated shell, with more numerous ribs, and straighter rostrum which is ornamented with two strong radiating lirae. In a series of specimens the characters enumerated seem variable and it seems likely that *C. californica* is hardly more than a subspecies of *C. pectinata*.

Distribution: *Cuspidaria pectinata* Carpenter has been reported as ranging from Puget Sound to Panama. The specimens in the present collection, dredged east of Cedros Island, appear to be referable to Carpenter's species but we have not seen specimens from more southern localities.

Genus **Leiomya** A. Adams.

Leiomya A. Adams, *Ann. & Mag. Nat. Hist.*, Ser. 3, Vol. 13, 1864 [prior to April], p. 208. Sole species, *Leiomya adunca* Gould.

Type (by monotypy): *Leiomya adunca* Gould [=*Neaera adunca* Gould, *Proc. Boston Soc. Nat. Hist.*, Vol. 8, March, 1861, p. 24. "Inhabits Kagosima Bay, sandy mud, 12-15 fathoms."]

A posterior and an anterior lateral tooth are present in the right valve of *Leiomya*, whereas in *Cuspidaria* only a posterior lateral tooth is present.

Subgenus **Plectodon** Carpenter.

Plectodon Carpenter, Rept. Brit. Assoc. Adv. Sci., for 1863 (issued August, 1864), pp. 611, 638. Sole species, *Plectodon scaber* Carpenter. Reprint in *Smithson. Miscell. Coll.*, No. 252, 1872, pp. 97, 124.—Dall, *Bull. Mus. Comp. Zool.*, Vol. 12, No. 6, 1886, p. 299.

Type (by monotypy): *Plectodon scaber* Carpenter.

Dall (1886) described the differences between *Plectodon* and *Leiomya* as follows: "It differs in the insertion of the cartilage behind and under the beaks, instead of on the hinge-margin or in a fossette; in having, rather than a true tooth upon the margin, a tooth-like prominence formed by the spiral twisting under the beaks of the hinge-margin itself, upon and over which, in *P. scaber*, there is a minute external ligament; lastly in *Plectodon* there is a granulated surface much as in *Poromya*."

Dall regarded *Plectodon* as "a mere section of *Leiomya*." We have not seen specimens of *Leiomya adunca*, the type of *Leiomya*, for comparison with *L. scabra*, but the differences in the hinge and exterior ornamentation described for the two has led us, at least for the present, to retain *Plectodon* as a subgenus of *Leiomya*.

Leiomya (Plectodon) scabra Carpenter.

Plectodon scaber Carpenter, Rept. Brit. Assoc. Adv. Sci. for 1863 (issued August, 1864), pp. 611, 638. "Cat. Is.; 2 similar valves, 40-60 fm." Reprint in *Smithson. Miscell. Coll.*, No. 252, 1872, pp. 97, 124.—Carpenter, *Proc. Calif. Acad. Sci.*, Vol. 3, 1865, p. 207. Hab. Catalina Island, California, in 40-60 fathoms.

Leiomya scabra Carpenter, I. S. Oldroyd, *Stanford Univ. Publ. Univ. Ser. Geol. Sci.*, Vol. 1, 1924, p. 103, pl. 54, fig. 10 [not fig. 4 as cited]. "Type locality, Catalina Island in 40-60 fathoms." Range, Puget Sound to San Diego, California.

[17] *Cuspidaria (Cardiomya) californica* Dall, *Bull. Mus. Comp. Zool.*, Vol. 12, No. 6. September, 1886, p. 296 (footnote). "Habitat. Catalina Island, California, dredged in 16 fms., mud; Dall, and previously Cooper, who confounded it, following Carpenter, with *pectinata*."

Type Locality: Catalina Island, California, in 40-60 fathoms.

Range: Catalina Island, California, to Santa Inez Bay, east coast of Lower California.

Collecting Stations: Mexico: East of Cedros Island (126-D-10, 12), 45-60 fathoms, crushed shell, eel grass, mud; Cape San Lucas; Arena Bank (136-D-22), 45 fathoms, mud; Santa Inez Bay (147-D-2), 60 fathoms, mud, crushed shell.

Description: Shell elongate, rostrate, covered by fine pustules giving the effect of a granular surface; color dingy white, umbonal area pink. Length about 24 mm.

Leiomya (Plectodon) granulata Dall[18] described from the Caribbean is a similar species. *"Cuspidaria (Plectodon)* cf. *granulata* Dall" has been cited by Gardner from the Shoal River formation, lower Miocene of Florida.

Distribution: The records of the occurence of *Leiomya (Plectodon) scabra* in Mexican waters is an extension south of the known range of the species.

FAMILY VERTICORDIIDAE.

Genus **Verticordia** S. Wood.

Subgenus **Trigonulina** d'Orbigny.

Verticordia (Trigonulina) ornata d'Orbigny.

Plate 1, Figure 7.

Trigonulina ornata d'Orbigny, in Sagra, Hist. Phys. Polit. et Nat. Cuba, Moll., Vol. 2, 1846, p. 292, pl. 27, figs. 30-33. "Nous l'avons découverte dans le sable de la Jamaïque."—Chenu, Man. de Conchyl., Vol. 2, 1862, p. 169, fig. 843.

Verticordia ornata d'Orbigny, H. & A. Adams, Gen. Rec. Shells, Vol. 2, 1858, p. 532, pl. 124, figs. 2, 2a.—I. S. Oldroyd, *Stanford Univ. Publ. Univ. Ser. Geol. Sci.*, Vol. 1, 1924, p. 103, pl. 54, figs. 15, 16, 17, 18. San Pedro, California. Range, Catalina Island, California, to Panama Bay. Also Japan and the Antilles.

Type Locality: Jamaica, in sand.

Range: Monterey Bay, California, to Panama. Also eastern America from Rhode Island to Jamaica and Barbados, Bermuda, and St. Helena.

Collecting Stations: Mexico: Manzanillo (184-D-2), 30 fathoms, gravelly sand; Costa Rica: Port Parker (203-D-3), 12 fathoms, shelly mud.

Description: Shell small, nacreous, with about 8 or 9 prominent radial ribs on the anterior two-thirds of the shell. The average length is about 4 mm.

Distribution: This species occurs on both the Pacific and Atlantic coasts of America. It is known from Monterey Bay, California, to Panama on the Pacific coast. It also has been reported from the Pleistocene of California.

[18] *Leiomya (Plectodon) granulata* Dall, *Bull. Mus. Comp. Zool.*, Vol. 9, 1881, p. 111.—Dall, *Bull. Mus. Comp. Zool.*, Vol. 12, No. 6, 1886, p. 300, pl. 3, fig. 8. Off Sombrero, in 54 and 72 fathoms; off Barbados, in 76 and 100 fathoms; off Dominica, in 118 fathoms.

Order Teleodesmacea.

Superfamily Astartacea.

FAMILY CRASSATELLITIDAE.

Key to the genera and subgenera of the Crassatellitidae.

A. Shell large (over 10 mm. in height); thick
  a. Margin crenulated ..... *Crassatellites s.s.*[19]
  aa. Margin smooth ..... *Hybolophus*
B. Shell small (less than 10 mm. in height); thin ..... *Crassinella*

Genus **Crassatellites** Krüger.

Subgenus **Hybolophus** Stewart.

Key to the species of *Hybolophus*.

A. Posterior end of shell pointed ..... *gibbosa*
B. Posterior end of shell truncated ..... *digueti*

Crassatellites (Hybolophus) digueti Lamy.

Crassatella undulata Sowerby, *Proc. Zool. Soc. London*, June 5, 1832, p. 56. "Hab. ad Puerto Portrero, Americae Centralis." "Dredged from sandy mud in eleven fathoms water."—Reeve, Conch. Icon., Vol. 1, *Crassatella*, 1843, species 2, pl. 1, figs. 2a, 2b. Original locality cited.

Not *Crassatella undulata* Lamarck, *Ann. Mus. Hist. Nat.* (Paris), Vol. 6, 1805, p. 408. Not *Crassatella undulata* Say, *Jour. Acad. Nat. Sci. Philadelphia*, Vol. 4, 1842, p. 142, pl. 11, fig. 2(a, b).

Crassatella digueti Lamy, *Journ. de Conchyl.*, Vol. 62, No. 4, February 15, 1917, p. 217. "Ile Ceralbo," Gulf of California. New name for *Crassatella undulata* Sowerby, not *Crassatella undulata* Lamarck.

Crassatellites laronus E. K. Jordan, *Nautilus*, Vol. 46, No. 1, July, 1932 ,p. 9. "Near salt works at San José Island, Gulf of California."—E. K. Jordan, *Contrib. Dept. Geol. Stanford Univ.*, Vol. 1, No. 4, 1936, p. 124, pl. 17, figs. 6, 7. Type locality cited. Also Angeles Bay, Lower California; Gulf of California and Central America. Also Magdalena Bay, Lower California, Pleistocene.

Type Locality: Puerto Potrero, Costa Rica, in 11 fathoms, sandy mud.

Range: Gulf of California to Gorgona Island, Colombia.

Collecting Stations: Mexico: Arena Bank (136-D-30), 35 fathoms, sand, weed; Port Guatulco (195-D-9), 7 fathoms, green sand, crushed shell; Costa Rica: Port Parker (203-D-3), 12 fathoms, shelly mud.

Description: The shell of *Crassatellites digueti* may be easily separated from that of *C. gibbosa*, the only other species of the

[19] Not represented in the present collection.

genus living in west American waters, by the less rostrate form and by the truncated posterior end. A large specimen from the Gulf of California in the collections of the California Academy of Sciences measures 92 mm. in length.

Distribution: Shells of *Crassatellites digueti* were dredged at depths of 7, 12 and 35 fathoms. The species is known to occur from the Gulf of California to Colombia. It also occurs in the Pleistocene of Magdalena Bay, Lower California.

Crassatellites (Hybolophus) gibbosus Sowerby.

Crassatella gibbosa Sowerby, *Proc. Zool. Soc. London*, June 5, 1832, p. 56. "Hab. ad oras Americae Meridionalis. (St. Elena and Xipixapi)." "Dredged from sandy mud in eleven fathoms water." — Reeve, Conch. Icon., Vol. 1, *Crassatella*, 1843, species 1, pl. 1, figs. 1a, 1b. Original locality cited.

Crassatillites rudis Li, *Bull. Geol. Soc. China*, Vol. 9, No. 3, 1930 [received at library of California Academy of Sciences May 2, 1931], p. 257, pl. 3, fig. 16. Dredged in Panama Bay. "Horizon: Gatun formation." [=*Crassatellites gibbosus* Sowerby. See Pilsbry, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 83, 1931, p. 429, pl. 41, figs. 9, 10.]

Type Locality: Santa Elena and Xipixapi, Ecuador, in 11 fathoms, sandy mud.

Range: Gulf of California to Paita, Peru.

Collecting Stations: Mexico: Arena Bank (136-D-30), 35 fathoms, sand, weed; Santa Inez Bay (143-D-1, 3), 29-35 fathoms, mud, crushed shell, weeds; Gorda Banks (150-D-23), 45 fathoms, sand, calcareous algae; Chamela Bay (182-D-2), 12 fathoms, sand, algae; Tangola-Tangola Bay (196-D-17), 23 fathoms, mud; El Salvador: La Libertad (198-D-1, 2), 13-14 fathoms, mud; Costa Rica: Port Parker (203-D-3), 12 fathoms, shelly mud; 14 mi. S. × E. of Judas Point (214-D-1, 4), 42-61 fathoms, mud, rocks.

Description: Shell elongately trigonal, the posterior end rostrate and pointed; early part of shell flattened and ornamented by concentric wrinkles. The posterior end of the shell of this species is narrower and more pointed than that of *C. digueti*. Specimens dredged off western Mexico measure 51 mm. in length.

Distribution: *Crassatellites gibbosus* was dredged at several localities from depths of 12 to 61 fathoms, mostly on sandy or shelly mud bottoms. It is known to occur from the Gulf of California to Peru and is also known to occur in the Pliocene of Costa Rica, and in the Pleistocene of Panama and Magdalena Bay, Lower California.

Genus **Crassinella** Guppy.

Key to the species of *Crassinella*.

A. Shell with usually 8-12 concentric ribs
  a. Anterior dorsal margin strongly concave ..... *pacifica*
  aa. Anterior dorsal margin weakly concave ..... *mexicana*
B. Shell with usually more than 12 concentric ribs which are finer and closer; shell smaller ..... *varians*

Crassinella pacifica C. B. Adams.

Gouldia pacifica C. B. Adams, *Ann. Lyceum Nat. Hist. New York*, Vol. 5, July, 1852, pp. 499, 545, (separate pp. 275, 321). "Panama."—H. & A. Adams, Gen. Rec. Shells, Vol. 2, 1858, p. 484, pl. 115, figs. 7a, 7b.

Type Locality: Panama.

Range: Gulf of California to Panama.

Collecting Stations: Mexico: Port Guatulco (195-D-9), 7 fathoms, gr. sand, crushed shell; El Salvador: Meanguera Island, Gulf of Fonseca (199-D-1), 16 fathoms, sand, mud, crushed shell; Nicaragua: Corinto, beach drift; Costa Rica: Port Parker (203-D-1, 3), 12-15 fathoms, sandy mud, shelly mud, crushed shell.

Description: Shell subtriangular, but with the ventral margin well excurved: the color varying in different specimens from dingy white to pale brown, often tinged with red about the beaks, with some narrow rays of brown, and rarely with short irregular lines of brown; with eight to twelve stout subequal concentric ridges; sometimes radially striated; beaks very acute and closely approximate; posterior area moderately depressed; lunule defined by a well impressed line, rising at the margin of the valves; margin of the interior not crenulate. It is closely allied to *G. parva* Ad. Length, .22 inch; height, .19 inch; breadth, .09 inch (C. B. Adams).

The type specimens of *Crassinella pacifica* have never been illustrated. H. & A. Adams give figures of the species but whether the specimen represented was from the type lot is not known. Specimens from the Gulf of California to Panama seem to agree with Adams' description. They also bear out Carpenter's conclusion that the West Indian *C. guadalupensis* d'Orbigny,[20] which species according to Lamy is identical with *C. parva* C. B. Adams (1845), is "the exact analogue of *Gouldia pacifica*." He also added that *C. martinicensis* d'Orbigny is intermediate between *C. pacifica* and *C. varians*.

The specific name *pacifica* is the earliest name available for specimens of the genus *Crassinella* found at Panama and it appears applicable to shells north to the Gulf of California. When a large series is examined it is apparent that there is so much variation in the size, shape, and amount of ribbing,

[20] *Crassatella guadalupensis* d'Orbigny, in Sagra, Hist. Cuba, Moll., Vol. 2, 1845, p. 289, Atlas, pl. 27, figs. 24, 25, 26.

that we are inclined to question whether more than one species, or at most one species and a subspecies, occurs in this region.

Distribution: Specimens of *Crassinella pacifica* were collected on the beach and dredged abundantly at depths of 7 to 16 fathoms, from Port Guatulco, Mexico, to Port Parker, Costa Rica. This species has also been reported as occuring in the Pliocene of Ecuador.

Crassinella pacifica mexicana Pilsbry & Lowe.

Crassinella mexicana Pilsbry & Lowe, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 84, May 21, 1932, p. 103, pl. 14, figs. 8, 9. "Mexico: Guaymas, in about 20 fathoms (Lowe)."

Type Locality: Guaymas, Mexico, in about 20 fathoms.

Range: Cedros Island to the Gulf of California.

Collecting Station: Mexico: East of Cedros Island, Lower California (126-D-12), 45 fathoms, crushed shell and mud.

Description: According to Pilsbry & Lowe *Crassinella mexicana* is very similar to *C. pacifica* C. B. Adams but "it differs chiefly by being relatively high and short, the posterior and anterior dorsal margins meeting in a smaller angle." Externally there are about 12 concentric ribs. The measurements given for the type were: length, 3.4 mm.; height, 3.3 mm.; diameter, 1.8 mm.

There appears to be but few if any constant characters by which this form differs from the variable *C. pacifica*. The large size and less concave anterior dorsal margin may be distinguishing characters but it is not at all certain that these can be relied upon to separate the form *mexicana* as a distinct species or subspecies.

Specimens dredged by the expedition east of Cedros Island resemble so closely the illustrations of *Crassinella mexicana* given by Pilsbry & Lowe that we have assigned the shells to that form which we consider to be a subspecies of *C. pacifica*, at least until more is known regarding the relationship between it and the type specimens of *C. pacifica*.

Distribution: The discovery of the presence of this form off Cedros Island in 45 fathoms is an extension north of the known range.

Crassinella varians Carpenter.

Gouldia varians Carpenter, Cat. Mazatlan Shells, October, 1855, p. 83. "Mazatlan." See also pp. 86 (footnote), 549.

Crassatella pacifica C. B. Adams, var. *varians* Carpenter, Lamy, *Journ. de Conchyl.*, Vol. 62, No. 4, 1917, p. 248. Bay of La Paz, Lower California, and Panama.

Type Locality: Mazatlan, Mexico.

Range: Gulf of California to Panama.

Collecting Stations: Mexico: Santa Inez Bay, Gulf of California (145-D-1, 3), 4-13 fathoms, sand; Nicaragua: Corinto (200-D-19), 12-13 fathoms, mangrove leaves.

Description: "It has the general size and appearance of *Astarte triangularis*." "It has concentric ribs either near the umbo, all over the shell, or not at all." "Even in its most ribbed form, it differs from *G. pacifica* in being very much smaller, not so flat, with umbos more spirally projecting, and with the anterior dorsal margin less concave, as well as in having the ribs smaller, and closer." (Carpenter).

As indicated by the specific name *varians* and by Carpenter's discussion, this is a very variable form. Specimens from the Gulf of California and south to Panama show great variation and certain ones could be picked out which could be assigned to *C. varians*, *C. pacifica* or *C. pacifica mexicana*. In the absence of any illustration of Carpenter's type and in view of the known variation of specimens of *Crassinella* from Mazatlan, the type locality of *C. varians*, and from Panama, the type locality of *C. pacifica*, the present authors question whether two distinct species exist in that region.

Apparently the chief characters which Carpenter relied upon to separate *C. varians* from *C. pacifica* were: the smaller size, more numerous and more closely spaced ribs and less concave anterior dorsal margin. Some specimens from Santa Inez Bay in the Gulf of California and others from Corinto, Nicaragua, seem to answer that description and have been referred to *C. varians*. They bear some resemblance to *C. goldbaumi* E. K. Jordan[21] from the Pleistocene of Magdalena Bay, Lower California, but we are inclined to refer them to Carpenter's species. *Crassinella haylocki* Pilsbry & Olsson[22] from the Pliocene of Ecuador appears to be a similar form, as does *Crassinella quintinensis* Manger[23] from the Pleistocene of San Quintin Bay, Lower California.

Distribution: The distribution of this species appears to be the same as that of *Crassinella pacifica;* that is, the Gulf of California to Panama.

Superfamily Carditacea.

FAMILY CARDITIDAE.

Genus **Cardita** Bruguière.

Key to the species of *Cardita*.

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[21] *Crassinella goldbaumi* E. K. Jordan, *Contrib. Dept. Geol. Stanford Univ.*, Vol. 1, No. 4, November 13, 1936, p. 126, pl. 18, figs. 4, 5, Magdalena Bay, Lower California, Pleistocene.

[22] *Crassinella haylocki* Pilsbry & Olsson, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 93, September 9, 1941, p. 57, pl. 18, figs. 7, 8, "Canoa formation, Punta Blanca." Ecuador, Pliocene.

[23] *Crassinella quintinensis* Manger, *Johns Hopkins Studies in Geol.*, No. 11, 1934, p. 298, pl. 21, figs. 1, 2. "San Quintin Bay, Lower California." Pleistocene.

A. Shell high, quadrate or trigonal; hinge without distinct anterior lateral tooth ..... (genus) *Cardita*
  a. Shell roundly trigonal in outline
    b. Shell large, very thick, ribs broad and rounded ... *megastropha*
    bb. Shell small (15-20 mm. long), ribs narrow and bearing a row of pustules ..... *spurca*
  aa. Shell subquadrate in outline
    c. Posterior end broadly rounded ..... *grayi*
    cc. Posterior end obliquely truncated
      d. Dorsal area offset: interspaces between ribs narrow ..... *cuvieri*
      dd. Dorsal area not offset; dorsal slope steep; interspaces two-thirds to three-fourths as wide as the ribs ..... *tricolor*

B. Shell laterally elongated; hinge with a distinct anterior lateral tooth ..... (subgenus) *Carditamera*
  a. Posterior ventral and dorsal margins nearly parallel; spines on early portion of posterior ribs ..... *affinis*
  aa. Posterior ventral and dorsal margins not parallel; spines only on rib next to posterior dorsal margin ..... *radiata*

Cardita cuvieri Broderip.

Venericardia crassicostata Sowerby, Cat. Shells Tankerville, Ap., 1825, p. IV. [No locality cited].—Hanley, Cat. Rec. Bivalve Shells, 1856, p. 129, pl. 17, fig. 56.

Not *Cardita crassicostata* Lamarck, 1819.

Cardita cuvieri Broderip, *Proc. Zool. Soc. London*, June 5, 1832, p. 55. "Hab. in Sinu Fonseca, Americae Centralis." "Dredged from sandy mud in eleven fathoms water, about seven miles from the shore."—Reeve, Conch. Icon., Vol. 1, *Cardita*, 1843, species 24, pl. 5, fig. 24. Original locality cited. Also "Acapulco."

Cardita varia Broderip, Reeve, Conch. Icon., Vol. 1, *Cardita*, 1843, pl. 5, fig. 25b [not 25a].

Cardita michelini Valenciennes, Voy. *Venus*, Zool., 1846, pl. 22, fig. 5 [two figs.]. [No locality cited.]

Type Locality: Gulf of Fonseca, Central America, in 11 fathoms, sandy mud.

Range: Gulf of California to Zorritos, Peru.

Collecting Stations: Mexico: Ceralbo Island, Gulf of California; Port Angeles; Port Guatulco; Colombia: Gorgona Island.

Description: Shell large (attaining a length of 66 mm.), subquadrate in outline, thick, dorsal area strongly set off from remainder of valve; ornamented by about 14 broad, square, nodulous ribs which are separated by very narrow channelled interspaces; about a half dozen smaller ribs occur on the dorsal area; color reddish or orange brown.

The subquadrate shape and square ribs easily serve to separate this species from *C. megastropha* which possesses a rounded trigonal shell with rounded ribs. The closer set ribs and offset dorsal area are characters which assist in separating *Cardita cuvieri* from *C. tricolor*. *Venericardia hadra* Dall, the type of *Glyptactis* Stewart, and *Venericardia himerta* Dall, described from the lower Miocene of Florida, are somewhat similar to *C. cuvieri*. *Cardita umbonata* Sowerby, described from Sierra Leone, West Africa, is said to be similar in form to *C. cuvieri*.

Distribution: Specimens of *Cardita cuvieri* in the present collection were collected on the beaches in the Gulf of California, along the mainland of western Mexico, and at Gorgona Island, Colombia. The species is known to occur from the Gulf of California to Peru. It also is known to occur in the Pleistocene of Oaxaca, Mexico, and Ecuador.

Cardita grayi Dall.

Cardita crassa G. B. Sowerby I, Zool. Beechey's Voy., 1839, p. 152, pl. 42, fig. 4 [two figures]. "Inhab. Found at Acapulco." —Reeve, Conch. Icon., Vol. 1, *Cardita*, 1843, species 34, pl. 7, fig. 34. Original locality cited.

Not *Cardita crassa* Lamarck, 1819.

Cardita grayi Dall, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 54, January 20, 1903, p. 706. "Cape St. Lucas, the Gulf of California and south to Panama and the Galapagos Islands." New name for *Cardita crassa* Gray," not *C. crassa* Lamarck.

Type Locality: Acapulco, Mexico.

Range: Gulf of California to Guayaquil, Ecuador, and the Galápagos Islands.

Collecting Stations: Mexico: Chamela Bay, beach; Port Guatulco, beach; Tangola-Tangola Bay, beach.

Description: Shell trapezoidal, inflated, posterior dorsal margin broadly rounded; a broad shallow depression occurs from the beak to the base slightly anterior to the center; ornamented by 15 or 16 fairly broad rounded ribs which are separated by much narrower interspaces. A large specimen measures 33 mm. in length and 28 mm. in height.

The rounded posterior portion of the shell, rounded ribs, broad sulcus and less strongly developed central cardinal tooth, easily separate *Cardita grayi* from *C. tricolor* Sowerby.

A. M. Keen has pointed out that in so far as the hinge is concerned this species might well be referred to the genus *Beguina* Bolten (see Min. Conch. Club South. Calif., No. 39, September, 1944, p. 12).

Distribution: A few specimens of this species were collected on the beaches of Mexico. It ranges south to Ecuador.

Cardita megastropha Gray.

Venericardia megastropha Gray, *Ann. Phil., New Ser.*, Vol. 25, February, 1825, p. 137, two figs. p. 138. [Not the locality "New Holland?"]—Lamy, *Journ. de Conchyl.*, Vol. 66, No. 4, 1922, p. 294, two text figs. p. 296. Lower California; Acapulco, Mexico.

Venericardia flammea Michelin, *Mag. de Zool.*, Vol. 1, 1831, Moll., pl. 6. [Locality unknown].

Cardita tumida Broderip, *Proc. Zool. Soc. London*, June 5, 1832, p. 56. "Hab. ad Americae Centralis et Meridionalis oras." "Found in a young state at Puerto Portrero, at a depth of eleven fathoms, in fine sand and gravel; and in a full-grown state at the Isle of Plata, in coral sand, at the depth of seventeen fathoms."—Reeve, Conch. Icon., Vol. 1, *Cardita*, 1843, species 26, pl. 5, fig. 26. Original locality cited.

Cardita varia Broderip, *Proc. Zool. Soc. London*, June 5, 1832, p. 56. "Hab. ad insulas Gallapagos." "Dredged in fine sand at the depth of six fathoms."—Reeve, Conch. Icon., Vol. 1, *Cardita*, 1843, species 25, pl. 5, fig. 25a [not 25b]. Original locality cited.

Type Locality: La Plata Island, Ecuador, in 17 fathoms, coral sand (here designated as type locality). ["New Holland?" originally cited].

Range: Gulf of California to La Plata Island, Ecuador, and the Galápagos Islands.

Collecting Stations: Mexico: Arena Bank (136-D-30), 35 fathoms, sand, weed; Ceralbo channel, Gulf of California (137-D-3), 46 fathoms, rock; Ceralbo Island, beach; 3 mi. off Pyramid Rock, Clarion Island (163-D-2), 55 fathoms, rock, coral; Port Guatulco (195-D-9), 7 fathoms, gr. sand, crushed shell; Santa Cruz Bay; Costa Rica: Port Parker, beach; Colombia: Gorgona Island, beach.

Description: Shell roundly trigonal with prominent curved beaks, ornamented by about 12 broad, rounded, often somewhat nodulous ribs, and additional finer ones which occur along the gently offset dorsal area; the ribs nearly merge one into the other at their bases but often they are separated by a shallow incised line; color usually brownish-red flecked with white or yellowish spots. A large specimen from Gorgona Island, Colombia, measures 54 mm. in altitude.

The shell of *Cardita megastropha* is easily separated from that of *C. cuvieri* by the more trigonal form, more projecting beaks, and broad rounded ribs. *Venericardia terryi* Olsson from the Miocene of Costa Rica and *V. terryi brassica* Maury from the Miocene of Trinidad are similar forms.

Distribution: Specimens of *Cardita megastropha* in the present collection were dredged from depths of 7 to 55 fathoms, and empty shells were found on beaches. The species is known to occur from the Gulf of California to Ecuador and the Galápagos Islands. It is also known to occur in the Pliocene and Pleistocene of Lower California.

Cardita spurca Sowerby.

Carita spurca Sowerby, *Proc. Zool. Soc. London*, for 1832 (issued March 13, 1833), p. 195. "Hab. ad oras Peruviae." "Dredged among coarse sand and gravel, in from six to ten fathoms, at Iquiqui, in Peru."—Reeve, Conch. Icon., Vol. 1, *Cardita*, 1843, species 32, pl. 7, fig. 32. Original locality cited.

Type Locality: Iquique, Chile, in 6 to 10 fathoms, sand and gravel.

Range: Mazatlan, Mexico, to Chile and Straits of Magellan.

Collecting Station: Mexico: Manzanillo (184-D-2), 30 fathoms, gravelly sand.

Description: Shell small, ovately oblong, anterior margin rounded, posterior dorsal area subangulated; ornamented by about 18 nodulous, radiating ribs; shell white or with brown spots, covered by an olivaceous periostracum; interiorly the dorsal area just beneath the beaks is often colored pink.

The specimens in the present collection agree so perfectly with the descriptions and illustrations of *Cardita spurca* that we have assigned them to that species. One of the largest specimens measures approximately 18 mm. in length and 16 mm. in height.

Cardita velutina E. A. Smith from Chile and the Strait of Magellan is a somewhat similar species.

Distribution: *Cardita spurca* is here recorded for the first time from west Mexican waters. It has previously been reported from Peru, Chile, and south to the Straits of Magellan. If our specimens are really *C. spurca* it has a long range. We have not seen specimens of the species from Chile and hence some doubt exists as to the identity of the present specimens from off Mexico.

Cardita tricolor Sowerby.

Cardita tricolor Sowerby, *Proc. Zool. Soc. London*, for 1832 (issued March 13, 1833), p. 194. "Hab. Americâ Centrali." "Found among sand and mud, at a depth of ten fathoms, in the Bay of Guayaquil."—Lamy, *Journ. de Conchyl.*, Vol. 66, No. 3, 1922, p.

248. [Lower] California; Guaymas; Acapulco; Panama.

Cardita laticostata Sowerby, *Proc. Zool. Soc. London*, for 1832 (issued March 13, 1833), p. 195. "Hab. Americâ Centrali (Guacomayo)." "Found in sand, at a depth of from six to twelve fathoms, at St. Elena, Panama, and Real Llejos."—Reeve, Conch. Icon., Vol. 1, *Cardita*, 1843, species 36, pl. 7, figs. 36a, 36b, 36c.

Cardita laticostata Sowerby var. B, Reeve, Conch. Icon., Vol. 1, *Cardita*, 1843, species 36, pl. 7, fig. 36d. [Ref. to *Cardita tricolor*]. Original locality records of *C. tricolor* cited.

Cardita arcella Valenciennes, Voy. *Venus*, Zool., Atlas, 1846, pl. 22, fig. 1 (two figures).

Cardita reeveana Clessin, Martini-Chemnitz Conchyl.-Cab., Bd. 10, Abt. 1, Carditacea, 1888, p. 37, pl. 13, figs. 1 and 2 [not pl. 15, figs. 6 and 7].

Type Locality: Bay of Guayaquil, Ecuador, in 10 fathoms, sand and mud.

Range: Gulf of California, to Paita, Peru, and the Galápagos Islands.

Collecting Stations: Mexico: Port Guatulco (195-D-15), 1.5 fathoms, coral; Santa Cruz Bay, beach; Guatemala: 7 miles west of Champerico (197-D-1, 2), 14 fathoms, mud; Nicaragua: Potosi and Monypenny Point, beach; Costa Rica: Port Parker, beach; Piedra Blanca Bay (200-D-1, 10), 2-6 fathoms, rocks, sand, algae; Panama: Isla Parida, beach; Bahia Honda, beach.

Description: Shell fairly large, thick, subquadrate, ornamented by about 22 or 23 high, square ribs, of these 5 or 6 on the steeply sloping posterior margin are much smaller; ribs crossed by strong raised lines; periostracum black or brownish colored with raised concentric lines, sometimes with bands of bluish-white. The color varies, the anterior and posterior portions or in some cases concentric bands may be orange colored. A large specimen in the collection from Port Parker, Costa Rica, measures approximately 60 mm. in length and 52 mm. in height.

A study of a series of specimens reveals that there are no constant characters which can be relied upon to separate *Cardita tricolor* from *C. laticostata*. The specific name *tricolor* has page priority over that of *laticostata* and for that reason we have accepted Lamy's choice of that name for the species.

Large shells of *Cardita tricolor* are somewhat similar to those of *C. cuvieri* but can be easily separated from that species by the narrower ribs, wider interspaces, flatter umbos, and by the steeply sloping posterior area. Heilprin compared *Cardita serricosta* from the Tampa Silex beds of Florida with *C. laticostata*. *Cardita tricolor* bears some resemblance to *C. floridana* Conrad of the Caribbean region, but the posterior area of the west American form slopes more steeply and it lacks the strong lateral teeth of the Floridan species. Other than the cardinals, the hinge of *C. tricolor* has only what Dall referred to as a lunular pustule.

Distribution: Specimens of *Cardita tricolor* in the present collection were found on beaches and dredged at depths of 1.5 to 14 fathoms. The species is known to occur from the Gulf of California to Peru. It also has been recorded as occurring in the Pliocene of Costa Rica and in the Pleistocene of the Tres Marias Islands.

Subgenus **Carditamera** Conrad.

Cardita (Carditamera) affinis Sowerby.

Cardita affinis Sowerby, *Proc. Zool. Soc. London*, for 1832 (issued March 13, 1833), p. 195. "Hab. in Americâ Meridionali." "Dredged from sandy mud, at a depth of from six to twelve fathoms, in the Bay of Montejo and Gulf of Nocoiya." — Reeve, Conch. Icon., Vol. 1, *Cardita*, 1843, species 6, pl. 1, fig. 6. [No locality cited].

Type Locality: Bay of Montijo, Panama, in 6 to 12 fathoms, sandy mud, (here selected as type locality). Gulf of Nicoya, Costa Rica, also cited originally.

Range: Pequeña Bay, Lower California, to the Gulf of California and south to Santa Elena, Ecuador.

Collecting Stations: Mexico: Santa Inez Bay, east coast of Lower California; Cape San Lucas, Lower California; Chamela Bay; Port Guatulco (195-D-9), 7 fathoms, gr. sand, crushed shell; Guatemala: 7 mi. W. of Champerico (197-D-2), 14 fathoms, mud; El Salvador: La Union, Gulf of Fonseca (199-D-22), 3 fathoms, mud, mangrove leaves; Nicaragua: Potosi and Monypenny Point, beach; Corinto (200-D-2), 5.3 fathoms, mangrove leaves; San Juan del Sur, beach; Costa Rica: Port Parker (203-D-1), 15 fathoms, sandy mud, crushed shell; Port Culebra, beach; Culebra Bay, beach; Piedra Blanca, beach; Golfito, Gulf of Dulce, beach.

Description: Shell elongately rectangular in shape, anterior end projecting and rounded, basal margin and posterior dorsal margin nearly parallel, posterior end rounded or obliquely truncated, posterior umbonal area angulated or rounded; ornamented by about 15 ribs, the anterior ones flattened and lacking scales and in some cases more crowded, while those on the posterior portion of the valves are convex, squamose on young specimens but later become smooth or bear a varying number of scattered scales. The shell is colored brownish-white anteriorly and olive brown posteriorly; interiorly the posterior dorsal area is brown as is the anterior dorsal margin; the remainder is white. Length often less than 50 mm.

The smaller size, more scaly and spinose character of the posterior ribs and often

more contracted anterior end, seem to be about the only differences between *Cardita affinis* and its subspecies *californica*.[24] The subspecies attains a much larger size (a large specimen from the Gulf of Calfiornia measures 82 mm. in length), the anterior end is broader with the ribs less crowded, and the posterior ribs almost or entirely lack spines, but in a large series there appears to be complete gradation between this form and *C. affinis*. The subspecies *C. affinis californica* is restricted to a more northern range and is particularly abundant in the Gulf of California. This appears to be the form illustrated by Reeve[25] as *Cardita pectunculus*.

Cardita gracilis Shuttleworth of the Caribbean region is similar to *C. affinis*.

Distribution: *Cardita affinis* was collected at many localities from the Gulf of California to Costa Rica, on beaches and dredged at depths of 3 to 15 fathoms. It is also known to occur in the Pleistocene of San Ignacio Lagoon and Magdalena Bay, Lower California, and of Oaxaca, Mexico.

Cardita (Carditamera) radiata Sowerby.

Cardita radiata Sowerby, *Proc. Zool. Soc. London*, for 1832 (issued March 13, 1833), p. 195. "Hab. ad Salango, Columbiae Occidentalis, et ad Panamam." "Found in muddy sand at from six to twelve fathoms."—Reeve, Conch. Icon., Vol. 1, *Cardita*, 1843, species 5, pl. 1, fig. 5a [not fig. 5b]. Original locality cited.

Lazaria radiata Sowerby, H. & A. Adams, Gen. Rec. Shells, Vol. 2, 1858, p. 489, pl. 116, figs. 4, 4a.

Lazaria observa Mörch, Malakozool. Blätter, Bd. 7, 1861, p. 199. (Proposed for Reeve's pl. 1, fig. 5a). "Puntarenas." Costa Rica.

Type Locality: Salango, Ecuador, in 6 to 12 fathoms, sandy mud (here selected as type locality). Panama also cited originally.

Range: San Juanico, Lower California (Stearns); Petatlan Bay, Mexico, to Negritos, Peru.

Collecting Stations: Nicaragua: Potosi and Monypenny Point, beach; Corinto (200-D-10, 16, 19), 4-13 fathoms, mangrove leaves; Costa Rica: Port Parker (203-D-3), 12 fathoms, shelly mud.

Description: The shell of *Cardita radiata* is somewhat similar to that of *C. affinis* but the ribs numbering about 17 are but little reduced anteriorly and scales occur only on the rib just below the posterior dorsal margin. The posterior end of *C. radiata* is more elongated, becomes gradually narrower and is usually somewhat pointed, and the two ribs at the posterior ventral margin are often projecting somewhat farther than the others. The color pattern of *C. radiata* is more spotted in effect, the ground color is yellowish-brown and on this are dark spots or narrow bands. The hinge of *C. radiata* is weaker and the left anterior cardinal tooth slopes much less steeply anteriorly than does that of *C. affinis*.

Distribution: Specimens of *Cardita radiata* in the present collection were found on beaches and dredged at depths of 4-13 fathoms, but not as abundantly as *C. affinis*.

Superfamily Chamacea.

FAMILY CHAMIDAE.

Key to the genera of the Chamidae.

A. Nearly equivalve; with lunule; regular radial rows of long spines ... *Echinochama*
B. Usually not equivalve; without lunule; concentric scaly laminae or spines
  a. Beaks turned to the right ... *Chama*
  aa. Beaks turned to the left *Pseudochama*

Genus **Chama** Linnaeus.

Key to the species of *Chama*.

A. Interior of adult shell entirely white
  a. Shell with concentric lamellae or dense spines
    b. Shell large; concentric scaly lamellae; exterior white and rose ... *pellucida*
    bb. Shell small, rounded; dense short white spines ... *squamuligera*
  aa. Shell with irregularly scattered spines; color pink ... *sordida*
B. Interior of adult shell dark red, purple or partly white
  a. Hinge bright coral red ... *echinata*
  aa. Hinge white; exterior with radially striated, expanded, frondose lamellae ... *frondosa*

Chama echinata Broderip.

Chama echinata Broderip, *Proc. Zool. Soc. London*, for 1834 (issued April 3, 1835), p. 150. "Hab. in Americâ Centrali. (Puerto Portrero)." "Found at low water attached to rocks."—Broderip, *Trans. Zool. Soc. London*, Vol. 1, 1835, p. 305, pl. 39, figs. 5-7.—Reeve, Conch. Icon., Vol. 4, *Chama*, 1847, species 35, pl. 7, fig. 35. Original locality cited.

Chama coralloides Reeve, Conch. Icon., Vol. 4, *Chama*, December, 1846, species 18, pl. 4, fig. 18. "Hab. Porto Portrero, Central America (found attached to rocks at low water); Cuming."

[24] *Cardita californica* Deshayes, *Proc. Zool. Soc. London*, 1852 (issued May 23, 1854), p. 100. "Hab. Gulf of California."

[25] *Cardita pectunculus* Reeve, Conch. Icon., Vol. 1, *Cardita*, June, 1843, species 4, pl. 1, fig. 4. [Not the record "Madagascar".] —Mabille, *Bull. Soc. Philomath. Paris*, Ser 8, Vol. 7, 1895, p. 74. Gulf of California; Lower California; coasts of Central America.

Type Locality: Puerto Potrero, Costa Rica, attached to rocks at low water.

Range: Magdalena Bay, Lower California, and the Gulf of California to Paita, Peru, and the Galápagos Islands.

Collecting Stations: Mexico: Gallito Point at entrance to Concepcion Bay, E. coast of Lower California; Port Guatulco; Nicaragua: Isla Cardon, Corinto.

Description: The purple interior and the bright coral red color of the hinge are characteristic features of the shell of this species.

Distribution: *Chama echinata* is commonly found attached to rocks at low tide along the west Mexican coast. It ranges south to Peru and the Galápagos Islands. It has also been reported from the Pleistocene of Oaxaca, Mexico.

Chama frondosa Broderip.

Chama frondosa Broderip, *Proc. Zool. Soc. London*, for 1834 (issued April 3, 1835), p. 148. "Hab. ad Insulam Platam Columbiae Occidentalis." "Dredged up from a rock of coral, to which it was adhering, at a depth of seventeen fathoms."—Broderip, *Trans. Zool. Soc. London*, Vol. 1, 1835, p. 302, pl. 38, figs. 1, 2.—Reeve, Conch. Icon., Vol. 4, *Chama*, 1846, species 1, pl. 1, fig. 1a. Original locality cited.

Type Locality: Island of La Plata, Ecuador, in 17 fathoms, attached to coral.

Range: Gulf of California to Guayaquil, Ecuador, and the Galápagos Islands.

Collecting Station: Mexico: Santa Inez Bay, Gulf of California (143-D-1), 29 fathoms, mud, crushed shell, weeds.

Description: The shell of *Chama frondosa* is ornamented by striated frondose laminae each of which, when perfect, is shaped like a broad fan-shaped leaf. The exterior is usually of a beautiful saffron color while most of the interior is white with purplish colored finely denticulated margins.

A single specimen in the present collection from Santa Inez Bay in the Gulf of California appears to have grown without attachment of any kind.

The subspecies *Chama frondosa mexicana* Carpenter has shorter, less frondose, more numerous and irregularly distributed lamellae and the exterior is colored purplish-red as is the margin of the interior. It is the form represented on Reeve's plate 1, figure 1*b*. It occurs commonly along the west coast of Mexico and ranges from Magdalena Bay, Lower California, and the Gulf of California to Panama and the Galápagos Islands. This subspecies attains a large size and is often so covered by marine growths that the original sculpture is not visible.

Distribution: *Chama frondosa* occurs from the Gulf of California to Ecuador but it appears to be much less commonly found in the northern part of its range. We have not seen specimens from the west coast of Lower California north of Cape San Lucas. It also occurs in the Pliocene of Lower California.

Chama pellucida Sowerby.

Chama pellucida Sowerby, *Proc. Zool. Soc. London*, for 1834 (issued April 3, 1835), p. 149. "Hab. ad Peruviam. (Iquiqui)." "Dredged up attached to stones, *Mytili*, and turbinated shells, at a depth varying from nine to eleven fathoms, from a bottom of coarse sand, and also found under stones at low water mark."—Broderip, *Trans. Zool. Soc. London*, Vol. 1, 1835, p. 302, pl. 38, fig. 3.—Reeve, Conch. Icon., Vol. 4, *Chama*, 1847, species 32, pl. 6, fig. 32. Original locality cited.

Type Locality: Iquique, Chile, in 9 to 11 fathoms, attached to stones and *Mytili;* also under stones at low water mark.

Range: Oregon (Lat. 44° N.), to Mejillones and Cobija, Chile, and Juan Fernandez Island.

Collecting Station: Mexico: Off Cedros Island, Lower California.

Description: Shell translucent, exteriorly white or waxy white rayed with rosy streaks; spines irregular in size; interior white, margin very finely denticulated.

The spines of *Chama pellucida* are not expanded, frondose and striated as are those of *C. frondosa*.

Distribution: *Chama pellucida* was dredged by the expedition off Cedros Island, Lower California. It has been recorded as occurring from Oregon to Chile but we have not seen specimens from south of Cedros Island. It occurs fairly commonly along the coast of southern California. It has also been recorded as occuring from upper Miocene to Recent in California.

Chama sordida Broderip.

Chama sordida Broderip, *Proc. Zool. Soc. London*, for 1834 (issued April 3, 1835), p. 151. "Hab. in America Centrali. (Isle of Cuña)." "Dredged up from a depth of eighteen fathoms, attached to rocks."—Broderip, *Trans. Zool. Soc. London*, Vol. 1, 1835, p. 309, pl. 39, figs. 8 and 9. Original locality cited.—Reeve, Conch. Icon., Vol. 4, *Chama*, 1847, species 23, pl. 5 fig. 23. Original locality cited.

Type Locality: Island of Cuña, Central America, in 18 fathoms, attached to rocks. [We have not noticed any South American island of this name in the atlases which we have consulted. There is, however, an island of "Caño" in the Gulf of Nicoya and another island of the same name in the Gulf of Dulce.]

Range: Carmen Island, Gulf of California, to Gorgona Island, Colombia.

Collecting Station: Mexico: Arena Bank (136-D-13), 45 fathoms, mud, *Arca* conglomerate.

Description: Shell of moderate size, lower valve deeply concave, upper valve gently convex, ornamented by short, sparse, irregularly scattered spines and by fine radial sculpture, color pale coral-red; interior white with finely crenulated margins. The short sharp rugosity in the hinge is finely serrated on some specimens. The original description mentions that the shell of this species varies much according to its age. The present specimen measures approximately 36.5 mm. from beak to base, and the convexity (both valves), 25.5 mm.

Apparently the record of *Chama iostoma* Conrad cited by Tomlin[26] from Gorgona Island, Colombia, can be referred to *Chama sordida*. Conrad's species was originally described from Hawaii.

Distribution: The present record is the second of *Chama sordida* from the Gulf of California. It occurs south to Colombia but is not a common species.

Chama squamuligera Pilsbry & Lowe.

Chama spinosa Broderip cited by authors from West American waters.

Not Chama spinosa Broderip, 1835.

Chama squamuligera Pilsbry & Lowe, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 84, May 21, 1932, p. 103, pl. 14, fig. 10. "Nicaragua: San Juan del Sur," type. Also, Manzanillo, Tres Marias, Cape San Lucas, and Mazatlan, Mexico.

Type Locality: San Juan del Sur, Nicaragua.

Range: San Martin Island, Lower California, to San Juan del Sur, Nicaragua, and the Galápagos Islands.

Collecting Stations: Mexico: Port Guatulco (195-D-9), 7 fathoms, gr. sand, crushed shell; also on beach; Tangola-Tangola Bay.

Description: Shell small, round, both valves moderately arched, the lower more so, attached by nearly one half of the surface of the lower valve; whitish colored; sculpture consisting of dense, small, projecting scales which are more or less united into irregularly concentric frills. Interior white, margin fringed with scales, extremely finely crenulated and on large specimens granulose. Usually not over 20 mm. in altitude but sometimes specimens attain a height of 30 mm. from beak to base.

The shell of *Chama squamuligera* is very similar to that of the species described by Broderip as *Chama spinosa* from Lord Hood's Island, a species referred by Lamy to *C. asperella* Lamarck. The white interior makes it possible to easily separate *Chama squamuligera* from the young of *C. echinata* in which the interior is brightly colored purple and the hinge red. Young specimens of *Chama pellucida* are more strongly and less densely spinose, often colored some shade of rose, and the margin has not the same granulose character as that of *C. squamuligera*.

Distribution: A few specimens of *Chama squamuligera* in the present collection were dredged in 7 fathoms at Port Guatulco, Mexico, and others were collected on the beach at Tangola-Tangola Bay, Mexico. It occurs south to the Galápagos Islands and has been recorded from the Pleistocene of Maria Magdalena Island, Tres Marias group.

Genus **Pseudochama** Odhner.

Pseudochama saavedrai Hertlein & Strong, sp. nov.

Plate I, Figures 1, 3, 8 and 10.

Shell ovately circular; color light yellowish-brown exteriorly; lower valve gently convex, beaks turned to the left, ornamented by rather appressed lamellae, which develop one strong and one weak row of scales toward the posterior margin; interior white, margin denticulate, one tooth on hinge; upper valve moderately inflated, ornamented similar to lower valve but with two well developed rows of scales; posterior to the scales the shell is ornamented only by the edges of close-set concentric lamellae; the concentric lamellae and scales on both valves are ornamented by radiating striae; interior white, margin denticulated. Length, 40.5 mm.; height, 46 mm.; convexity (both valves), approximately 30 mm. Holotype, from Station 184-D-1, dredged in 25 fathoms (45 meters), Lat. 19° 03′ 45″ N., Long. 104° 20′ 45″ W., off Manzanillo, Mexico. A paratype was collected by Fred Baker in 1921 at Puerto Ballandra, Carmen Island, in the Gulf of California.

Pseudochama saavedrai n. sp. seems to possess characters which separate it from all described west American species. The white interior of the shell, denticulate margin, and two radial rows of scales on the upper valve are characteristic features. The new species resembles *Pseudochama panamensis* Reeve[27] but the upper valve is more inflated and is ornamented by stronger concentric sculpture as well as by two radial

[26] Tomlin, J. R. leB., *Jour. Conch.*, Vol. 18, No. 7, May, 1928, p. 193. "Gorgona Is. on shore, common living; dead shells from Albemarle Is."

[27] *Chama panamensis* Reeve, Conch. Icon., Vol. 4, *Chama*, January, 1847, species 45, pl. 8, fig. 45. "Hab. Panama (attached to stones); Cuming."—Clessin, Martini-Chemnitz Conchyl.-Cab., Bd. 10, Abt. 1, *Chama*, 1889, p. 32, pl. 13, fig. 5.—Lamy, *Journ. de Conchyl.*, Vol. 71, No. 4, 1928, p. 330.Panama and La Paz.

Pseudochama panamensis Reeve, Pilsbry & Lowe, *Nautilus*, Vol. 47, No. 3, 1934 p. 84. Panama.

rows of lamellae on the posterior half of the shell in comparison to the rudely fimbriated sculpture of Reeve's species. Furthermore Reeve stated that the margin of *P. panamensis* is smooth while in the new species it is denticulated.

This species is named for Alvaro de Saavedra Cerón[28] who had charge of the first ship built on the west American coast and sailed from a west American port across the Pacific Ocean.

Genus ***Echinochama*** Fischer.

Echinochama californica Dall.

Echinochama californica Dall, *Proc. U. S. Nat. Mus.*, Vol. 26, July 10, 1903, p. 950, pl. 62, fig. 5. "From off Cerros Island, Lower California, in 25 fathoms."—Dall, *Trans. Wagner Free Inst. Sci.*, Vol. 3, Pt. 6, October, 1903, p. 1404, 1406 (in text). Lower California.

Type Locality: Off Cedros Island, Lower California, Mexico, in 25 fathoms.

Range: Cedros Island, Lower California, to Coiba Island, Panama.

Collecting Station: Costa Rica: Port Parker (203-D-3), 12 fathoms, shelly mud.

Description: Shell roundly trigonal, beaks turned to the left; a depressed lunular area present; color yellowish-white; about 20 to 21 ribs ornamented by long hollow spines; between the ribs there is a criss-cross granular sculpture; interior white, border finely crenulated; hinge rugosity serrated. Specimens attain an altitude of at least 40 mm. from beak to base.

Echinochama californica is similar to *E. arcinella* Linnaeus, a Caribbean species, but has larger, flatter and more quadrate valves, the beaks are less prominent, the lunule is less depressed and the ribs are more numerous and the spines are longer. According to Dall & Simpson the east American species is usually detached before it becomes adult. The same appears to be true of *E. californica*.

Distribution: Two specimens of *Echinochama californica* were collected by the expedition. One was dredged in 12 fathoms at Port Parker, Costa Rica, and the other was without locality information. The species is known to occur from Cedros Island and the Gulf of California to Panama.

Superfamily Lucinacea.

FAMILY THYASIRIDAE.

Genus ***Thyasira*** Leach in Lamarck.

Thyasira excavata Dall.

Thyasira excavata Dall, *Proc. U. S. Nat. Mus.*, Vol. 23, August 22, 1901, pp. 790, 818, pl. 39, figs. 12, 15. "Dredged by the U. S. Fish Commission in the Gulf of California, between San Marcos Island and Guaymas, in 1,005 fathoms; bottom temperature, 37°. 6 F. Also off Tillamook, on the coast of Oregon, in 786 fathoms, mud; bottom temperature, 37.3 F."

Type Locality: Between San Marcos Island and Guaymas, in the Gulf of California, in 1,005 fathoms.

Range: Tillamook, Oregon, to the Gulf of California, in 43 to 1,005 fathoms.

Collecting Station: Mexico: Arena Bank, Gulf of California (136-D-20, 22), 43-45 fathoms, mud.

Description: This species is markedly characterized by the deeply excavated and sharply bounded escutcheon and lunule, in which respect it is not closely approached by any other (Dall). In each valve there are three sharp and two or three obscure radial ridges.

Two specimens in the collection from Arena Bank show the rather deeply excavated lunule and escutcheon and radial ridges mentioned as characteristic of *Thyasira excavata*. The larger of the two measures approximately 9.3 mm. in altitude.

Wilckens[29] mentioned that *Thyasira townsendi* White from the Cretaceous of the Antarctic region possesses a lunule similar to that of *T. excavata*.

Thyasira tomeana Dall described from Chile bears some resemblance to *T. excavata* but differs somewhat in shape, is not as deeply furrowed posteriorly, and lacks strong radial ridges.

Distribution: The present specimens of *Thysira excavata* from the Gulf of California appear to be the first found since those mentioned in the original description. According to Dall the species occurs to depths of 1,005 fathoms in the Gulf of California and ranges north to Oregon.

FAMILY LUCINIDAE.

Key to the genera and subgenera of the Lucinidae.

A. Hinge with teeth
  a. Sculpture divaricate ..... *Divaricella*
  aa. Sculpture not divaricate
    b. Hinge with cardinal teeth, laterals absent
      c. Valves equally convex; strong concentric lamellae ... *Lucinoma*
      cc. Valves unequally convex; concentric sculpture of growth lines only ..... *Miltha*
    bb. Hinge with both cardinal and lateral teeth

[28] Regarding this voyage by Alvaro de Saavedra Cerón, see I. S. Wright, *Geogr. Rev.*, Vol. 29, No. 3, July, 1939, pp. 472-482, 1 fig. [map].

[29] *Thyasira townsendi* White, Wilckens, Wiss. Ergeb. Schwed. Südpolar Exped. 1901-1903, Bd. 3, Lief. 12, 1910, p. 53, pl. 2, figs. 31a-c; pl. 3, fig. 1. Snow Hill, Seymour Island, Antarctica, Cretaceous.

d. Surface with concentric sculpture only
  e. Shell globose; lunule deeply impressed ..... *Here*
  ee. Shell compressed, obliquely elongate ..... *Cavilinga*
dd. Surface with concentric and radial sculpture
  f. Radiating ribs divaricate ..... *Ctena*
  ff. Radiating ribs not divaricate
    g. Shell large, thick, anterior lateral close to cardinals ..... *Codakia*
    gg. Shell smaller, thinner, anterior lateral not close to cardinals
      h. Radial sculpture of 1 to 3 very broad ribs ..... *Pleurolucina*
      hh. Radial sculpture of 10 or more ribs
        i. Radial and concentric sculpture about equal, strong
          j. Sculpture with spines; many radial ribs *Lucinisca*
          jj. Sculpture without spines; usually 10 to 12 ribs *Bellucina*
        ii. Radial and concentric sculpture unequal, feeble *Parvilucina*

B. Hinge without teeth ..... *Anodontia*

Genus **Lucina** Bruguière.

Subgenus **Bellucina** Dall.

Lucina (Bellucina) cancellaris Philippi.

Lucina cancellaris Philippi, *Zeit. f. Malakozool.*, February, 1846, p. 21. "Patria: Mazatlan". Mexico.

Phacoides (Bellucina) cancellaris Philippi, Dall, *Proc. U. S. Nat. Mus.*, Vol. 23, 1901, pp. 814, 829, pl. 39 fig. 11. "Cerros Island, west of Lower California, and south to the Gulf and to Panama, in 5 to 30 fathoms."

Type Locality: Mazatlan, Mexico.

Range: Cedros Island, Lower California, and the Gulf of California to Panama, in 4 to 40 fathoms.

Collecting Stations: Mexico: Santa Inez Bay, Gulf of California (145-D-1, 3), 4-13 fathoms, sand; Tenacatita Bay (183-D-3), 40 fathoms, sandy mud; Manzanillo (184-D-2), 30 fathoms, gravelly sand; El Salvador: Meanguera Island, Gulf of Fonseca (199-D-1), 16 fathoms, sand, mud, crushed shell; Costa Rica: Port Parker (203-D-1, 3), 12-15 fathoms, sandy mud, crushed shell, shelly mud.

Description: Shell small, obliquely roundly trigonal, number of ribs variable, but usually there are from 10 to 12 fairly broad, radial ribs which are wider than the interspaces and are crossed by weaker concentric sculpture forming a cancellated pattern. Large specimens attain a height of 6 mm.

Lucina amianta Dall, which occurs from North Carolina to Brazil, and *L. tuomeyi* Dall from the upper Miocene of Florida, are similar species.

Distribution: *Lucina cancellaris* was dredged at a number of localities from depths of 4 to 40 fathoms, from Santa Inez Bay in the Gulf of California, where it was quite abundant, to Port Parker, Costa Rica. It also occurs in the Pleistocene of Magdalena Bay, Lower California, Maria Magdalena Island of the Tres Marias group and in the Pliocene of Ecuador.

Subgenus **Cavilinga** Chavan.

Key to the species of *Cavilinga*.

A. Shell longer than high ..... *lampra*

B. Shell with length and height about equal ..... *lingualis*

Lucina (Cavilinga) lampra Dall.

Phacoides (Cavilucina) lamprus Dall, *Proc. U. S. Nat. Mus.*, Vol. 23, August 22, 1901, pp. 811, 827, pl. 39, fig. 9. Type locality, "La Paz, Lower California."

Lucina lampra Dall, E. K. Jordan, *Contrib. Dept. Geol. Stanford Univ.*, Vol. 1. No. 4, 1936, p. 130. Magdalena Bay, Lower California, Pleistocene. Also Gulf of California, Recent.

Type Locality: La Paz, Lower California.

Range: Gulf of California, to Santa Cruz Bay, Mexico.

Collecting Stations: Mexico: Cape San Lucas, beach; Manzanillo (184-D-2), 30 fathoms, gravelly sand; Port Guatulco (195-D-2, 6), 3 fathoms, sand, algae, crushed shell, also on beach; Santa Cruz Bay, beach.

Description: Shell of Dosinioid form, nearly orbicular, rather thick; beaks subcentral, lunule small, excavated, and nearly equally divided between the two valves; a broad shallow flexuosity is present along the posterior dorsal area but is sometimes nearly obsolete; sculpture of fine, low, rather sharp, concentric threads with occasional well marked sulci; microscopic radial striations sometimes present; internal margins

very finely crenulated in perfect specimens; color of shell white, yellow or pink. The largest specimens in the collection are about 21 mm. in length.

E. K. Jordan pointed out that the lunule in *Lucina lampra* is usually equally divided between the two valves, while in *L. californica* it is chiefly in the right valve. *Lucina lampra* is more circular in outline than the similar species *L. prolongata* Carpenter or *L. lingualis* Carpenter. Jordan also pointed out that the shell of *L. lampra* is longer than high, in *L. lingualis* the two dimensions are about equal, while that of *L. prolongata* is higher than long and pronouncedly oblique. The color of *Lucina lampra* varies from white to yellow or pink. All other species of the genus from the west coast are usually pure white.

Distribution: Specimens of *Lucina lampra*, most of them empty shells, were collected by the expedition at several localities from Cape San Lucas to Santa Cruz Bay, Mexico, on the beach and dredged to a depth of 30 fathoms. The discovery of the occurence of this species at Santa Cruz Bay, Mexico, is an extension south of the known range. It also has been recorded as occurring in the Pleistocene of Magdalena Bay, Lower California.

Lucina (Cavilinga) lingualis Carpenter.

Lucina lingualis Carpenter, *Ann. & Mag. Nat. Hist.*, Ser. 3, Vol. 13, April, 1864, p. 313. Cape St. Lucas. Reprint in *Smithson. Miscell. Coll.*, No. 252, 1872, p. 211.—E. K. Jordan, *Contrib. Dept. Geol. Stanford Univ.*, Vol. 1, 1936, p. 131. Magdalena Bay, Lower California, Pleistocene. Gulf of California to Acapulco, Mexico, Recent.

Phacoides (Cavilucina) lingualis Carpenter, Dall, *Proc. U. S. Nat. Mus.*, Vol. 23, 1901, p. 827, pl. 39, fig. 7. Gulf of California.

Type Locality: Cape San Lucas, Lower California.

Range: Magdalena Bay to the Gulf of California and south to Acapulco, Mexico.

Collecting Stations: Mexico: Cape San Lucas, beach; San Lucas Bay (135-D-25), 7 fathoms, sand; Santa Inez Bay (145-D-1, 3), 4-13 fathoms, sand.

Description: The shell of this species resembles that of *Lucina lampra* but is higher and somewhat produced below; the height and length are about equal. A large right valve of this species from Magdalena Bay, Lower California, in the collections of the California Academy of Sciences, measures 13 mm. in height.

Distribution: Specimens of *Lucina lingualis* were collected by the expedition on the beach at Cape San Lucas and dredged at depths of 4-13 fathoms in the Gulf of California. It has been reported to range south to Acapulco and as occurring in the Pleistocene at Magdalena Bay, Lower California.

Subgenus **Here** Gabb.

Lucina (Here) excavata Carpenter.

Lucina excavata Carpenter, Cat. Mazatlan Shells, November, 1855, p. 98. "Mazatlan."

Phacoides (Here) richthofeni Gabb, Dall, *Proc. U. S. Nat. Mus.*, Vol. 23, 1901, pp. 810, 827, pl. 40, figs. 7 and 9. Catalina Island to the Gulf of California, in 16 to 66 fathoms.

Type Locality: Mazatlan, Mexico.

Range: San Pedro, California, to Mazatlan, Mexico, in 16 to 66 fathoms.

Collecting Stations: Mexico: Santa Inez Bay, Gulf of California (142-D-3, 4), 40-50 fathoms, sand, weed, (146-D-1), 35 fathoms, mud, crushed shell; Gorda Banks (150-D-6) 60 fathoms, muddy sand, rocks.

Description: Shell globose, inflated; ornamented by concentric ridges and a deeply depressed lunule. A specimen from Santa Inez Bay in the Gulf of California measures approximately 23.5 mm. in altitude.

Lucina (Here) iduna Olsson from the Miocene of Peru has been compared to *L. excavata*.

Distribution: A few specimens of *Lucina excavata* were dredged at depths of 35 to 60 fathoms, from Cape San Lucas to Santa Inez Bay in the Gulf of California. It has also been recorded occurring as a fossil in California as far back as the middle Miocene.

Subgenus **Lucinisca** Dall.

Key to the species of *Lucinisca*.

A. About 18 major ribs ..... *liana*

B. More than 18 major ribs

a. Ribs equal, regularly spaced... *nuttalli*

aa. Ribs unequal, not regularly spaced, shell flatter ..... *fenestrata*

Lucina (Lucinisca) fenestrata Hinds.

Lucina fenestrata Hinds, Zool. Voy. *Sulphur*, Moll., Pt. 3, 1844 [January, 1845, on cover of Pt. 3], p. 66, pl. 19, fig. 2. "Inhab. Monte Christi; San Blas. In seven to fourteen fathoms."

Lucina (Lucinisca) fenestrata Hinds, Dall, *Proc. U. S. Nat. Mus.*, Vol. 23, 1901, p. 811. Lower California to Panama (and Tumbez, Peru?). [Not *Lucina muricata* mentioned in the text].

Type Locality: Montechristi, Ecuador, in 7 to 14 fathoms (here designated as type locality). San Blas, Mexico, also cited originally.

Range: Cedros Island, Lower California, and the Gulf of California, to Salinas, Ecuador. Peru (Dall; Carpenter).

Collecting Stations: Mexico: East of

d. Surface with concentric sculpture only
  e. Shell globose; lunule deeply impressed ..... *Here*
  ee. Shell compressed, obliquely elongate ..... *Cavilinga*
dd. Surface with concentric and radial sculpture
  f. Radiating ribs divaricate ..... *Ctena*
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    gg. Shell smaller, thinner, anterior lateral not close to cardinals
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      hh. Radial sculpture of 10 or more ribs
        i. Radial and concentric sculpture about equal, strong
          j. Sculpture with spines; many radial ribs *Lucinisca*
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Distribution: Specimens of *Lucina lampra*, most of them empty shells, were collected by the expedition at several localities from Cape San Lucas to Santa Cruz Bay, Mexico, on the beach and dredged to a depth of 30 fathoms. The discovery of the occurence of this species at Santa Cruz Bay, Mexico, is an extension south of the known range. It also has been recorded as occurring in the Pleistocene of Magdalena Bay, Lower California.

Lucina (Cavilinga) lingualis Carpenter.

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Phacoides (Cavilucina) lingualis Carpenter, Dall, *Proc. U. S. Nat. Mus.*, Vol. 23, 1901, p. 827, pl. 39, fig. 7. Gulf of California.

Type Locality: Cape San Lucas, Lower California.

Range: Magdalena Bay to the Gulf of California and south to Acapulco, Mexico.

Collecting Stations: Mexico: Cape San Lucas, beach; San Lucas Bay (135-D-25), 7 fathoms, sand; Santa Inez Bay (145-D-1, 3), 4-13 fathoms, sand.

Description: The shell of this species resembles that of *Lucina lampra* but is higher and somewhat produced below; the height and length are about equal. A large right valve of this species from Magdalena Bay, Lower California, in the collections of the California Academy of Sciences, measures 13 mm. in height.

Distribution: Specimens of *Lucina lingualis* were collected by the expedition on the beach at Cape San Lucas and dredged at depths of 4-13 fathoms in the Gulf of California. It has been reported to range south to Acapulco and as occurring in the Pleistocene at Magdalena Bay, Lower California.

Subgenus **Here** Gabb.

Lucina (Here) excavata Carpenter.

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Type Locality: Mazatlan, Mexico.

Range: San Pedro, California, to Mazatlan, Mexico, in 16 to 66 fathoms.

Collecting Stations: Mexico: Santa Inez Bay, Gulf of California (142-D-3, 4), 40-50 fathoms, sand, weed, (146-D-1), 35 fathoms, mud, crushed shell; Gorda Banks (150-D-6) 60 fathoms, muddy sand, rocks.

Description: Shell globose, inflated; ornamented by concentric ridges and a deeply depressed lunule. A specimen from Santa Inez Bay in the Gulf of California measures approximately 23.5 mm. in altitude.

Lucina (Here) iduna Olsson from the Miocene of Peru has been compared to *L. excavata*.

Distribution: A few specimens of *Lucina excavata* were dredged at depths of 35 to 60 fathoms, from Cape San Lucas to Santa Inez Bay in the Gulf of California. It has also been recorded occurring as a fossil in California as far back as the middle Miocene.

Subgenus **Lucinisca** Dall.

Key to the species of *Lucinisca*.

A. About 18 major ribs ..... *liana*

B. More than 18 major ribs

a. Ribs equal, regularly spaced... *nuttalli*

aa. Ribs unequal, not regularly spaced, shell flatter ..... *fenestrata*

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Lucina fenestrata Hinds, Zool. Voy. *Sulphur*, Moll., Pt. 3, 1844 [January, 1845, on cover of Pt. 3], p. 66, pl. 19, fig. 2. "Inhab. Monte Christi; San Blas. In seven to fourteen fathoms."

Lucina (Lucinisca) fenestrata Hinds, Dall, *Proc. U. S. Nat. Mus.*, Vol. 23, 1901, p. 811. Lower California to Panama (and Tumbez, Peru?). [Not *Lucina muricata* mentioned in the text].

Type Locality: Montechristi, Ecuador, in 7 to 14 fathoms (here designated as type locality). San Blas, Mexico, also cited originally.

Range: Cedros Island, Lower California, and the Gulf of California, to Salinas, Ecuador. Peru (Dall; Carpenter).

Collecting Stations: Mexico: East of

Cedros Island (126-D-2), 38 fathoms, mud; Arena Bank (136-D-15), 40 fathoms, mud, crushed shell; Santa Inez Bay (143-D-1, 2, 3, 4), 25-35 fathoms sand, weed, rocks.

Description: Shell resembling that of *Lucina nuttalli* but much larger. One valve in the present collection measures 44 mm. in altitude. The narrow elongate lunule appears to be about equally divided between the two valves. The sculpture is coarser and more rasp-like, the radial ribs are more unequal, smaller, and wider spaced in proportion to the size of the shell than are those of *L. nuttalli*. The major ribs of *L. fenestrata* are greater in number, finer, and more closely spaced than are those of *L. liana* Pilsbry. *Lucina (Lucinisca) fausta* Pilsbry & Olsson[80] from the Pliocene of Ecuador is a similar species.

Distribution: A number of specimens of *Lucina fenestrata* were dredged east of Cedros Island, on Arena Bank and in Santa Inez Bay at depths of 25 to 40 fathoms. It is much less commonly taken than the somewhat similar species *L. nuttalli*.

Lucina (Lucinisca) liana Pilsbry.

Lucina muricata Chemnitz, Reeve, Conch. Icon., Vol. 6, *Lucina*, June, 1850, species 46, pl. 8, fig. 46. "Hab. Tumbez, Peru (in soft mud at a depth of eleven fathoms); Cuming."

Not *Lucina muricata* Chemnitz, 1795. An east American species.

Phacoides (Lucinisca) hispaniolana Maury, Li, *Bull. Geol. Soc. China*, Vol. 9, No. 3, 1930 [received at the library of the California Academy of Sciences May 2, 1931], p. 258, pl. 3, fig. 20. "Gatun Stage, Port Limon, Costa Rica." "Gatun formation." Dredged in the Bay of Panama.

Not *Phacoides (Lucinisca) hispaniolana* Maury 1917. Santo Domingo, Miocene.

Phacoides (Lucinisca) liana Pilsbry, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 83, November 13, 1931, p. 435, pl. 41, fig. 3. "Panama Bay, a mile out in 10-40 ft." [Rectification of the record cited by Li].

Type Locality: Panama Bay, 1 mile out, in 10-40 feet.

Range: Santa Inez Bay, east coast of Lower California, to Tumbez, Peru.

Collecting Stations: Mexico: Arena Bank (136-D-15, 22), 40-45 fathoms, mud, crushed shell; Santa Inez Bay (143-D-1), 29 fathoms, mud, crushed shell, weed; Port Guatulco (195-D-2), 3 fathoms, sand; Guatemala: 7 mi. W. of Champerico (197-D-1, 2), 14 fathoms, mud; El Salvador: La Libertad (198-D-1, 2), 13-14 fathoms, mud; Meanguera Island, Gulf of Fonseca (199-D-1), 16 fathoms, sand, mud, crushed shell; Panama: Gulf of Chiriqui (221-D-1), 35 fathoms, sandy mud.

Description: Shell rounded, white; the upper anterior area ornamented by a few irregular ribs, the upper posterior area with 3 or 4 radial ribs followed by about the same number in a shallow groove, the remainder of the shell ornamented by about 18 major slightly wavy ribs between which there are smaller riblets, usually one or two toward the anterior end and 3 along the ventral margin; ribs and riblets ornamented by projecting points or scales where the ribs are crossed by rather widely spaced, thin concentric ridges. Hinge similar to *L. muricata*. Large specimens attain a length of 19.5 mm.

The unequal size between the major and minor ribs is a character which easily serves to separate *Lucina liana* from *L. nuttalli centrifuga* Dall. The major ribs of *L. liana* are much less numerous than those of *L. fenestrata* Hinds. *Lucina roigi* Maury from the Pliocene of Trinidad is another species of the *L. muricata* group to which *L. liana* belongs.

Distribution: The discovery of the occurence of *Lucina liana* in the Gulf of California is an extension north of the known range of the species. It also has been recorded as occurring in the Pliocene of Panama and Ecuador.

Lucina (Lucinisca) nuttalli Conrad.

Lucina nuttalli Conrad, *Journ. Acad. Nat. Sci. Philadelphia*, Vol. 7, 1837, p. 255, pl. 20, fig. 2. "Inhabits California."

Lucina (Myrtea) nuttallii Conrad, Grant & Gale, *Mem. San Diego Soc. Nat. Hist.*, Vol. 1, 1931, p. 288, pl. 14, figs. 4a, 4b, 18. Earlier records cited. Upper Miocene to Recent.

Type Locality: California.

Range: Santa Barbara, California, to Manzanillo, and the Tres Marias Islands, Mexico.

Collecting Stations: Mexico: Arena Bank (136-D-22), 45 fathoms, mud; Santa Inez Bay (145-D-1, 3), 4-13 fathoms, sand; Tenacatita Bay (183-D-3), 15 fathoms, sand; Manzanillo (184-D-2), 30 fathoms, gravelly sand.

Description: Shell orbicular, ornamented by even, strong, cancellate sculpture; the ribs are nearly equal in strength but there are some finer ones interspersed; ribs more widely spaced toward the anterior and posterior margins. The lunule usually lies chiefly in the left valve. Large specimens attain a height of 25 mm.

The subspecies *Lucina nuttalli centrifuga* Dall, a form with widely spaced concentric lamellae described from the Gulf of California, intergrades completely with specimens of *L. nuttalli* from that region. The sub-

[80] *Lucina (Lucinisca) fausta* Pilsbry & Olsson, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 93, September 9, 1941, p. 58, pl. 17, figs. 3, 6. "Canoa formation, Punta Blanca," Ecuador, Pliocene.

species has not been reported outside the Gulf of California except as a fossil in southern California.

Distribution: *Lucina nuttalli* occurs commonly from southern California to the Gulf of California. The present record of the species from Manzanillo, Mexico, is an extension south of the known range. It is also known to occur from upper Miocene to Recent in California.

Subgenus **Lucinoma** Dall.

Lucina (Lucinoma) annulata Reeve.

Lucina annulata Reeve, Conch. Icon., Vol. 6, *Lucina*, May, 1850, species 17, pl. 4, fig. 17. "Hab. California?"

Phacoides annulatus Reeve, I. S. Oldroyd, *Stanford Univ. Publ. Univ. Ser. Geol. Sci.*, Vol. 1, 1924, p. 126, pl. 33, figs. 5a, 5b. Port Althorp, Alaska, to the Coronado Islands, Lower California. Also upper Miocene, Pliocene and Pleistocene of California.

Type Locality: California.

Range: Port Althorp, Alaska, to Santa Inez Bay, east coast of Lower Calfiornia.

Collecting Stations: Mexico: East of Cedros Island (126-D-2, 9, 12), 38-56 fathoms, crushed shell, eel grass, mud; Santa Inez Bay (142-D-4), 40-50 fathoms, sand.

Description: Shell suborbicular, often large, posterior dorsal margin straight; posterior sulcus slight; ornamented by fairly regular, sharp, raised concentric lamellae between which there are a number of low concentric threads; cardinal teeth well developed, lateral teeth weak.

The largest specimen in the present collection is about 26 mm. in altitude and appears to be typical of the species. Large specimens of *Lucina annulata* attain an altitude of 55 mm.

Distribution: The present records of *Lucina annulata* from off Cedros Island and from Santa Inez Bay in the Gulf of California furnish an extension south of the known range of the species. It is also known to occur in the Pliocene and Pleistocene of California.

Subgenus **Miltha** H. & A. Adams.

Lucina (Miltha) xantusi Dall.

Plate I, Figure 13.

Phacoides (*Miltha*) *xantusi* Dall, *Nautilus*, Vol. 18, No. 10, February, 1905, p. 111. "Cape St. Lucas." Lower California.

Type Locality: Cape San Lucas, Lower California.

Range: Gulf of California.

Collecting Stations: Mexico: Cape San Lucas; Arena Bank (136-D-5), 33 fathoms, sand, weed.

Description: Shell large, ovately rounded, produced ventrally, rather flat, right valve more convex than the left; ornamentation consists of concentric lines of growth and radial striae; posterior sulcus present, ornamented by one radial ridge; lunule chiefly in the right valve, depressed; two cardinal teeth, the right anterior and left posterior tooth bifid; ligamental groove, long, posterior; muscle scars, especially the anterior one, large; inner surface of valve scatteringly pitted; margin smooth.

The specimen from Arena Bank measures 68 mm. in length, 71.2 mm. in height, and convexity (both valves), 23 mm. This is almost the same size as the type specimen described by Dall. Young specimens are rounder in outline. This species is very close to *Lucina* (*Miltha*) *joannis* Dall described from the Pliocene of Lower California. According to Dall the margin of the lunule of *L. joannis* is more deeply infolded, the shell heavier, more elongately oyal and about one-fourth smaller than that of *L. xantusi*. The measurements given for *L. xantusi* are 71 mm. in height and 65 mm. in width as compared to 55 mm. in height and 51 mm. in width for *L. joannis*. These measurements do not indicate that the shell of *L. joannis* is more elongate in proportion to the width as compared to that of *L. xantusi*. The illustration given by Hanna[31] of a fossil shell from Imperial County, California, which he referred to *L. xantusi*, represents a rather round form which may perhaps be referable to *L. joannis*.

Lucina (*Miltha*) *childreni* Gray from Brazil is a similar species and there are other similar forms which occur in the late Tertiary of the Caribbean region.

Distribution: *Lucina* (*Miltha*) *xantusi* is a rare species. The two specimens taken on the expedition from the southern part of the Gulf of California from Cape San Lucas and Arena Bank are from the same region where it has been found previously by collectors.

Subgenus **Parvilucina** Dall.

Key to the species of *Parvilucina*.

A. Concentric lamellae strong and dense; lunule deep ..... *mazatlanica*

B. Concentric lamellae weaker; lunule shallower ..... *approximata*

Lucina (Parvilucina) approximata Dall.

Phacoides (*Parvilucina*) *approximatus* Dall, *Proc. U. S. Nat. Mus.*, Vol. 23, August 22, 1901, pp. 813, 828, pl. 39 fig. 4. "From the Gulf of California, in 26 fathoms, sand." Also cited from Catalina Island, California, and south to Panama, in 5 to 40 fathoms.

Lucina (*Myrtea*) *tenuisculpta* Carpenter

[31] *Phacoides xantusi* Dall, Hanna, *Proc. Calif. Acad. Sci.*, Ser. 4, Vol. 14, No. 18, 1926, p. 475, pl. 28, fig. 7, pl. 29, fig. 1. Coyote Mountain, Imperial County, California, Pliocene.

var. *approximata* Dall, Grant & Gale, *Mem. San Diego Soc. Nat. Hist.*, Vol. 1, 1931, p. 289, pl. 14, figs. 8a, 8b. Earlier records cited. Pleistocene and Recent.

Type Locality: Gulf of California, in 26 fathoms, sand.

Range: Monterey, California, to Panama.

Collecting Stations: Mexico: East of Cedros Island (126-D-12), 45 fathoms, crushed shell, mud; Nicaragua: Corinto (200-D-19, also beach), 12-13 fathoms, mangrove leaves; Costa Rica: Port Parker (203-D-1, 3, also beach), 12-15 fathoms, sandy mud, crushed shell, shelly mud.

Description: Shell small, usually not exceeding 6 mm. in length, nearly equilateral, tumid, lunule lanceolate in shape and depressed; sculpture of numerous fine radial ribs separated by narrow interspaces, radial sculpture absent on the dorsal areas, ribs crossed by distant elevated concentric lines which are feebly lamellose on the dorsal areas; margin crenulated. The measurements given for the type specimen of this species were, length, 6.3 mm.; height, 6.5 mm.

The shell of *Lucina approximata* is very similar to that of the generally more northern *L. tenuisculpta* but is smaller, more delicate, has stronger radial sculpture and lacks the right anterior cardinal tooth of the northern form. The radial ribbing tends to become obsolete in the northern part of its range and the two species are scarcely separable in southern California.

Lucina crenella Dall from the Atlantic coast is a similar species.

Distribution: *Lucina approximata* occurs fairly abundantly from southern California to Panama. It was dredged abundantly off Cedros Island and was taken by the expedition as far south as Costa Rica. It is also known to occur in the Pleistocene of southern California and Lower California.

Lucina (Parvilucina) mazatlanica Carpenter.

Lucina mazatlanica Carpenter, Cat. Mazatlan Shells, November, 1855, p. 99. "Mazatlan," Mexico.—E. K. Jordan, *Contrib. Dept. Geol. Stanford Univ.*, Vol. 1, No. 4, 1936, p. 130. Magdalena Bay, Lower California, Pleistocene. Recent in the Gulf of California.

Phacoides (Here) mazatlanicus Carpenter, Dall, *Proc. U. S. Nat. Mus.*, Vol. 23, 1901, p. 811. Mazatlan.

Type Locality: Mazatlan, Mexico.

Range: Gulf of California to Panama.

Collecting Station: Mexico: Santa Inez Bay, E. coast of Lower California (145-D-1, 3), 4-13 fathoms, sand.

Description: Shell small, tumid, nearly equilateral; lunule rather large and depressed; sculpture of numerous fine, rounded riblets separated by narrow interspaces, weak or absent on the early part of the shell; concentric sculpture of elevated laminae which are very dense on the early part of the shell but are less pronounced on later stages; basal margin crenulated.

Lucina mazatlanica resembles *L. approximata* Dall and *L. tenuisculpta* Dall but average specimens (about 4.5 mm. in length) are smaller than either of these species. The lunule appears to be deeper and the concentric lamellae stronger and denser in comparison to young forms of *L. approximata*.

There is doubt regarding the exact identification of *Lucina mazatlantica* because, as mentioned by Dall (1901) "Carpenter's specimens are so small that it is difficult to be certain about them," furthermore, no illustrations of them have been published. Dall thought the species might be allied to *L. sombrerensis*, a Caribbean species. In the original description of *Lucina sombrerensis*[32] no mention was made of any radial sculpture on that species. Carpenter definitely mentioned radial sculpture on *L. mazatlanica* which would seem to place it near *L. approximata* Dall.

Distribution: Specimens referred to *Lucina mazatlanica* were dredged in 4 to 13 fathoms in Santa Inez Bay, in the Gulf of California. It also has been reported as occurring in the Pleistocene of Magdalena Bay, Lower California.

Subgenus **Pleurolucina** Dall.

Lucina (Pleurolucina) leucocymoides Lowe.

Phacoides (Pleurolucina) leucocymoides Lowe, *Trans. San Diego Soc. Nat. Hist.*, Vol. 8, No. 6, March 21, 1935, p. 17 pl. 1, fig. 4. "Tres Marias" Islands, (type). Also from Carmen Island in 20 fathoms, and Angel de la Guardia, in 20 fathoms, Gulf of California.

Type Locality: Tres Marias Islands, Mexico.

Range: Angel de la Guardia Island, Gulf of California, to Manzanillo, and Tres Marias Islands, Mexico.

Collecting Stations: Mexico: Arena Bank (136-D-15, 22, 23), 40-45 fathoms, mud, crushed shell, sand; Santa Inez Bay (142-D-3, 4), 40-50 fathoms, sand, weed, also (147-D-2), 60 fathoms, mud crushed shell; Gorda Banks (150-D-9), 50-60 fathoms, muddy sand; Manzanillo (184-D-2), 30 fathoms, gravelly sand.

Description: Shell with a single wide costa which occupies the entire middle half

[32] *Lucina sombrerensis* Dall, *Bull. Mus. Comp. Zool.*, Vol. 12, No. 6, September, 1886, p. 264. "Off Sombrero in 72 fms., two valves; West Florida, 50 fms., one small valve."—Dall, *Proc. U. S. Nat. Mus.*, Vol. 12, 1889, p. 263, pl. 14, fig. 13. Off Cape Florida, in 84 to 85 fathoms, sand and mud. "Also in the Gulf of Mexico and off Sombrero Island, West Indies, by the *Blake*, in 50 to 72 fathoms."

of the shell and is bounded on either side by a channeled groove; concentric sculpture of reflexed concentric lirae; lunule large, heart-shaped, equally divided between each valve, shallowly depressed. The shell of adult specimens is quite thick. Hinge with two cardinals and divided laterals. Inner margin finely crenulated. The shell of this species attains a height of 20 mm.

Lucina leucocyma Dall of the Atlantic coast is a similar species.

Lucina undatoides Hertlein & Strong (*Lucina undata* Carpenter[33], not *L. undata* Lamarck) is ornamented by three or four broad costae, and by finer concentric sculpture, and the shell is longer and less convex than that of *L. leucocymoides*.

Distribution: The present record of the occurrence of *Lucina leucocymoides* at Manzanillo, Mexico, is an extension south of the known range of the species. It is also known to occur in the Pleistocene of Albemarle Island, Galápagos group, where it was found by Professor Nicolas Reformatsky.

Genus ***Anodontia*** Link.

Anodontia edentuloides Verrill.

Loripes edentuloides Verrill, *Amer. Jour. Sci.*, Ser. 2, Vol. 49 (whole No. 99), No. 146, March, 1870, p. 226. "La Paz,—J. Pedersen. One specimen."

Lucina edentuloides Verrill, Dall, *Proc. U. S. Nat. Mus.*, Vol. 23, 1901, p. 802. Magdalena Bay, Lower California and the Gulf of California.

Anodontia edentuloides Verrill, Grant & Gale, *Mem. San Diego Soc. Nat. Hist.*, Vol. 1, 1931, p. 292. Earlier records cited. Pliocene and Recent.

Type Locality: La Paz, Lower California.

Range: San Clemente Island, California (Dall), and Cedros Island, Lower California, to the Gulf of California, and south to Tenacatita Bay, Mexico.

Collecting Stations: Mexico: East of Cedros Island (126-D-2), 38 fathoms, mud; Arena Bank (136-D-4, 13, 14, 20, 22), 43-55 fathoms, mud, *Arca* conglomerate; Santa Inez Bay (143-D-1, 2, 3, 4, 5), 18-35 fathoms, mud, crushed shell, weed, sand; Tenacatita Bay (183-D-3), 40 fathoms, sandy mud.

Description: Shell subglobose, beaks subcentral, ornamented by irregular lines of growth and submicroscopic radial striae; hinge without teeth. The largest specimen taken by the expedition measures approximately 43 mm. in length but the species attains a larger size.

Young shells about 10 mm. in length, from Arena Bank, have two cardinals and one lateral tooth in the left valve and one cardinal and one lateral in the right valve. Apparently these teeth become covered as growth proceeds. Exteriorly these young shells are sculptured by concentric lines of growth and fine radial striation exactly as in large specimens of *Anodontia edentuloides*. These features as well as the exact shape of that species have led us to refer these young shells to Verrill's species.

The shell of *Anodontia edentuloides* is very similar to *A. chrysostoma* (Meuschen) Philippi, a Caribbean species, but the beaks are more centrally located on the west American shell which also appears to be slightly more elongated in proportion to the height.

Distribution: Specimens of this species were found off Cedros Island, in the southern part of the Gulf of California, and at Tenacatita Bay. The present record of the occurrence of the species at Tenacatita Bay, Mexico, is an extension south of the known range. It has also been recorded from the Pliocene of Imperial County, California.

Genus ***Codakia*** Scopoli.

Codakia distinguenda Tryon.

Lucina (Codakia) distinguenda Tryon, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 24, September 3, 1872, p. 130, pl. 6, fig. 3. "Gulf of California."

Codakia colpoica Dall, *Proc. U. S. Nat. Mus.*, Vol. 23, August 22, 1901, pp. 801, 821, pl. 41, fig. 4. "Gulf of California."

Type Locality: Gulf of California.

Range: Magdalena Bay, Lower California, and the Gulf of California to Panama.

Collecting Stations: Mexico: Ceralbo Island, beach; Port Guatulco (195-D-10, also beach), 4 fathoms, gravelly sand, crushed shell, coral; Costa Rica: Port Parker, beach; Panama: Bahia Honda, beach.

Description: Shell large, orbicular, thick, white exteriorly, interiorly reddish colored around the margin and hinge and cream colored in the central part of the valve; ornamented exteriorly by many narrow fairly regular, radial ribs; lunule small, depressed, mostly confined to the right valve. A large specimen from the Gulf of California measures 140 mm. in length.

The shell of this species is very similar to that of the east American *Codakia orbicularis* Linnaeus, but the valves of the west American species are more depressed, the posterior dorsal area is straighter and longer, the inner margin of the hinge is usually reddish colored and the exterior is usually tinted faintly pinkish-white rather than the usually pure white of *C. orbicularis*.

A study of a series of specimens suggests that there is little to separate the form

[33] *Lucina undata* Carpenter, *Proc. Zool. Soc. London*, 1865, p. 279. "Hab. Gulf of California (teste Rowell)." Not *Lucina undata* Lamarck, 1819. Due to the fact that the combination of names *Lucina undata* proposed by Carpenter had already been used by Lamarck, the name *Lucina undatoides* was proposed by Hertlein & Strong for the species described by Carpenter (*Nautilus*, Vol. 58, No. 3, January, 1945, p. 105).

described as *C. pinchoti* Pilsbry & Lowe[34] from *C. distinguenda* or from *C. recta* Dall & Ochsner which was originally described from the Pliocene of the Galápagos Islands.

Distribution: *Codakia distinguenda* occurs fairly commonly in the Gulf of California and 15 valves were taken by the expedition at Ceralbo Island. It was also collected at Costa Rica and Panama. It is also known to occur from Pliocene to Recent in the Gulf of California region.

Genus **Ctena** Mörch.

Key to the species of *Ctena*.

A. Radial sculpture present on dorsal areas
  a. Radial sculpture much heavier than the concentric
    b. Ribs fine, numerous ..... *mexicana*
    bb. Ribs coarse, less numerous ..... *galapagana*[35]
  aa. Radial sculpture only slightly heavier than or equal with the concentric
    c. Transversely oval or subcircular; anterior end broadly rounded ..... *clippertonensis*
    cc. Obliquely transversely ovate; anterior end narrower ..... *clarionensis*
B. Radial sculpture not present on dorsal areas ..... *chiquita*

Ctena chiquita Dall.

Codakia (Jagonia) chiquita Dall, *Proc. U. S. Nat. Mus.*, Vol. 23, August 22, 1901, pp. 801, 823, pl. 39, fig. 1. "On the west side of the lower end of the peninsula of Lower California, nearly abreast of La Paz, in 66 fathoms."

Type Locality: Off the west coast of Lower California, nearly abreast of La Paz, in 66 fathoms.

Range: West coast of Lower California in about Lat. 24°18'N., and the Gulf of California to La Libertad, El Salvador.

Collecting Stations: Mexico: Manzanillo (184-D-2), 30 fathoms, gravelly sand; Santa Cruz Bay, beach; Tangola-Tangola Bay (196-D-6, 7), 6-7 fathoms, sand, crushed shell; El Salvador: La Libertad (198-D-2), 14 fathoms, mud.

Description: Shell small, suborbicular, flattish, color yellowish-white, sculpture of fine nearly obsolete radial threads which often bifurcate toward the ventral margin, less prominent on the middle of the valves and absent along the dorsal margin, radials crossed by regular, concentric, crowded threads; lunule small, depressed, nearly equally divided between the two valves. A large specimen from off Lower California measures 13.5 mm. in length.

The shell of *Ctena chiquita* is less elongate, and the radial sculpture is finer than that of *C. mexicana* Dall and is lacking on the dorsal areas.

Distribution: The present record of *Ctena chiquita* from La Libertad, El Salvador, is an extension southward of the known range of the species. It has not been recorded previously from south of the Gulf of California.

Ctena clarionensis Hertlein & Strong, sp. nov.

Plate I, Figures 11, 12 and 14.

Shell small, solid, plump, obliquely ovately quadrate, with the beaks nearer the posterior end; without posterior or anterior areas; sculptured with many, fine, close, rounded threads which are notched by somewhat wider spaced radial lines, giving the whole surface a finely beaded appearance; lunule narrow, moderately long, well impressed, equally divided between the two valves; growth stages distinctly marked, particularly the last three; interior with the muscle scars distinct, about equal in size; interior basal margin with fine radial ridges extending to the pallial line; cardinal teeth small, the right valve with a strong, distant anterior lateral and a smaller, closer, posterior lateral tooth; left valve with a weak posterior cardinal and a low projection which may represent a broken anterior cardinal, one small anterior lateral and socket and one posterior lateral and socket present; above each socket there is a faint lateral. The type measures: longitudinal diameter, 13.8 mm.; vertical diameter, 12.5 mm.; convexity (both valves), 8.2 mm.

Holotype, from Sulphur Bay, Clarion Island, collected by the Templeton Crocker Expedition of the New York Zoological Society.

The unique type is white with the anterior end and posterior edge dark reddish-brown but this color may be a stain. The new species resembles *Ctena clippertonensis* Bartsch & Rehder[36] described from Clipperton Island, but the present species is more oblique in outline, the anterior end is narrower and the sculpture is coarser. The new species has much finer sculpture than *C. mexicana* Dall.

Ctena clippertonensis Bartsch & Rehder.

Ctena clippertonensis Bartsch & Rehder, *Smithson. Miscell. Coll.*, Vol. 98, No. 10, (Publ. 3535), June 13, 1939, p. 13, pl. 3, figs.

[34] *Codakia pinchoti* Pilsbry & Lowe, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 84, May 21, 1932, p. 103, pl. 14, figs. 1 and 2. "Panama City, on the reef off 'French Plaza'."

[35] Not represented in the present collection.

[36] *Ctena clippertonensis* Bartsch & Rehder, *Smithson. Miscell. Coll.*, Vol. 98, No. 10, (Publ. 3535), June 13, 1939, p. 13, pl. 3, figs. 1, 2, 3, 4, 5. "It was collected on Clipperton Island, on rocks to the south of the landing place."

1-5. "It was collected on Clipperton Island, on rocks to the south of the landing place."

Type Locality: Clipperton Island, on rocks.

Range: Maria Madre Island, Mexico, to Hannibal Bank, Panama, and Clipperton Island.

Collecting Station: Panama: Hannibal Bank (Sta. 224), 35-40 fathoms, rocks, dead coral, mud, sand, shells, algae.

Description: Left valve, white, transversely oval to subcircular, moderately inflated, beaks back of the center; ends broadly rounded; ornamented by fine radial riblets crossed by concentric lamellae of nearly equal strength which give the ribs a nodulose character; lunule, well defined, narrow, elongately lanceolate; hinge with an anterior cardinal and a smaller grooved posterior cardinal tooth, lateral teeth paired, the larger pointed one of each pair occurs on the inside and the smaller one near the margin.

The present specimen measures: length, 15.2 mm.; height, 13.8 mm.; convexity (one valve), 3.8 mm.

The broadly rounded anterior end of the present specimen as well as its other characters appear to be those of *Ctena clippertonensis* Bartsch & Rehder.

Distribution: A single left valve of this species was dredged by the expedition on Hannibal Bank, Panama, in 35-40 fathoms. This is an extension south of the known range of the species.

Ctena mexicana Dall.

Codakia (Jagonia) mexicana Dall, *Proc. U. S. Nat. Mus.*, Vol. 23, August 22, 1901, pp. 801, 822, pl. 40, fig. 6. "Gulf of California" (figured specimen). Range cited as Gulf of California to Panama and Guacomayo.

Lucina (Jagonia) mexicana Dall, Lamy, *Journ. de Conchyl.*, Vol. 65, No. 3, 1921, p. 253. Colombia; Lower California.

Type Locality: Gulf of California.

Range: Gulf of California, to Santa Elena, Ecuador. Galápagos Islands (Tomlin).

Collecting Stations: Mexico: Arena Bank (136-D-1), 45 fathoms, mud, *Arca* conglomerates; Santa Inez Bay (143-D-1), 29 fathoms, mud, crushed shell, weed; also (145-D-1, 3), 4-13 fathoms, sand; also beach; Port Guatulco (195-D-9), 7 fathoms, gr. sand, crushed shell; Nicaragua: Corinto (200-D-11, 19), 8-13 fathoms, mangrove leaves; Costa Rica: Port Parker (203-D-1, 3), 12-15 fathoms, sandy mud, crushed shell.

Description: Shell small, usually somewhat elongated, ornamented by numerous well developed but fairly fine radial ribs which usually bifurcate toward the ventral margin; these are decussated by fine fairly regular concentric threads; lunule lanceolate moderately depressed. A large specimen measures 22 mm. in length and 19.4 mm. in height.

The shell of *Ctena mexicana* is quite similar to that of the east American *C. imbricatula* C. B. Adams but the sculpture of the west American form is generally a little finer and more regular and the lunule is a little longer and less deeply impressed. The ribbing of the species in this group is variable.

Distribution: This species was collected by the expedition at various localities from the Gulf of California to Costa Rica. It occurs South to Panama and Ecuador. It has been cited as occurring in the Pleistocene of Magdalena Bay and the Tres Marias Islands.

Genus **Divaricella** von Martens.

Divaricella lucasana Dall & Ochsner.

Lucina eburnea Reeve, Conch. Icon., Vol. 6, *Lucina*, June, 1850, species 49, pl. 8, fig. 49. "St. Elena, West Columbia and Panama (in sandy mud at a depth of eleven fathoms); Cuming."

Not *Lucina eburnea* Andrzejowski, Deshayes, *Bull Soc. Geol. France*, Ser. 1, Vol. 6, 1835, p. 321. Miocene of Poland. [*Nomen nudum*].

Divaricella lucasana Dall & Ochsner, *Proc. Calif. Acad. Sci.*, Ser. 4, Vol. 17, No. 4, June 22, 1928, p. 122, pl. 2, figs. 17, 21, 24. "1¼ miles northeast of Vilamil, Albemarle Island, Galapagos Group. Probably Pleistocene." New name for *Lucina eburnea* Reeve, not *L. eburnea* Deshayes, 1835.

Divaricella columbiensis Lamy, *Bull. Mus. Nat. Hist. Nat. Paris*, Ser. 2, Vol. 6, No. 5, October, 1934, p. 433. Colombia. New name for *Lucina eburnea* Reeve, not *Venus eburnea* Gmelin, 1790 (which = *Codakia (Jagonia) jagon* Adanson); not *Lucina eburnea* Andrzejowski, Deshayes, 1835; not *Loripes eburnea* Conrad, 1847.

Type Locality: 1¼ miles northeast of Vilamil, Albemarle Island, Galápagos Islands, Pleistocene. Of *Lucina eburnea* Reeve, Santa Elena, Ecuador, in 11 fathoms, sandy mud (here designated as type locality). Panama also cited originally.

Range: Magdalena Bay, and the Gulf of California, to Mancora, Peru.

Collecting Stations: Mexico: Cape San Lucas, beach; Arena Point area, beach; Santa Inez Bay (143-D-1), 29 fathoms, mud, crushed shell, weed, also (144-D-2), 2½ fathoms, sand, weed, rocks, also (145-D-1, 3), 4-13 fathoms, sand; Manzanillo (184-D-2), 30 fathoms, gravelly sand; Port Guatulco (195-D-2), 3 fathoms, sand; Nicaragua: Corinto (200-D-17, 19), 7-13 fathoms, sand, mangrove leaves, also beach.

Description: Shell round, nearly equilateral, inflated, with divaricate sculpture.

Shells of the species attain a height of 25 mm.

The name *Divaricella lucasana* was proposed by Dall & Ochsner because of the citation of *Lucina eburnea* Andrzejowski by Deshayes. So far as we have been able to ascertain the name cited by Deshayes is a *nomen nudum* and if the species was not formally described it does not invalidate the use of the same combination of names by Reeve. However, Lamy (1931) also considered Reeve's species to be nomenclatorially invalid and proposed a new name for it. Whether or not Reeve's name must be abandoned appears to be open to question. We have, at least for the present, used the name applied to the species by Dall & Ochsner.

Dall proposed the name *Divaricella perparvula* for *Lucina pisum* Philippi, 1850, not *L. pisum* Sowerby, 1837. According to Dall *Divaricella perparvula* differs from *D. eburnea* [= *lucasana*] in that it possesses a smaller shell which is ornamented by weaker external sculpture. There is variation in the size of the shell and in the sculpture of *Divaricella lucasana* and it seems doubtful whether two distinct species of *Divaricella* occur in this region.

Divaricella quadrisulcata d'Orbigny, which occurs in the Caribbean region, is a similar species.

Distribution: *Divaricella lucasana* was taken by the expedition at various localities from Santa Inez Bay in the Gulf of California to Nicaragua, on the beach and at depths of 2½ to 30 fathoms. It was found abundantly on the beach at Cape San Lucas and at Corinto, Nicaragua. It is also known to occur in the Pliocene and Pleistocene of the Gulf of California region and in the Pleistocene of Oaxaca, Mexico, and the Galápagos Islands.

EXPLANATION OF THE PLATE.

Fig. 1. *Pseudochama saavedrai* Hertlein & Strong, sp. nov. Holotype, left valve, from Station 184-D-1, dredged in Lat. 19° 03′ 45″ N., Long. 104° 20′ 45″ W., off Manzanillo, Mexico, in 25 fathoms (45 meters). Approximately natural size. View of the interior. P. 110.

Fig. 2. *Periploma teevani* Hertlein & Strong, sp. nov. Holotype, right valve, from Station 196-D-19, dredged in Lat. 15° 44′ N., Lon. 96° 05′ W., Tangola-Tangola Bay, Oaxaca, Mexico, in 30 fathoms (55 meters). Length, 23 mm.; height, 19 mm. View of the exterior. P. 95.

Fig. 3. *Pseudochama saavedrai* Hertlein & Strong, sp. nov. Holotype. View of the exterior of the specimen shown in Fig. 1.

Fig. 4. *Cyathodonta lucasana* Dall. Hypotype, left valve, from Station 195-D-9, dredged in Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., Port Guatulco, Mexico, in 7 fathoms (12.6 meters). Length, 21 mm.; height, 14 mm.; convexity (one valve), 3.4 mm. P. 96.

Fig. 5. *Pandora* (*Kennerlia*) *convexa* Dall. Hypotype, left valve, from Cape San Lucas, Lower California, Mexico. Length, approximately 13.4 mm., height, 8.2 mm.; convexity (both valves, 2.5 mm. P. 97.

Fig. 6. *Periploma teevani* Hertlein & Strong, sp. nov. Holotype. View of the interior of the left valve of the specimen shown in Fig. 2.

Fig. 7. *Verticordia ornata* d'Orbigny. Hypotype, right valve, from Station 203-D-3, dredged in Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., Port Parker, Costa Rica, in 12 fathoms (22 meters). Length, approximately 3.2 mm.; height, approximately 3 mm. P. 102.

Fig. 8. *Pseudochama saavedrai* Hertlein & Strong, sp. nov. Holotype. View of the interior of the right valve of the specimen shown in Fig. 1. Length, 40.5 mm.; height, 46 mm.

This specimen is attached to the shell of a gastropod shown in the upper left part of the figure.

Fig. 9. *Cyathodonta lucasana* Dall. Hypotype. View of the exterior of the specimen shown in Fig. 4.

Fig. 10. *Pseudochama saavedrai* Hertlein & Strong, sp. nov. Holotype. View of the exterior of the specimen shown in Fig. 8.

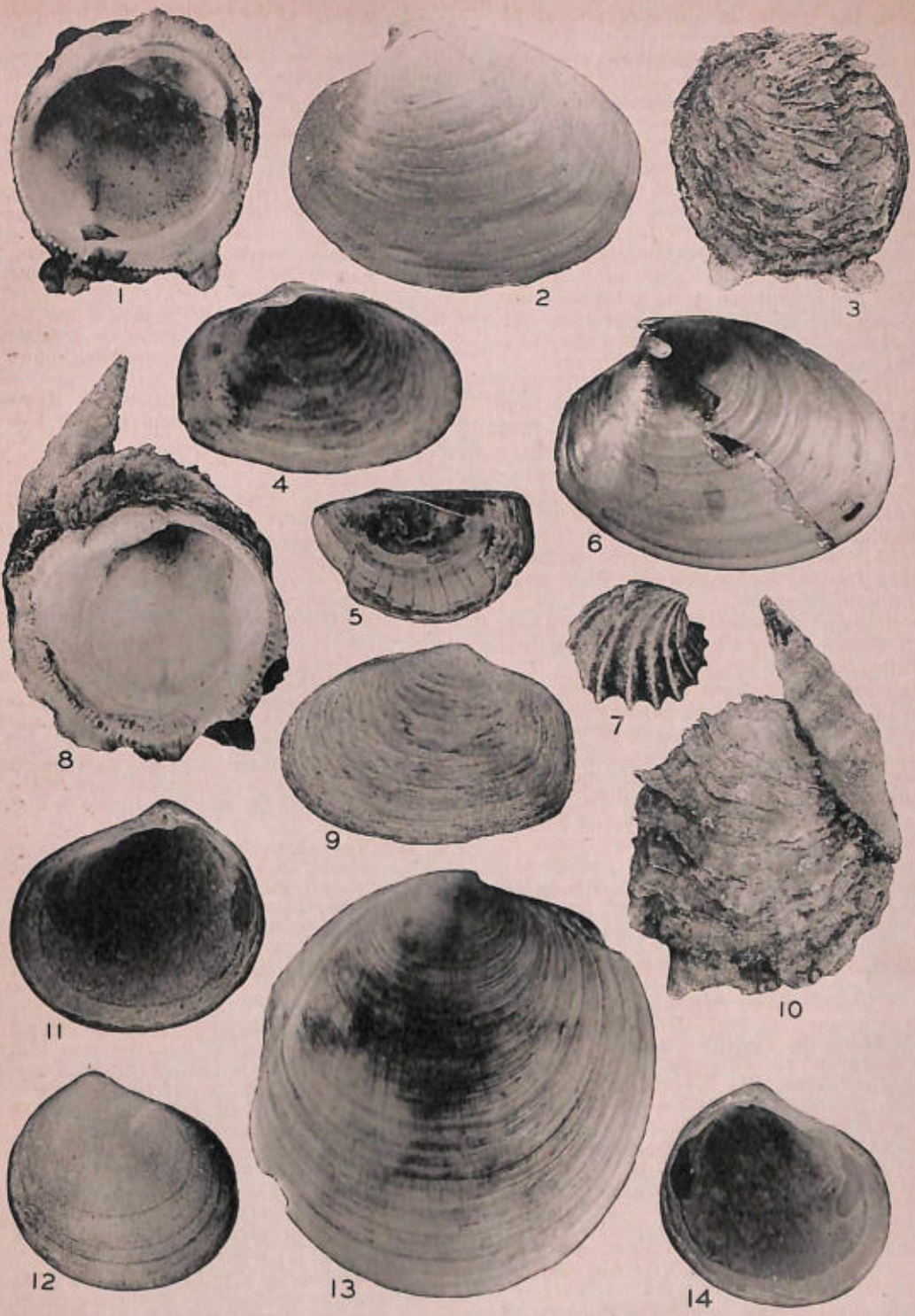
Fig. 11. *Ctena clarionensis* Hertlein & Strong, sp. nov. Holotype, right valve, from Sulphur Bay, Clarion Island, Revillagigedo Islands, Mexico. Length, 13.8 mm., height, 12.5 mm. P. 118.

Fig. 12. *Ctena clarionensis* Hertlein & Strong, sp. nov. Holotype, right valve. View of the exterior of the specimen shown in Fig. 11.

Fig. 13. *Lucina* (*Miltha*) *xantusi* Dall. Hypotype, right valve, from Station 136-D-5, dredged in Lat. 23° 31′ N., Long. 109° 27′ 30″ W., Arena Bank, southern part of the Gulf of California, in 33 fathoms (60 meters). Length, 68 mm.; height, 71.2; convexity (both valves), 23 mm. P. 115.

Fig. 14. *Ctena clarionensis* Hertlein & Strong, sp. nov. Holotype. View of the interior of the left valve of the specimen shown in Figs. 11 and 12.

All the specimens illustrated on this plate are in the type collection of the Department of Paleontology of the California Academy of Sciences.



MOLLUSKS FROM THE WEST COAST OF MEXICO AND CENTRAL AMERICA.

9.

Effects of Sex Hormones on the Development of the Platyfish, *Platypoecilus maculatus*[1].

HERMAN COHEN[2]

Department of Biology, Washington Square College of Arts and Sciences, New York University.

(Plates I-V; Text-figure 1).

In a discussion of the relation of genic and endocrine factors in sex determination Danforth (1939) used the term *genic* to refer in a general way to the influences emanating from the nucleus and dependent upon its genetic constitution. To the term *environmental* he referred all influences reaching a cell from beyond the limits of its own cytoplasm. He suggested that hormones and organizers even when of autogenous derivation belong to the environmental group. However, he distinguished between the *internal* and *external* environmental agents depending on whether or not they normally arise within the individual.

In an effort to evaluate the part played by the environmental agents determining sex it is desirable to use an organism in which the genetical mechanism for sex determination and the embryological history of the germ cells are known. In the domesticated stocks of the Mexican viviparous platyfish, *Platypoecilus maculatus* Bellamy (1922, 1928), Gordon (1927, 1937), Fraser and Gordon (1929) and others showed that the chromosomal regulation of sex may be expressed by the formula: WZ = female, ZZ = male. The history of the platyfish germ cells from their earliest appearance in the 1.2 millimeter embryos through their post-embryonic development and adult stages were described in great detail by Wolf (1931). He pointed out that definitive ovaries and definitive testes were distinguishable on the day of the platyfish's birth.

The present study is concerned with the effects of the synthetic steroid, pregneninolone upon immature, but genetically determined female platyfish and the effects of the estrogenic substance alpha-estradiol benzoate on immature, but genetically determined male platyfish. Utilizing the genetic sex determining mechanism, we sexed the platyfish within two weeks after birth and applied the hormonal chemicals to the fish at this early age. This paper will describe, but only in a preliminary manner, the effects of the hormones on the developing gonad, skeleton, and sexual behavior. Grobstein (1940, 1942) had previously used the platyfish in studying the effects of testosterone proprionate on the normal and regenerating anal fins of adults. The experimental results reported in the present report are based upon the work of Cohen (1942).

Hormonal regulation of development in poeciliid teleosts, other than *Platypoecilus maculatus*, were studied by Berkowitz (1937, 1938, 1940), Eversole (1939) and Scott (1941, 1944), all of whom used the guppy, *Lebistes reticulatus;* Turner (1941, 1942) used *Gambusia affinis;* and Regnier (1937, 1938), Baldwin and Goldin (1940), Witschi and Crown (1940), Noble and Borne (1940) studied the swordtail *Xiphophorus hellerii*. Much of this and other work was summarized and discussed broadly by Witschi (1939, 1942).

MATERIAL AND METHODS[3]

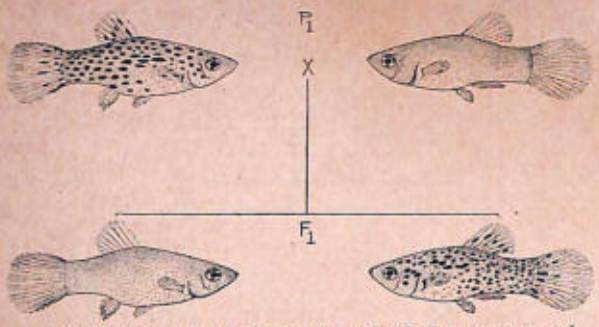
The genetic method used to sex immature *Platypoecilus maculatus* for these studies was as follows: a black-spotted female of the domesticated stock, heterozygous for the pigmentation pattern, (W)+(Z)*Sp*, was mated to an unspotted, recessive male. (Z)+(Z)+. They produced black-spotted sons (Z)+(Z)*Sp*, and unspotted daughters (W)+(Z)+, see Text-figure 1. The spotted pattern which is made up of clusters of large melanophores was recognized readily within a week of the fish's birth.

Fraser and Gordon (1929) indicated that crossing-over of the sex chromosomes occurred at the rate of about one per cent and this value has been recorded by other geneticists. Thus any error in sex determination, due to genetic factors, could not have been of any consequence. Furthermore, only two instances of complete and functional sex reversals have been reported during 24 years of genetic work with these fish (Gordon, 1946).

[1] Aided by the staff and facilities of the New York Aquarium, New York Zoological Society.

[2] Present address: E. R. Squibb and Co., New Brunswick, N. J.

[3] The hormones used in these studies were kindly supplied by Dr. Erwin Schwenk of the Schering Corporation, Bloomfield, New Jersey.



TEXT-FIG. 1. The genetic method that was used to sex immature domesticated *Platypoecilus maculatus*. A black-spotted female of the domesticated stock, heterozygous for the spotted pattern, was mated to an unspotted, recessive male. These are shown on the top line. They produced black-spotted sons and unspotted daughters, as shown on the second line. The spotted pattern may be recognized on the day of birth of the fish or within a week thereafter. (After Gordon, 1932).

Fifteen immature but genetically determined males were treated with one milligram of crystalline alpha-estradiol benzoate once a week; nineteen immature but genetically determined females were treated with five milligrams of the synthetic steroid pregneninolone once a week. Thirty-one fish were used as controls. The fish were kept in water, temperature at approximately 25°C., in three gallon glass aquaria, six animals to each tank. The hormonal substances were given to the fish beginning at an age of two weeks. Some of the animals were treated for eight weeks while others were given the hormones for twelve weeks, and still others received treatment for a maximum of twenty weeks. The fish swallowed many of the crystals as they fell through the water. Some of the crystals might have dissolved partially in the water and affected the fish directly.

All the fish were fed similarly with commercial fishfoods, dried shrimp, dried liver and occasionally they were given live tubifex worms. At the conclusion of the experiments the animals were fixed in Bouin's picro-formol fluid; the fish were measured, dissected, their gonads removed, sectioned and prepared for microscopical examination by staining with Harris' hematoxylin alum and eosin. When gonopodia were induced, these organs were removed and mounted for study in balsam or glycerin.

EXPERIMENTAL RESULTS

1. *Effect of alpha-estradiol benzoate on gonads of immature, genetic male platyfish.*

In the untreated, control males, the testes were found to be *fused* and relatively large. The sperm duct epithelial cells were cuboidal, the spermatophores were abundant and all the other stages in spermatogenesis were found. In the estrogen-treated males, the gonads were small, compact and appeared bipartite, the two lobes being separated by a membrane. The cells of the sperm duct epithelium were columnar; the interstitial tissue was profuse; a number of large ova were seen but spermatophores and spermatids were absent. The testicular elements that remained were spermatogonia. The general picture seen was one of a radical modification of development of the testes. As the treatment was continued the effects instead of continuing along the lines of greater modification, changed slightly in the direction of the controls. Thus after 20 weeks of treatment, the gonads were found to contain some spermatophores and none of them contained ova.

2. *Effect of pregneninolone on gonads of immature, genetic female platyfish.*

In the untreated, control females, the ovaries were fairly large, containing many oocytes and ova; the latter had abundant yolk material. In the pregneninolone-treated females, the ovaries were markedly changed; they were small and contained only a few oocytes. Mature ova with their usual complement of yolk were entirely wanting. The modified ovaries appeared definitely degenerate. With continuing treatment, up to 20 weeks, the conditions of gonadal degeneration were maintained. Within a single modified ovary a structure resembling a sperm duct was discovered (Fig. 8).

3. *Effect of sex hormones on certain skeletal elements.*

(*a*) *Gonopodium, the modified anal fin.*

In genetic males in which the testes had been modified by estrogenic substance to a point where no mature sperms or secondary spermatocytes were present, the anal fins were not transformed. However, in those fish where the treatment with estrogens did not completely inhibit spermatogenesis and mature sperm were present, perfect gonopodia were found.

Genetic females treated with pregneninolone for only two weeks developed gonopodia which, however, were aberrant in form. Similar abnormalities were described by Grobstein (1942) when he treated adult females with testosterone after removing their anal fins.

(*b*) *Gonopodial Suspensorium.*

Pregneninolone-treated females in which gonopodia were developed moved these fins just as normal males moved their gonopodia. Histological preparations of the internal skeletons of the modified females revealed that they had developed typical, male-like gonopodial suspensoria. The gonapophyses were well developed and the connections between these and the gonactinosts were present. The gonopodial muscle was strongly developed. The induced skeletal elements conformed to the descriptions of the species by Langer (1913) and by Gordon and Benzer (1945). Turner (1942) reported

TABLE I.

EFFECT OF ALPHA-ESTRADIOL BENZOATE ON GONADS OF DEVELOPING MALE PLATYFISH.

	Estrogen	*Control*	*Estrogen*	*Control*	*Estrogen*	*Control*
No.	4	4	5	5	6	5
Age	2 Weeks	2 Weeks	2 Weeks	2 Weeks	2 Weeks	2 Weeks
Duration	8 Weeks	8 Weeks	12 Weeks	12 Weeks	20 Weeks	20 Weeks
Gross Gonad	Small, bipartite, compact	Loose, fused	Small, bipartite, compact (fig. 3)	Large, loose, fused (fig. 1)	Small, bipartite, compact	Large, loose, fused
Sperm Duct Epithelium	Columnar	Low, cuboidal	Columnar	Low cuboidal almost squamous	Columnar	Low cuboidal
Interstitial Tissue	Profuse	Scant	Profuse (fig. 4)	Scant (fig. 2)	Profuse	Scant
Presence of Ova	Large ova (fig. 5)	Absent	Absent	Absent	Absent	Absent
Spermatophores	Absent	Profuse	Absent	Profuse (fig. 1)	Few	Profuse
Spermatids	Absent	Present	Absent	Present	Few	Few
Physiological Status	Inhibited	Active	Inhibited	Highly active	Slightly active	Highly active

similar results in treating female *Gambusia*, while Scott (1944) obtained them in *Lebistes*.

(*c*) *Caudal fin rays.*

In females treated with pregneninolone the shortening of the 7th, 8th and 9th caudal fin rays, and the lengthening of the 6th fin ray were induced. These changes produced a tiny sword-like extension on the tail fin, a feature which is characteristic of a related species, *Platypoecilus xiphidium*. In normal *P. maculatus* the caudal fins were symmetrical; in addition, the fin rays are strong and their terminal elements bifurcate at least once. The fin rays of treated females were not bifurcate at their tips and they were of a smaller dimension than those of the normal animals (Figs. 10, 11, 12).

4. *Effect of sex hormones on total body size and form.*

The females treated with androgens approached the body form and size of normal males (Table III). The males treated with estrogens resembled normal females. The values for body form were determined by dividing the value of their body length (not including tail fin; this is the standard length) by the value of their body width (measured from the base of anterior margin of the dorsal fin to the mid-point between the origins of the pelvic fins).

Normal female platyfish exceeded the males in standard length. The treated females showed the generalized effects of the androgens by their relatively smaller size. On the other hand, the estrogen-treated males attained a size greater than did their controls. These results confirmed those obtained by Scott (1944) in *Lebistes*.

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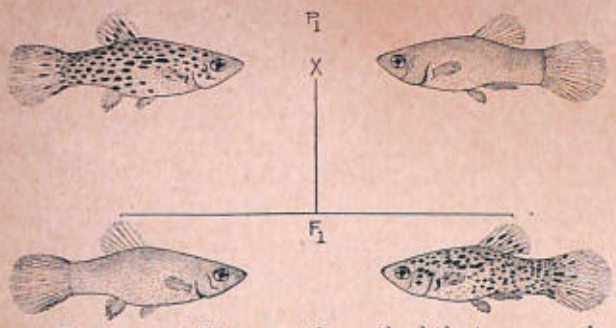
TABLE II.

EFFECTS OF PREGNENINOLONE ON GONADS OF DEVELOPING FEMALE PLATYFISH.

	No. of ♀	*Duration of Experiment*	*Size of Gonad*	*Oocytes*	*Ova*	*Yolk Deposition*	*Physiological Status*
Treated	19	5-20 Weeks	Very small (fig. 7)	Very few present	Absent	Inhibited	Inhibited (fig. 9)
Control	19	5-20 Weeks	Large (fig. 6)	Many present	Present	Active	Active



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Treated	19	5-20 Weeks	Very small (fig. 7)	Very few present	Absent	Inhibited	Inhibited (fig. 9)
Control	19	5-20 Weeks	Large (fig. 6)	Many present	Present	Active	Active

TABLE III.
FORM INDEX[4].

Alpha-estradiol Benzoate-treated Males				Pregneninolone-treated Females		
Length Cm.	*Width Cm.*	*Form Index*		*Length Cm.*	*Width Cm.*	*Form Index*
1.95	.65	3.0		1.55	.45	3.4
2.2	.70	3.14		1.9	.50	3.8
2.4	.85	2.8		2.05	.65	3.18
2.35	.80	2.9		1.3	.40	3.25
2.3	.70	3.2		1.9	.50	3.80
1.9	.70	2.7		1.4	.40	3.50
1.7	.60	2.8		1.4	.40	3.50
2.2	.80	2.75		1.55	.45	3.40
1.75	.60	2.9		1.50	.45	3.33
1.85	.70	2.6		1.40	.40	3.50
Mean		2.90	$t = 6.7$ $P < 0.001$	Mean		3.50
Normal Males				Normal Females		
1.75	.50	3.50		2.1	.74	2.8
2.20	.60	3.67		2.1	.75	2.8
1.73	.45	3.80		2.1	.75	2.8
1.75	.50	3.50		1.8	.70	2.56
1.75	.50	3.50		2.55	.85	3.00
1.73	.45	3.80		2.6	.90	2.90
1.75	.45	3.50		2.6	.90	2.90
Mean		3.61	$t = 9.8$ $P < 0.001$	Mean		2.82

[4] The data on form index differences in males and females were treated according to the methods described by Simpson and Roe in Quantitative Zoology (1939:210-211) for the comparison of the means of two small samples. The data are significant.

DISCUSSION

The newly born platyfish is about 6.5 mm. long. At this stage, according to Wolf (1931) who traced the history of their germ cells, sex differentiation has already occurred. In the immature female, the paired gonads are fused medially; the germ cells have multiplied, spread throughout the body of the gland and enlarged to two or three times their original size. A number of stroma cells surround them, forming oocytes, and this is the first indication of follicle formation. When pregneninolone is applied to two-week-old fishes, apparently oogenesis is inhibited beyond oocyte development for no ova were found after 5, 8, 11 and 20 weeks of treatment; in one female a sperm duct-like structure was found. The gonads of the control fish contained all stages of oogenesis including yolk-filled ripe ova. These results were similar, for the most part, to work on female swordtails and guppies.

The work of Vivian (1939) and Matthews (1939), who hypophsectomized *Fundulus* females and found that maturation of the primary oocytes was suppressed, and the work of Hasler, Meyer and Field (1939) on inducing trout to spawn prematurely with the aid of pituitary glands of the carp, are suggestive of the possibility that the pituitary function in female platyfish was inhibited by the application of pregneninolone. This appears likely for not only were the oogenesis processes interrupted in treated platyfish, but the larger size of the normal female was never reached by pregneninolene-treated females.

In the early postnatal male platyfish Wolf found that the germ cells are pushed out to the periphery of the gland, so that the center of the embryonic testis is occupied by stroma cells only, and this condition he reported is similar to the one found in *Xiphophorus hellerii*. The stroma cells cluster to form a duct which is destined to be the sperm duct. In slightly older fish (9 to 12 mm.) Wolf found that the gonads are united and partially fused, but even the mature testis shows its bilateral origin in its bilobed contour, but it is not bipartite. In the normal 16 mm. or late juvenile testis, spermatocytes only are present; indeed, at this stage there seems to be a great deal of degeneration of the sex cells in the normal fish. This degeneration is attributed to the rapid proliferation of the germ cells with an inadequate blood supply for all of them. Wolf is convinced, however, that this degeneration of some germ cells has no significance in the history of the germ cells. In the definitive adult gonad, in *Platypoecilus* and in *Xiphophorus*, Wolf found no seminiferous tubules. Acini form from preexisting acini at the periphery of the testis, which in turn are descended from the primordial germ cells, and as they form they are

pushed in toward the center of the testis. Wolf is emphatic in his belief that neither the peritoneal covering of the testis, the stroma cells, nor the cells of the sperm duct transform into sex cells.

The generalized effects of treating genetically determined male platyfish with alpha-estradiol benzoate was the suppression of spermatogenesis beyond the spermatocyte stages and in the induction of ovo-testes in some instances. In males treated for 8 weeks large ova were found; in males treated for 12 weeks a few small oocytes were found, while in males treated for 20 weeks no oocytes or ova were seen. This indicates a lessening of effectiveness of the estrogen. In the early stages of the treatment an insufficient testicular secretion may have been overruled by the applied estrogen; in more mature males the normal testicular secretion may have been sufficient. The generalized inhibitory effects of normal testicular development by estrogens have been reported in the swordtail and guppy. However, the experiments of Crown (1941) described briefly by Witschi (1942) show that many *Xiphophorus* females may become masculinized by estrone, too. Their ovaries regress, the anal fin transforms incompletely into a gonopodium and the sword characteristic of the male tail fin begins to form. One might wish that the genetic sex determining mechanism in the swordtail was as clear as that in the platyfish. Nevertheless, we have one confirmatory fact to add in this connection. We had a gravid female platyfish which produced a brood under normal conditions. It was then subjected to alpha-estradiol benzoate treatment for three months; at frequent intervals it was allowed the company of a fertile male platy under normal conditions. After the three month period, the treatment was discontinued. While under the influence of the estrogen, it did not produce any further broods, but after the fourth month, six weeks after the treatment was over, it had another brood. In this instance the estrogenic hormones may have affected the sperm adversely within the oviduct, or they may have prevented oogenesis.

Gardner and Pfieffer (1945) reviewed the subject of the influences of estrogens and androgens on the skeletal systems of higher vertebrates, but gave only passing attention to fishes. Grobstein (1941) found that gonopodia regenerated in place of normal anal fins in female platyfish when subjected to testosterone treatment, and similar results were found in *Gambusia* by Turner (1941, 1944) and in *Mollienisia* by Cummings (1943).

The gonopodium articulates with a complex internal skeletal and muscular mechanism which makes possible the movement of the copulatory fin. The hemal spines of the first three caudal vertebrae become modified into gonapophyses and the anterior interhemal spines become modified into a series of fused gonactinosts; in addition, a powerful gonopodial muscle is developed in normal adult male platyfish. The skeletal gonopodial suspensorial elements in the male platyfish were first described by Langer (1913) and more recently in a comparative way by Gordon and Benzer (1945). Similar gonopodial suspensorial elements were induced in treating young females with pregneninolone. This androgen also modified the structures of the caudal fin, the most interesting effect being the induction of a tiny sword in female *Platypoecilus maculatus* which is taxonomically diagnostic of *Platypoecilus xiphidium*. This feature was discussed previously by Gordon, Cohen and Nigrelli (1943). In addition, we have found a specific effect of androgens in suppressing the tertiary bifurcation of the caudal fin rays and in reducing the calibre of the rays.

Berkowitz (1938) showed that estrogens increased the size of *Lebistes* males beyond that usually attained by them, and Eversole (1941) found that androgens reduce the size attained by female guppies. In our experiment, these general results were confirmed in the platyfish. In addition, the body contour characteristic of the normal female was induced in estrogen-treated males and that of the male was obtained in pregneninolone-treated females. Gerschler (1914) and Bellamy (1922) measured platyfish and found that the greatest depth divided into the standard length produced the body index value of 2.7 in both sexes, but Chambers (unpublished) found that females had a greater depth than the males, and our figures are in line with those of Chambers (1935).

Noble and Borne (1940) showed that androgens would elevate the rank of an individual swordtail in the social hierarchy of a group living under aquarium conditions. Androgen treatment caused female guppies to act like males in their great sexual drive, according to Eversole (1940, 1941). The difference in the sexual behavior in *Lebistes* is great; the females (according to Breder and Coates, 1935) show no response whatever, while the males are ceaseless in their courtship activities.

Braddock (1945) found that a social hierarchy is present in a group of platyfish. We found that the behavior patterns in platyfish may be reversed completely by the treatment of females with pregneninolone and the treatment of males with alpha-estradiol benzoate, and this is in line with the results of others working with many species of fishes and other vertebrates.

In summarizing the work on hormonal regulation of development in lower vertebrates, Witschi (1942) claimed that sex hormones

have relatively little to do with primary sex differentiation, and that the inductor substances, which play their roles at earlier stages of the ontogenetic process than sex hormones, belong to a separate class of chemical materials. It appears then in order to tackle this general problem of the influence and nature of the internal and external environmental agents in sex-determination, it is desirable to know accurately and in advance the genetic sex of an individual before treatment. For this purpose the platyfish, *Platypoecilus maculatus*, and their sex-linked characters might provide the suitable test animals.

Summary.

Alpha-estradiol benzoate suppressed spermatogenesis but stimulated the development of connective and interstitial tissues in genetic, immature male *Platypoecilus maculatus*. The transformation of the anal fins into gonopodia was prevented. Young males treated for 8 to 12 weeks showed ova in ovo-testes; males treated 20 weeks showed no ova and indicated a falling off of the inhibiting effects of the estrogen.

Pregneninolone suppressed oogenesis and yolk formation in genetic, immature female platyfish. The effects did not diminish in animals treated for 20 weeks; on the contrary, the ovaries showed greater degeneration. The following male-like characters appeared: gonopodia, elements of the gonopodial suspensorium: gonapophyses and gonactinosts. In addition, tiny sword-like extensions appeared in the caudal fins. Bifurcations of the fin rays did not proceed beyond the primary stage.

Immature females treated with pregneninolone developed a body index and body size characteristic of normal males, while immature males treated with alpha-estradiol benzoate developed the body index and body size characteristic of normal females.

Pregneninolone-treated females developed courtship behavior patterns characteristic of males; they became aggressive; pursued and thrust their gonopodia toward and attempted to copulate with normal mature females. Estrogen-treated males behaved like females; they lost their aggressiveness and normal males pursued them. None of the sexually reversed males or females were fertile.

The use of genetic methods for the determination of the genic sex of the immature animal was suggested as a desirable tool in evaluating the effects of the environmental agents like sex hormones on sexual development.

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EXPLANATION OF THE PLATES

PLATE I.

Fig. 1. *Testis of Normal Male, 12 Weeks Old.* This normal testis is fused with no evidence of an earlier developmental bipartite gonad. All stages of spermatogenesis including many spermatophores (*Sp*) are represented. The interstitial tissue is scant; the gonad as a whole is loosely constructed. 100×.

Fig. 2. *Testis of Normal Male, 12 Weeks Old.* This is same as above but under greater magnification. The deeply staining ring-like structures are spermatophores (*Sp*) containing mature sperms, ripe and ready for ejaculation. The spermatids and other stages of spermatogenesis (*Sr*) are represented by the lighter-staining roundish masses. 440×.

Fig. 3. *Testis of Estrogen-treated Male, 12 Weeks Old.* This testis of a treated male shows the bipartite structure (*P* to *P*). Spermatogenesis has only proceeded to the stage of formation of spermatogonia and spermatocytes (*Sr*). Spermatids, mature sperms and spermatophores are wanting. 100×.

PLATE II.

Fig. 4. *Testis of Estrogen-treated Male, 12 Weeks Old.* This is the same as Fig. 3 but under greater magnification. The testis is compact with a greater amount of interstitial tissue (*N*) than is found in an untreated male. Spermatogonia and spermatocytes (*Sr*) are the prevailing germinal elements. 440×.

Fig. 5. *Ovo-testis of Estrogen-treated Male, 8 Weeks Old.* An oocyte (*O*) is present in the upper left portion of the figure. The interstitial tissue is profuse throughout the gonad. 440×.

PLATE III.

Fig. 6. *Ovary of Normal Female, 8 Weeks Old.* The ovary is large and occupies the greater portion of the abdominal cavity. The ova (*ov*) are well developed and well filled with yolk (*Y*). The smaller circular masses are oocytes (*o*). In sectioning the ovary, the yolk within the ova fragments. 100×.

Fig. 7. *Ovary of Pregneninolone-treated Female, 8 Weeks Old.* The ovary is very small and compact; compare this figure with Fig. 6 which is reproduced at the same magnification. The dominant germinal elements present are oocytes (*o*). No yolk is present. 100×.

Fig. 8. *Ovary of Pregneninolone-treated Female, 8 Weeks Old.* This ovary is shown under higher magnification. It is a tubular structure which resembles a testicular sperm duct (*Sd*). Oocytes (*o*) are found throughout. 100×.

Fig. 9. *Abdominal Region of a Pregneninolone-treated Female, 11 Weeks Old.* The ovary is represented by a few scattered oocytes (*o*) and these germinal elements do not contain yolk. Portions of the intestine (*i*) are shown. 100×.

PLATE IV.

Fig. 10. *Caudal Fin Rays of Normal Female.* The fin rays near their origin have a greater diameter than those shown below. At their terminal points shown here, the fin rays show a secondary (2) bifurcation. The primary (1) bifurcation may be seen through the center of the figure. The dots represent the micromelanophores. 5×.

Fig. 11. *Caudal Fin Rays of a Pregneninolone-treated Female.* The fin rays have a narrower diameter than those of the normal shown above. The rays show only a primary (1) bifurcation. Owing to the shortening of the 7th, 8th and 9th fin rays and a lengthening of the 6th, a tiny sword-like strutcure was induced (*S*), a feature which resembles the "sword" of a related species, *Platypoecilus xiphidium*. See Fig. 12. 5×.

PLATE V.

Fig. 12. *The Platyfishes: Platypoecilus maculatus and xiphidium.* The male *P. maculatus* is on the left and the female is on the lower right. *P. xiphidium* male is on the upper right. Note the short "sword" in *P. xiphidium* male. The fin rays of all the fishes have primary and secondary bifurcations. The male *P. maculatus* has no "sword". In this paper it has been shown that a "sword" may be induced in female *P. maculatus* by the application of the androgenic substance, pregneninolone.

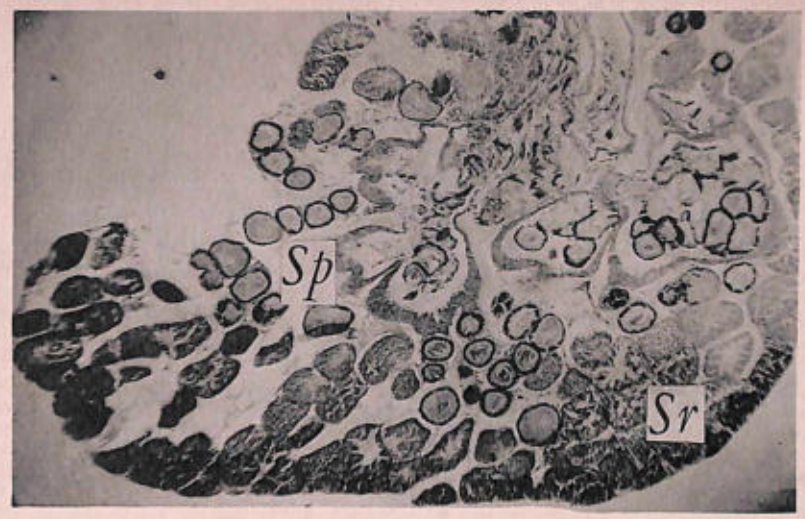

FIG. 1.

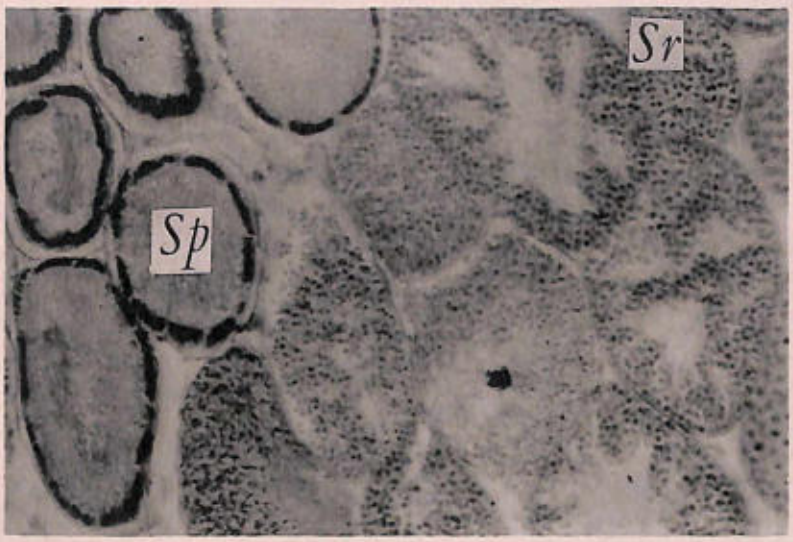

FIG. 2.

FIG. 3.

EFFECTS OF SEX HORMONES ON THE DEVELOPMENT OF THE PLATYFISH, PLATYPOECILUS MACULATUS.

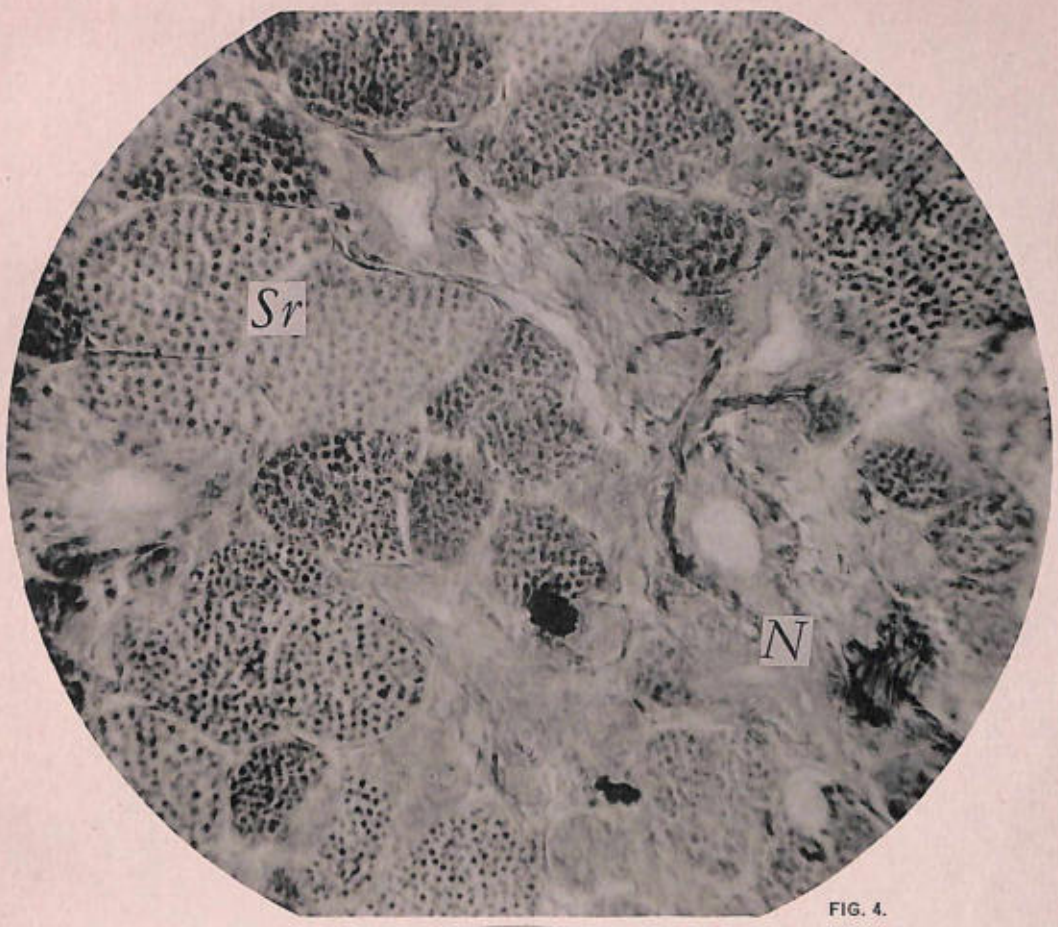

FIG. 4.

FIG. 5.

EFFECTS OF SEX HORMONES ON THE DEVELOPMENT OF THE PLATYFISH, PLATYPOECILUS MACULATUS.

FIG. 6.

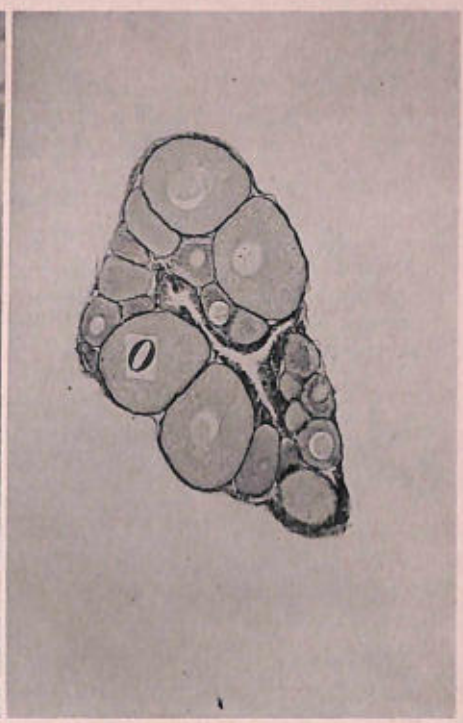

FIG. 7.

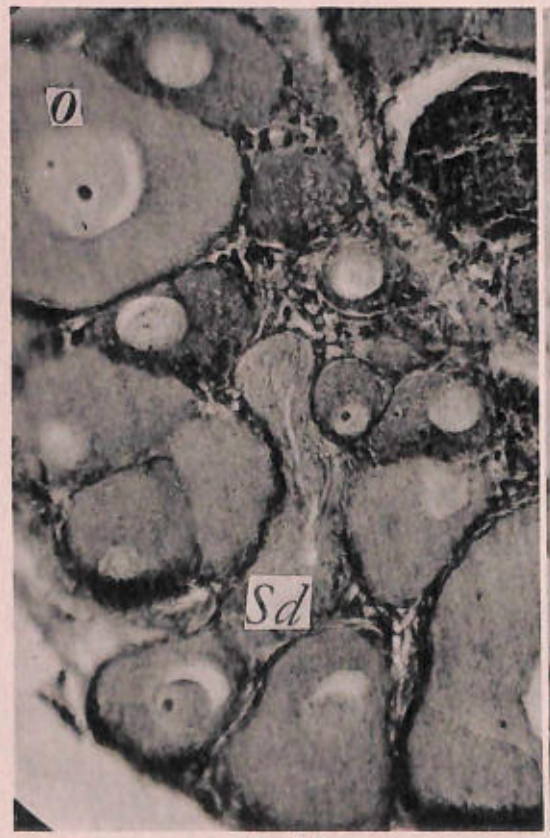

FIG. 8.

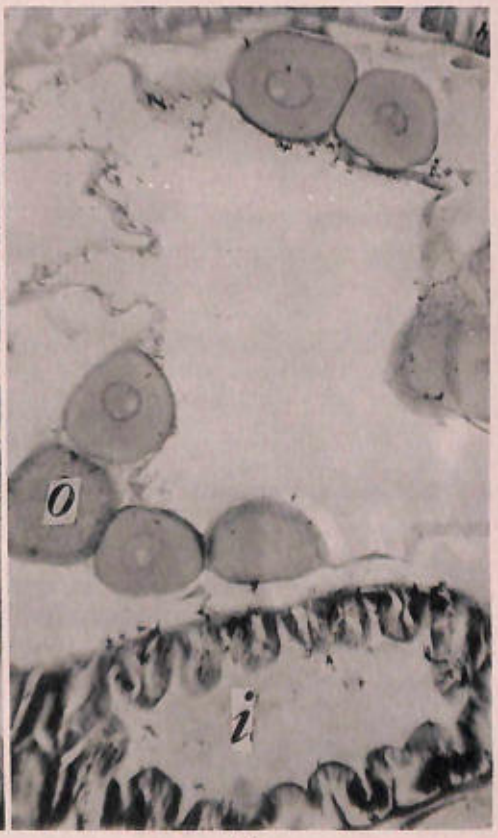

FIG. 9.

EFFECTS OF SEX HORMONES ON THE DEVELOPMENT OF THE PLATYFISH, PLATYPOECILUS MACULATUS.

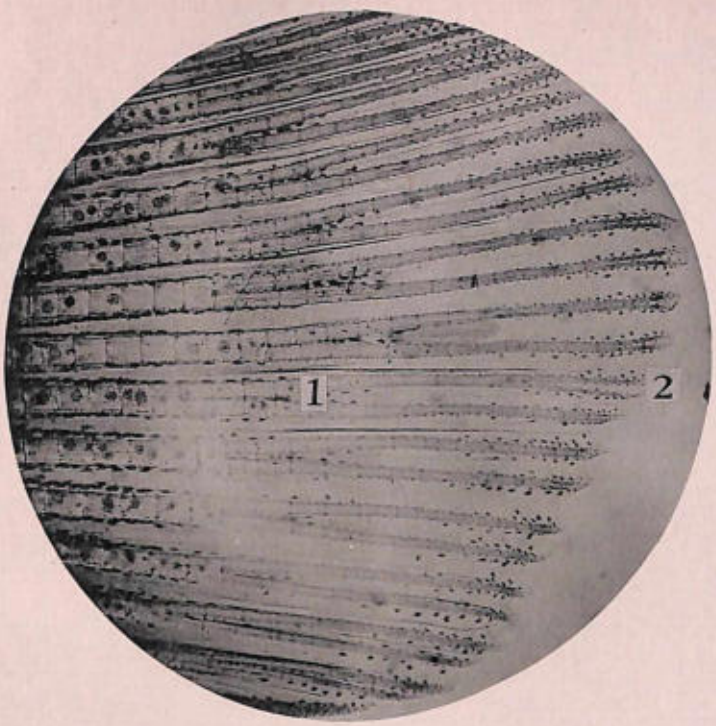

FIG. 10.

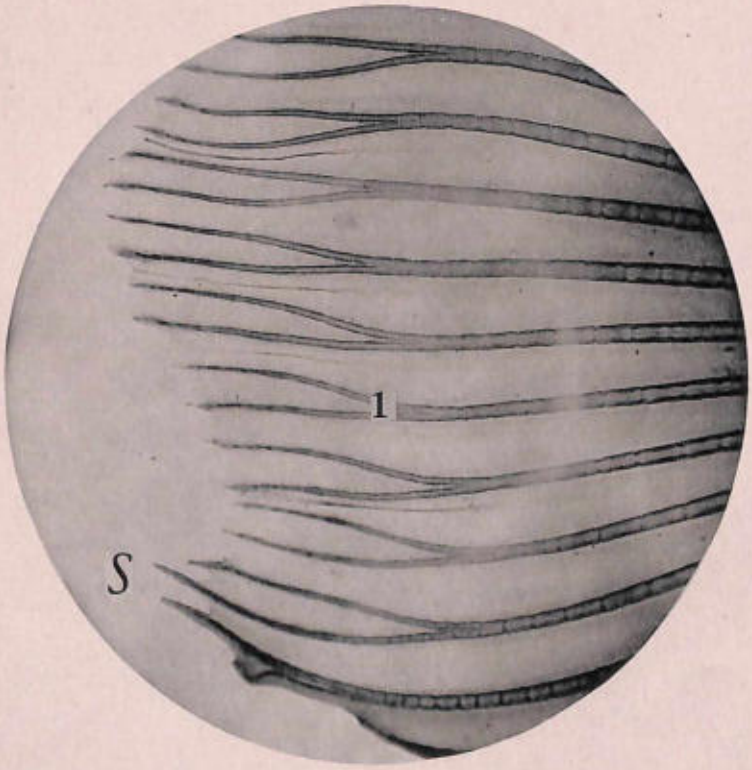

FIG. 11.

EFFECTS OF SEX HORMONES ON THE DEVELOPMENT OF THE PLATYFISH, PLATYPOECILUS MACULATUS.

PLATE V.

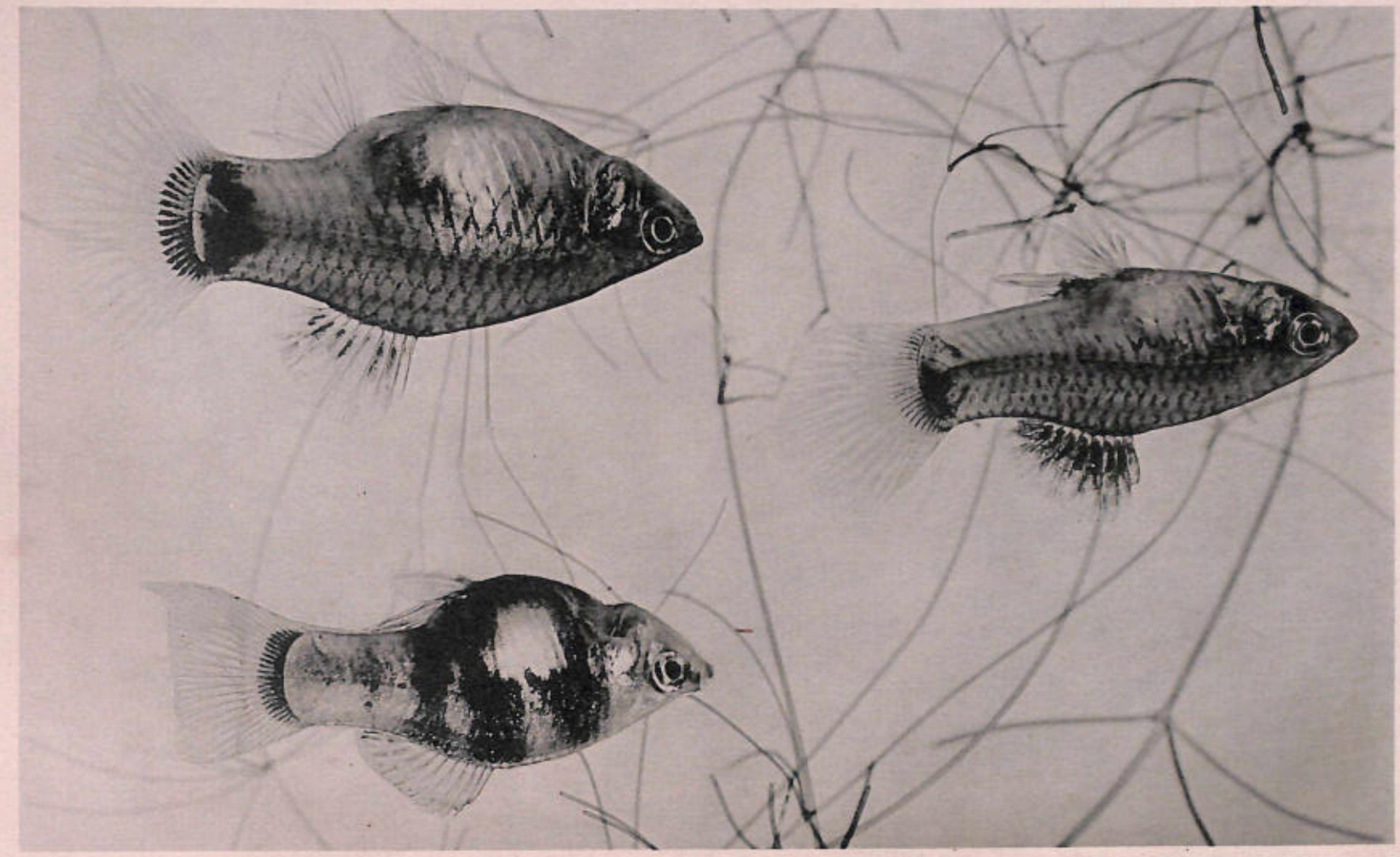

FIG. 12.

EFFECTS OF SEX HORMONES ON THE DEVELOPMENT OF THE PLATYFISH, PLATYPOECILUS MACULATUS.

COHEN.

10.

Eastern Pacific Expeditions of the New York Zoological Society. XXXVI. Mollusks from the West Coast of Mexico and Central America. Part V.[1]

LEO GEORGE HERTLEIN & A. M. STRONG.
California Academy of Sciences.

(Plate I).

[This is the thirty-sixth of a series of papers dealing with the collections of the Eastern Pacific Expeditions of the New York Zoological Society made under the direction of William Beebe. The present paper is concerned with specimens taken on the Templeton Crocker Expedition (1936) and the Eastern Pacific *Zaca* Expedition (1937-1938). For data on localities, dates, dredges, etc., refer to *Zoologica*, Vol. XXII, No. 2, pp. 33-46, and Vol. XXIII, No. 14, pp. 287-298.]

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INTRODUCTION.

This is the fifth of a series of papers dealing with collections of mollusks taken on the Templeton Crocker Expedition (1936) and the Eastern Pacific *Zaca* Expedition (1937-1938). The general plan of presentation followed in the present contribution is that mentioned in Part II of this series of papers[2]. Formal headings and keys are given only for the species collected by the Expeditions of 1936 and 1937-38. Occasionally additional species are included in the keys for convenience but in such cases it is indicated which ones do not occur in the present collections.

Acknowledgment is due Dr. G. D. Hanna, Curator, Department of Paleontology of the California Academy of Sciences, and Mr. A. G. Smith, Berkeley, California, for their assistance and suggestions. Acknowledgment is especially due Dr. A. Myra Keen, Stanford University, California, for assistance in the identification of some of the species of Leptonidae and for suggestions regarding the classification of the Cardiidae. The preparation of the photographs by Mr. Frank L. Rogers is here acknowledged: his work was accomplished during the course of Federal Works Progress Administration Project Number 8569.

[1] Contribution No. 744, Department of Tropical Research, New York Zoological Society.

[2] Hertlein, L. G., and Strong, A. M. Eastern Pacific Expeditions of the New York Zoological Society. XXXII. Mollusks from the West Coast of Mexico and Central America. Part II. *Zoologica*, New York Zool. Soc., Vol. 28, Pt. 3, December 6, 1943, pp. 149-168, pl. 1.

Superfamily Lucinacea.

FAMILY UNGULINIDAE [=DIPLODONTIDAE].

Genus *Taras* Risso.

Key to the subgenera of *Taras*.

A. Sculpture concentric only
  a. Subglobose, nearly equilateral; white ..... *Taras* s.s.
  aa. Compressed, inequilateral; a dark periostracum usually present ..... *Felaniella*
B. Sculpture concentric, also punctate, pustulate or subreticulate .. *Phlyctiderma*

Subgenus *Taras* s.s.

Key to the species of *Taras* s.s.

A. Shell globose
  a. Shell thick ..... *orbellus*
  aa. Shell thin ..... *inezensis*
B. Shell subquadrate; thin ... *subquadratus*

Taras (Taras) inezensis Hertlein & Strong, sp. nov.

Plate I, Figures 1 and 4.

Shell a right valve, inflated, umbos projecting, anterior dorsal margin broadly rounded, posterior dorsal margin sloping obliquely, ventral half of margin suborbicular; hinge with anterior cardinal tooth and a posterior cardinal wide and strongly bifid on end and on top but not completely bifid in center. Length, 18.4 mm.; height, 16.9 mm.; convexity (one valve), 8 mm.

Holotype, right valve from collecting station 146-D-1, Lat. 26° 54′ 20″ N., Long. 111° 48′ 45″ W., Santa Inez Bay, east coast of Lower California, dredged in 35 fathoms (64 meters), Templeton Crocker Expedition, 1936. A small specimen of this species was dredged at Tenacatita Bay, Mexico. by the Templeton Crocker Expedition in 1932.

This new species differs from *Taras orbellus* Gould in the thinner shell, more strongly projecting beaks and umbos, the more steeply sloping dorsal margin, and in the character of the broad posterior cardinal tooth which is very strongly bifid, giving the appearance of two teeth.

The posterior dorsal margin of the shell of *Taras inezensis* is less projecting than that of *T. artemidis* Dall[3] in which it is not only more projecting but subtruncate or very obliquely rounded.

Taras (Taras) orbellus Gould.

Lucina orbella Gould, *Proc. Boston Soc. Nat. Hist.*, Vol. 4, November, 1851, p. 90. "San Diego, Lieut. Green."—Gould. *Boston Journ. Nat. Hist.*, Vol. 6, 1853, p. 395, pl. 15, fig. 3. "From San Diego. Lieut. Green. Santa Barbara. Col. Jewett."

[3] *Diplodonta (Felaniella) artemidis* Dall, *Proc. U. S. Nat. Mus.*, Vol. 37, November 24, 1909, pp. 156, 263, pl. 28, fig. 8. "On the 'inside' or lagoon beach at Capon, in the sand." Peru.

Diplodonta orbella Gould, I. S. Oldroyd, *Stanford Univ. Publ. Univ. Ser. Geol. Sci.*, Vol. 1, 1924, p. 124, pl. 6, figs. 5 and 6. Type Locality cited. Range, Pribiloff Islands, Alaska, to the Gulf of California.

Type Locality: San Diego, California.

Range: Pribiloff Islands, Alaska, to the Gulf of California.

Collecting Stations: Mexico: East of Cedros Island (126-D-10), 60 fathoms, crushed shell and eel grass; Santa Inez Bay, Gulf of California (145-D-1-3), 4-13 fathoms, sand.

Description: The globose shell and the centrally situated inconspicuous beaks are characters which serve to separate *Taras orbellus* from other species of the genus in west American waters This species sometimes forms a nest of sand cemented by mucus so that the shell is wholly concealed.

Distribution: Specimens of *Taras orbellus* in the present collection were dredged at depths of 4-60 fathoms, on a bottom of sand, crushed shell and eel grass. The species ranges from Alaska to the Gulf of California and also has been recorded from Miocene to Recent in western North America.

Taras (Taras) subquadratus Carpenter.

Plate I, Figure 11.

Diplodonta subquadrata Carpenter, *Proc. Zool. Soc. London* for 1855 (issued February 5, 1856), p. 230. "Mazatlan." Recent.—Dall, *Proc. U. S. Nat. Mus.*, Vol 23, 1901, p. 795. Catalina Island, California, south to Panama, in 16 to 36 fathoms.—Soot-Ryen, *Nyt Mag. Naturvid.*, Bd. 70 (Medd. Fra. Zool. Mus. Oslo, No. 27), 1932, p. 319, pl. 1, fig. 2. Floreana (Charles) Island, Galápagos Islands, Recent.

Type Locality: Mazatlan, Mexico.

Range: San Ignacio Lagoon, Lower California, to Gorgona Island, Colombia, and the Galápagos Islands.

Collecting Stations: Mexico: Arena Bank (136-D-30), 35 fathoms, sand, weed; Ceralbo Channel (137-D-3), 46 fathoms, rock; Santa Inez Bay (143-D-1), 29 fathoms, mud, crushed shell, weed, (145-D-1, 3), 4-13 fathoms, sand (146-D-1), 35 fathoms, mud, crushed shell; Gorda Banks (150-D-2, 24), 60-75 fathoms, sand, calcareous algae; Cape San Lucas, Lower California; 3 mi. off Pyramid Rock, Clarion Island (163-D-2), 55 fathoms, rock, coral; El Salvador: La Union, Gulf of Fonseca (199-D-12), 5 fathoms, mud; Nicaragua: Corinto (200-D-1-3, 16), 2-7 fathoms, mangrove leaves; Costa Rica: Port Parker (203-D-1, 3), 12-15 fathoms, sandy mud, crushed shell, shelly mud; Port Culebra (206-D-1, 2, 3), 14 fathoms, sandy mud.

Description: The shell of *Taras subquadratus* is thinner, much more compressed and quadrate in form than that of *T. orbellus*.

The cardinal teeth are less sloping than are those of *T. orbellus*, in which species they are more nearly parallel to the hinge line. The angularity of the outline of the shell of *T. subquadratus* is more pronounced in large shells. The largest specimen in the collection measures: length, 29 mm.; height, 25 mm.; convexity (one valve), 7.6 mm.

Distribution: Specimens of this species were dredged at depths of 2 to 75 fathoms. The greatest number of specimens was dredged off Port Parker, Costa Rica, in 12 fathoms. The species has been recorded from the Pleistocene of San Quintin, Lower California.

Subgenus ***Felaniella*** Dall.

Key to the species of *Felaniella*.

A. Shell large, wide ..... *sericatus*
B. Shell small, narrow ..... *obliquus*

Taras (Felaniella) obliquus Philippi.

Diplodonta obliqua Philippi, *Zeitschr. f. Malakozool.*, Jahrg. 3, February, 1846, p. 20. "Patria: Mazatlan."

Not *Lucina obliqua* Philippi, 1850.

Lucina calculus Reeve, Conch. Icon., Vol. 6, *Lucina*, August, 1850, species 68, pl. 11, fig. 68. "Hab. Gulf of Nicoiya (dredged from among coarse sand at a depth of from ten to thirteen fathoms); Cuming."

Diplodonta (*Felaniella*) *obliqua* Philippi, Dall, *Proc. U. S. Nat. Mus.*, Vol. 23, 1901, p. 796. Cape San Lucas, Lower California, to Guayaquil, Ecuador.

Type Locality: Mazatlan, Mexico.

Range: Cape San Lucas, Lower California, to Guayaquil, Ecuador.

Collecting Station: Nicaragua: Corinto (200-D-10, 11, 16, 19), 4-13 fathoms, mangrove leaves, sand.

Description: Shell small, narrow, oblique, rather compressed, polished, white.

The shell of this species differs from other west American species of the genus in the narrower, oblique form. It differs from *Lucina prolongata* Carpenter, which it somewhat resembles in shape, in possessing a thinner shell, and in lacking the depressed lunule which is present on Carpenter's species.

Taras (*Felaniella*) *minor* Dall from the Bowden Miocene of Jamaica is a somewhat similar species.

Distribution: Specimens of *Taras obliquus* were dredged by the Expedition in 4 to 13 fathoms off Corinto, Nicaragua, on a bottom of sand and mangrove leaves.

Taras (Felaniella) sericatus Reeve.

Plate I, Figure 10.

Lucina sericata Reeve, Conch. Icon., Vol. 6, *Lucina*, June, 1850, species 55, pl. 9, fig. 55. "Hab.—?"—Adams & Reeve, Voy. Samarang, Moll., 1848 (issued 1850), p. 80, pl. 24, fig. 6, [not the locality "Hab. Philippine Archipelago."]

Lucina cornea Reeve, Conch. Icon., Vol. 6, *Lucina*, June, 1850, species 25, pl. 9, fig. 25. "Hab. Gulf of Nicoiya (in coarse sand at a depth of from ten to thirteen fathoms); Cuming."

Lucina nitens Reeve, Conch. Icon., Vol. 6, *Lucina*, June, 1850, species 50, pl. 9, fig. 50. "Hab. Isle of Muerte, Bay of Guayaquil (in sandy mud at a depth of about eleven fathoms); Cuming."

Diplodonta (*Felaniella*) *sericata* Reeve, Dall, *Proc. U. S. Nat. Mus.*, Vol. 23, 1901, p. 796. Lower California to Panama.

Taras parilis (Conrad) variety *sericatus* (Reeve), Grant & Gale, *Mem. San Diego Soc. Nat. Hist.*, Vol. 1, 1931, p. 295, pl. 14, figs. 12a, 12b. Earlier records cited. Pleistocene and Recent.

Type Locality: Gulf of Nicoya, Costa Rica (here designated as type locality). No locality originally cited.

Range: Monterey Bay, California (Burch); San Ignacio Lagoon, Lower California, to Guayaquil, Ecuador. [We have not seen specimens from north of San Ignacio Lagoon, Lower California.]

Collecting Stations: Mexico: Santa Inez Bay, Gulf of California (145-D-1-3), 4-13 fathoms, sand; Chamela Bay; Nicaragua: Corinto (200-D-10, 11, 16, 17, 19, also beach) 4-13 fathoms, mangrove leaves, sand; Costa Rica: Culebra Bay; Golfito, Gulf of Dulce; Panama: Gulf of Chiriqui (221-D-1-5), 35-40 fathoms, sandy mud.

Description: Shell thin, compressed, higher than long, obliquely produced posteriorly; semi-pellucid, white, covered by a pale-olive colored periostracum. A large specimen measures approximately 22 mm. from beak to base.

Large specimens of *Taras sericatus* are thicker and more quadrate in outline than juvenile forms.

The shell of this species is much wider and larger than that of *Taras obliquus*. *Taras candeanus* d'Orbigny, which occurs in the Caribbean region, is a similar species.

The name *Lucina sericata* was originally proposed by Reeve for a specimen the locality of which was unknown. Later Adams & Reeve referred to the species and gave the locality as the Philippine Islands. Hidalgo[4] later cited the species from the Philippine Islands and referred it to the genus *Lucina*. If this generic allocation is correct it would appear that the species referred to by Hidalgo is a different one from that described by Reeve which is a "*Diplodonta*," as pointed out by Lamy. Carpenter, Dall, Lamy and others have considered Reeve's species to be a west American shell. An additional reason for accepting this conclusion is that at least

[4] Hidalgo, J. G., Cat. Mol. Test. Filipinas, *Rev. R. Acad. Cienc.* Madrid, Vol. 3, 1905, p. 11. See also Lamy, E., *Journ. de Conchyl.*, Vol. 65, No. 4, 1921, p. 375.

three other species cited by Adams & Reeve from the East Indian region are now known to occur in tropical west American waters. These include "*Artemis*" *dunkeri* Philippi, cited from "Eastern Seas," and *Conus borneensis*, cited from Borneo, but which is now thought to be identical with *Conus arcuatus* Sowerby, a west American species.

After a consideration of the facts relating to *Lucina sericata* we have, at least for the present, accepted it as the earliest name for the west American species discussed here. The names *Lucina cornea* Reeve and *Lucina nitens* Reeve were also applied to the same species as *L. sericata* Reeve.

Distribution: Specimens of this species were collected on the beach and dredged at depths of 4-40 fathoms from off western Mexico and Central America. It occurs south to Ecuador. We have not seen specimens from north of San Ignacio Lagoon, Lower California. It is known to occur in the Pleistocene of southern California and Lower California.

Subgenus ***Phlyctiderma*** Dall.

Taras (Phlyctiderma) semirugosus Dall.

Diplodonta semiaspera, ? Phil., Carpenter, Cat. Mazatlan Shells, November, 1855, p. 102. Mazatlan. Also other localities.

Not *Diplodonta semiaspera* Philippi, 1836.

Diplodonta (*Phlyctiderma*) *semirugosa* Dall, *Jour. Conch.*, Vol. 9, No. 8, October 1, 1899, p. 246. "Range. Gulf of California."—Dall, *Proc. U. S. Nat. Mus.*, Vol. 23, 1901, p. 796. Gulf of California to Panama.

Type Locality: Gulf of California.

Range: Gulf of California to Panama.

Collecting Stations: El Salvador: Meanguera Island, Gulf of Fonseca (199-D-1), 16 fathoms, sand, mud, crushed shell; La Union, Gulf of Fonseca (199-D-12), 5 fathoms, mud; Nicaragua: Corinto (200-D-10, 17), 7-10 fathoms, mangrove leaves, sand; Costa Rica: Port Parker (203-D-1, 3), 12-15 fathoms, sandy mud, crushed shell, shelly mud; Cedro Island, Gulf of Nicoya (213-D-1-10), 4-10 fathoms, mud, sand, crushed shell.

Description: Shell subrounded, moderately inflated, somewhat expanded anteriorly and posteriorly; in some specimens the posterior area is set off by a faint depression; surface ornamented by fine concentric sculpture and the entire surface is finely punctate. One of the largest specimens measures approximately 15 mm. (beak to base).

The smaller size, finer sculpture and more externally placed ligament are characters which serve to separate the shell of this species from that of *Taras caelatus* Reeve[5].

[5] *Lucina caelata* Reeve, Conch. Icon., Vol. 6, *Lucina*, June, 1850, species 27, pl. 6, figs. 27a, 27b. "Hab. Island of Muerte, Bay of Guayaquil (dredged from a depth of about eleven fathoms) : Cuming."

A specimen of Reeve's species was collected by the senior author at Sihuatanejo Bay, Mexico. *Taras semiasperus* Philippi, a West Indian species, is said to be less globose and to possess somewhat different sculpture than that of *T. semirugosus*.

Carpenter described a shell from Mazatlan under the name of "*Diplodonta ? semiaspera*, var. *discrepans*"[6]. According to Dall (1901), this is an indeterminable form and a pencil sketch of it made by Carpenter somewhat resembles a young *Taras orbellus*.

Distribution: Specimens of *Taras semirugosus* were dredged by the expedition from El Salvador to Costa Rica at depths of 5 to 16 fathoms.

Superfamily Leptonacea.

Family Leptonidae.

Key to the genera of the Leptonidae.

A. Shell punctate; pallial line crenulated
  a. Adductor impressions lying entirely within the pallial line ..... *Solecardia*
  aa. Adductor impressions not lying entirely within the pallial line ..... *Bornia*[7]

B. Shell not punctate
  a. Shell equilateral or nearly so
    b. Inflated; 1 cardinal tooth in right and 2 in left valve .... *Kellia*
    bb. Compressed; 1 cardinal tooth in each valve ..... *Pseudopythina*
  aa. Shell inequilateral
    c. Right valve with cardinal teeth
      d. Lateral teeth present
        e. 2 anterior laterals in left valve; shell minute; hinge large ..... *Lasaea*
        ee. 1 anterior lateral in left valve ..... *Erycina*
      dd. Lateral teeth lacking *Aligena*
    cc. Right valve without cardinal teeth ..... *Rochefortia*

Genus ***Erycina*** Lamarck.

Erycina colpoica Dall.

Erycina colpoica Dall, *Proc. U. S. Nat. Mus.*, Vol. 45, No. 2002, June 11, 1913, p. 596. "Beach at the head of the Gulf of California."—Dall, *Proc. U. S. Nat. Mus.*, Vol. 66, Art. 17, 1925, p. 16, pl. 27, fig. 2. "Gulf of California."

Type Locality: Beach at the head of the Gulf of California.

[6] *Diplodonta ? semiaspera*, var. *discrepans* Carpenter, Cat. Mazatlan Shells, November, 1855, p. 103. "Hab.—Mazatlan; 1 sp. in burrow from Chama." See also Dall, W. H., *Proc. U. S. Nat. Mus.*, Vol. 23, 1901, p. 797.

[7] Not represented in the present collection.

Range: Gulf of California to Corinto, Nicaragua.

Collecting Stations: Mexico: Santa Inez Bay, Gulf of California (145-D-1-3), 4-13 fathoms, sand; Port Guatulco (195-D-9), 7 fathoms, gr. sand, crushed shell; Nicaragua: Corinto (200-D-19), 12-13 fathoms, mangrove leaves, also on beach.

Description: Shell small, white, equivalve, very inequilateral, the anterior end much the longer and somewhat expanded, posterior shorter and smaller, both rounded; the dorsal and basal margins slightly arcuate, subparallel; surface sculptured only with concentric incremental lines, covered with a thin, pale yellowish periostracum; beaks low, inconspicuous, valves rather compressed; interior polished, hinge formula lo.01.olo
ol.10.lol; chondrophore very narrow, oblique, and posteriorly directed. Length of shell, 10; of anterior part, 8.1; height, 6; diameter, 3.5 mm. (Dall).

Most of the specimens in the present collection measure about 6-8 mm. in length. Some show a tinge of salmon-yellow coloration.

Distribution: This species was dredged in Santa Inez Bay in the Gulf of California and was taken quite abundantly at Corinto, Nicaragua, in beach drift and at a depth of 12-13 fathoms. A few specimens, apparently the same species, were taken off Port Guatulco, Mexico, in 7 fathoms. The present record of occurrence at Corinto is an extension south of the known range of the species.

Genus ***Kellia*** Turton.

Kellia suborbicularis Montagu.

Mya suborbicularis Montagu, Test. Brit., Pt. 1, 1803, p. 39. "In hard lime-stone at Plymouth." Also "sometimes dredged up in Salcomb-bay"; Pt. 2, 1803, p. 564; Suppl., 1808, pl. 26, fig. 6.

Kellia suborbicularis Montagu, Forbes & Hanley, Hist. Brit. Moll., Vol. 2, 1849, p. 87, Vol. 1, pl. 0, figs. 4, 4a (animal), pl. 18, figs. 9, 9a, 9b, 1848. Various localities cited in northern Europe and south to the Mediterranean. [For dates of issue of this work see A. Reynell, *Proc. Malacol. Soc.* London, Vol. 13, 1918, pp. 25-26].—H. & A. Adams, Gen. Rec. Moll., Vol. 3, 1858, pl. 114, figs. 8, 8a, 8b, 8c.

Type Locality: Plymouth, England (cited as type locality by I. S. Oldroyd, 1924, and accepted as such by the present authors). Also cited originally from Salcomb Bay, England.

Range: Sitka, Alaska, to Peru. Also Atlantic.

Collecting Station: Mexico: Port Guatulco (195-D-9), 7 fathoms, green sand, crushed shell.

Description: Shell small, thin, suborbicular or roundly subquadrate; ornamented by concentric lines of growth.

There appears to be no method by which the shells in the present collection can be separated with certainty from the European *Kellia suborbicularis* and we have therefore referred them to that species. One specimen is quite round and is similar to the figures of *Kellia biocculta* de Folin[8] but the hinge agrees with *K. suborbicularis* rather than with the species described by de Folin.

Distribution: A few specimens of *Kellia suborbicularis* were dredged by the Expedition at Port Guatulco, Mexico, in 7 fathoms. It has been cited as ranging south to Peru. It also has been recorded as occurring in the Pliocene and Pleistocene of western North America and from Miocene to Recent in Europe. At the present time the species occurs from Alaska to Peru, and in the north and south Atlantic and is said to occur in other regions.

Genus ***Aligena*** Lea.

Burch[9] has discussed and illustrated several west American species of *Aligena*. Orcutt[10] cited "*Aligena cooperi* Dall" from Magdalena Bay, Lower California, but so far as we know this is a *nomen nudum*. *Aligena pisum* Dall[11], was described from the Strait of Magellan in 61 fathoms.

Key[12] to the species of *Aligena*.

A. Shell with a median radial constriction ..... *cokeri*

B. Shell without a median radial constriction

  a. Anterior portion of shell sloping steeply down ..... *cerritensis*[13]

  aa. Anterior portion of shell broadly rounded

    b. Posterior portion of shell rounded, sloping gently down; left valve with a tooth ..... *nucea*

    bb. Posterior portion of shell nearly straight, sloping abruptly down; left valve edentulous ..... *redondoensis*[13]

[8] *Erycina* (*Kellia*) *biocculta* de Folin, Les Méléagrinicoles, (Havre), 1867, p. 21, pl. 3, figs. 8, 9, 10, 11, 12. Cited on p. 9 as from "environs des Negritos" or "îles aux Perles dans la baie de Panama". —de Folin, Fonds de la Mer, Vol. 1, 1867-1871, p. 8 (as *Erycina biocculta*). "La baie de Panama."

[9] Burch, T. A Survey of the West American Aligenas with a description of a new species. *Nautilus*, Vol. 55, No. 2, October, 1941, pp. 48-51, 1 pl.

[10] Orcutt, C. R., *West American Sci.*, Vol. 21, No. 5 (Whole No. 169), May, 1919, p. 39.

[11] *Aligena pisum* Dall, *Bull. Mus. Comp. Zool.*, Vol. 43, No. 6, October, 1908, p. 413. "U.S.S. 'Albatross', station 2778, Magellan Strait, in 61 fathoms, mud, bottom temperature 48°F. U. S. N. Mus. 110,715."

[12] Adapted from T. Burch.

[13] Not represented in the present collection.

Aligena cokeri Dall.

Aligena cokeri Dall, *Proc. U. S. Nat. Mus.*, Vol. 37, No. 1704, November 24, 1909, p. 155, pl. 28, figs. 5 and 6. "Attached to worm tubes thrown upon the beach of the lagoon at Capon, Peru. The worms live in the beach."—T. Burch, *Nautilus*, Vol. 55, No. 2, October, 1941, p. 49. Original record cited.

Type Locality: Capon, Peru, beach of the lagoon, attached to worm tubes.

Range: Punta Penasco, Gulf of California, to Capon, Peru.

Collecting Stations: Mexico: Santa Inez Bay, Gulf of California (145-D-1-3), 4-13 fathoms, sand; Nicaragua: Corinto (200-D-16, 19), 4-13 fathoms, mangrove leaves, also on beach.

Description: Shell small, white, thin, fragile, roundly quadrate; a wide shallow radial furrow is present on the medial portion of the shell; beaks high, tumid, closely adjacent, slightly anteriorly directed and situated somewhat anteriorly; sculpture of concentric incremental lines and little elevated concentric threads; hinge edentulous, a small callosity present in front of the ligament; pallial line entire. A large specimen measures approximately: length, 9.5 mm.; height, 8 mm.; convexity (one valve), 4 mm.

The shell of this species is similar to that of *Aligena aequata* Conrad from the Miocene of Virginia. The presence of a medial radial furrow on *A. cokeri* easily serves to separate it from other west American species of *Aligena*. The present specimens appear to be identical with the shell from the Pleistocene of Magdalena Bay, Lower California, which was identified as *A. nucea* by E. K. Jordan.

Distribution: Two small valves of this species were dredged in Santa Inez Bay, Gulf of California, and three valves were dredged by the Expedition at Corinto, Nicaragua, in 4 to 13 fathoms. This is an extension north of the known range of the species.

Aligena nucea Dall.

Aligena nucea Dall, *Proc. U. S. Nat. Mus.*, Vol. 45, No. 2002, June 11, 1913, p. 597. "Gulf of California."—Dall, *Proc. U. S. Nat. Mus.*, Vol. 66, Art. 17, 1925, p. 2, pl. 28, fig. 2. "Gulf of California."—T. Burch, *Nautilus*, Vol. 55, No. 2, 1941, p. 49, pl. 4, figs. 3 and 4. Original locality cited.

Type Locality: Gulf of California.

Range: Punta Penasco, Gulf of California, to Corinto, Nicaragua.

Collecting Stations: Mexico: Santa Inez Bay, Gulf of California (145-D-1-3), 4-13 fathoms, sand; Nicaragua: Corinto, beach.

Description: Shell small, white, rather solid, ovate, slightly inequilateral, moderately inflated; surface rather rude, with irregular, rather coarse incremental lines; beaks full, somewhat posterior, the anterior end of the shell shorter; interior porcellanous, the muscular scars unusually large, the pallial line irregular, entire; hinge with a long, strong, narrow chondrophore, a small pustular projection in front of it, as usual in the genus. Length of shell, 4.0; of anterior portion, 1.75; height, 3.0; diameter, 2.2 mm. (Original description).

The gently sloping posterior portion of the shell and the presence of a tooth in the left valve of this species are characters which serve to separate it from *A. redondoensis* T. Burch, dredged off Redondo Beach, California, in which the posterior margin slopes abruptly down and the hinge of the left valve is edentulous.

Distribution: Two single valves of this species were dredged in Santa Inez Bay in the Gulf of California in 4-13 fathoms and one valve was taken on the beach at Corinto, Nicaragua. This is an extension south of the known range of this species.

Genus **_Rochefortia_** Vélain.

Key to the species of *Rochefortia*.

A. Shell oval; diaphanous ..... *chalcedonica*
B. Shell subquadrate; opaque; umbos appressed ..... *subquadrata*

Rochefortia chalcedonica Carpenter.

?Montacuta chalcedonica Carpenter, Cat. Mazatlan Shells, April, 1857, p. 531. "Hab. —Mazatlan; 1 valve off frond of *Murex nigritus;* L'pool Col."

Mysella chalcedonica Carpenter, Dall, *Proc. U. S. Nat. Mus.*, Vol. 21, No. 1177, 1899, p. 881. Mazatlan.

Type Locality: Mazatlan, Mexico, on *Murex nigritus*.

Range: Santa Inez Bay, Gulf of California, to Mazatlan, Mexico.

Collecting Station: Mexico: Santa Inez Bay, Gulf of California (145-D-1-3), 4-13 fathoms, sand.

Description: "?M. t. tenuissimâ, interdum opacâ, interdum diaphanâ, castaneâ; ovali, marginibus regulariter excurvatis, umbone prominente; nitente, sed striulis tenuissimis, et concentricis, et radiantibus; valvâ alterâ dent. card. post. elongato, ant. evanescente, lat. nullis; alterâ. . . ." "Long. .02, lat. .028, alt. .006." (Original description).

The type of this species has never been figured but Carpenter's description fits the present specimens rather well. The thin, chalcedonic shell, as indicated by its specific name, is a characteristic feature of this species.

Distribution: A few single valves, here referred to this species, were dredged by the expedition in Santa Inez Bay in the Gulf of California, in 4-13 fathoms. This is the first record of the occurrence of this species outside of the type locality.

Rochefortia subquadrata Carpenter.

?*Montacuta subquadrata* Carpenter, Cat. Mazatlan Shells, December, 1855, p. 113. "Hab.—Mazatlan; off Chamae, extremely rare; L'pool Col."

?*Mysella subquadrata* Carpenter, Dall, *Proc. U. S. Nat. Mus.*, Vol. 21, No. 1177, 1899, p. 881. Mazatlan.

Type Locality: Mazatlan, Mexico, off Chamae.

Range: Santa Inez Bay, Gulf of California, to Mazatlan, Mexico.

Collecting Station: Mexico: Santa Inez Bay, Gulf of California (145-D-1-3), 4-13 fathoms, sand.

Description: "M. t. oblongâ, subquadratâ, solidiore, flavescente seu cinereâ; sulcis concentricis, creberrimis, rotundatis; umbonibus appressis, lunulâ excavatâ; valvâ alterâ dent. card. uno, inter fossas duas, dent. lat. longis, prominentibus; valvâ alterâ dent. card. uno, elongato, prope marginem, fossâ unâ, latâ; dent. lat. subobsoletis." "Long. .1, lat. .13, alt. .03." (Original description).

A left valve in the present collection agrees well with Carpenter's description of "?*Montacuta subquadrata*." The subquadrate outline, appressed umbos and excavated lunule mentioned by Carpenter are noticeable on the present specimen. Carpenter mentioned that "Outside it resembles in miniature some of the oval Oolitic Astartidae."

Distribution: One left valve of this species was dredged by the Expedition in Santa Inez Bay, Gulf of California, in 4-13 fathoms. This is the first record of the occurrence of this species outside the type locality.

Genus **Pseudopythina** Fischer.

Pseudopythina Fischer in Monterosato, Nom. Gen. e Spec. Medit. (Palermo), 1884, p. 17. Sole species cited, "*P. Mac-Andrewi*, Fischer (*Kellia*)—*Journ. Conchyl.* 1867, p. 194, t. 9, f. 1 (Coste del Portogallo)." Also "*Pythina* sp., M'Andrew—Rep. 1856 (Faro). Gibilterra (Hidalgo)."—Fischer, Man. de Conchyl., 1887, p. 1026. Sole species, "*P. Mac-Andrewi*, Fischer."—Dall, *Trans. Wagner Free Inst. Sci.*, Vol. 3, Pt. 5, December, 1900, p. 1142. Type, *Kellia MacAndrewi* Fischer.

Type (by monotypy): *Pseudopythina macandrewi* Fischer [=*Kellia Mac-Andrewi* Fischer, *Journ. de Conchyl.*, Vol. 15, 1867, p. 194, pl. 9, fig. 1. "Hab. Nord de l'Espagne; bassin d'Arcachon (Gironde)"].

Description: West American shells referred to this genus are elliptical, subquadrangular or trapezoidal in outline, somewhat compressed, often slightly flattened medially, and possess 1 cardinal tooth in each valve. The type species of the genus is said to possess 2 cardinal teeth in each valve.

Pseudopythina chacei Dall.

Erycina chacei Dall, *Proc. U. S. Nat. Mus.*, Vol. 52, No. 2183, December 27, 1916, p. 410. "Station 4343, off the South Coronado Island, in 155 fathoms."

Pseudopythina chacei Dall, Keen in Burch, *Min. Conch. Club South. Calif.*, No. 40, October, 1944, p. 17, figs. pp. 12 and 18. Santa Rosa Island, California, to South Coronado Island, Mexico.

Type Locality: Off South Coronado Island, Mexico, in 155 fathoms.

Range: Santa Rosa Island, California, to Santa Inez Bay, Gulf of California.

Collecting Station: Mexico: Santa Inez Bay, Gulf of California (145-D-1-3), 4-13 fathoms, sand.

Description: Shell small, compressed, rounded-quadrate; nearly equilateral, the anterior end slightly shorter; beaks low, pustular, minute; dorsal margin nearly straight, basal margin gently arcuate; surface finely concentrically striate, whitish under a pale ashy periostracum, both ends nearly evenly rounded, hinge very feeble. Length, 5.3; height, 3.5; diameter, 1.8 mm. (Original description).

Two small left valves in the present collection agree well with Dall's description of "*Erycina*" *chacei*. A comparison of these specimens with a photograph of the type of Dall's species and with a drawing of the hinge in the possession of Dr. A. M. Keen, reveals only slight differences between these and the present shells. We have therefore, at least for the present, referred the specimens to Dall's species.

Judging from the description alone, it is possible that the present specimens may be referable to the species described as *Montacuta elliptica* Carpenter[14] described from Mazatlan, Mexico. The type of that species has never been illustrated and we are uncertain whether or not our specimens could be referred to it.

Distribution: Two single valves of this species were dredged in Santa Inez Bay, Gulf of California, in 4-13 fathoms. This is an extension south of the known range of the species.

Genus **Lasaea** Leach in Brown.

A. M. Keen[15] has discussed the genus *Lasaea* and cited the Recent species referable to it.

Key to the species of *Lasaea*.

A. Anterior dorsal margin broadly rounded; umbos very tumid; subquadrate

[14] *Montacuta elliptica* Carpenter, Cat. Mazatlan Shells, December, 1855, p. 113. "Hab.—Mazatlan; off *Chama* and *Spondylus*, extremely rare; L'pool Col." —Dall, *Proc. U. S. Nat. Mus.*, Vol. 21, 1899, p. 881 (as *Mysella elliptica*). Mazatlan.

[15] Keen, A. M. New Pelecypod species of the genera Lasaea and Crassinella. *Proc. Malacol. Soc. London*, Vol. 23, Pt. 1, March 16, 1938, pp. 18-32, 1 pl. See also corrections in Vol. 23, Pt. 4, March 15, 1939, p. 252.

a. Anterior end evenly rounded *cistula*[15a]
aa. Anterior end slightly obliquely rounded ..... *petitiana*
B. Anterior dorsal margin sloping obliquely; umbos less tumid; shell more elongate ..... *subviridis*[15a]

Lasaea petitiana Recluz.

Poronia petitiana Recluz, *Rev. Zool. Soc. Cuvierienne*, Vol. 6, 1843, p. 175. "Hab. Callao de Lima, ou elle ne paraît pas rare."

Lasaea petitiana Recluz, Keen, *Proc. Malacol. Soc. London*, Vol. 23, Pt. 1, March 16, 1938, pp. 19, 22. Original record cited.

Type Locality: Callao, Peru.

Range: Atacama, Chile, to the Galápagos Islands.

Collecting Station: Ecuador: Tower Island, Galápagos Islands, shore.

Description: "Testa ovata seu ovato-trigona, convexo-depressa, inaequilatera, anticè producta, albido-rosea, transversim substriata; apicibus parvis, vix antice flexis utroque latere dentibusque roseo-pictis; fovea ligamentali latiuscula; marginibus valvarum acutiusculis." "Long. 2½ mill., larg. 3 mill., conv., 2 mill." (Original description).

The minute, inflated, subquadrate, often reddish-tinted shell of this species is much like that of *Lasaea cistula* Keen[16] described from Halfmoon Bay, California, but the anterior dorsal margin appears to slope a little more obliquely. Compared to *L. subviridis* Dall, the anterior dorsal margin of the present species slopes much less steeply and the umbos are more tumid, as in *L. cistula*. Some of the largest specimens in the present collection are 2.5-2.75 mm. in length.

The exact synonymy and range of this species are uncertain. Dall[17] considered it to be identical with *Kellia miliaris Philippi*[18] which was described from the Strait of Magellan. Haas[19] stated that specimens which he identified as *Lasaea miliaris* Philippi from Peru are hardly separable from *L. cistula* Keen.

Lasaea macrodon Stempell[20] was described from Juan Fernandez Island.

Distribution: Several specimens in the present collection, apparently referable to this species, were collected, probably by William Beebe, on Tower Island, Galapágos Islands, in 1925. Although not a part of the present collections of the Expeditions of the *Zaca*, the species is recorded here for convenience of reference. The exact range of this species is uncertain. Dall recorded it as ranging south to the Strait of Magellan. The present shells appear to belong to the species cited by the present authors under the name of *Lasaea rubra* from the Pleistocene of the Galápagos Islands.

Genus **Solecardia** Conrad.

Solecardia eburnea Conrad.

Solecardia eburnea Conrad, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 4, 1849, p. 155. Described under the title "Shells are from the coasts of Lower California and Peru."—Conrad, *Jour. Acad. Nat. Sci. Philadelphia*, Ser. 2, Vol. 1, 1850, p. 279, pl. 39, fig. 1. Locality same as in preceding reference.—Dall, *Proc. U. S. Nat. Mus.*, Vol. 21, 1899, pp. 875, 879, 884. "Cape St. Lucas to Panama."

Not *Scintilla eburnea* Mörch, *Journ. de Conchyl.*, Vol. 24, No. 4, 1876, p. 373. "Hab. Saint-Thomas," dredged. Renamed *Solecardia mörchi* Dall, *Proc. U. S. Nat. Mus.*, Vol. 21, June 26, 1899, p. 884.

Scintilla cumingii Deshayes, *Proc. Zool. Soc. London* for 1855 (issued January 5, 1856), p. 173. "Hab. ad littora Panamensia." —Sowerby, Conch. Icon., Vol. 19, *Scintilla*, 1874, species 3, pl. 1, figs. 3a, 3b. Panama.

Type Locality: Lower California.

Range: Punta Penasco, Gulf of California, to Panama.

Collecting Station: Mexico: Santa Inez Bay, Gulf of California (144-D-2), 2½ fathoms, sand, weed, rocks.

Description: Shell ovately oblong, thin, punctate; hinge with 2 diverging teeth and a linear oblique cartilage pit between; pallial line entire. "In this singular bivalve the pallial impression shows no junction with the adductor impressions, but joins the extremities of the cardinal plate. The muscular impressions are as distinct on the exterior as on the interior" (Conrad).

A specimen in the present collection measures: length, 21.2 mm.; height, 14.3 mm.

The large size of the shell, for the family, and the close radial rows of fine pits on the outer surface, are very distinctive features of this species. It is the type of the genus *Solecardia*.

Wood[21] mentioned a similarity between *Kellia ambigua* Nyst from the Crag Pliocene of England and *Solecardia eburnea* Conrad.

Some of the Hawaiian species originally referred to *Solecardia* have been placed in

[15a] Not represented in the present collection.

[16] *Lasaea cistula* Keen, *Proc. Malacol. Soc. London*, Vol. 23, Pt. 1, March 16, 1938, p. 25, pl. 2, figs. 7-9. "Type locality.—Moss Beach, Half Moon Bay, California—Sect. 4, T. 5 S., R. 6 W., Mount Diablo Meridian."

[17] Dall, W. H., *Proc. U. S. Nat. Mus.*, Vol. 37, 1909, p. 264.

[18] *Kellia miliaris* Philippi, *Archiv f. Naturgesch.*, Jahrg. 11, Bd. 1, 1845, p. 51. "Patria Fretum Magellanicum, Eagle Bay, frequens."—Philippi, Reise durch die Wueste Atacama (Eduard Anton: Halle), 1860, p. 175, pl. 7, figs. a [cited as d on pl.], b, c. Indicated as ranging from Cobija to the Strait of Magellan.

[19] Haas, F., *Zool. Ser. Field Mus. Nat. Hist.*, Vol 29, No. 1, 1943, p. 17. With *Mytilus granulatus* from rocks at Chincha Norte Island, Peru.

[20] *Lasaea macrodon* Stempell, *Zool. Jahrb.*, Suppl. Bd. 5. Fauna Chilensis, Bd. 2, December 20, 1899, p. 231, figs. 16, 17. "3 Exemplare aus der Bahia Padres auf Juan Fernandez."

[21] *Kellia ambigua* Nyst, Wood, *Palaeontogr. Soc.*, Vol. 4, Mon. Crag Moll., Pt. 2, No. 1, Bivalves, for 1850 (issued June, 1851), p. 120, Tab. 12, figs. 11a, 11b.

the genus *Nesobornia* Dall, Bartsch & Rehder, 1938, the type of which is *Solecardia ovata* Gould.

Distribution: A single valve of *Solecardia eburnea* was dredged by the Expedition in Santa Inez Bay in the Gulf of California. It has been recorded as ranging south to Panama.

Family Sportellidae.

Key to the genera of the Sportellidae.

A. Left valve with one cardinal tooth ..... *Basterotia*

B. Left valve with two cardinal teeth ..... *Sportella*

Genus *Basterotia* Mayer in Hörnes.

Harlea Gray, Synop. Brit. Mus., 1842, p. 78. [No species cited]. See E. A. Smith, *Proc. Zool. Soc. London*, April 1, 1890, p. 303.

Eucharis Recluz, *Journ. de Conchyl.*, Vol. 1, 1850, p. 164. Type, *Corbula quadrata* Hinds.—Fischer, *Journ. de Conchyl.*, Vol. 34, No. 3, 1886, p. 198.

Not *Eucharis* Latreille, 1804.

Basterotia Hörnes, Verhandl. k. k. Zool.-Bot. Gesell. Wien, Bd. 9, 1859, Abh. p. 71. *Basterotia corbuloides* Hörnes cited and illustrated. [*Corbula quadrata* (as illustrated by Reeve, pl. 5, fig. 40) was mentioned as a similar species but it was not definitely referred to the genus *Basterotia*].

Not *Basterotia* Bayle in Jousseaume, *Bull. Soc. Zool. France*, Vol. 9, 1884, p. 95. Gastropoda.

Type (by Monotypy): *Basterotia corbuloides* Hörnes, Verhandl. k. k. Zool.-Bot. Gesell. Wien, Bd. 9, 1859, p. 71, [three figs.]. "Wiener Becken." See also Hörnes, Abhandl. k. k. Geol. Reichsanst., Bd. 4, 1870, p. 40, pl. 3, figs. 11a-g. Various localities cited in Vienna Basin, Austria. Miocene.

The species originally described as *Anisodonta peninsulare* by E. K. Jordan, from the Pleistocene of Magdalena Bay, Lower California, has been found among beach shells along the west coast of the tropical Americas. The species appears to be referable to the genus *Basterotia* Mayer in Hörnes which is known from Miocene to Recent. Species living in the present seas have been described from the south Atlantic, Caribbean, and western Pacific. The west coast of Mexico, Nicaragua, and the Galápagos Islands can now be added to the records of the distribution of the genus.

Lamy[22] has cited the species referred to this genus.

Basterotia peninsularis Jordan.

Anisodonta peninsulare E. K. Jordan, *Contrib. Dept. Geol. Stanford Univ.*, Vol. 1, No. 4, November 13, 1936, p. 147, pl. 18, figs. 11, 12. "Magdalena Bay, Lower California." "Pleistocene."

Type Locality: Magdalena Bay, Lower California. Pleistocene.

Range: Port Guatulco, Mexico, to Corinto, Nicaragua, and the Galápagos Islands.

Collecting Stations: Mexico: Port Guatulco (195-D-9), 7 fathoms, gr. sand, crushed shell; Nicaragua: Corinto, beach drift.

Description: Shell subquadrate, thin; umbos gently rounded, a broadly rounded shoulder on the posterior portion of the shell; anterior end short; a prominent cardinal tooth which is separated from the resilium pit by a distinct notch. Length, 15 mm.; height, 10.6 mm.; convexity of left valve, 4 mm. (Jordan).

A right valve in the present collection measures approximately: length, 13 mm.; height, 8 mm.; convexity (one valve), 3 mm.

Distribution: One fairly large valve of this species was found in the beach drift at Corinto, Nicaragua. Another very small valve also referred to this species was dredged in 7 fathoms at Port Guatulco, Mexico. This is the first record of the occurrence of the species living in west American waters. Heretofore it has been known to occur only in the Pleistocene of Magdalena Bay, Lower California. Specimens apparently referable to this species were collected by Professor Nicholas Reformatsky in the Pleistocene of Albemarle Island, Galápagos group. Dr. A. M. Keen of Stanford University, called our attention to the fact that this species also occurs in the Recent fauna of the Galápagos Islands.

Genus *Sportella* Deshayes.

Sportella Deshayes, Descript. Anim. s. Vert. bas. Paris, Vol. 1, 1858, p. 593. Type, *Psammotea dubia* Deshayes.—Dall, *Trans. Wagner Free Inst. Sci.*, Vol. 3, Pt. 5, 1900, p. 1125. Type, *Psammotea dubia* Deshayes. [On p. 1125 as *Psammobia dubia* Deshayes].

Type (by original designation): *Psammotea dubia* Deshayes, Descript. Coq. Fos. env. Paris, Vol. 1, 1824, p. 76, pl. 10, figs. 13, 14. "Localité: Parnes, C. G."

Shell oblong, transverse, smooth, flattened, subequilateral, closed, margins simple and sharp. Hinge narrow bearing two unequal teeth diverging in the left valve, a single simple one in right valve. Muscular impressions large, oval, nearly equal. Pallial impression simple. Ligament external [translation from Deshayes, 1858].

Sportella stearnsii Dall.

Sportella stearnsii Dall, *Proc. U. S. Nat. Mus.*, Vol. 21, No. 1177, June, 1899, p. 885, pl. 87, figs. 9, 12. "Gulf of California, exact locality unknown."

[22] Lamy, E. Note sur le genre Basterotia Mayer, 1859 [Mollusques Lamellibranches]. *Comp. Rend. Congrès des Soc. Savantes*, Paris, 1925, pp. 503-508, 1 fig. in text.

Type Locality: Gulf of California.

Range: Gulf of California to Corinto, Nicaragua, and the Galápagos Islands.

Collecting Stations: Mexico: Santa Inez Bay, Gulf of California (145-D-1-3), 4-13 fathoms, sand; Nicaragua: Corinto (200-D-17), 7-10 fathoms, sand, also in beach drift.

Description: Shell of moderate size for the genus, inequilateral, not very convex, white, with an almost imperceptible yellowish epidermis; anterior dorsal margin nearly straight, the base parallel with it, the ends bluntly rounded; surface nearly smooth, with faint incremental lines and microscopic sagrination; teeth normal, strong, the posterior cardinal prominent, vertical; ligament strong, external, on a nymph; resilium well developed, its area of attachment thickened; posterior adductor scar rounded, unusually large. Lon. 13.5, alt. 10, diam. 5 mm. (Dall).

A right valve from Corinto, Nicaragua, measures approximately: length, 14 mm.; height, 8.8 mm.; convexity (one valve), 3 mm.

Distribution: One valve of this species was dredged in Santa Inez Bay, Gulf of California, three single valves were found in the beach drift and one left valve was dredged in 7-10 fathoms at Corinto, Nicaragua. The occurrence here recorded from Corinto, as well as that from the Galápagos Islands, represents an extension south of the known range of this species.

Superfamily Cardiacea.

Family Cardiidae.

A paper dealing with the nomenclature of the superspecific units of this family has been published by A. M. Keen[23].

Genus **Cardium** Linnaeus.

Key to the subgenera[24] of *Cardium*.

A. Shell decidedly longer than high
  a. Two distinct areas of sculpture; no lateral teeth ..... *Lophocardium*
  aa. Without distinct areas of sculpture; lateral teeth present ..... *Papyridea*

B. Shell decidedly higher than long, or round
  a. Shell nearly smooth ..... *Laevicardium*
  aa. Shell strongly sculptured
    b. Posterior area set off with strong concentric or scaly sculpture
      c. All ribs and interspaces on posterior area crossed by strong concentric laminae *Nemocardium*
      cc. Various ribs on posterior area with strong scales only *Microcardium*
    bb. Posterior area not set off with strong concentric or scaly sculpture
      d. Umbos abruptly angulated posteriorly; posterior margin truncated
        e. Ribs beaded; anterior laterals crowded against cardinals; shell small *Trigoniocardia*
        ee. Ribs with fine concentric imbrications; cardinals symetrically spaced between anterior and posterior laterals ..... *Americardia*
      dd. Umbos rounded or roundly angled posteriorly
        f. Ribs broad, flattish; smooth on top
          g. Very convex; ribs without scales ..... *Mexicardia*
          gg. Gently convex; central ribs fringed with scales on anterior and posterior sides; elongate *Acrosterigma*
        ff. Ribs narrow, well elevated; central ribs with scales or nodes on posterior side.
          h. Central ribs with scales on posterior side and arching over top *Trachycardium*
          hh. Central ribs with a serrate ridge or nodes on posterior side only or nodes on both sides
            i. Central ribs with an elevated serrate ridge on posterior side ..... *Phlogocardia*
            ii. Central ribs with diagonal nodes on posterior (and on some specimens also, to a lesser degree, on anterior) side *Dallocardia*

Subgenus **Lophocardium** Fischer.

Cardium (Lophocardium) annettae Dall.

Plate I, Figures 3, 8 and 13.

Cardium (Lophocardium) annettae Dall, *Nautilus*, Vol. 3, No. 2, June, 1889, p. 13. "Dredged in 25 fathoms off the coast of Lower California, near Cerros Island."

Lophocardium annettae Dall, *Proc. U. S. Nat. Mus.*, Vol. 12, 1889 (issued March 7, 1890), p. 264, pl. 10, fig. 4. "Hab.—Coast of Lower California at station 2828 in north

[23] Keen, A. M. Nomenclatural Units of the Pelecypod Family Cardiidae. *Bull. Mus. Roy. Hist. Nat. Belgique*, Tome 13, No. 7, March, 1937, pp. 1-22.

[24] The subgenus *Dinocardium* has been omitted from this key because it is believed that it does not occur in the west American fauna.

latitude 24° 11′ and west longitude 109° 55′ in 10 fathoms; fragments were collected at Stations 2823 and 2826, in 8 to 27 fathoms, shelly bottom, within a few miles of the preceding and also in material dredged near San Clemente Island in 25 fathoms."

Protocardia (*Lophocardium*) *annettae* Dall, Dall, *Proc. U. S. Nat. Mus.*, Vol. 23, 1901, p. 392. Gulf of California, 6 to 24 fathoms.

Type Locality: Off the coast of Lower California, near Cedros Island, in 25 fathoms.

Range: San Clemente Island, California, to Port Culebra, Costa Rica.

Collecting Stations: Mexico: East of Cedros Island; Santa Inez Bay, Gulf of California (143-D-2, 4), 25-30 fathoms, mud, crushed shell, sand; Port Guatulco (195-D-21), 18 fathoms, mud; Costa Rica: Port Parker (203-D-1, 2, 3), 12-15 fathoms, sandy mud, crushed shell, shelly sand and mud, algae; Port Culebra (206-D-1, 2, 3), 14 fathoms, sandy mud.

Description: Shell elongated, thin, fragile, gaping posteriorly; color salmon pink to almost white, the color deepest on the posterior area; a raised radial lamina fringed with periostracum separates about five-sixths of the shell from the posterior area; the surface of this anterior area is finely reticulated; flat, little elevated, radial ribs become very weak and can be observed only with magnification on the anterior end, the radial sculpture is crossed by fine raised irregular concentric laminae; the posterior area is ornamented by well developed radials crossed by somewhat irregular laminae which are sparser and higher than the radials and much higher than on the anterior area; two pointed cardinal teeth are present in the right valve and one in the left but lateral teeth are absent; periostracum light brown in color. The largest specimen in the present collection is 46.8 mm. long and 38.7 mm. high.

A study of the series available suggests that there are not two species of this remarkable group of shells in the area, and were it not for Broderip's statement regarding *cumingii* that the lamina separating the posterior part of the shell from the remainder is *Mactra*-like, we would feel that the name *annettae* should be relegated to the synonymy of *Cardium cumingii*[25]. L. C. Smith[26] discussed both species and stated that the lamina on *C. cumingii* is not made of shelly material.

Dall stated that the bounding ridge of the type of *C. annettae* is notched and fringed with periostracum and much less prominent than that of *C. cumingii*. Specimens from as far south as Costa Rica show some variation in the height and character of the lamina and it is not certain that the specific name *annettae* can be retained for a form distinct from *C. cumingii*.

Distribution: Specimens of *Cardium annettae* were dredged at depths of 12 to 30 fathoms from Cedros Island to Costa Rica. It was not found abundantly at any locality and in some localities specimens of this fragile shell were broken into pieces.

Subgenus **Papyridea** Swainson.

Cardium (Papyridea) aspersum Sowerby.

Cardium aspersum Sowerby, *Proc. Zool. Soc. London*, September 8, 1833, p. 85. "Hab. ad Sanctam Elenam et ad Montem Christe." "Found in sandy mud at seven fathoms depth."—Sowerby, Conch. Illustr., *Cardium*, Cat., p. 2, 1840?, pl. 48, fig. 15, January, 1834. St. Elena.—Reeve, Conch. Syst., Vol. 1, 1841, p. 99, pl. 75, fig. 15.

Type Locality: Santa Elena, Ecuador (here designated as type locality). Montechristi also cited originally.

Range: Manuela Lagoon, Lower California, and the Gulf of California, to Lobitos, Peru.

Collecting Stations: Mexico: Southeast of Cedros Island (126-D-19), 25 fathoms, rocks, algae; Cape San Lucas; Santa Inez Bay, Gulf of California (141-D-2), 10-15 fathoms, sand, weed; Port Guatulco; Nicaragua: Corinto (200-D-19), mangrove leaves; Panama: Hannibal Banks.

Description: Shell elongately oval, subequilateral, gaping; mottled with reddish-brown and light colored areas; ribs numerous, the anterior ones finer and crenulated, the central ones flattened, the posterior ones coarser and ornamented with short spines; the ends of the ribs form a serrated margin posteriorly.

Cardium aspersum is very similar to the Atlantic species *C. spinosum* Meuschen but the form from the eastern Pacific appears to have flatter ribs and less posterior elongation. The form described by *Verrill* as *Papyridea bullata* var. *californica*[27] has not been illustrated but is probably identical with the species described by Sowerby.

Distribution: *Cardium aspersum* was collected on beaches and dredged at depths of 10 to 25 fathoms from Cedros Island to Panama. It is also known to occur in the Pleistocene of Magdalena Bay, Lower California, of Oaxaca, Mexico, and the Galápagos Islands.

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[25] *Cardium cumingii* Broderip, *Proc. Zool. Soc. London*, September 8, 1833, p. 82. "Hab. in America Centrali. (Gulf of Dulce)." "It was obtained from sandy mud, at a depth of twelve fathoms."—Reeve, Conch. Icon., Vol. 2, Cardium, 1844, species 59, pl. 12, fig. 59. Original locality cited.

[26] Smith, L. C., *Mus. Comp. Zool., Occ. Papers on Moll.*, No. 4, July 30, 1945, p. 31-32.

[27] *Papyridea bullata* Sw. var. *californica* Verrill, *Amer. Jour. Sci.*, Ser. 2, Vol. 49, March, 1870, p. 225. "La Paz."

Subgenus ***Phlogocardia*** Stewart.

Cardium (Phlogocardia) belcheri Broderip & Sowerby.

Cardium belcheri Broderip & Sowerby, *Zool. Jour.*, Vol. 4, January, 1829, p. 366, pl. 9, fig. 3. "Hab. in Oceano Pacifico." Dredged "to the northward of Isabella Island, at the entrance to the Gulf of California, in 15 fathoms."—Sowerby, Conch. Illustr., *Cardium*, Cat., p. 3, No. 41, 1840?. "Coast of California and Panuma" [Panama].—Reeve, Conch. Icon., Vol. 2, *Cardium*, 1844, species 5, pl. 1, fig. 5. "Hab. California and Panama; Belcher."

Type Locality: North of Isabel Island, Mexico, at the entrance to the Gulf of California, in 15 fathoms.

Range: Cedros Island, Lower California, and the Gulf of California, to Panama.

Collecting Stations: Mexico: East of Cedros Island (126-D-2), 38 fathoms, mud; Arena Bank, Gulf of California (136-D-15), 40 fathoms, mud, crushed shell; Santa Inez Bay (141-D-1-4), 7-20 fathoms, sand, crushed shell, calcareous algae, weed, (142-D-2), 30-35 fathoms, muddy sand, crushed shell, (143-D-1-5), 18-30 fathoms, mud, crushed shell, sand, weed; Costa Rica: 14 miles S.E. of Judas Point (214-D-1-4), 42-61 fathoms, mud, shell, rocks; Panama: Gulf of Chiriqui (221-D-1-5), 35-40 fathoms, sandy mud.

Description: Shell elongately oval from beak to base, inflated; ornamented by about 24 triangular ribs which, on the posterior side, are surmounted by a narrow, serrated ridge. A large specimen measures approximately 53 mm. in altitude.

Cardium stiriatum Brown & Pilsbry from the Miocene of Panama, and *C. stiriatum leonense* Mansfield from the upper Miocene of Florida, are forms similar to *C. belcheri*. Other species of this group occur in the late Tertiary of the Caribbean region.

Distribution: *Cardium belcheri* was dredged at several localities between Cedros Island, Lower California, and Panama, at depths of 7 to 61 fathoms.

Subgenus ***Americardia*** Stewart.

Key to the species of *Americardia*.

A. About 28 fairly broad, flat ribs; interior with brownish-red areas ..... *biangulatum*

B. About 30 narrow ribs; interior white ..... *guanacastense*

Cardium (Americardia) biangulatum Broderip & Sowerby.

Cardium biangulatum Broderip & Sowerby, *Zool. Jour.*, Vol. 4, January, 1829, p. 367. "Hab."—Sowerby, Conch. Illustr., *Cardium*, Cat., p. 7, 1840?, pl. 46, fig. 2, issued between July 19, 1833, and January, 1834. "St. Elena, Mr. Cuming."—Reeve, Conch. Icon., Vol. 2, *Cardium*, 1844, species 29, pl. 6, fig. 29. "Hab. St. Elena and Isle of Plata, West Columbia (found in coral sand at the depth of seventeen fathoms); Cuming."

Type Locality: Santa Elena, Ecuador (here designated as type locality). No locality cited originally but Santa Elena cited with first illustration of the species.

Range: Catalina Island, California, to Guayaquil, Ecuador.

Collecting Stations: Mexico: East of Cedros Island (126-D-2), 38 fathoms, mud; Santa Inez Bay (142-D-1-4), 30-50 fathoms, sand, crushed shell, muddy sand, weed, calcareous algae, (143-D-1), 29 fathoms, mud, crushed shell, weeds, (145-D-1, 3), 4-13 fathoms, sand, also at San Domingo Point and Monument Station; coast of Lower California; Arena Point; Cape San Lucas; Port Angeles; Port Guatulco (195-D-9, 10, also on shore), 4-7 fathoms, gray sand, crushed shell; Santa Cruz Bay; Tangola-Tangola Bay (196-D-6, 7, 14, 15), 5-7 fathoms, sand, crushed shell; Nicaragua: Corinto (200-D-19), 12-13 fathoms, mangrove leaves; Costa Rica: Port Parker (203-D-1, 3, also on shore), 12-15 fathoms, sandy mud, crushed shell, shelly mud; Cedro Island, Gulf of Nicoya (213-D-4-15), 4-40 fathoms, mud, sand, crushed shell; Golfito, Gulf of Dulce.

Description: Shell inflated, umbos abruptly angulated posteriorly, posterior end concavely flexed and truncated; ribs fairly broad, flattened, about 27-28 in number; color of exterior light brown with reddish-brown spots, interior white tinged with reddish-brown areas.

The shell of this species is proportionately broader, the ribs fewer and broader, and the interior is partially colored reddish-brown in comparison to that of *C. guanacastense*, which is white. *Cardium medium* of the Caribbean region is similar in shape but has more numerous and narrower ribs.

Distribution: *Cardium biangulatum* was collected at many localities from Cedros Island, Lower California, to Costa Rica, on beaches and dredged at depths of 4 to 50 fathoms. The largest number of specimens was found at Corinto, Nicaragua. The species is known to occur from Pliocene to Recent in the Gulf of California region and in the Pleistocene of the San Pedro region in southern California.

Cardium (Americardia) guanacastense

Hertlein & Strong, sp. nov.

Cardium planicostatum Sowerby, *Proc. Zool. Soc. London*, September 8, 1833, p. 83. "Hab. ad oras Americae Centralis. (Guacomayo)." "Found in fine sand, at a depth of thirteen fathoms." — Sowerby, Conch. Il-

lustr., *Cardium*, Cat., p. 7, 1840?, pl. 50, fig. 25, February, 1834. "Guacomayo. Mr. Cuming."—Reeve, Conch. Icon., Vol. 2, *Cardium*, 1844, species 31, pl. 6, fig. 31. Original locality cited.

Not *Cardium planicostatum* Sedgwick & Murchison, 1829.

Cardium (Fragum) magnificum (Deshayes MS) in Carpenter, Dall, *Proc. U. S. Nat. Mus.*, Vol. 23, 1901, p. 390. Lower California to Paita, Peru, in 10 to 13 fathoms.

Not *Cardium magnificum* Deshayes in Carpenter, Rept. Brit. Assoc. Adv. Sci. for 1856 (issued 1857), p. 187. "Is. Plata, St. Elena," coral sand, in 17 fathoms. Reference to Plate 6, fig. 29 of Reeve [which represents *Cardium biangulatum* Broderip & Sowerby].

Type Locality: Culebra Bay, Costa Rica.

Range: Off San Jose del Cabo, Lower California, to Paita, Peru.

Collecting Station: Costa Rica: Culebra Bay.

Description: Shell somewhat cordate, the beaks somewhat attenuated, rounded anteriorly, truncated posteriorly, umbos angulated posteriorly and sloping abruptly downward, the median portion of the posterior area concave; sculptured with about 30 narrow, flat-topped ribs of which about 20 occur anterior to the posterior umbonal angulation and about 10 posterior to it, ribs and interspaces crossed by fine concentric imbrications; hinge with 2 cardinals, the anterior the larger, and 2 laterals which are double in the left valve; exterior yellowish-white and pinkish and with somewhat irregularly concentric blotches of brown, the interior white. The type measures: height (beak to base), 25 mm.; length, approximately, 22 mm. Another specimen, a right valve, measures: height, 46 mm.: length, 36 mm.

Holotype, left valve, in Calif. Acad. Sci. Paleo. Type Coll., from Culebra Bay, Province of Guanacaste, Costa Rica. A right valve, somewhat worn, also was collected at the type locality.

The shell of this species is in general shape similar to that of *Cardium biangulatum* but it is proportionately higher and narrower, has about 30 radial ribs which are narrower, and the interior is white rather than with reddish-brown areas.

The first citation of *Cardium magnificum* was by Carpenter (1857, p. 187) who stated "*Cardium biangulatum* [= *magnificum*, Desh.]" with a reference to Reeve's plate 6, figure 29, which represents *C. biangulatum*. Carpenter did not make any additional statement regarding *Cardium magnificum* in any subsequent publication. Dall, 1901, stated regarding *C. magnificum* "This is *Cardium planicostatum* Sowerby, 1833, not of Sedgwick and Murchison, 1829." He also stated that Carpenter was mistaken in referring Deshayes' species to *Cardium medium*. Dall apparently referred to Carpenter's statement (1863, p. 364; 1864, p. 552. See *Smithson. Miscell. Coll.*, No. 252, 1872, pp. 38, 201) that a specimen identified by C. B. Adams as *C. planicostatum* Sowerby "may be a worn valve of *Hemicardia biangulata*, but more resembles a ballast specimen of the W. Indian *H. media*."

It seems reasonable to suppose that Deshayes intended to propose the specific name *magnificum* to replace the preoccupied name *planicostatum* of Sowerby. However, according to the rules of nomenclature, the name *Cardium magnificum* must be relegated to the synonymy of *Cardium biangulatum*. Sowerby's combination of names, *Cardium planicostatum*, had been used earlier by Sedgwick & Murchison; therefore a new name is required for *Cardium planicostatum* of Sowerby and the name *Cardium guanacastense* based upon a type from Culebra Bay, Costa Rica, is here proposed.

Cardium arrestum Dall from the Caloosahatchie Pliocene of Florida is a similar species.

Distribution: Two specimens of this species were collected by the Expedition at Culebra Bay, Costa Rica. The northernmost locality represented by specimens in the collection of the California Academy of Sciences is that of shells collected by the Templeton Crocker Expedition in 1932 off Mexico in Lat. 23° 03′ N., Long. 109° 31′ to 109° 36′ W. The species also has been recorded as occurring in the Pliocene of Costa Rica, and in the Pleistocene of Ecuador.

Subgenus ***Nemocardium*** Meek.

Cardium (Nemocardium) centifilosum Carpenter.

Cardium var. *centifilosum* Carpenter, Rept. Brit. Assoc. Adv. Sci. for 1863 (issued August, 1864), p. 611. "Cat. Is., 30-40 fm.," p. 642. Santa Barbara Islands. Reprint in *Smithson. Miscell. Coll.*, No. 252, 1872, pp. 97, 128.

Cardium (Protocardium) centifilosum Carpenter, Packard, *Univ. Calif. Publ. Zool.*, Vol. 14, No. 2, 1918, p. 267, pl. 20, figs. 2a, 2b, 2c, 2d. Dredged in 40 and 46 fathoms on a bottom of fine dark green sand off the Farallon Islands, California.

Type Locality: Catalina Island, California, 30-40 fathoms.

Range: Farallon Islands, California, to Abreojos Point, Lower California.

Collecting Station: Mexico: Cedros Island (126-D-3, 6, 10, 12, 15), 40-60 fathoms, mud, crushed shell, eel grass.

Description: Shell small, roundly trigonal, ornamented by numerous fine radial ribs, the posterior ribs are coarser and are

crossed by raised concentric lamellae. Average specimens in the present collection measure approximately 15 mm. in height.

Cardium centifilosum richardsoni Whiteaves, a northern form of this species, is generally a little larger and more coarsely sculptured.

Distribution: *Cardium centifilosum* was found in five dredge hauls in the channel east of Cedros Island, Lower California, from depths of 40-60 fathoms. The species has also been recorded from the Pliocene and questionably from the Miocene of California.

Subgenus ***Microcardium*** Thiele.

Cardium (Microcardium) pazianum Dall.

Plate I, Figures 9, 12, 15 and 16.

Protocardia paziana Dall, *Proc. U. S. Nat. Mus.*, Vol. 52, December 27, 1916, p. 412. "Off La Paz, Gulf of California, in 10 fathoms."

Type Locality: Off La Paz, Lower California, in 10 fathoms.

Range: Cedros Island, Lower California, to Santa Inez Bay in the Gulf of California, to Panama.

Collecting Stations: East of Cedros Island (126-D-10), 60 fathoms, crushed shell, eel grass; Arena Bank, Gulf of California (136-D-22, 24, 26, 29, 31), 35-70 fathoms, mud, *Arca* conglomerate, sand, crushed shell, rock, weed, calcareous algae; Santa Inez Bay (141-D-2), 10-15 fathoms, sand, weed, (142-D-2), 30-35 fathoms, mud, sand, crushed shell, (146-D-1), 35 fathoms, mud, crushed shell, (147-D-2), 60 fathoms, mud, crushed shell; Gorda Banks (150-D-8, 9), 40-60 fathoms, muddy sand; Manzanillo, (184-D-2), 30 fathoms, gravelly sand; Costa Rica: Port Parker (203-D-1, 3), 12-15 fathoms, sandy mud, crushed shell, shelly mud; 14 mi. S. E. of Judas Point (214-D-1-4), mud, shell, rocks; Panama: Gulf of Chiriqui (221-D-1-5), 35-40 fathoms, sandy mud.

Description: Shell small, thin, rounded, posteriorly somewhat obliquely produced and subtruncated; the anterior area ornamented by about 40 fine ribs which are finely nodulous where the concentric crosses the radial sculpture; posterior area with about 22 ribs which are minutely scaled, but interspersed in this series there are five or six with comparatively large scales; the color of the shell is yellowish-white, some specimens entirely so, but many are ornamented by vivid red and orange interiorly toward the hinge and occasionally there is exteriorly a narrow concentric band which is tinged with this color. A large specimen measures approximately 15.2 mm. in length and 15 mm. in height.

This species is very close to "*Protocardia*" *panamensis* Dall[28], a Panamanian species, which was described as possessing a shorter shell with about 33 ribs and the interior whitish and polished. No mention was made at the time of description of any orange red color on the shell. From the illustration given by Dall there seems to be little to separate the two species except color. However, the coloration is variable and there is often variability in the proportion of length to height in the shells of *Cardium* and furthermore the presence of *C. pazianum* as far south as Panama leads us to doubt whether *C. pazianum* is really distinct from *P. panamensis*. We have for the present retained the name *pazianum* because of the color, the greater length in proportion to height, and because we have but one somewhat imperfect specimen from Panama for comparison, but even it shows a faint trace of pink above the hinge line. *Cardium* (*Microcardium*) *peramabile* Dall[29], the type of *Microcardium* and its subspecies *tinctum* Dall[30], are similar to the two west American species here mentioned.

Distribution: This species was dredged from east of Cedros Island, Mexico, to the Gulf of Chiriqui, Panama, at depths of 10-70 fathoms.

Subgenus ***Mexicardia*** Stewart.

Cardium (Mexicardia) procerum Sowerby.

Cardium procerum Sowerby, *Proc. Zool. Soc. London*, September 8, 1833, p. 83. "Hab. in Americâ Centrali. (Real Llejos)." "Found in coarse sand in from four to six fathoms water."—Reeve, Conch. Icon., Vol. 2, *Cardium*, 1844, species 51, pl. 10, fig. 51. Original locality cited.

Cardium laticostatum Sowerby, *Proc. Zool. Soc. London*, September 8, 1833, p. 85. "Hab. in Sinu Xipixapi." "Found in sandy mud at the depth of eleven fathoms."—Sowerby, Conch. Illustr., *Cardium*, Cat., p. 1, 1840?, pl. 51, fig. 30, February, 1834. "Xipixapi, West Colombia. Mr. Cuming."

Cardium panamense Sowerby, *Proc. Zool. Soc. London*, September 8, 1833, p. 85. "Hab. ad Panamam." "Found in sandy mud at a depth of ten fathoms."—Reeve, Conch. Icon., Vol. 2, *Cardium*, 1844, species 56, pl. 11, fig. 56. Original locality cited.

Cardium subelangatum "Reeve," Valenciennes, Zool. Voy. Venus, 1846, Atlas, pl. 17, fig. 2.

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[28] *Protocardia panamensis* Dall, *Bull. Mus. Comp. Zool.*, Vol. 43, No. 6, October, 1908, p. 415, pl. 18, fig. 1. "Gulf of Panama, in 182 fathoms, mud."

[29] *Cardium (Fulvia) peramabilis* Dall, *Bu'l. Mus. Comp. Zool.*, Vol. 9, No. 2, 1881, p. 132. Various localities cited, Siesbee, 119 fathoms, Barbados, 100 fathoms; off Sombrero, 54-72 fathoms; west of Florida, 50 fathoms, etc.—Dall, *Bu'l. Mus. Comp. Zool.*, Vol. 12, No. 6, 1886, p. 269, pl. 4, fig. 7.

[30] See *Microcardium tinctum* Dall, McLean, *Mem. Soc. Cubana Hist. Nat.*, Vol. 13, No. 3, 1939, p. 173, pl. 26, figs. 5 and 6. Key West, Florida, and the West Indies, in 7 to 100 fathoms.

Cardium rotundatum Carpenter, Rept. Brit. Assoc. Adv. Sci. for 1856 (issued 1857), pp. 247, 307. Mazatlan, Mexico; Gulf of California.—Carpenter, Cat. Mazatlan Shells, April, 1857, p. 531. "Mazatlan: extremely rare, off Spondylus."

Cardium eudoxia Dall, *Proc. U. S. Nat. Mus.*, Vol. 52, No. 2183, December 27, 1916, p. 412. "Station 3020 Gulf of California, in 7 fathoms."—Keen, *Min. Conch. Club South. Calif.*, No. 41, November, 1944, p. 25. "The holotype, from the Gulf of California, is a young *Trachycardium* (*Mexicardia*) *procerum*."

Cardium parvulum Li, *Bull. Geol. Soc. China*, Vol. 9, No. 3, October, 1930, p. 259, pl. 3, fig. 22. Panama Bay. "Probably Recent."

Type Locality: Real Llejos [near Corinto], Nicaragua, in 4 to 6 fathoms, sand.

Range: Lagoon Head (Lat. 28° 15′ N., Long. 114° 07′ W.), Lower California, to Lobos Islands, Peru.

Collecting Stations: Mexico: Santa Inez Bay, on beach, also at Monument Station; Banderas Bay; Chamela Bay; Tenacatita Bay; Santa Cruz Bay; Guatemala: 7 mi. W. of Champerico (197-D-2), 14 fathoms, mud; Nicaragua: Corinto (200-D-1, 3, 11, 19), 2-13 fathoms, mangrove leaves, also on beach, and at Isla Encantada; San Juan del Sur; Costa Rica: Port Parker; Port Culebra; Cedro Island, Gulf of Nicoya (213-D-1-10), 4-10 fathoms, mud, crushed shell; Golfito, Gulf of Dulce; Panama: Isla Parida; Bahia Honda.

Description: Shell elongately trigonal, somewhat oblique posteriorly, 22 to 25 smooth, flattish-topped, radial ribs, these are not strongly developed on the anterior slope of the shell but the posterior margin is serrated due to the projecting ends of the ribs which interlock with the opposite valve; externally brownish colored with a tendency toward yellowish or whitish colored concentric areas.

In the young stages up to about 35 mm. in length the shell is longer in proportion to the height while in the more adult stages the height is much greater than the length. The ribs are rounded in the younger stages up to 10 or 15 mm. in length but they gradually become broader, subtriangular and flatter and are separated by narrow and fairly deep interspaces. The rather considerable variation in shape during the growth has led to descriptions of this species under several different names, such as *Cardium laticostatum* Sowerby, which name was based on a young rounded stage of *C. procerum*. Large specimens of this species attain a height of more than 80 mm.

Distribution: *Cardium procerum* occurs commonly from the Gulf of California to Peru. It was collected from the Gulf of California to Panama on the beaches and dredged at depths of 2 to 14 fathoms. The largest number of specimens of this species found at any locality was in the beach drift at Corinto, Nicaragua. The species is also known to occur in the Pleistocene of southern California, Lower California, Costa Rica and Panama, and in the Pliocene and Pleistocene of Ecuador.

Subgenus ***Trigoniocardia*** Dall.

Key to the species of *Trigoniocardia*.

A. Shell subtrigonal; about 18 strongly noded ribs ..... *graniferum*
B. Shell subovate; about 21 finely noded ribs ..... *obovale*

Cardium (Trigoniocardia) graniferum
Broderip & Sowerby.

Cardium graniferum Broderip & Sowerby, *Zool. Jour.*, Vol. 4, January, 1829, p. 367. "Hab. ad littora Oceani Pacifici." "Dug from a depth of about 6 inches in the mud of the Estaro de Mazatlan." — Sowerby, Conch. Illustr., *Cardium*, Cat., p. 3, 1840?, pl. 49, fig. 17, January, 1834. "Pacific Ocean. Mr. Cuming."—Reeve, Conch. Icon., Vol. 2, *Cardium*, 1844, species 43, pl. 8, fig. 43. "Hab. Gulf. of Nicoya, Central America; and Xipixapi, West Columbia; Cuming."

Type Locality: Mazatlan, Mexico, in about 6 inches, mud.

Range: Gulf of California, to Zorritos, Peru.

Collecting Stations: Mexico: Santa Inez Bay, Gulf of California (145-D-1, 3), 4-13 fathoms, sand; San Domingo Point; Port Guatulco (195-D-19, 21), 17-18 fathoms, mud, crushed shell; El Salvador: Meanguera Island, Gulf of Fonseca (199-D-1), 16 fathoms, sand, mud, crushed shell; Nicaragua: Corinto (200-D-3, 10, 17, 19), 2-13 fathoms mangrove leaves, sand, also on beach; Costa Rica: Port Parker (203-D-1), 15 fathoms, sandy mud, crushed shell; Cedro Island, Gulf of Nicoya (213-D-1-10), 4-10 fathoms, mud, sand, crushed shell; Golfito Bay, Gulf of Dulce (218); Panama: Bahia Honda (222).

Description: Shell small, subtrigonal, there are about a dozen rather widely spaced, elevated, triangular, finely noded ribs followed by about 6 to 8 finer, closely spaced, noded ribs which occur on the steeply sloping posterior area; the interspaces are marked by deep narrow, transverse grooves. A large specimen measures approximately 15 mm. in altitude. Reeve has mentioned the *Trigonia*-like appearance of this shell.

Cardium haitense Sowerby from the Miocene of the Caribbean region is a similar species.

Distribution: Specimens of *Cardium*

graniferum were collected at various localities from the Gulf of California to Panama on beaches and dredged at depths of 4 to 18 fathoms. The largest number of specimens was found in the beach drift at Corinto, Nicaragua. It is also known to occur in the Pleistocene of Magdalena Bay, Lower California, and Panama and in the Pliocene of Ecuador. A fossil form cited as "*Cardium (Fragum)* aff. *graniferum* Broderip"[31] has been recorded from Barbados Island.

Cardium (Trigoniocardia) obovale Sowerby.

Cardium obovale Sowerby, *Proc. Zool. Soc. London*, September 8, 1833, p. 84. "Hab. ad oras Americae Meridionalis. (Xipixapi)." "Found in sandy mud at eleven fathoms depth."—Sowerby, Conch. Illustr., *Cardium*, Cat., p. 7, 1840?, pl. 46, fig. 4, issued between July 19, 1833, and January, 1834. "Xipixapi. Mr. Cuming."—Reeve, Conch. Icon., Vol. 2, *Cardium*, 1845, species 117, pl. 21, fig. 117. Original locality cited.—Hertlein, *Bull. South. Calif. Acad. Sci.*, Vol. 33, Pt. 2, May-August (issued August 31), 1934, p. 62, pl. 21, fig. 14. Maria Magdalena Island, Tres Marias group, Mexico, Pleistocene.

Type Locality: Xipixapi (Jipijapa), Ecuador, in 11 fathoms, sandy mud.

Range: Magdalena Bay, Lower California, and the Gulf of California to Salinas, Ecuador.

Collecting Stations: Mexico: San Lucas Bay (135-D-2), 8-16 fathoms, sand; 17 mi. S. E. of Acapulco (189-D-3), 13 fathoms, mud; Guatemala: 7 mi. W. of Champerico (197-D-1, 2), 14 fathoms, mud; El Salvador: La Libertad (198-D-1, 2), 13-14 fathoms, mud; Nicaragua: Corinto (200-D-10, 11, 16, 19, 20-26), 1.5-13 fathoms, mangrove leaves, sand, also on beach; Panama: Gulf of Chiriqui (221-D-1-5), 35-40 fathoms, sand, mud.

Description: Shell small, subovate, obl'que, fairly convex and peaked, ornamented by about 21 finely noded radial ribs, those anteriorly and posteriorly somewhat broadly and asymmetrically triangular, those along the posterior umbonal ridge higher and rounded, those on the posterior area, about 8 in number, flatter, narrower and closer together than those on the anterior area; interspaces transversely grooved. A large specimen in the collection of the California Academy of Sciences from near Isabel Island, west Mexico, measures, approximately, 20.5 mm. in altitude, 14 mm. in length, convexity (one valve) 8 mm.

Cardium ovuloides Reeve[32], described without information as to the locality, appears to be similar to *C. obovale* but was described as possessing sculpture similar to that of *C. graniferum*. *Cardium (Trigoniocardia) cabopasadum* Pilsbry & Olsson[33] from the Pliocene of Ecuador and *Cardium (Trigoniocardia) spiekeri* Hanna & Israelsky from the upper Miocene of Ecuador and Pliocene of Peru are other species of the *C. obovale* group.

Distribution: Specimens of *Cardium obovale* were collected from Cape San Lucas Bay, Lower California, to the Gulf of Chiriqui, Panama, on the beach and dredged at depths of 1.5 to 40 fathoms. The largest number found at any one locality was west of Champerico, Guatemala, in 14 fathoms on a muddy bottom. This species is also known to occur in the Pleistocene of the Tres Marias Islands, and in the Pliocene of Panama and Ecuador.

Subgenus **Laevicardium** Swainson.

Key to the species of *Laevicardium*.

A. Shell large, very convex; radially grooved ..... *elatum*

B. Shell small, more compressed, oblique; smooth or with very fine nearly obsolete ribbing

  a. Elongately trigonal; interior spotted, banded or entirely reddish-brown

    b. Interior entirely reddish-brown or with concentric bands *elenense*

    bb. Interior with reddish-brown spots; shell broader ..... *apicinum*

  aa. Elongately oblique; interior white with a yellow patch under the umbos ..... *clarionense*

Cardium (Laevicardium) clarionense Hertlein & Strong, sp. nov.

Plate I, Figures 5, 6, 7 and 14.

Shell very obliquely ovate, rather compressed, pointed at the beaks, very slightly gaping at the sides; smooth over most of the surface but with fine radial sculpture along the basal margin and at the edges of the resting stages, internally with the basal and the lower half of the anterior margin finely serrated; there is also a narrow posterior area defined by a slight angle exteriorly but scarcely visible internally; exterior light yellowish, variously maculated and spotted with brown, internally with a large yellow patch extending from the beaks to the middle of the shell, a broad white band along the margins; lateral teeth strong, cardinal teeth small, two in the left valve, one in the right. The type measures: maximum vertical diameter, 31.4 mm.; max-

[31] *Cardium (Fragum)* aff. *graniferum* Broderip, Trechtmann, *Geol. Mag.*, Vol. 70 (Whole No. 823), 1933, p. 35. Fossil at Gun Hill, Barbados.

[32] *Cardium ovuloides* Reeve, Conch. Icon., Vol. 2, *Cardium*, March, 1845, species 126, pl. 22, fig. 126. "Hab.—?"

[33] *Cardium (Trigoniocardia) cabopasadum* Pilsbry & Olsson, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 93, September 9, 1941, p. 59, pl. 12, figs. 6, 7. "Jama formation, Puerto Jama." Ecuador, Pliocene.

imum longitudinal diameter, 23.9 mm.; convexity (both valves), 16.5 mm.

Holotype, (California Academy of Sciences Paleo. Type Coll.), from Station 163-D-2, dredged 3 miles off Pyramid Rock, south of Clarion Island, Lat. 18° 19′ N., Long. 114° 45′ W., in 55 fathoms (100 meters), rock and coral bottom. Two complete specimens and three odd valves were dredged at the same locality. Additional specimens were dredged as follows: one valve at Arena Bank (136-D-15), 40 fathoms, mud, crushed shell; one valve at Arena Bank (136-D-28), 85 fathoms, muddy sand; one specimen in Ceralbo Channel (137-D-1), 46 fathoms, rock; one specimen at Santa Inez Bay (143-D-3), 35 fathoms, mud, crushed shell, and two specimens from the same locality but without further information.

Range: Santa Inez Bay, Gulf of California, to Clarion Island, Revillagigedo group.

This species resembles in many ways the young of *Cardium elatum* Sowerby of the same size but is much more oblique and more compressed. It differs from *Cardium elenense* Sowerby in the larger size, more oblique shape and in the coloration, particularly the large internal yellow patch. The largest single specimen of the new species measures: maximum vertical diameter, 41 mm.; maximum longitudinal diameter, 32 mm.

Cardium (Laevicardium) elatum Sowerby.

Cardium elatum Sowerby, *Proc. Zool. Soc. London*, September 8, 1833, p. 84. "Hab. ad Guaymas in Sinu Californiensi." "Found in sandy mud at low water."—Sowerby, Conch. Illustr., *Cardium*, Cat., p. 5, 1840?, pl. 46, fig. 3, issued between July 19, 1833 and January, 1834. "California."—Reeve, Conch. Icon., Vol. 2, *Cardium*, 1844, species 41, pl. 8, fig. 41. "Hab. Bay of California (found on mud-banks at low water)."

Type Locality: Guaymas, Sonora, Mexico, in the Gulf of California, at low water, in sandy mud.

Range: San Pedro, California, to Panama.

Collecting Stations: Mexico: Santa Inez Bay, Monument Station; 1 mile south of San Domingo Point, Concepcion Bay; Banderas Bay.

Description: Shell large, oval, somewhat oblique, very ventricose, yellow, with a thin brownish periostracum; surface ornamented by numerous shallow radiating grooves, but the anterior and posterior margins are smooth; ventral margin serrated and interlocking.

This is the largest Recent species of *Cardium* known. A large specimen from San Diego, California, in the collections of the California Academy of Sciences measures approximately 170 mm. in altitude and Lowe has mentioned a specimen slightly larger (5½ inches long) from the Gulf of California.

Distribution: This species was taken in Santa Inez Bay in the Gulf of California, and at Banderas Bay, Mexico. It has been recorded as occurring south to Panama but we have not seen specimens from south of Tenacatita Bay, west Mexico. It is also known to occur in the Pleistocene of southern California and Lower California and in the archaeologic ruins and middens of southwestern United States.

Cardium (Laevicardium) elenense Sowerby.

Cardium elenense Sowerby, Conch. Illustr., *Cardium*, Cat., p. 6 (*elenensis*), 8 (*elenense*), No. 73, 1840?, pl. 181, fig. 58, issued between June, 1839, and 1841. "St. Elena." [Shaw (*Proc. Malacol. Soc. London*, Vol. 8, 1909, p. 340) cited the date of issue of the Catalogue of *Cardium* in Conch. Illustr., as "*Cardium*. Cat., pp. 1-8, with part 184? 1840?." Tomlin, 1928, cited the Conch. Illustr., as the earliest reference to the present species].—Sowerby, *Proc. Zool. Soc. London* for 1840 (issued May, 1841), p. 109. "Hab. ad Sanctam Elenam. H. Cuming legit." Ref. to Conch. Illustr., fig. 58.—Reeve, Conch. Icon., Vol. 2, *Cardium*, 1845, species 104, pl. 20, fig. 104. "Hab. St. Elena, West Columbia (found in sandy mud at the depth of seven fathoms); Cuming."—E. K. Jordan, *Contrib. Dept. Geol. Stanford Univ.*, Vol. 1, No. 4, 1936, p. 134. Magdalena Bay, Santa Margarita Island and San Ignacio Lagoon, Lower California, Pleistocene. Recent, Gulf of California.

Type Locality: Santa Elena, Ecuador.

Range: Magdalena Bay and the Gulf of California, to Salinas, Ecuador, and the Galápagos Islands.

Collecting Stations: Mexico: Gulf of California; Arena Bank (136-D-6, 30), 35 fathoms, sand, weed; Santa Inez Bay (141-D-2), 10-15 fathoms, sand, weed, (142-D-4), 40-50 fathoms, sand, (143-D-1), 29 fathoms, mud, crushed shell, weed, (144-D-2), 2½ fathoms, sand, weed, rocks, (145-D-1), 13 fathoms, sand, also 1 mile off San Domingo Point, Concepcion Bay; Arena Point Area; San Lucas Bay, off west beach; Cape San Lucas; Port Guatulco (195-D-1, 2, 3, 6, 7, 13, 19), 2.5-17 fathoms, sand, algae, crushed shell, rocks, green mud; Tangola-Tangola Bay (196-D-14), 5 fathoms, crushed shell; Nicaragua: Corinto (200-D-3, 17, 19), 2-13 fathoms, mangrove leaves, sand, also on beach; Costa Rica: Port Parker (203-D-1, 2, 3, 4-15), 1-15 fathoms, sandy mud, crushed shell, shelly mud, algae, gravel, rocks, coral; Cedro Island, Gulf of Nicoya (213-D-1-10), 4-10 fathoms, mud, sand, crushed shell; Golfito, Gulf of Dulce (218-D-8), 6 fathoms,

graniferum were collected at various localities from the Gulf of California to Panama on beaches and dredged at depths of 4 to 18 fathoms. The largest number of specimens was found in the beach drift at Corinto, Nicaragua. It is also known to occur in the Pleistocene of Magdalena Bay, Lower California, and Panama and in the Pliocene of Ecuador. A fossil form cited as "*Cardium* (*Fragum*) aff. *graniferum* Broderip"[31] has been recorded from Barbados Island.

Cardium (Trigoniocardia) obovale Sowerby.

Cardium obovale Sowerby, *Proc. Zool. Soc. London*, September 8, 1833, p. 84. "Hab. ad oras Americae Meridionalis. (Xipixapi)." "Found in sandy mud at eleven fathoms depth."—Sowerby, Conch. Illustr., *Cardium*, Cat., p. 7, 1840?, pl. 46, fig. 4, issued between July 19, 1833, and January, 1834. "Xipixapi. Mr. Cuming."—Reeve, Conch. Icon., Vol. 2, *Cardium*, 1845, species 117, pl. 21, fig. 117. Original locality cited.—Hertlein, *Bull. South. Calif. Acad. Sci.*, Vol. 33, Pt. 2, May-August (issued August 31), 1934, p. 62, pl. 21, fig. 14. Maria Magdalena Island, Tres Marias group, Mexico, Pleistocene.

Type Locality: Xipixapi (Jipijapa), Ecuador, in 11 fathoms, sandy mud.

Range: Magdalena Bay, Lower California, and the Gulf of California to Salinas, Ecuador.

Collecting Stations: Mexico: San Lucas Bay (135-D-2), 8-16 fathoms, sand; 17 mi. S. E. of Acapulco (189-D-3), 13 fathoms, mud; Guatemala: 7 mi. W. of Champerico (197-D-1, 2), 14 fathoms, mud; El Salvador: La Libertad (198-D-1, 2), 13-14 fathoms, mud; Nicaragua: Corinto (200-D-10, 11, 16, 19, 20-26), 1.5-13 fathoms, mangrove leaves, sand, also on beach; Panama: Gulf of Chiriqui (221-D-1-5), 35-40 fathoms, sand, mud.

Description: Shell small, subovate, obl'que, fairly convex and peaked, ornamented by about 21 finely noded radial ribs, those anteriorly and posteriorly somewhat broadly and asymmetrically triangular, those along the posterior umbonal ridge higher and rounded, those on the posterior area, about 8 in number, flatter, narrower and closer together than those on the anterior area; interspaces transversely grooved. A large specimen in the collection of the California Academy of Sciences from near Isabel Island, west Mexico, measures, approximately, 20.5 mm. in altitude, 14 mm. in length, convexity (one valve) 8 mm.

Cardium ovuloides Reeve[32], described without information as to the locality, appears to be similar to *C. obovale* but was described as possessing sculpture similar to that of *C. graniferum*. *Cardium* (*Trigoniocardia*) *cabopasadum* Pilsbry & Olsson[33] from the Pliocene of Ecuador and *Cardium* (*Trigoniocardia*) *spiekeri* Hanna & Israelsky from the upper Miocene of Ecuador and Pliocene of Peru are other species of the *C. obovale* group.

Distribution: Specimens of *Cardium obovale* were collected from Cape San Lucas Bay, Lower California, to the Gulf of Chiriqui, Panama, on the beach and dredged at depths of 1.5 to 40 fathoms. The largest number found at any one locality was west of Champerico, Guatemala, in 14 fathoms on a muddy bottom. This species is also known to occur in the Pleistocene of the Tres Marias Islands, and in the Pliocene of Panama and Ecuador.

Subgenus **Laevicardium** Swainson.

Key to the species of *Laevicardium*.

A. Shell large, very convex; radially grooved ..... *elatum*

B. Shell small, more compressed, oblique; smooth or with very fine nearly obsolete ribbing

  a. Elongately trigonal; interior spotted, banded or entirely reddish-brown

    b. Interior entirely reddish-brown or with concentric bands *elenense*

    bb. Interior with reddish-brown spots; shell broader ..... *apicinum*

  aa. Elongately oblique; interior white with a yellow patch under the umbos ..... *clarionense*

Cardium (Laevicardium) clarionense Hertlein & Strong, sp. nov.

Plate I, Figures 5, 6, 7 and 14.

Shell very obliquely ovate, rather compressed, pointed at the beaks, very slightly gaping at the sides; smooth over most of the surface but with fine radial sculpture along the basal margin and at the edges of the resting stages, internally with the basal and the lower half of the anterior margin finely serrated; there is also a narrow posterior area defined by a slight angle exteriorly but scarcely visible internally; exterior light yellowish, variously maculated and spotted with brown, internally with a large yellow patch extending from the beaks to the middle of the shell, a broad white band along the margins; lateral teeth strong, cardinal teeth small, two in the left valve, one in the right. The type measures: maximum vertical diameter, 31.4 mm.; max-

[31] *Cardium* (*Fragum*) aff. *graniferum* Broderip, Trechtmann, *Geol. Mag.*, Vol. 70 (Whole No. 823), 1933, p. 35. Fossil at Gun Hill, Barbados.

[32] *Cardium ovuloides* Reeve, Conch. Icon., Vol. 2, *Cardium*, March, 1845, species 126, pl. 22, fig. 126. "Hab.—?"

[33] *Cardium* (*Trigoniocardia*) *cabopasadum* Pilsbry & Olsson, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 93, September 9, 1941, p. 59, pl. 12, figs. 6, 7. "Jama formation, Puerto Jama." Ecuador, Pliocene.

imum longitudinal diameter, 23.9 mm.; convexity (both valves), 16.5 mm.

Holotype, (California Academy of Sciences Paleo. Type Coll.), from Station 163-D-2, dredged 3 miles off Pyramid Rock, south of Clarion Island, Lat. 18° 19′ N., Long. 114° 45′ W., in 55 fathoms (100 meters), rock and coral bottom. Two complete specimens and three odd valves were dredged at the same locality. Additional specimens were dredged as follows: one valve at Arena Bank (136-D-15), 40 fathoms, mud, crushed shell; one valve at Arena Bank (136-D-28), 85 fathoms, muddy sand; one specimen in Ceralbo Channel (137-D-1), 46 fathoms, rock; one specimen at Santa Inez Bay (143-D-3), 35 fathoms, mud, crushed shell, and two specimens from the same locality but without further information.

Range: Santa Inez Bay, Gulf of California, to Clarion Island, Revillagigedo group.

This species resembles in many ways the young of *Cardium elatum* Sowerby of the same size but is much more oblique and more compressed. It differs from *Cardium elenense* Sowerby in the larger size, more oblique shape and in the coloration, particularly the large internal yellow patch. The largest single specimen of the new species measures: maximum vertical diameter, 41 mm.; maximum longitudinal diameter, 32 mm.

Cardium (Laevicardium) elatum Sowerby.

Cardium elatum Sowerby, *Proc. Zool. Soc. London*, September 8, 1833, p. 84. "Hab. ad Guaymas in Sinu Californiensi." "Found in sandy mud at low water."—Sowerby, Conch. Illustr., *Cardium*, Cat., p. 5, 1840?, pl. 46, fig. 3, issued between July 19, 1833 and January, 1834. "California."—Reeve, Conch. Icon., Vol. 2, *Cardium*, 1844, species 41, pl. 8, fig. 41. "Hab. Bay of California (found on mud-banks at low water)."

Type Locality: Guaymas, Sonora, Mexico, in the Gulf of California, at low water, in sandy mud.

Range: San Pedro, California, to Panama.

Collecting Stations: Mexico: Santa Inez Bay, Monument Station; 1 mile south of San Domingo Point, Concepcion Bay; Banderas Bay.

Description: Shell large, oval, somewhat oblique, very ventricose, yellow, with a thin brownish periostracum; surface ornamented by numerous shallow radiating grooves, but the anterior and posterior margins are smooth; ventral margin serrated and interlocking.

This is the largest Recent species of *Cardium* known. A large specimen from San Diego, California, in the collections of the California Academy of Sciences measures approximately 170 mm. in altitude and Lowe has mentioned a specimen slightly larger (5½ inches long) from the Gulf of California.

Distribution: This species was taken in Santa Inez Bay in the Gulf of California, and at Banderas Bay, Mexico. It has been recorded as occurring south to Panama but we have not seen specimens from south of Tenacatita Bay, west Mexico. It is also known to occur in the Pleistocene of southern California and Lower California and in the archaeologic ruins and middens of southwestern United States.

Cardium (Laevicardium) elenense Sowerby.

Cardium elenense Sowerby, Conch. Illustr., *Cardium*, Cat., p. 6 (*elenensis*), 8 (*elenense*), No. 73, 1840?, pl. 181, fig. 58, issued between June, 1839, and 1841. "St. Elena." [Shaw (*Proc. Malacol. Soc. London*, Vol. 8, 1909, p. 340) cited the date of issue of the Catalogue of *Cardium* in Conch. Illustr., as "*Cardium*. Cat., pp. 1-8, with part 184? 1840?." Tomlin, 1928, cited the Conch. Illustr., as the earliest reference to the present species].—Sowerby, *Proc. Zool. Soc. London* for 1840 (issued May, 1841), p. 109. "Hab. ad Sanctam E'enam. H. Cuming legit." Ref. to Conch. Illustr., fig. 58.—Reeve, Conch. Icon., Vol. 2, *Cardium*, 1845, species 104, pl. 20, fig. 104. "Hab. St. Elena, West Columbia (found in sandy mud at the depth of seven fathoms); Cuming."—E. K. Jordan, *Contrib. Dept. Geol. Stanford Univ.*, Vol. 1, No. 4, 1936, p. 134. Magdalena Bay, Santa Margarita Island and San Ignacio Lagoon, Lower California, Pleistocene. Recent, Gulf of California.

Type Locality: Santa Elena, Ecuador.

Range: Magdalena Bay and the Gulf of California, to Salinas, Ecuador, and the Galápagos Islands.

Collecting Stations: Mexico: Gulf of California; Arena Bank (136-D-6, 30), 35 fathoms, sand, weed; Santa Inez Bay (141-D-2), 10-15 fathoms, sand, weed, (142-D-4), 40-50 fathoms, sand, (143-D-1), 29 fathoms, mud, crushed shell, weed, (144-D-2), 2½ fathoms, sand, weed, rocks, (145-D-1), 13 fathoms, sand, also 1 mile off San Domingo Point, Concepcion Bay; Arena Point Area; San Lucas Bay, off west beach; Cape San Lucas; Port Guatulco (195-D-1, 2, 3, 6, 7, 13, 19), 2.5-17 fathoms, sand, algae, crushed shell, rocks, green mud; Tangola-Tangola Bay (196-D-14), 5 fathoms, crushed shell; Nicaragua: Corinto (200-D-3, 17, 19), 2-13 fathoms, mangrove leaves, sand, also on beach; Costa Rica: Port Parker (203-D-1, 2, 3, 4-15), 1-15 fathoms, sandy mud, crushed shell, shelly mud, algae, gravel, rocks, coral; Cedro Island, Gulf of Nicoya (213-D-1-10), 4-10 fathoms, mud, sand, crushed shell; Golfito, Gulf of Dulce (218-D-8), 6 fathoms,

mangrove leaves, mud, shells; Panama: Bahia Honda (222), 3-11 fathoms, rocks, coral, shells, green mud, leaves.

Description: Shell thin, smooth, oval, gently inflated, externally colored reddish-yellow and brown, with brown or purple dots, interiorly with reddish-brown bands or, in some specimens, almost completely reddish-brown. Weathered specimens usually show the presence of fine radial sculpture. Height about 20 mm.

Cardium elenense is very similar to the subspecies *C. elenense apicinum* Carpenter but appears to be narrower in form and is exteriorly ornamented by more color of yellow with reddish-brown bands on the beaks and the interior is more completely colored reddish-brown or with concentric bands rather than spotted and blotched as in *C. elenense apicinum*. *Cardium elenense* is similar to the generally more northern *C. substriatum* Conrad, from southern California, but is smaller and is colored reddish-brown exteriorly while Conrad's species never shows more than obscure markings upon a yellowish-gray background.

A number of species of this group occur both Recent and fossil in the Caribbean region.

Distribution: *Cardium elenense* was collected at many localities from the Gulf of California to Panama, on the beach and at depths of 1 to 50 fathoms. The largest number of specimens, approximately 200, were dredged in Santa Inez Bay in 13 fathoms on a sandy bottom. The species has also been cited as occurring in the Pleistocene of Lower California, the Tres Marias Islands and Panama, and in the Pliocene of Ecuador.

Cardium (Laevicardium) elenense apicinum Carpenter.

Levicardium apicinum Carpenter, *Ann. & Mag. Nat. Hist.*, Ser. 3, Vol. 13, April, 1864, p. 313. Cape St. Lucas, Lower California. Reprint in *Smithson. Miscell. Coll.*, No. 252, 1872, p. 211. See also pp. 23, 104, 261 (as *Liocardium apicinum*).

Cardium (Liocardium) apicinum Carpenter, Stearns, *Proc. U. S. Nat. Mus.*, Vol. 17, 1894, p. 151. Boca de las Piedras; Mulege Bay; Cape San Lucas; Mazatlan.

Cardium apicinum Carpenter, Strong and Hanna, *Proc. Calif. Acad. Sci.*, Ser. 4, Vol. 19, No. 3, 1930, p. 15. Maria Madre Island, Tres Marias Islands.

Type Locality: Cape San Lucas, Lower California.

Range: Gulf of California to Isla Grande, West Mexico, and probably to Peru.

Collecting Station: Mexico: Arena Bank (136-D-30), 35 fathoms, sand, weed.

Description: The form described as *Cardium apicinum* by Carpenter appears to intergrade with *C. elenense* Sowerby but some of the northern specimens appear to be separable as a subspecies. They are broader with more spotted coloring both exteriorly and interiorly. Specimens of *C. elenense* from Santa Elena, Ecuador, are externally more yellowish in color with reddish-brown concentric bands on the beaks and the interior is almost completely dark reddish-brown or with concentric bands of this color.

Distribution: Specimens of this subspecies were dredged by the Expedition on Arena Bank, in 35 fathoms, on a sand and weed bottom.

Subgenus *Dinocardium* Dall.

Cardium (Dinocardium) robustum Solander.

Cardium magnum Born, *Mus. Caes. Vind.*, 1780, p. 46, pl. 3, fig. 5. "Habitat ad Jamaicam, Linnaeus."—Reeve, Conch. Icon., Vol. 2, *Cardium*, 1844, species 20, pl. 4, fig. 20. "Hab. Gulf of Mexico."

Not *Cardium magnum* Linnaeus, Syst. Nat., ed. 10, 1758, p. 680. "Habitat ad Jamaicam."

Cardium robustum Solander, Cat. Portland Mus., 1786, p. 58, No. 1358, p. 162, No. 3517. "A large and fine *Cardium robustum*, S. from Florida, very scarce—Lister, 328. 165."

Cardium (Dinocardium) robustum Solander, McLean, *Mem. Soc. Cubana Hist. Nat.*, Vol. 13, No. 3, June, 1939, p. 163, pl. 24, figs. 10-11. Virginia to Belize, British Honduras and in the West Indies south to Jamaica.

Type Locality: Florida.

Range: Virginia to Belize, British Honduras, and in the West Indies south to Jamaica.

Collecting Station: Mexico: Santa Inez Bay, Gulf of California.

Description: One valve of *Cardium robustum* was collected at Santa Inez Bay. This is a Caribbean species and has not been recorded as occurring in the Gulf of California. The specimen was probably brought to the Gulf of California by some adventitious means. It is interesting to note that this species has been reported by Brand[34] as occurring in archaeologic ruins and middens of southwest United States along with other undoubted east American shells. The shape, ribbing and color of the specimen is typical and agrees perfectly with specimens in the collections of the California Academy of Sciences which were collected in Florida by Henry Hemphill.

Distribution: *Cardium robustum* is a Caribbean species and occurs in that region from Virginia to British Honduras and in the West Indies to Jamaica. It has also been

[34] Brand, D. D., Yearbook Assoc. Pac. Coast Geogr., Vol. 4, 1938, p. 5.

reported from upper Miocene to Recent in that region.

Subgenus ***Trachycardium*** Mörch.

Cardium (Trachycardium) consors Sowerby.

Cardium consors Sowerby, *Proc. Zool. Soc. London*, September 8, 1833, p. 85. "Hab. ad Sanctam Elenam et ad Guacamayo." "Collected in sandy mud at from six to eleven fathoms."—Sowerby, Conch. Illustr., *Cardium*, Cat., p. 3, 1840?, pl. 47, fig. 8, issued between July 19, 1833, and January, 1834. Original locality cited.—Reeve, Conch. Icon., Vol. 2, *Cardium*, 1845, species 86, pl. 17, fig. 86. Original locality cited.

Type Locality: Santa Elena, Ecuador, in 6 to 11 fathoms, sandy mud (here designated as type locality). "Guacamayo" also cited originally.

Range: Gulf of California to Guayaquil, Ecuador, and the Galápagos Islands.

Collecting Stations: Mexico: Arena Point (136-D-32), 42 fathoms, sand; Ceralbo Island; Santa Inez Bay, and at Monument Station; Chamela Bay (182-D-1), 8 fathoms, sand, algae; Sihuatanejo Bay; Port Guatulco (195-D-2, 3, 5, 8, 11, 19) 2-17 fathoms, sand, crushed shell, algae, green sand, green mud, also on beach; Tangola-Tangola Bay (196-D-6, 7, 8, 14, 15), 5-9 fathoms, sand, crushed shell; Costa Rica: Port Parker; Golfito; Panama: Bahia Honda.

Description: Shell elongately oval, very convex, thick, somewhat oblique and gaping posteriorly; ornamented by about 30 to 34 strong, elevated, radial ribs which bear strong, close-set squamose imbrications which are compressly flattened on the posterior side, extend over the top, but are absent on the anterior side of the ribs; colored yellowish-white stained with brown especially on the posterior portion, the interior colored reddish-purple with white along the margins. Large shells attain a height of about 75 mm.

A variety of this species said to be more elongated and with the imbrications rather distant from each other was named *laxum* by Dall[35]. *Cardium isocardia* Linnaeus, which occurs in the Caribbean region, is similar to *C. consors*, as is *C. emmonsi* Conrad in the Pliocene of North Carolina.

Distribution: *Cardium consors* was collected at a number of localities from the Gulf of California to Panama on the beach and dredged at depths of 2 to 24 fathoms. It occurs commonly in that region. It is also known to occur in the Pliocene and Pleistocene of the Gulf of California region, and has been cited from the Quaternary of Manta, Ecuador.

[35] Dall, W. H., *Proc. U. S. Nat. Mus.*, Vol. 23, No. 1214, January, 1901, p. 389. Gulf of California.

Subgenus ***Acrosterigma*** Dall.

Cardium (Acrosterigma) pristipleura Dall.

Cardium maculosum Sowerby, *Proc. Zool. Soc. London*, September 8, 1833, p. 85. "Hab. ad Insulas Tres Marias, in Sinu Californiensi." "Found on the sands."

Not *Cardium maculosum* Wood, 1815.

Cardium maculatum Sowerby, Conch. Illustr., *Cardium*, Cat., p. 4, 1840?, pl. 49, fig. 18, January, 1834. "California." New name for *Cardium maculosum* Sowerby, not *C. maculosum* Wood.—Reeve, Conch. Icon.; Vol. 2, *Cardium*, 1844, species 58, pl. 11, fig. 58. "Hab. Island of Tres Marias, Gulf of Mexico."

Not *Cardium maculatum* Gmelin, 1792.

Cardium (*Trachycardium*) *pristipleura* Dall, *Proc. U. S. Nat. Mus.*, Vol. 23, 1901, p. 389. "Range: Gulf of California (La Paz) and west coast of Middle America." A new name for *Cardium maculosum* Sowerby, 1833, not *C. maculosum* Wood, 1815. *Cardium maculatum* "Reeve" not *C. maculatum* Gmelin.

Cardium (*Trachycardium*) *hornelli* Tomlin, *Jour. Conch.*, Vol. 18, No. 7, May, 1928, p. 194. "Gorgona" Island, Colombia, on shore. A new name for *Cardium maculosum* Sowerby, not *C. maculosum* Wood; *C. maculatum* Sowerby, not *C. maculatum* Gmelin.

Type Locality: Tres Marias Islands, west Mexico, on the sands.

Range: Gulf of California to Guayaquil, Ecuador.

Collecting Stations: Mexico: Ceralbo Island, Gulf of California; Port Guatulco (195-D-6, 18), 3-6 fathoms, sand, algae, crushed shell; Tangola-Tangola Bay, on beach; Panama: Bahia Honda; Colombia: Gorgona Island.

Description: Shell elongately obliquely ovate, gently convex; ornamented by 34 to 39 flattened, laterally imbricated ribs; colored exteriorly whitish-yellow and reddish-brown, the interior white. Height about 60-70 mm.

Distribution: Specimens of this species were collected from west Mexico to Colombia, on the beach and dredged at depths of 3-6 fathoms, usually only one or two specimens at a locality.

Subgenus ***Dallocardia*** Stewart.

Cardium (Dallocardia) senticosum Sowerby.

Cardium senticosum Sowerby, *Proc. Zool. Soc. London*, September 8, 1833, p. 84. "Hab. ad Sanctam Elenam, Americae Meridionalis." "Found in sandy mud at from six to twelve fathoms depth."—Sowerby, Conch. Illustr., *Cardium*, Cat., p. 3, 1840?, pl. 47, fig. 10, issued between July 19, 1833, and January, 1834. "St. Elena."

Cardium rastrum Reeve, Conch. Icon., Vol. 2, *Cardium*, 1845, species 82, pl. 16, fig. 82.

"Hab.—?." Referred to *Cardium senticosum* in errata.

Type Locality: Santa Elena, Ecuador, in 6 to 12 fathoms, sandy mud.

Range: West coast of Lower California in about Lat. 24° N., and the Gulf of California, to Paita, Peru.

Collecting Stations: Mexico: Port Guatulco (195-D-7, 14), 4-4.5 fathoms, rocks, coral; Guatemala: 7 mi. W. of Champerico (197-D-1, 2), 14 fathoms, mud; El Salvador: La Libertad (198-D-1, 2), 13-14 fathoms, mud; Meanguera Island, Gulf of Fonseca (199-D-1), 16 fathoms sand, mud, crushed shell; Nicaragua: Potosi and Monypenny Point, Gulf of Fonseca (199-D-6), 4 fathoms, mud; Corinto (200-D-10, 11, 19), 7-13 fathoms, sand, mangrove leaves; Costa Rica: Cedro Island, Gulf of Nicoya (213-D-1-10), 4-10 fathoms, mud, sand, crushed shell; Jasper Island; Golfito Bay, Gulf of Dulce; Panama: Gulf of Chiriqui (221-D-1-5), 35-40 fathoms, sandy mud.

Description: Shell rounded, gently convex, ornamented with 36 to 39 ribs which in their earlier stages are subtriangular but later become subrounded; the ribs bear obliquely projecting scale-like imbrications which toward the ventral margin develop into oblique nodes; on the central ribs the nodes are strongly developed on the posterior side, although on some specimens, they are also present, but to a lesser degree, on the anterior side; on the anterior ribs nodes may be present on top or on the anterior side while on the posterior ribs they are strongly developed on the posterior side; exteriorly the color is brownish-white and banded or spotted with reddish-brown or purple, interiorly the portion under the umbones is usually reddish-purple; the remainder, and sometimes all of the shell, is white. The shell attains an altitude of 40 mm. Some specimens from off Guatemala in 14 fathoms on a muddy bottom are thinner and less colored than the other specimens.

Cardium muricatum Linnaeus from the western Atlantic is a similar species. Möricke has considered *Cardium auca* d'Orbigny from the Tertiary of Chile to be a subspecies of *C. senticosum*. We have not seen specimens of the fossil form from Chile.

Distribution: Specimens of *Cardium senticosum* were collected from West Mexico to Panama, on the beach and dredged from depths of 4 to 40 fathoms, mostly on muddy bottoms. The largest number of specimens was taken off Meanguera Island in the Gulf of Fonseca in 16 fathoms. This species is also known to occur in the Pleistocene of Maria Magdalena Island, Tres Marias group, also Panama and Ecuador.

Superfamily Cyrenacea.

Family Corbiculidae.

Genus *Polymesoda* Rafinesque.

A monograph of the American Corbiculidae by Prime[36] is very useful as an aid in the identification of the American species of *Polymesoda*.

Key to the species of *Polymesoda*.

A. Posteriorly attenuated and pointed ..... *anomala*

B. Posteriorly subrounded and slightly truncated ..... *recluzii*

Polymesoda anomala Deshayes.

Cyrena anomala Deshayes, *Proc. Zool. Soc. London* for 1854 (issued January 10, 1855), p. 21. "Hab. Bay of Caraccas; Peru."—Deshayes, Cat. Conch. Bivalve Shells Brit. Mus., Pt. 2, 1854, p. 257. "Hab. Sinus Caraccasensis et ad oras Peruvianas. Coll Cuming."—Prime, *Smithson. Miscell. Coll.*, Vol. 7, Article 5, No. 145, 1865, p. 30, fig. 24. "Hab. South America in Peru. (Cabinets of Cuming and Prime.)"—Sowerby, Conch. Icon., Vol. 20, *Cyrena*, 1878, species 109, pl. 19, fig. 109. "Hab. Bay of Caraccas."

Cyrena peruviana Deshayes, Cat. Conch. Bivalve Shells Brit. Mus., Pt. 2, 1854, p. 259. "Hab. Tumbez in littore Peruviano. Coll. Cuming."

Type Locality: Bay of Caraccas, Ecuador (here designated as type locality). Peru also cited originally.

Range: Corinto, Nicaragua, to Tumbez, Peru.

Collecting Stations: Nicaragua: Corinto, Castanones peninsular lagoon, also Isla Encantada; Colombia: Gorgona Island.

Description: Shell subtrigonal, thin, umbos inflated, anterior end rounded, ventral margin evenly rounded, posterior end attenuated and pointed, umbos with a carina posteriorly from which the shell slopes steeply to the margin; periostracum olive green in color and raised in crenulated, concentric lamellae; hinge area narrow; the hinge area, also the interior of the shell under the umbos, is purple, the remainder white.

Distribution: The present record of this species from Corinto, Nicaragua, is an extension north of the known range. It occurs in brackish water.

Polymesoda recluzii Prime.

Cyrena cordiformis Recluz, *Journ. de Conchyl.*, Vol. 4, December, 1853, p. 251, pl. 7, fig. 9. [No locality cited].—Deshayes, Cat. Conch. Bivalve Shells Brit. Mus., Pt. 2,

[36] Prime, T. Monograph of the American Corbiculidae. *Smithson. Miscell. Coll.*, Vol. 7, Article 5, No. 145, December, 1865, pp. I-XI, 1-80, 86 figs. in text.

1854, p. 259. "Hab.—?"—Sowerby, Conch. Icon., Vol. 20, *Cyrena*, 1878, species 27, pl. 8, figs. 27a, 27b. "Payta, Peru."

Not *Cyrena cordiformis* Deshayes, Dict. Class. Hist. Nat., Vermes, 1824, p. 290.

Cyrena recluzii Prime, *Smithson. Miscell. Coll.*, Vol. 7, Article 5, No. 145 (Mon. Amer. Corbiculidae), December, 1865, p. 24, fig. 19. "Hab. Central America. (Cabinet of Cuming.)"

Polymesoda inflata var. *cordiformis* Recluz, von Martens, Biol. Centrali-Americana, (Land and Freshwater Moll.), October, 1900, p. 549. "Hab. ?Central America."

Type Locality: Central America.

Range: Puntarenas, Costa Rica, to Paita, Peru.

Collecting Stations: Costa Rica: Puntarenas; Puntarenas Lagoon; Ballenas Bay, Gulf of Nicoya.

Description: Shell subtrigonal, heart-shaped, inflated, moderately thick; posterior angulation present, a gentle depressed or flattened area posterior to the angulation; exteriorly covered with a dark olive green periostracum raised in irregular concentric lamellae; hinge with three cardinals and two right laterals, interior purple near the posterior margin, also small patches on posterior part of hinge and below beaks, the remainder white tinged with purple bands showing through from the other side.

"Cyrena" maratima C. B. Adams was considered to be identical with *Polymesoda recluzii* by von Martens. He also pointed out that *P. recluzii* differs from *P. panamensis* Prime[37] in that the shell is more angulated posteriorly below the furrow. Both *P. recluzii* (cited as *cordiformis*) and *P. panamensis* were considered by von Martens to be only varieties of *P. inflata* Philippi, a species in which it appears that the shell lacks a distinct posterior furrow. *Polymesoda isocardioides* Deshayes is very similar to *P. recluzii* but according to Prime it possesses a thinner shell, narrower hinge margin and smaller teeth.

Distribution: A few specimens of *Polymesoda recluzii* were collected by the Expedition at Puntarenas and at Ballenas Bay in the Gulf of Nicoya, Costa Rica. It occurs in brackish water and ranges south to Peru.

[37] Not to be confused with *Cyrenoida panamensis* Pilsbry & Zetek, *Nautilus*, Vol. 45, No. 2, October, 1931, p. 69, pl. 3, fig. 4. "Near Panama City."

EXPLANATION OF THE PLATE.

PLATE I.

Fig. 1. *Taras* (*Taras*) *inezensis* Hertlein & Strong, sp. nov. Holotype, right valve, from Station 146-D-1, Santa Inez Bay, east coast of Lower California, Mexico. Lat 26° 54′ 20″ N., Long. 111° 48′ 45″ W., dredged in 55 fatnoms (64 meters). Length, 18.4 mm.; height, 16.9 mm. P. 130.

Fig. 2. *Chama sordida* Broderip. Hypotype, lower valve, from Station 136-D-13, Arena Bank, Gulf of California, Lat. 23° 29′ N., Long. 109° 24 ′ W., dredged in 45 fathoms (82 meters). Height, 44 mm. (including *Arca* shell [shown on upper portion of figure] to which the *Chama* is attached).

This species was discussed in *Zoologica*, New York Zool. Soc., Vol. 31(8):109.

Fig. 3. *Cardium* (*Lophocardium*) *annettae* Dall. Hypotype, left valve, from Station 143-D-2, Santa Inez Bay, east coast of Lower California, Lat. 26° 58′ N., Long. 111° 56′ 30″ W., dredged in 30 fathoms (55 meters). Length, 41 mm.; height, 35.5 mm. P. 138.

Fig. 4. *Taras* (*Taras*) *inezensis* Hertlein & Strong, sp. nov. View of the interior of the specimen shown in Figure 1.

Fig. 5. *Cardium* (*Laevicardium*) *clarionense* Hertlein & Strong, sp. nov. Holotype, left valve, from Station 163-D-2, 3 miles off Pyramid Rock, Clarion Island, Lat. 18° 19′ N., Long. 114° 45′ W., dredged in 55 fathoms (100 meters). Length, 23.9 mm.; height, 31.4 mm. View of the interior. P. 144.

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Fig. 12. *Cardium* (*Microcardium*) *pazianum* Dall. Hypotype, left valve of specimen shown in Figure 9.

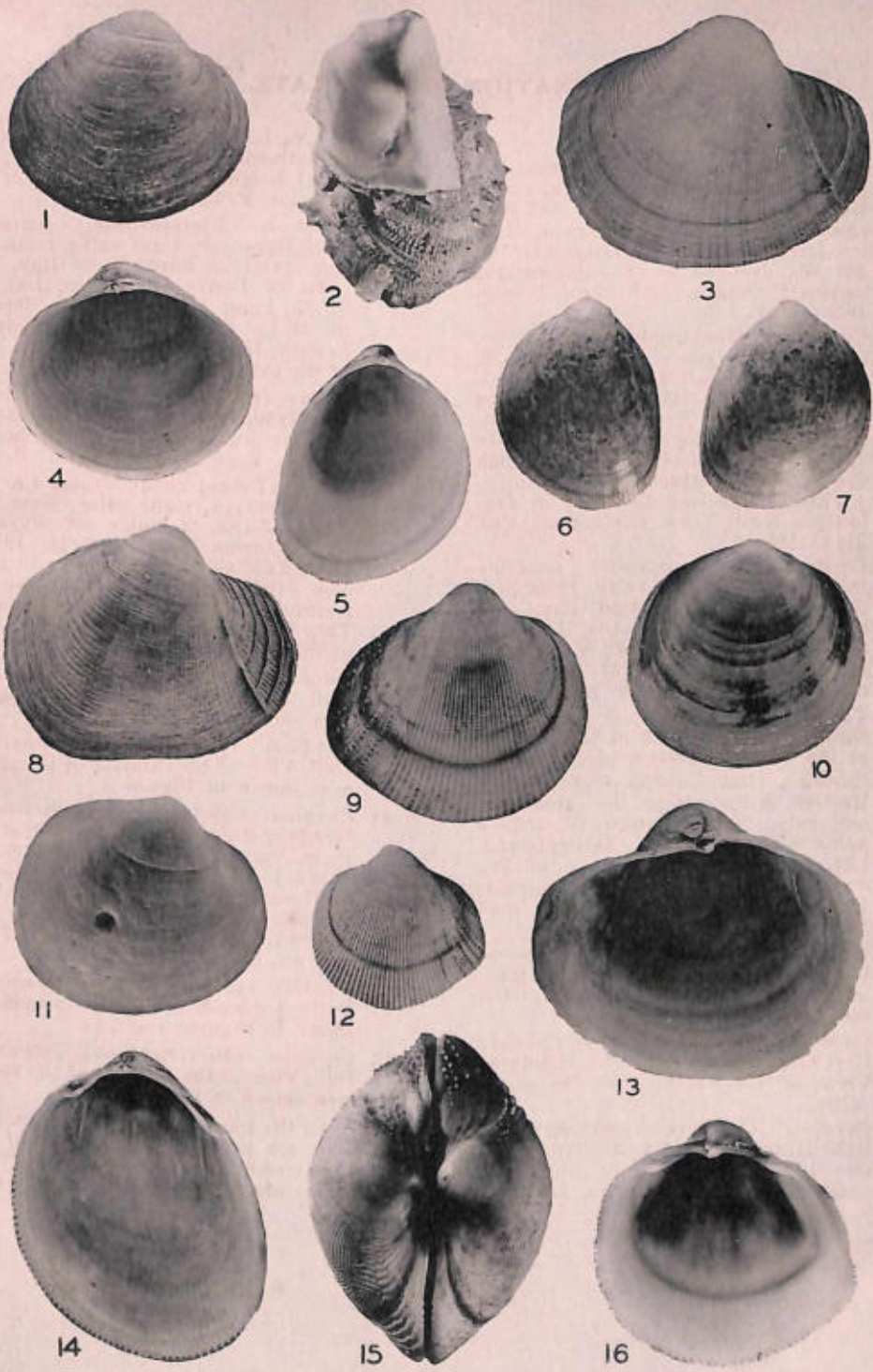
Fig. 13. *Cardium* (*Lophocardium*) *annettae* Dall. View of the interior of the specimen shown in Figure 3.

Fig. 14. *Cardium* (*Laevicardium*) *clarionense* Hertlein & Strong, sp. nov. Paratype, right valve, from Station 143-D-3, Santa Inez Bay, east coast of Lower California, Lat. 26° 57′ N., Long. 111° 56′ W., dredged in 35 fathoms (64 meters). Height, 41 mm. View of the interior. P. 144.

Fig. 15. *Cardium* (*Microcardium*) *pazianum* Dall. Umbonal view of specimens shown in Figures 9 and 12.

Fig. 16. *Cardium* (*Microcardium*) *pazianum* Dall. View of the interior of the specimen shown in Figure 9.

All the specimens illustrated on this plate are in the type collection of the Department of Paleontology of the California Academy of Sciences.



MOLLUSKS FROM THE WEST COAST OF MEXICO AND CENTRAL AMERICA.

11.

Eastern Pacific Expeditions of the New York Zoological Society. XXXVII. Deep-sea Ceratioid Fishes[1].

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Department of Tropical Research, New York Zoological Society.

(Plates I-III. Text-figures 1-19.)

[This is the thirty-seventh of a series of papers dealing with the collections of the Eastern Pacific Expeditions of the New York Zoological Society made under the direction of William Beebe. The present paper is concerned with specimens taken on the *Arcturus* Oceanographic Expedition (1925), the Templeton Crocker Expedition (1936) and the Eastern Pacific *Zaca* Expedition (1937-1938). For data on localities, dates, nets, etc., refer to *Zoologica*, Vol. VIII, No. 1, pp. 1-22; Vol. XXII, No. 2, pp. 33-46; and Vol. XXIII, No. 14, pp. 287-298.]

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INTRODUCTION.

The twenty-four species discussed in this paper include ten forms apparently new. In addition, a group of ten free-swimming linophrynid males are referred to *Ceratias* spp. because the inadequacy of present knowledge makes further division too tentative to be practicable. Rather, it seems more profitable to treat the group as a unit, suggesting the use of various hitherto unused characters as indices of either growth stages or specific distinctions.

[1] Contribution No. 745, Department of Tropical Research, New York Zoological Society.

With the possible exception of several *Dolopichthys*, the only specimens young enough to be referable to post-larvae and young adolescents are a few of these *Ceratias*. The indications of youth are very similar to those found in corresponding stages of other deep-sea fish previously studied (See especially *Zoologica*, Vol. XVI, No. 1, 1933, general discussion; and *Zoologica*, Vol. XXIV, No. 6, 1939, Melanostomiatids). The post-larvae are distinguished by the general character of imperfectly differentiated pectorals and/or the remains of larval finfolds and by the persistence of apparently larval teeth. Typically male ceratioid characters of this stage are great inflation of the dermal envelope, almost normal eyes and small nostrils.

Adolescence is distinguished by the general characters of disappearance of true finfolds and complete differentiation of pectorals, and by the male ceratioid characters of reduced inflation, eyes gradually revolving forward and down, expansion of nostrils, and the beginning of gonad growth.

The majority of the ceratioids in this paper, as usual in deep-sea fish collections, are transitional adolescents. That is, they are in the long period of pre-adult growth where practically adult appearance has been assumed, but with immaturity shown internally by the small size of the gonads and, in the case of males of parasitic families, by the non-degenerate digestive organs. Only two attached males were taken, each found on a large *Borophryne apogon*. Since both sexes of one pair were found to be very immature internally, attachment obviously cannot strictly speaking be called an indication of adulthood.

We wish to emphasize here the necessity of examining the internal organs of ceratioids, in order that growth characters may eventually be properly distinguished from those of taxonomic importance.

The field notes on color and luminescence were all made by the senior author on freshly caught specimens, only a few minutes after their removal from the net. In some cases, always specially mentioned in the text, the fish were still living.

Family Melanocetidae.

Melanocetus ferox Regan, 1926.

Reference: *Melanocetus ferox* Regan, 1926, p. 33, pl. ix, fig. 1; Regan & Trewavas, 1932, p. 52, text-fig. 75.

Range: Eastern Pacific; Gulf of Panama. The present specimens are the first taken outside the Gulf.

Specimens Taken by the Eastern Pacific Expeditions: Two specimens, from 300 and 500 fathoms, off Costa Rica and Galápagos Islands, respectively; lengths 33.5 (22+11.5) mm. and 23.5 (15+8.5) mm.; young transitional adolescents.

Color (living specimens): Smaller brownish-black, larger pale brown; all fins, eye sockets, gill openings and illicium stem colorless to grayish-white; bulb black in smaller, dark blue in larger; envelope and distal, conical projection translucent white in smaller, translucent and colorless in larger.

Luminescence: The illicium bulb of the smaller fish gave off two weak flashes of whitish light in the dark room, when a few drops of weak formalin were added to the water. Both fishes died within a few minutes of capture.

Measurements: 23.5 mm. specimen: mandible 9.9 mm.; interorbital width 3.8; postorbital width 9.6; illicium length 6.4; longest fang 1.6. 33.5 mm. specimen: mandible 16.5 mm.; interorbital width 4.8; postorbital width 7.8; illicium length 9; longest fang 2.5.

Fins: Pectoral 19; dorsal 15; anal 4.

Remarks: These young fish, both of which are smaller than any of the three previously taken, differ from the latter chiefly in the teeth, which, as was to be expected, are weaker and smaller in the jaws and lacking on the vomer. It is interesting that the 23.5 mm. specimen had the pigment more highly developed than the 33.5 mm. example; in other respects, however, the larger was the more advanced.

Study Material: Cat. No. 6338; *Arcturus* Oceanographic Expedition; Sta. 86 T-8; 16 miles S.W. of Narborough I., Galápagos (0°42′ N. Lat., 91°47′ W. Long.); 500 fathoms; June 12, 1925; length 23.5 (15+8.5) mm.

Cat. No. 28,489; Eastern Pacific *Zaca* Expedition; Sta. 219 T-1; 25 miles W × N of Pt. Burica, Costa Rica (8°08′ N. Lat., 83°17′ W. Long.); 300 fathoms; March 10, 1938; length 33.5 (22+11.5) mm.

Melanocetus johnsoni Gunther, 1864.

References: *Melanocetus johnsoni* Gunther, 1864, p. 301, pl. xxv; Regan & Trewavas, 1932, p. 50, figs. 72, 73.

Range: North Atlantic, Caribbean, Indian and Pacific Oceans. The present specimen extends the known Pacific range about 2,160 miles to the east.

Specimen Taken by the Eastern Pacific Expeditions: One specimen, Cat. No. 28,628; Station 227 T-1, Eastern Pacific *Zaca* Expedition; 20 miles southwest of Morro de Puercos, Panama (7°0′ N. Lat., 80°40′ W. Long.); 500 fathoms; March 21, 1938; length 46 (31+15) mm.; transitional adolescent with ovaries feebly developed.

Color (fresh specimen): Body brownish-black; fins white; illicium stem pigmented light brown, increasingly darker up to and around bulb; crest above bulb white with distal tubercle pigmented brown; peritoneum jet black.

Measurements: Illicium 12.5 mm.; mandible 21; interorbital width 5.6; postorbital head width 13.

Fins: Pectoral 20; dorsal 15; anal 4.

Food: Well digested, small myctophids.

Remarks: This specimen agrees perfectly with those of similar size described by Regan & Trewavas (1932).

Melanocetus megalodontis sp. nov.

(Text-fig. 1).

Type.

(The unique specimen).

Department of Tropical Research No. 25,791; Templeton Crocker Expedition of the New York Zoological Society; Sta. 165 T-3; May 17, 1936; 500 fathoms; 145 miles north of Clarion Island (20° 36′ N. Lat., 115° 07′ W. Long.); total length 38.5 (27+11.5) mm.; a transitional adolescent with small ovaries.

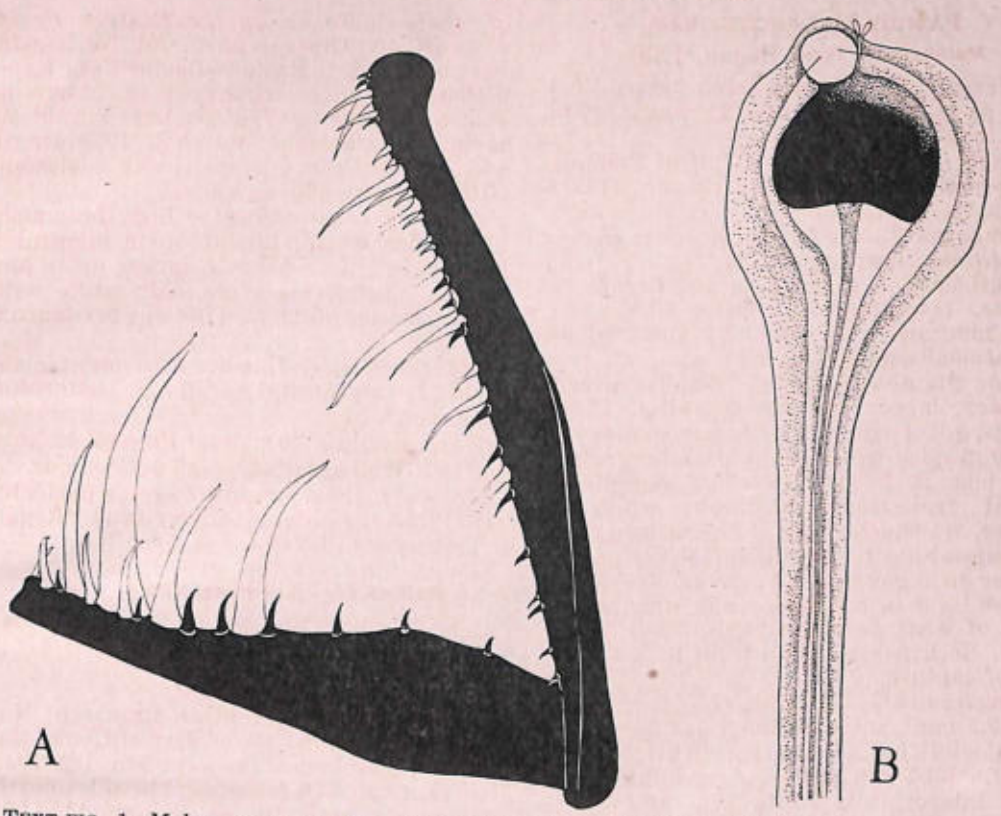
Description.

With the characteristics of the genus.

Color (fresh specimen): Dark brownish-black; all fins and stem of illicium colorless; major illicium bulb blue-black, its translucent envelope and minor bulb colorless; peritoneum jet black.

Measurements and Proportions: Total length 38.5 (27+11.5) mm.; illicium length 13.5 (in length 2.9 or 35%); lower jaw 13 (in length 3.0 or 33.8%); postorbital width of head 9.1 (in length 4.2 or 23.6%); interorbital width 4.4 (in postorbital width of head 2.07 or 14.2% of length); length longest fang 5 (in interorbital width .88 or 13% of length).

Illicium: From the anterior distal portion of the major, pigmented bulb arises a much smaller bulb, round and unpigmented. Both bulbs are enclosed in a translucent envelope which is distinctly compressed longitudinally, arising considerably below major bulb, and projecting well beyond it anteriorly, dorsally and posteriorly, although it is stretched tightly over the distal half of the minor bulb; it shows no trace of distal pigmentation. Behind the minor bulb the envelope gives rise to two minute flaps, facing



TEXT-FIG. 1. *Melanocetus megalodontis*, holotype. **A**, Dentition. Depressible teeth unshaded. **B**, Illicium.

anteriorly, side by side; the posterior part of the envelope shows several asymmetrically placed ribs or wrinkles not due to post mortem shrinkage.

Teeth: In each half of the upper jaw are 3 large fangs, the third longest, inserted near the inner margin of the jaw. External to these is a series of about 16 to 20 smaller teeth, including 4 or 5 which are moderately enlarged, the remainder being minute. In each half of the lower jaw are 4 or 5 fangs, the second of which is enormous, and 8 or 9 small teeth, most of them minute. Vomer with 4 teeth close together. Four pharyngeal teeth on each side.

Fins: Pectoral 19; dorsal 15; anal 14; caudal 10.

Food: Three scarlet-eyed euphausiids, packed together, each 25 mm. long. All have been identified by Dr. H. J. Hansen as male *Euphausia eximia*.

Behavior: The fish lived for two hours after which we preserved it. In the dark room we caught a fairly strong orange gleam, given forth three times, but could not be sure the illicium was the source. It swam actively but slowly about, with alternate movements of the pectorals. When the caudal moved from side to side it wagged the whole fish. When the gill opening closed the lower part remained immovable, the upper portion pressing down obliquely, leaving much of the lower half wide open. The position in life was exactly like Brauer's old illustration of *Melanocetus krechi* (1906, Taf. 15, fig. 3).

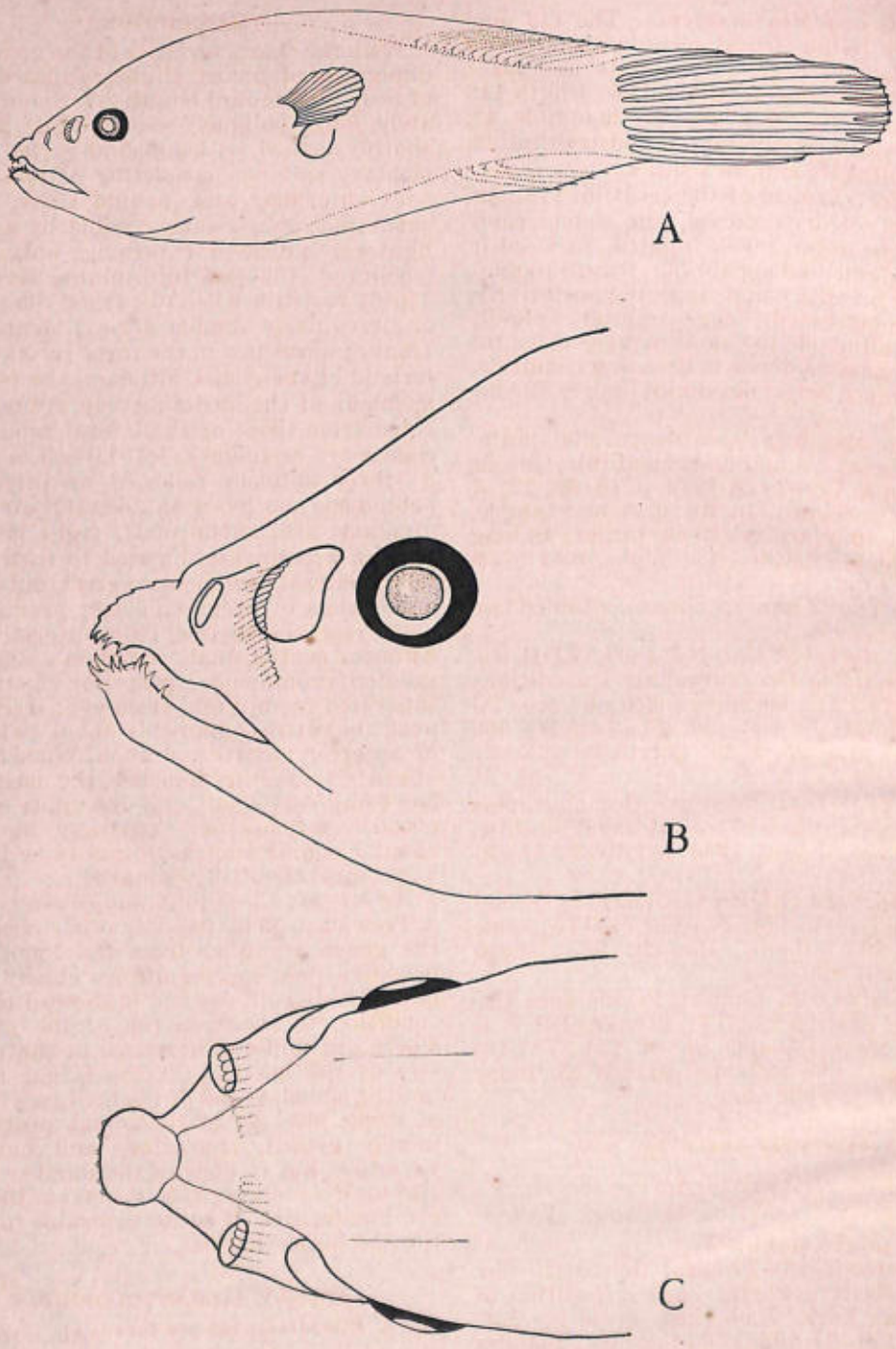
DISCUSSION.

This proposed new species differs from all the others as follows: in the character of the illicium; in the great length and robustness of the fangs, the length of the largest being greater than the interorbital width; and in the shortness of the lower jaw, which in spite of the small size of the specimen is only about a third of the total length. The fish clearly belongs in the long-fanged group in the key given by Regan & Trewavas (1932, p. 49), and, among these, is perhaps most closely related to *M. murrayi* on the one hand and to *M. ferox* on the other.

Melanocetus niger Regan, 1925.

References: *Melanocetus niger* Regan, 1925, p. 565; Regan, 1926, p. 33, plate VIII, fig. 1; Regan & Trewavas, 1932, p. 53, fig. 76B.

Range: Eastern Pacific: Gulf of Panama and 500 miles to the west near Cocos Island. The present specimens are the first to be taken outside the Gulf.



TEXT-FIG. 2. *Xenoceratias nudus*, holotype. **A**, lateral view. **B**, Head, lateral view. **C**, Head, dorsal view. Dotted lines indicate externally invisible lamellae.

Specimens Taken by the Eastern Pacific Expeditions: Four specimens, from 500 to 833 fathoms, off Gulf of Panama and Cocos Island, one adult, length 113 (85+28) mm.; three transitional adolescents 72 (52+20) mm., 23 (14+9) mm. and 20 (13+7) mm.

Color in Life: 72 mm. fish: black, fins colorless except for pale pigment on the caudal; illicium stem dark brown, the luminous bulb black on the proximal three-fourths, translucent white at the tip, enclosing a small, opaque black organ.

Counts and Measurements: The 113 mm. specimen is the largest recorded, and shows the following details of counts and size: Dorsal fin 14, anal 4, pectoral 20; length 113 (85+28) mm., maxillary 40, mandible 42, mouth width 61, illicium 30, postorbital 23, interorbital 15, longest tooth 4.

Ovaries: Typical of the ceratiid. 113 mm. specimen: ovaries dorsal, one considerably behind the other, much foliated, enclosed in lightly pigmented membrane; length 10 mm., anterior breadth 6 mm., tapering posteriorly, little compressed; eggs minute, closely packed, all about the same size; ovaries too small to be considered in breeding condition, though much better developed than in 72 mm. specimen.

72 mm. specimen: Ovaries parallel, posterior, between bladder and end of intestine, as in Regan & Trewavas, 1932, p. 15, fig. 22, of a young specimen. In the present example, however, they are relatively larger, as long as bladder; length 3.5 mm., maximum breadth 1 mm.

Food: The 23 mm. specimen contained two entire copepods.

Study Material: Cat. No. 5889 (KOH No. 18)[2]: *Arcturus* Oceanographic Expedition; Station 74 PT2; 60 miles south of Cocos Island (4° 50′ N. Lat., 87° W. Long.); 600 fathoms; May 25, 1925; length 20 (13+7) mm.

Cat. No. 6332: *Arcturus* Oceanographic Expedition; Station 74 T76; same locality; 500 fathoms; June 3, 1925; length 23 (14+9) mm.

Cat. No. 6414 (KOH 34): *Arcturus* Oceanographic Expedition: Station 74 OT3; same locality; 833 fathoms; May 29, 1925; length 72 (52+20) mm.

Cat. No. 28,642: Eastern Pacific *Zaca* Expedition; Station 228 T1: 52 miles SE × E of Cape Mala, Panama (7° N. Lat., 79° 16′ W. Long.); 500 fathoms; March 25, 1938; length 113 (85+28) mm.

Xenoceratias nudus sp. nov.

(Text-fig. 2).

TYPE.

(The unique specimen).

Department of Tropical Research No. 28,402; Eastern Pacific *Zaca* Expedition of the New York Zoological Society; Sta. 210T-8; Feb. 27, 1938; 500 fathoms; 20 miles south of Cape Blanco, Costa Rica (9° 12′ N. Lat., 85° 10′ W. Long.); total length 31.4 (21.4+10) mm., a transitional adolescent with moderately developed testicles (measuring about 3.5 × 2.4 mm. in length and breadth).

[2] Owing to catalogue confusion between regular and KOH numbers, this specimen was erroneously recorded as No. 6552 from Station 113, T35, 600 fathoms, in Hudson Gorge, Atlantic Ocean (*Zoologica*, VIII, No. 1, 1929, p. 18).

DESCRIPTION.

With the characteristics of the genus. Skin unpigmented, naked, slightly inflated. Depth of body in standard length 2.7. Snout moderately long, obliquely descending. Rostrum sharply defined, with a median series of rudimentary spinules, consisting of two minute ones anteriorly and, behind these, several subdermal ones clearly visible by substage lighting, indicated externally only by the pushing of the skin into minute serrations. Tip of rostrum with 10 curved denticles in an irregularly double series; denticles in front of lower jaw in the three series characteristic of the genus, although the posterior members of the median group are not separated from those of the lateral groups; the counts are as follows: left lateral 5, median 9 (three anterior followed by three pairs behind one another with several posterior individuals still subdermal), right lateral 4. Median prominence opposed to rostral denticles; lateral prominences erect, outside anterior ends of premaxillaries; premaxillary about reaching vertical from anterior of eye. Anterior nostril small, round on a separately inflated prominence; posterior nostril well separated from it and from eye; irregularly oval, its vertical diameter about twice that of anterior nostril and about equal to that of eye; 17 olfactory lamellae, the most dorsal one being very small, only the upper ones exposed. Testicles only partially developed, about 7 mm. in length. Dorsal 14 or 15; anal 4; pectoral about 18; caudal 9.

Affinities: Close to *X. longirostris* Regan & Trewavas, 1932, the only other member of the genus recorded from the Pacific. The proposed new species differs chiefly in the lack of body spinules and in the rudimentary condition of those on top of the rostrum. There are minor differences in the relative size of the nostrils, in the larger number both of lamellae, and of the denticles in front of lower jaw. All of these may prove to be merely growth characters and individual variation, but in view of the number of species of *Melanocetus* recorded from the Eastern Pacific area, it seems desirable to record the species as distinct.

FAMILY HIMANTOLOPHIDAE.

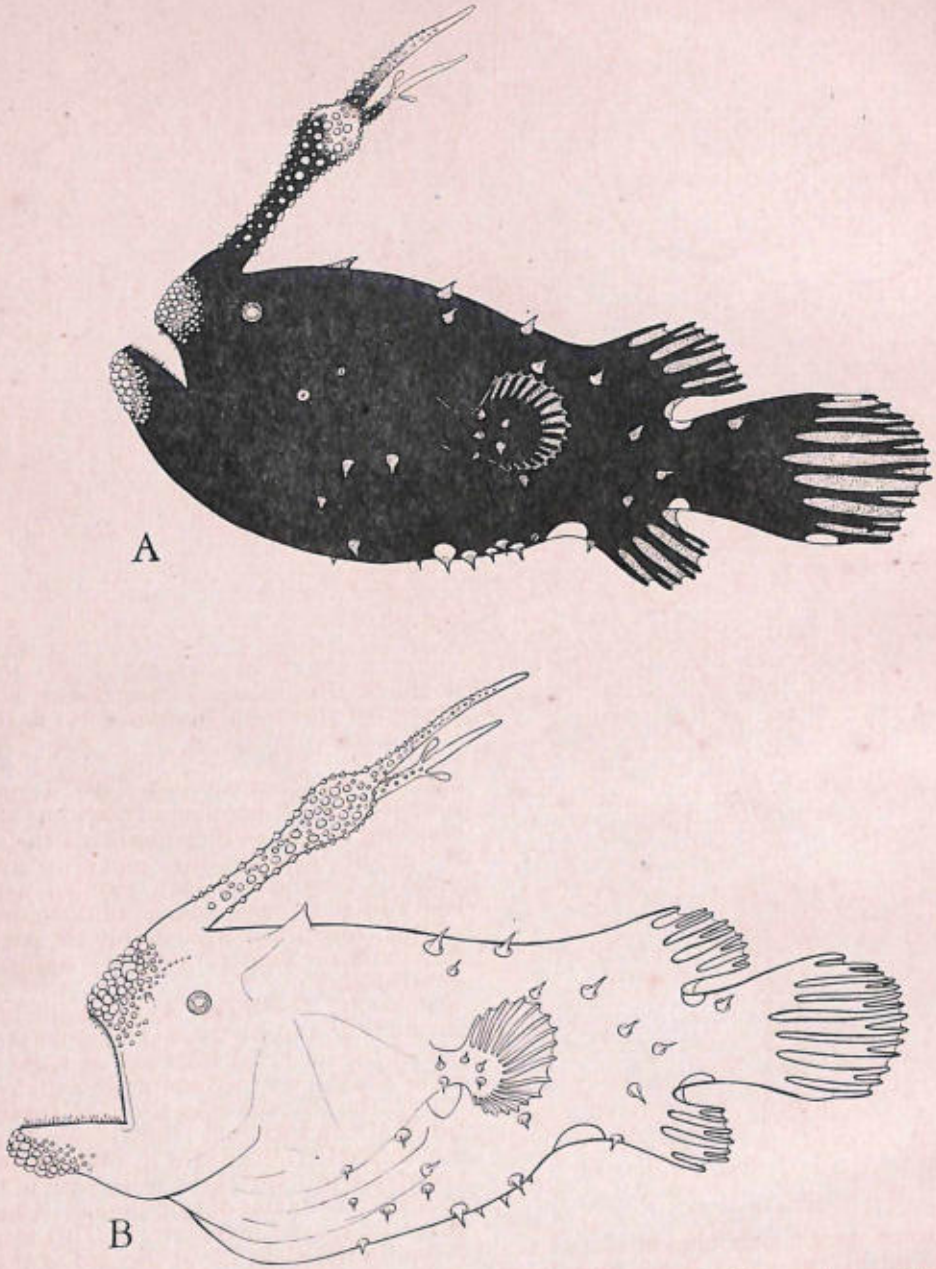
Himantolophus azurlucens sp. nov.

(Plate I, Figs. 1, 2; Text-figs. 3, 4).

TYPE.

(The unique specimen).

Department of Tropical Research No. 28,641; Eastern Pacific *Zaca* Expedition; Station 228, T-1 (7° N. Lat., 79° 16′ W. Long.); 52 miles SE × E of Cape Mala, Panama; 500 fathoms; March 25, 1938; total length 123 (98+25) mm.



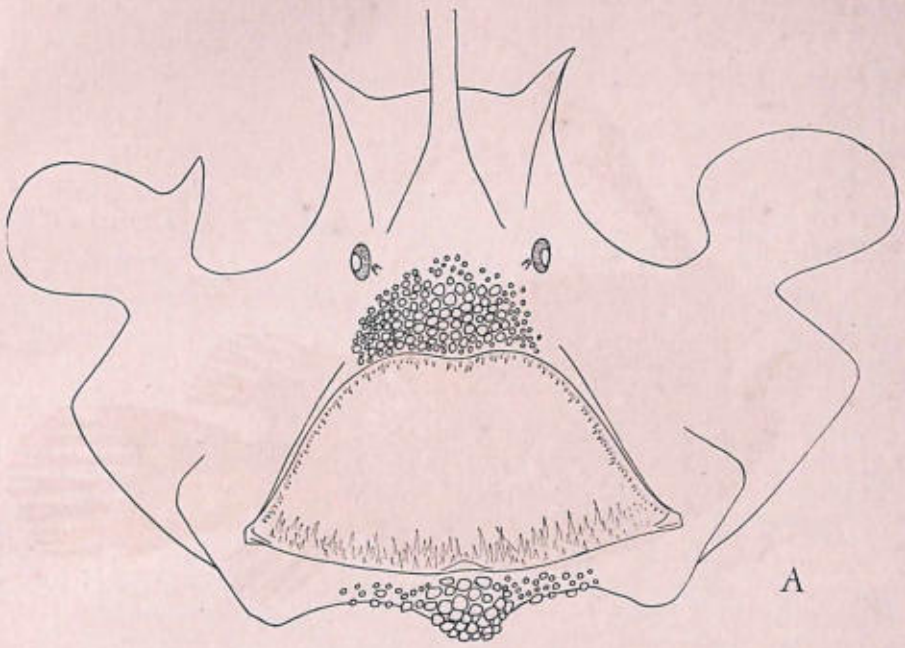
TEXT-FIG. 3. *Himantolophus azurlucens*, holotype. **A**, Freshly caught specimen, lateral view. **B**, Preserved specimen, showing distortion.

DESCRIPTION.

With the characteristics of the genus.

Color.: Jet black, paling to smoky gray in groove under illicium, and down the back to dorsal fin; also on flattened belly from chin to anal fin. All fin rays black, webs transparent. See additional color under *Luminescence*.

Luminescence: Body with conspicuous, sharp, sparsely scattered spines. Three of these, two on the left and one on the right upper posterior back, have luminous turquoise blue bases. A patch, not a spine, of the same color on upper, and another on lower base of peduncle; five luminous-based spines in a loose group on belly in front of anal fin; a triangular patch at anterior base of anal fin; others on the upper and lower caudal rays and on the anterior anal ray. In daylight all are brilliant turquoise blue, and in



TEXT-FIG. 4. *Himantolophus azurlucens*, holotype. **A**, Preserved specimen, anterior view. **B**, Illicium.

the darkroom we got pale blue luminescence from several of the spine bases and from two of the patches. In the dead preserved fish all trace of blue color is lost, the areas being distinguishable only by a slightly paler color of the tissue. Much of the illicium and its tentacles and many of the snout and chin papillae were distinguishable as pale grayish-white in the dark, and several times before the fish expired we detected flashes of yellow light, possibly from the facial papillae and illicium stem, but strongly from the swollen distal end of the illicium club, at the base of the tentacles.

Cephalic Papillae: Upper lips, snout and base of illicium covered with a mass of rounded, tumid papillae of varying size, increasing in size as they approach the mouth. A few of these on the upper lip are pale gray. A second compact, swollen patch on lower lip very conspicuous, pinkish or fleshy white in daylight. Surrounding the periphery is a narrow zone of smaller papillae of a neutral gray.

Illicium: The large, complex illicium lies normally on and partly in the groove scoooped out of the back. At least six or eight times, while the fish was swimming in a dish of iced water, the illicium was brought forward so far that the terminal tentacle overhung the mouth, well in advance of it. (We say tentacle because originally there were two, but when the fish was taken out of the net it had lost three-fourths of one tentacle. This was later found in the glass jar at the end of the net).

The main illicium stem is thick, black for about a fifth of its length, the distal five-sixths studded with round-based, low but sharp spines, all pale gray in color. The distal end of the stem is enlarged, club-like, on which the spines flatten out and merge into a solid pale gray. Yet the minute points are distinct even to the flat end and rim in the monocolored area.

The extreme tip of the stem is flattened and silvery white and it was this area which gave forth the strongest flashes of yellow light in the darkroom. From the flattened portion there arise, side by side, two silvery

tentacles, rather thick at the base and tapering slightly to a slender, but blunt, finger-like tip. The tentacle which was torn away is shorter than its fellow, and bears two stemmed and lobed bodies half-way to the tip. These are absent from the other. Illicium base to bulb tip 31.5, longer illicium tentacle 31, illicium total length 62.5 mm.

Spinous Bony Plates: On each side of the body, from gill arches to base of caudal fin, there are 26 or 27 low sharp spines, each arising from a small, subdermal plate. They are not arranged in perfect symmetry on the two sides, although total counts and general positions correspond closely. Their location on each side is as follows: on skin covering gill arches, 5 and 6; anterior base of pectoral, 5 and 7; each side of midline of abdomen, 4 and 6; anterior base of anal, 1; lower part of side, 2 and 3; upper part of side, 7.

Teeth: Small, in series, all depressible, except smallest in outer rows particularly in premaxillary. Upper jaw teeth in two irregular rows, outer series with very small teeth, close-set, varying in size, extending entire length of mouth; inner row composed of larger teeth chiefly in anterior part, widely spaced and smaller posteriorly. Mandible with teeth larger and more numerous than in premaxillary, set in four or five rows, running entire length of jaw, in a somewhat quincunxial arrangement, increasing in size from outer to inner series.

Fin Counts: Dorsal 5 (last four bifid), anal 4 (last three bifid), pectoral 17, caudal 9 (seven bifid).

Ovaries: Posterior, parallel, small (9 by 6 mm.), compressed. Eggs minute, all same size. Judged by the ovaries, the fish would be classed as a transitional adolescent.

Food: 1 *Sternoptyx*, length 19 mm.; 4 *Cyclothone*, length 15-30 mm.; 1 *Melamphaes*-like fish, length 25 mm.; 1 adolescent myctophid, length 10 mm.; 1 adolescent sudid, length 22 mm.; 2 euphausids (possibly shrimps), 45 mm.; 3 small euphausids, 15-20 mm.; 2 gammarid amphipods (possibly food of above food), 6 and 7 mm.; assorted small copepods (probably food of food); squid beak.

Behavior: This Blue-lighted Anglerfish was brought up at 2:30 p. m. and was very much alive, swimming around its large dish, keeping upright and twice biting the finger of the senior author as he turned it over. As we have said, the entire illicium was occasionally thrown forward, until the stem almost touched the snout, the slender remaining tentacle waving back and forth as the stem moved. It swam almost entirely by movements of the caudal fin but turned with the help of the pectorals. It lived until 5 o'clock in ice water, then expired slowly, and only lost its shape when put into preservative. The stretched mouth and the greatly distended gill arches gave it a wholly abnormal contour.

Discussion: This new member, the fourth of the genus *Himantolophus*, is the most specialized as regards illicium, dermal tubercularity, armature and luminescence. The three most characteristic features are the spiny armed illicium, the non-spinous cephalic papillae of snout and chin, and the patches of brilliant turquoise blue luminescence on body and fins.

Family Oneirodidae.

Chaenophryne parviconus

Regan & Trewavas, 1932.

References and Synonymy: *Chaenophryne parviconus* Regan & Trewavas, 1932, p. 87, fig. 138; *Chaenophryne columnifera* l. c., p. 88, fig. 140; *Chaenophryne melanorhabdus* l. c., p. 98, fig. 143.

Range: Eastern Pacific, within an isosceles triangle bounded by the Gulf of Panama, Cocos and Galápagos Islands, and Cape Corrientes, Colombia.

Specimens Taken by the Eastern Pacific Expeditions: Six specimens, from 400 to 700 fathoms, off Gulf of Panama, Cocos and Galápagos Islands, total lengths 17.3 to 25 mm., young transitional adolescents.

Color and Luminescence: These small fish were jet black in life. No. 6226 in the dark room gave forth two rather long drawn out flashes of pale yellow light from the ball-like organ at the tip of the illicium, the second flash being the stronger. In daylight the rounded or, in other specimens, slightly elongated structure showed a strong iridescence in striking contrast with the jet black skin.

Development and Discussion: The six specimens of the present collection indicate that at least three of the species of *Chaenophryne* described as new by Regan & Trewavas, 1932, represent stages in development and should be synonymized. These three species are *parviconus*, *columnifera* and *melanorhabdus*, all from the Gulf of Panama. *C. parviconus* and *columnifera* are described from 9 and 3 specimens respectively, of similar size, 16 to 21 mm. in total length, while *melanorhabdus* is known from the unique holotype, 55 mm. long. Except for 6, not 7, rays in the dorsal of *melanorhabdus*, and 15, not 16 to 17, rays in the pectoral, all of the described differences separating the three species are in the illicium. In our series, 3 of the 5 specimens have 6 dorsal rays, the others 7. Pectoral counts are especially difficult in this group, and ours are uncertain, but appear to range from 14 to 17.

Two of the present six specimens, total lengths 17.3 and 24 mm., agree perfectly

with the description and illustration of *C. parviconus*, in which the illicium shows relatively simple development. The third and fourth, 18 and 19 mm. long, have the conical distal papilla of the bulb slightly longer than in *parviconus*, but not as long as in *columnifera*. The fifth and sixth specimens, 18.6 and 21 mm. long, have the distal papilla relatively as long as the 55 mm.-long *melanorhabdus*, but lack the anterior branched filaments, in this respect resembling *columnifera*. However, the filaments appear to be represented subdermally by a pair of rudimentary, tiny, curved, dark tentacles at the base of the distal papilla; it may be that the "basal pair of luminous patches" in Regan & Trewavas's description of *columnifera*, present also in our specimens, are also rudiments of tentacles. In any event, there now appears to remain no valid reason for maintaining the three species, and *parviconus*, by pagination priority, is accepted as the specific name.

The typically *parviconus*-like specimens appear more juvenile than the *columnifera-melanorhabdus*-like pair in development of teeth and in that of the base of the illicium, in addition to the simple character of the bulb already mentioned. In each of these four the basal bone is very short, and the tip of the bulb, when laid back, reaches no further than the vertical from the posterior edge of the eye. In the *melanorhabdus*-like 21 mm. specimen (taken in the same net with a *parviconus*-like stage) the basal bone is still short, but the entire illicium bulb lies beyond the level of the eye; in the 18.5 mm. example, the basal bone is as long as the illicium stem, the illicium, including bulb, measuring about one-fifth the length of the fish (as compared with two-sevenths in the 55 mm. type of *melanorhabdus*). The length of the fringes on the wings of the posterior bulb appendages vary regardless of age.

In deep-sea pediculates, as in other fish groups, shrinking occurs to variable degrees during metamorphosis (that is, in adolescence and early transitional adolescence). This is clearly evident in this series, where the 25 mm. fish is one of the youngest, judged by tooth and illicium development, and, of the two best developed examples, the 18.6 mm. specimen is younger than that of 21 mm. The latter shows youth also in its relatively greater depth, because of the juvenile fatty tissue. The stomachs (empty) of these two oldest samples are entirely unpigmented and the ovaries are minute. There is no doubt but that all the specimens are extremely immature, in spite of the fact that in life the exterior black pigment was fully developed.

Study Material: Cat. No. 5209; *Arcturus* Oceanographic Expedition; Station 33, PT-1, 70 miles N.E. of Tower Island, Galápagos (0° 40′ N. Lat., 88° 51′ W. Long.); 700 fathoms; April 3, 1925; total length 19 (15+4) mm.

Cat. No. 5210; same station, net, locality, depth and date; total length 17.3 (13.6+3.7) mm.

Cat. No. 6226; Col. Pl. 2104; *Arcturus* Oceanographic Expedition. Station 84, T-8; one mile N. of Narborough, Galápagos (0° 17′ S. Lat., 91° 34′ W. Long.); 400 fathoms; June 9, 1925; total length 25 (19.3+5.7) mm.

Cat. No. 6645; Col. Pl. 2069; *Arcturus* Oceanographic Expedition; 74, T-78; 60 miles S. of Cocos Island (4° 50′ N. Lat., 87° W. Long.); 700 fathoms; June 3, 1925; total length 18.3 (14+4.3) mm.

Cat. No. 28,766; Eastern Pacific *Zaca* Expedition; Station 233, T-1; 55 miles SSW Cape Corrientes, Colombia (4° 45′ N. Lat., 78° 02′ W. Long.); 500 fathoms; April 3, 1938; total length 18 (14.4+3.6) mm.

Cat. No. 28,767; same station, net, locality, depth and date; total length 21 (16.3+4.7) mm.

Dolopichthys luetkeni Regan, 1925.

References and Synonymy: *Dolopichthys luetkeni* Regan, 1925, p. 562; 1926, p. 27, pl. IV, fig. 2; Regan and Trewavas, 1932, p. 76, fig. 116; *Dolopichthys heteracanthus* Regan, 1925, p. 562; 1926, p. 28, pl. V, fig. 4; Regan & Trewavas, 1932, p. 77, fig. 117.

Range: Eastern Pacific; off Costa Rica from 9° 12′ N. Lat. south, Gulf of Panama and off Cocos Island.

Color: Jet black. The outer sheath of illicium is colorless; terminal, rounded bulb encloses a lemon yellow body, topped by a cap and a slender, finger-like tentacle, all of glistening silver tissue. Behind these, a second candle- or finger-like tentacle arises, with an orange, flame-like appendage, topped by a short, very slender filament.

Discussion: We agree with Parr (1927, p. 15) in considering *D. heteracanthus* to be the immature form of *D. luetkeni*. Although in our series, composed entirely of small examples, the posterior appendage is smaller than the anterior, as in *heteracanthus*, there is considerable variation in its length and in other details of the bulb, the amount of fringing on the anterior flaps varying, as well as the position and subdivisions of the membraneous appendages behind it. In our specimens these membranes are set at varying angles to the anterior flaps, but always are more nearly one above the other as in *luetkeni*, rather than one behind the other as in *heteracanthus*. All of the present specimens are clearly immature, with feeble teeth in varying stages of development, large articular spines, and basal bone much shorter than illicium.

Study Material: Cat. No. 5944; Col. Pl. 2103; *Arcturus* Oceanographic Expedition; Station 74, PT3; 60 miles south of Cocos (4° 50′ N. Lat., 87° W. Long.); 620 fathoms; May 27, 1925; total length 25.5 (18.5+7) mm.

Cat. No. 6011; *Arcturus* Oceanographic Expedition; Station 74, OT4; 60 miles south of Cocos (4° 50′ N. Lat., 87° W. Long.); 625 fathoms; May 30, 1925; total length 29 (22+7) mm.

Cat. No. 28,247; Col. Pl. Z185, fig. 1; Eastern Pacific *Zaca* Expedition; Station 210, T-1; 20 miles south of Cape Blanco, Costa Rica (9° 12′ N. Lat., 85° 05′ W. Long.); 300 fathoms; Feb. 7, 1938; total length 20.3 (14.3+6) mm.

Cat. No. 28,768; Eastern Pacific *Zaca* Expedition; Station 219, T-1; 25 miles W×N of Pt. Burica, Costa Rica (8° 08′ N. Lat., 83° 17′ W. Long.); 300 fathoms; March 10, 1938; 3 specimens, total length 18 (13.6+4.4); 19.3 (12.9+6.4) and 21 (14.7+6.3) mm.

Dolopichthys implumis

Regan & Trewavas, 1932.
(Text-fig. 5).

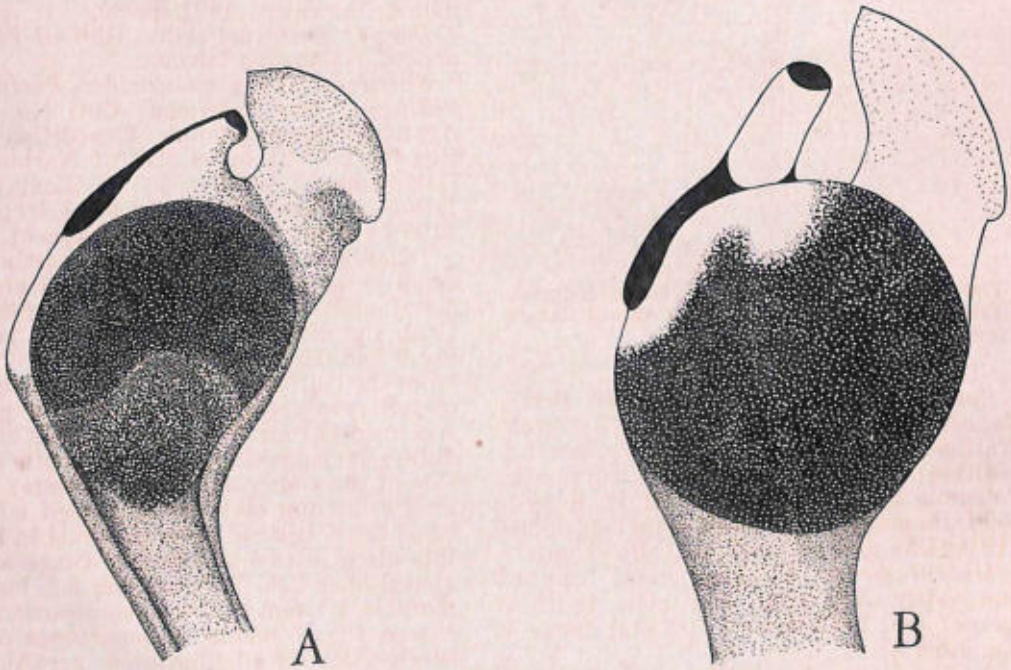
Reference: *Dolopichthys implumis* Regan & Trewavas, 1932, p. 78, fig. 122.

Range: Eastern Pacific: from Gulf of Panama north to 9° 15′ N. Lat., off Costa Rica, and southwest to the Galápagos.

Specimens Taken by the Eastern Pacific Expeditions: Two specimens, both from 500 fathoms, off Costa Rica and Galápagos respectively; total lengths 18.7 and 20.2 mm.

Color: Jet black; bulb and short stem of illicium blue black, tentacles silvery, medium comb translucent white.

Discussion: Three small specimens have heretofore been recorded, all from the Gulf of Panama, by Regan & Trewavas. Although the top of the posterior appendage in our specimens is oblique, not horizontal as in their drawings, there is no other appreciable difference; the shape and height of our papillae vary even in our two specimens. There seems no reason why Regan & Trewavas's entire subgenus *Microlopichthys*, known solely from small specimens, will not prove to be composed merely of young forms of another group—very likely of the subgenus *Dolopichthys*. The vital factor in question is how fast and when the basal bone of the illicium is exserted and lengthens. We think this must be a suddenly accelerated character, and at the same time when it hurries up its growth, the bulb ornaments lose their simplicity. We can compare this with the sudden growth change in leptocephalids and some melanostomiatids, where individuals of very different appearance occur of the same length, and others show a similar appearance but unequal lengths, during metamorphosis.



TEXT-FIG. 5. *Dolopichthys implumis* Regan & Trewavas. End of Illicium. **A**, Specimen No. 6286a. **B**, Specimen No. 28,401.

Study Material: Cat. No. 6286a, Col. Pl. 2099; *Arcturus* Oceanographic Expedition; Station 84, T-14; one mile north of Narborough, Galápagos (0° 17′ S. Lat., 91° 34′ W. Long.); 500 fathoms; June 9, 1925; total length 18.7 (14.7+4) mm.

Cat. No. 28,401; Eastern Pacific *Zaca* Expedition; Station 210, T-8; 20 miles south of Cape Blanco, Costa Rica (9° 12′ N. Lat., 85° 10′ W. Long.): 500 fathoms; Feb. 27, 1938; total length 20.2 (14.5+5.7) mm.

Dolopichthys pullatus

Regan & Trewavas, 1932.

(Text-fig. 6).

Reference: *Dolopichthys pullatus* Regan & Trewavas, 1932, p. 79. text-fig. 123, pl. III, fig.-1.

Range: Unique specimen previously known taken in the Mollucas.

TEXT-FIG. 6. *Dolopichthys pullatus* Regan & Trewavas. Illicium. Broken terminal flange indicated by dotted lines.

Specimen Taken by the Eastern Pacific Expedition: One specimen; Cat. No. 28,769; Station 233 T-1; Eastern Pacific *Zaca* Expedition; 55 miles SSW of Cape Corrientes, Colombia (4° 45′ N. Lat., 78° 02′ W. Long.); 500 fathoms; April 3, 1938; total length 23.6 (19.3+4.3) mm.; transitional adolescent.

Measurements: Illicium: basal bone 1.6 mm., stem 3.9; stem and bulb (without flange) 5.6; bulb alone 1.7; distal flange 1; mandible 8.

Teeth: Upper jaw with about 35; lower jaw, 44 or 45; all slender, close-set, in a single series, in successive groups of 3 or 4; the members of each group decrease progressively in size posteriorly; groups obsolete in posterior part of premaxillary, where teeth are short and irregularly spaced; 3 teeth on each side of vomer.

Fins: Pectoral 20 or 21; dorsal 6; anal 4.

Remarks: This specimen is referred with hesitation to *pullatus*, known from a single East Indian specimen twice its length; it agrees almost equally well with *D. mucronatus* Regan & Trewavas, 1932, and one or two others of the same subgenus, and is the first of its close relatives to be recorded from the Eastern Pacific. However, it agrees almost perfectly with *pullatus*, differing noticeably from the description and figures only as follows: the kidney-shaped bulb is almost vertical instead of horizontal; the exserted part of basal bone is shorter and the lower jaw is slightly longer (both characters to be expected in a younger fish) and there are a few more teeth in the lower jaw (about 45 instead of 40) and 3 instead of 2 teeth on each side of the vomer. Most of the posterior appendage, indicated by dotted lines in our Text-figure, was broken off and lost shortly after capture; however it was measured and a sketch made when the specimen was freshly caught.

Dolopichthys allector Garman, 1899.

(Text-fig. 7).

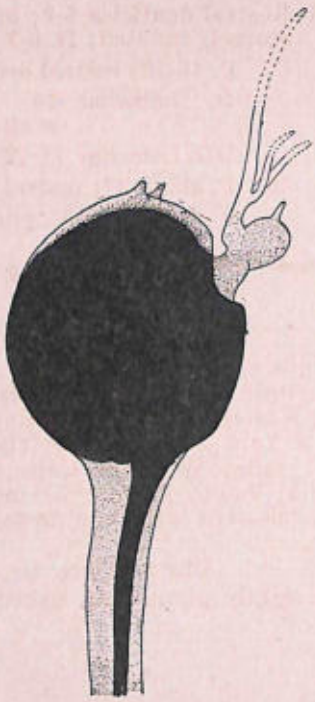
References: Garman, 1899, p. 81, plates XIII-XVI; Regan, 1926, p. 28 (part?); Regan & Trewavas, 1932, p. 80.

Range: Eastern Pacific: Gulf of Panama and off Galápagos Islands.

Specimen Taken on Eastern Pacific Expeditions: One specimen; Cat. No. 6394; *Arcturus* Oceanographic Expedition; Station 87 T-3; 21 miles NW of Narborough, Galápagos 0° 00′, 91° 53′ W. Long.); 450 fathoms; June 13, 1925; total length 25 (19+7) mm.; transitional adolescent.

Discussion: Regan, after accrediting nine small specimens in 1926 to *D. allector*, redistributed 7 of them to other species in 1932, and makes no mention of the remaining 2 fish. Hence Garman's type of 72 mm. from the Gulf of Panama is left as the only certain representative before the present specimen. From the original type our fish differs in possessing a single tooth on one side of the vomer, and in the greater length of the illicium stem as compared with the basal bone. Instead of being equal in length, this stem is two and a half times as long (basal bone 2.8, illicium stem 5.3, bulb and tentacle 1.4 mm.). We have elsewhere discussed the probable unimportance of this acceleration of illicium stem growth.

The bulb itself is somewhat more like that of *danae* from the north than that of *allector*. The posterior tentacle arises from a rounded appendage of the bulb, this ap-



TEXT-FIG. 7. *Dolopichthys allector* Garman. End of illicium. Broken filaments indicated by dotted lines.

pendage having, in addition, a distal papilla. In Garman's type the tentacle appears to rise directly. Our tentacle has at least two marginal filaments, the basal appearing bifid.

Dolopichthys atratus

Regan & Trewavas, 1932.

References: Regan & Trewavas, 1932, p. 81, fig. 129.

Range: Eastern Pacific; Gulf of Panama and off Costa Rica and Cocos Island.

Specimens Taken on Eastern Pacific Expeditions: Two specimens, from 500 fathoms, off Costa Rica and Cocos Island, total lengths 25.7 and 41.7 mm.

Color: Jet black to the tip of all the fins. Basal bone dark brown, illicium stem pale brown, bulb blue and tentacle colorless.

Illicium: There is considerable variation in length and distribution of filaments on the distal tentacle of the illicium in the two fish. In the 41.7 mm. specimen the basal bone is 2.4, illicium stem and bulb 7.1, and tentacle 4.3 mm. In the smaller fish of 25.7 mm., the basal bone is practically sessile or subdermal, the stem and bulb 4.7 and the tentacle 3.5 mm. The teeth are more than twice as numerous in the lower jaw in the larger specimen.

Study Material: Cat. No. 6640, Color Plate 2070; *Arcturus* Oceanographic Expedition; Station 74, T-4; 60 miles south of Cocos (4° 50′ N. Lat. 87° W. Long); 500 fathoms; May 25, 1925; total length 41.7 (32.9+8.8) mm.

Cat. No. 28,274; Eastern Pacific *Zaca* Expedition; Station 210 T-6; 20 miles south of Cape Blanco, Costa Rica (9° 12′ N. Lat., 85° 05′ W. Long.); 500 fathoms; Feb. 7, 1938; total length 25.7 (20+5.7) mm.

Genus ***Trematorhynchus***

Regan & Trewavas, 1932.

Six specimens in the present collection are male oneirodids. All possess the characters of the genus *Trematorhynchus*, as set up by Regan & Trewavas to receive the few known males in this diverse family of many genera and species. As in those previously recorded, all of our specimens have the skin naked, the snout short and somewhat decurved, the nostrils not raised, the anterior nostril opening forward near end of snout, teeth in both jaws lacking, and denticles present above and below, including an outer series on the chin.

They all fit well enough into the species framework of *T. leucorhinus* Regan & Trewavas (1925, p. 566; 1930, p. 44, fig. 25b; 1932, p. 91), having large nostrils of which the anterior are almost contiguous and the posterior set close to the eyes, while the nasal area is more or less pale. This species, described from the Atlantic and Indian Oceans and the Gulf of Panama, is also the only one which has been hitherto recorded from the Pacific. However, we agree with Parr (1934, p. 41) that sharper specific differences must be sought in the material upon which *leucorhinus* is based, and in the absence of a designated holotype, we are proposing five new species. Although it is likely that some of our material will prove to agree with some of Regan & Trewavas' Pacific examples, synonymy is impossible without comparison of specimens and, preferably, a large amount of new material.

In addition to the usual diagnostic characters of fin ray counts, curvature of snout, nostril shape, size and position, eye size and denticle number, arrangement and projection, the number of olfactory lamellae appears to be of value in this group. This character has already been used by Regan & Trewavas (1932) in the specific descriptions of *Xenoceratias*. Additional material will doubtless show that the shape of the individual lamellae also has importance. Eye diameter in length of dentary is sometimes a useful character. The amount of expansion of the dermal envelope will probably also prove to have a diagnostic value, although it is certainly also connected with development.

Judging by the rudimentary development of pigment and the small size of the testicles, none of the six specimens is adult; however,

the diagnostic characters mentioned above are so well developed that descriptions of these fish, as advanced transitional adolescents, appear warranted.

As Parr has indicated, there seems to be little use in erecting new genera for these males in our present state of ignorance, even though some of the differences obviously transcend generic boundaries.

The large nostrils at once distinguish all five of the proposed new species, as well as *leucorhinus*, from the other *Trematorhynchus* thus far described (*exiguus* and *obliquidens*, both of Regan & Trewavas, 1932, and *phyllodon* Parr, 1934, all from the Atlantic). The following key is given only to clarify the major distinctions in the present material.

A. Lamellae 7; eye small (3.7 in dentary) ..... *paucilamellatus*

AA. Lamellae 11-15; eye large (2-2.2 in dentary)

B. Rostral denticles 3; outer skin inflated; D. 5 ..... *adipatus*

BB. Rostral denticles 5-9; outer skin scarcely inflated; D. 6-7

C. P. 16-18; rostral denticles 5-6

D. Lamellae 15 *multilamellatus*

DD. Lamellae 11-12 *moderatus*

CC. P. about 27; rostral denticles 9; lamellae 13 ... *multiradiatus*

Trematorhynchus adipatus sp. nov.

(Text-fig. 8).

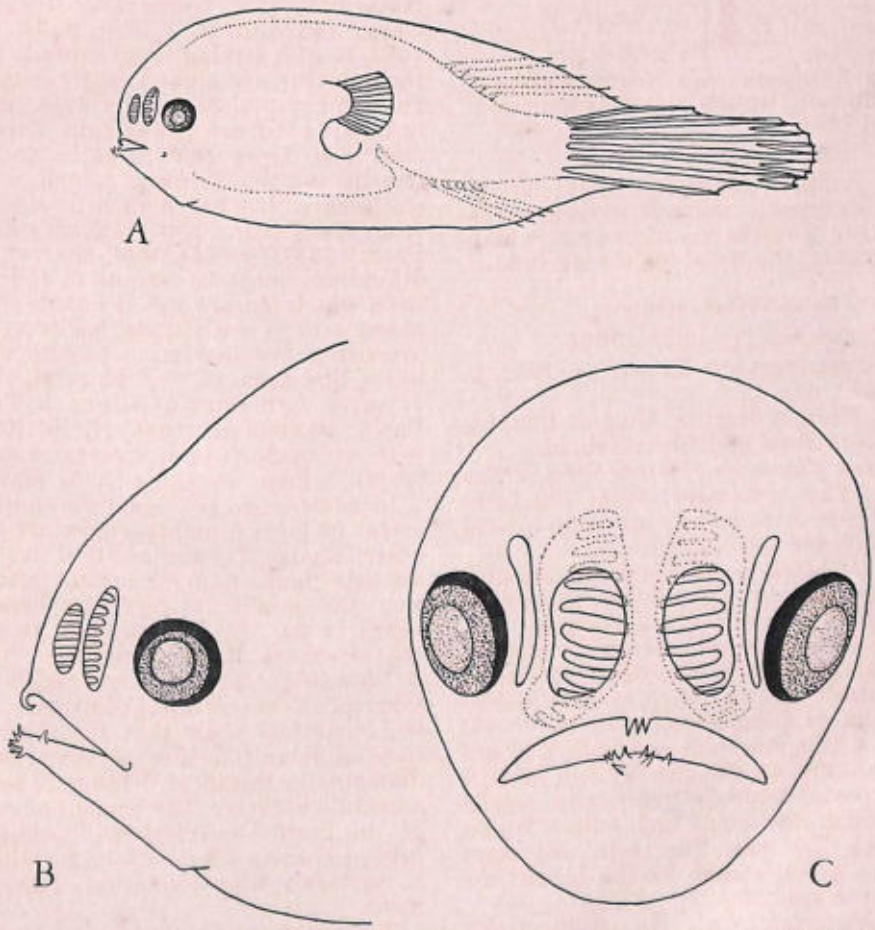
TYPE.

(Unique specimen).

Department of Tropical Research No. 28,770; Eastern Pacific *Zaca* Expedition of the New York Zoological Society; Sta. 230 T-1, 71 miles W×S of Cape Corrientes, Colombia; length 15 (10+5) mm.; transitional adolescent with minute testicles.

DESCRIPTION.

Skin lightly pigmented, naked, consider-



TEXT-FIG. 8. *Trematorhynchus adipatus*, holotype. **A**, Lateral view. **B**, Head, lateral view. **C**, Head, front view. Dotted lines indicate externally invisible lamellae.

ably inflated. Head (to gill opening) contained slightly more than twice in standard length; snout obtuse, the rostral portion almost vertical, but rounded, not straight, in profile. A close-set series of 3 rostral denticles, all long and slender and strongly hooked. Opposite these, in front of the mandible is a series of 8 denticles, long and slightly curved, in an irregular cluster. Maxillary reaching vertical from about middle of eye; posterior process of dentary not quite reaching that from posterior margin of eye.

Eye contained about twice in distance from symphysis to end of posterior process of dentary. Anterior nostril oval, about 4/5 as long as diameter of eye; posterior nostril narrow, its length about 1.2 times diameter of eye. Septa separating nostrils from each other narrow, and from eyes moderately broad. Twelve olfactory lamellae, of which 8 are visible in the posterior orifice in a lateral view.

Dorsal 5; anal 4; pectoral about 16; caudal 9.

DISCUSSION.

Distinguishing characteristics are the small number of rostral denticles (3) and the high degree of inflation. These may be merely signs of youth.

Trematorhynchus moderatus sp. nov.

(Text-fig. 9).

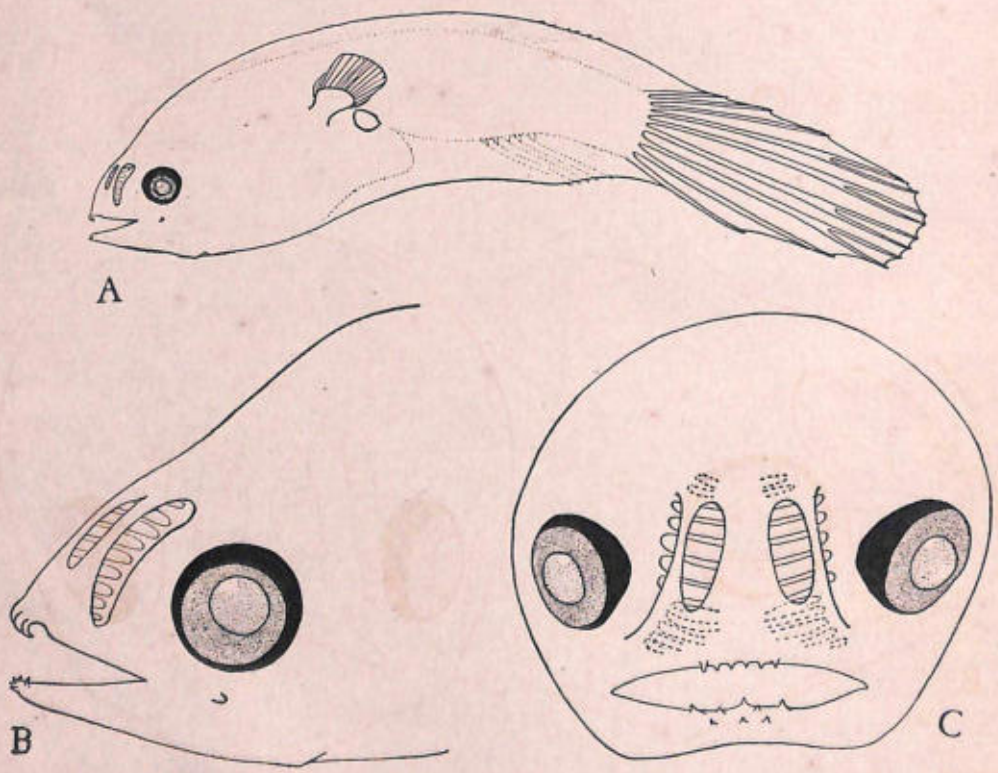
TYPE.

Holotype: Department of Tropical Research No. 28,771; Eastern Pacific *Zaca* Expedition of the New York Zoological Society; Sta. 230 T-1, 71 miles W×S of Cape Corrientes, Colombia; length 17 (11+6) mm.; transitional adolescent with testicles about 1.2 mm. long.

Paratype: Department of Tropical Research No. 28,772: same station and net as holotype; length 14.5 (10+4.5) mm.; transitional adolescent, slightly less well developed than above.

DESCRIPTION.

Skin scarcely pigmented, naked, inflation very slight. Head (to gill opening) contained slightly more than twice in standard length; snout obtuse. A series of 6 rostral denticles, all curved, the outer and inner pairs most. Denticles in front of mandible consisting of 1 or 2 inner, 4 marginal and 3 outer ones, all moderately curved, less so than rostral series. Maxillary almost or quite reaching vertical from middle of eye; dentary scarcely beyond that from its posterior margin.



TEXT-FIG. 9. *Trematorhynchus moderatus*, holotype. **A**, Lateral view. **B**, Head, lateral view. **C**, Head, front view. Dotted lines indicate externally invisible lamellae.

Eye contained about twice in distance from symphysis to end of posterior process of dentary. Anterior nostril narrow, 4/5 as long as diameter of eye; posterior nostril 1.25 times diameter of eye in holotype, but only 4/5 times diameter in the younger paratype, narrow in both specimens. Septa separating anterior and posterior nostrils narrow, between anterior nostrils broad, and between posterior nostrils and eyes broad. Twelve olfactory lamellae in holotype, 11 in paratype; 9 of these are visible in the posterior orifice in a lateral view in holotype, about 6 in paratype.

Dorsal 6; anal 5; pectoral 17 or 18; caudal 9.

DISCUSSION.

In distinguishing this species, which has no striking characteristics, the combination of lamellae numbers, denticle arrangements and fin counts must be held of equal value.

Trematorhynchus multilamellatus sp. nov.

(Text-fig. 10).

TYPE.

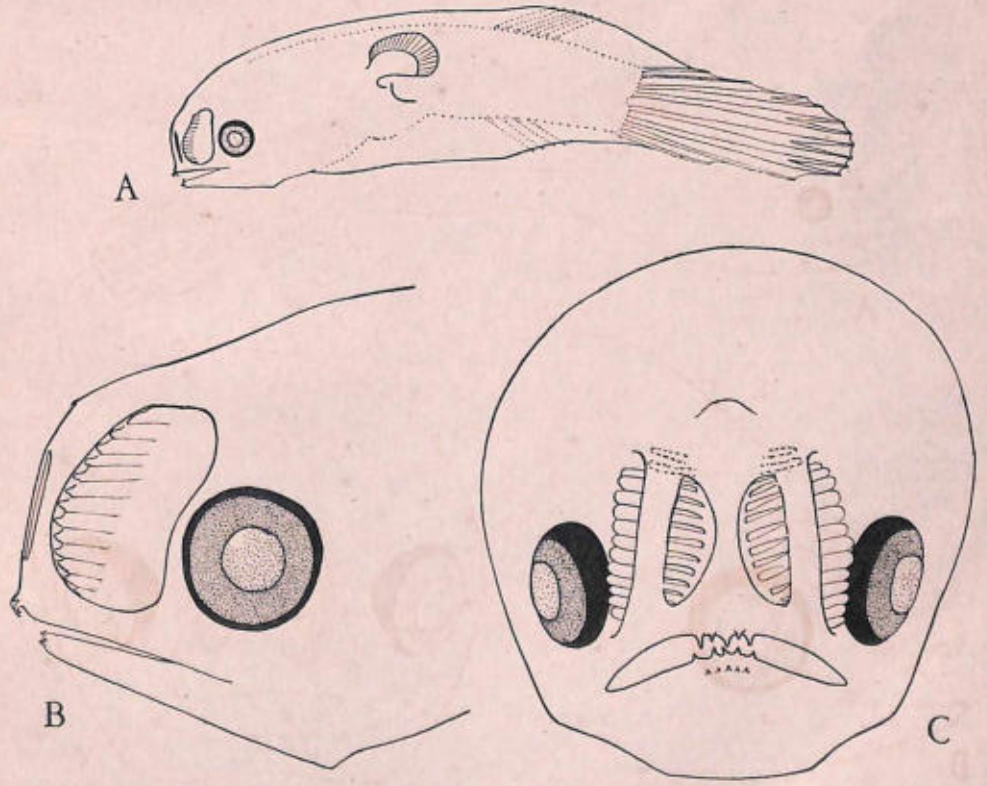
(Unique specimen).

Department of Tropical Research No. 6321; *Arcturus* Oceanographic Expedition of the New York Zoological Society; Sta. 86 T-10; 16 miles southwest of Narborough I., Galápagos; length *ca.* 15.5 (10.5+*ca.* 5) mm. transitional adolescent with minute testicles (about 1 mm. long).

DESCRIPTION.

Skin unpigmented, naked, slightly inflated. Head (to gill opening) contained slightly more than twice in standard length; rostrum practically vertical. A row of 5 denticles across tip of rostrum, the members of outer pair and median denticle most curved. Opposed to these in front of lower jaw is a row of 5 denticles, shorter and straight, and outside these a group of 5 minute spinules. Maxillary reaching verticle from middle of eye, and posterior process of dentary to slightly beyond eye's posterior margin.

Eye contained about 2.2 times in distance from symphysis to end of posterior process of dentary. Anterior nostril elongated, directed forward, its vertical axis slightly longer than diameter of eye; posterior broader, its vertical axis more than 1½ times longer than eye. Septa, separating nostrils from each other and from eye, narrow. Fifteen olfactory lamellae, of which 12 to 13 are visible in the posterior orifice in a lateral view.



TEXT-FIG. 10. *Trematorhynchus multilamellatus*, holotype. **A**, Lateral view. **B**, Head, lateral view. **C**, Head, front view. Dotted lines indicate externally invisible lamellae.

Dorsal 7; anal 4; pectoral about 20; caudal ? (broken).

DISCUSSION.

The most noteworthy characteristic of this species is the great number of olfactory lamellae.

Trematorhynchus multiradiatus sp. nov.

(Text-fig. 11).

TYPE.

(Unique specimen).

Department of Tropical Research No. 28,773; Eastern Pacific *Zaca* Expedition of the New York Zoological Society; Sta. 225 T-1, 11 miles southwest of Jicaron Island, Panama; length 17.5 (11.5+6) mm.; transitional adolescent with minute testicles.

DESCRIPTION.

Skin scarcely pigmented, naked, slightly inflated. Head (to gill opening) contained twice in standard length; snout obtuse; a single row of 9 denticles across tip of rostrum, the outer pair strongly curved, the median denticle straight; the others asymmetrically straight and curved, in about equal numbers. Opposed to these, in front of lower jaw, is a row of about 8 denticles almost straight, and outside of these 3, wide-spaced, median, straight. Maxillary not reaching vertical from middle of eye; posterior process of dentary not quite reaching that from end of eye.

Eye contained about 2⅓ times in distance from symphysis to end of posterior process of dentary. Anterior nostril small, oval, only two-thirds diameter of eye; posterior long, curving, about half again as long as diameter of eye. Septa separating nostrils moderate. Thirteen olfactory lamellae, of which 10 are visible in the posterior orifice in a lateral view.

Dorsal 7; anal 4; pectoral about 27; caudal 8 (2 lower rays broken off short).

DISCUSSION.

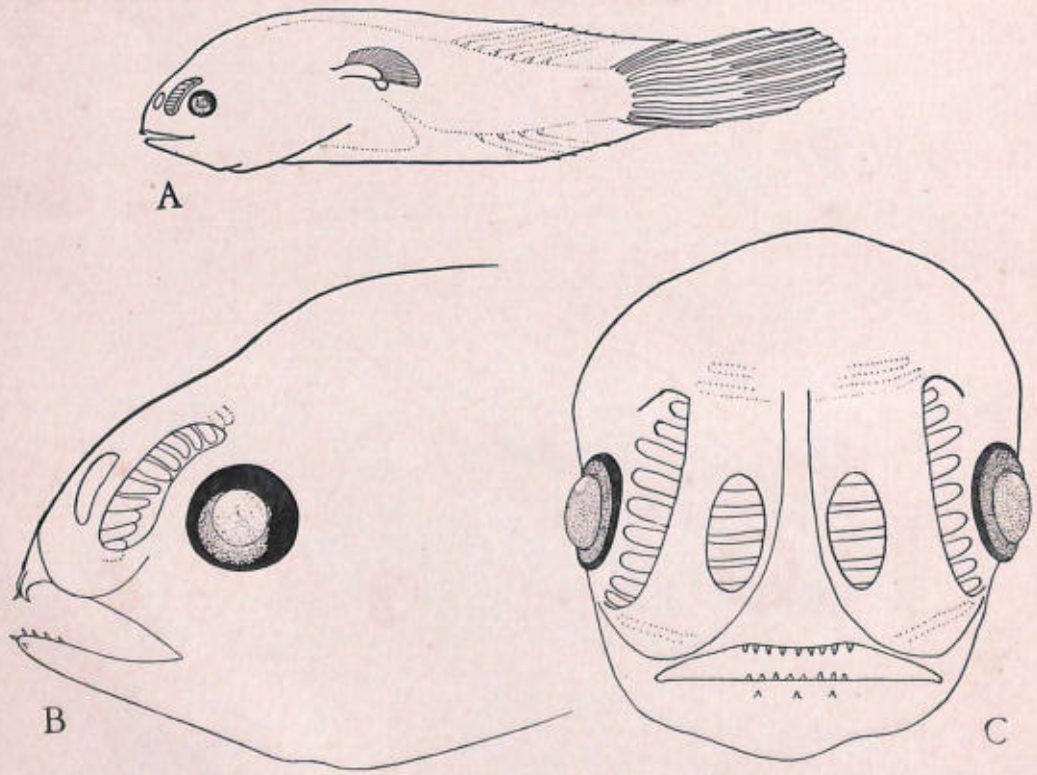
The great number of rays in the pectoral, combined with their insertion on the upper and distal margins of the elongated lobe, make it likely that this male belongs to the genus *Ctenochirichthys* Regan & Trewavas, 1932, known from the Gulf of Panama.

Trematorhynchus paucilamellatus sp. nov.

(Text-fig. 12).

TYPE.

(Unique specimen).



TEXT-FIG. 11. *Trematorhynchus multiradiatus*, holotype. **A**, Lateral view. **B**, Head, lateral view. **C**, Head, front view. Dotted lines indicate externally invisible lamellae.

Department of Tropical Research No. 28,-250. Eastern Pacific *Zaca* Expedition of the New York Zoological Society; Sta. 210 T-3, 20 miles south of Cape Blanco, Costa Rica; length 17 (11+6) mm.; transitional adolescent with minute testicles (2 mm. long).

DESCRIPTION.

Skin lightly pigmented, naked, scarcely inflated. Head (to gill opening) more than half standard length; snout strongly perpendicular distally. A single row of 8 denticles across tip of rostrum, the outer and inner ones most curved, those next to the innermost almost straight. Above these is a minute, median denticle. Opposed to these, in front of lower jaw, a row of about 8 denticles, less curved, and below them two others, median, almost straight. Two tiny teeth, apparently on mandible itself, at symphysis. Maxillary reaching vertical from middle of eye; posterior process of dentary reaching slightly beyond vertical from posterior margin of eye.

Eye very small, contained 3.7 times in distance from symphysis to end of posterior process of dentary. Both nostrils large and vertically oval. Vertical diameter of anterior nostril about two-fifths longer than that of eye, of posterior about two-thirds. Anterior nostril directed straight forward. Septa separating nostrils from eyes and each other moderately narrow. Seven olfactory lamellae, all almost entirely exposed.

Dorsal 7; anal 4; pectoral 17; caudal 9.

DISCUSSION.

The most conspicuous characteristics of this fish are the small number of nasal lamellae and the small size of the eye.

FAMILY GIGANTACTINIDAE.

Gigantactis perlatus sp. nov.

(Plate II, Fig. 3; Text-fig. 13).

TYPE.

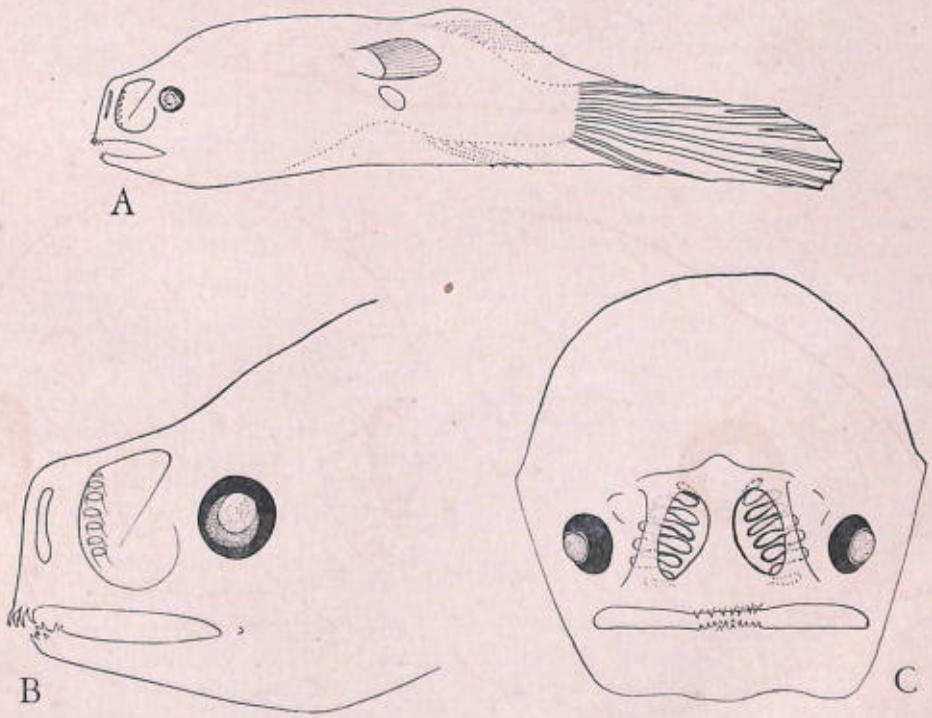
(The unique specimen).

Department of Tropical Research No. 28,621; Eastern Pacific *Zaca* Expedition; Station 225 T-1 (7° 08′ N. Lat., 81° 57′ W. Long.); 11 mi. SW×W of Jicaron Is., Panama; 500 fathoms; March 20, 1938; total length 42 (34+8) mm.

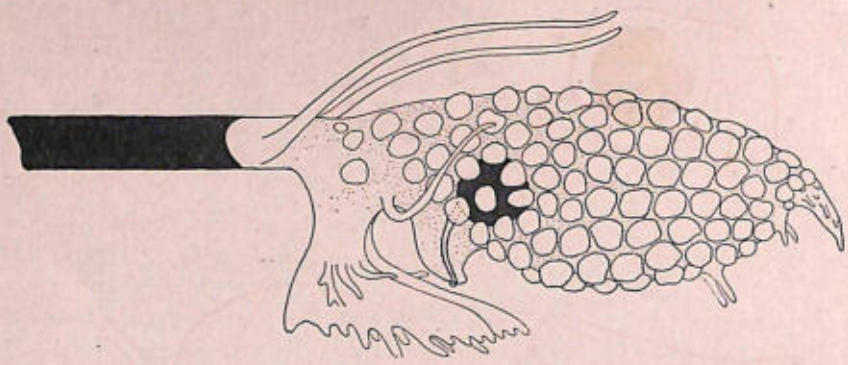
DESCRIPTION.

With the characteristics of the genus.

Color: Jet black except for bulb of illicium which, in the fresh specimen, was completely semi-translucent white, except for a small, black, subdermal body less than halfway from base to tip of bulb. In the preserved fish, this body is practically invisible, the bulb now being olive brown, opaque except at the very base, which is still pale.



TEXT-FIG. 12. *Trematorhynchus paucilamellatus*, holotype. **A**, Lateral view. **B**, Head, lateral view. **C**, Head, front view. Dotted lines indicate externally invisible lamellae.



TEXT-FIG. 13. *Gigantactis perlatus*, holotype. End of illicium.

Proportions: Illicium longer than standard length, shorter than total (37 mm. to tip of bulb; bulb measures 3 mm.). Distance from last dorsal ray to caudal less than one-fourth length of fish. Eyes appear to be practically non-functional.

Illicium: The bulb is similar to that of *G. vanhoeffeni* Brauer, 1902 (1906, pl. XV) from the Indian Ocean, being elongate, unpigmented, covered with pearl-like nodules, furnished with a number of tentacles and papillae, and having a round subdermal, presumably glandular body in the proximal half.

The pearl-like nodules are oval, round or irregularly quadrilateral, and commence close to the base, although they are not closely set before the distal half of bulb. They total around 150.

The filamentous ornaments consist of a pair of long tentacles arising from the tip of the stem; a pair of winglike, posterior basal flanges, each with several external papillae and an irregularly fringed edge; a pair of shorter posterior tentacles; a large unpaired posterior tubercle arising distal to the flanges and surmounted by a pore; two pairs of small elongate posterior papillae near the bulb's tip; and finally, a tapering distal tubercle covered irregularly with elongate papillae.

As reported under *Color*, the small, round black subdermal body so conspicuous in the proximal half of the bulb is now almost invisible. It appears to give rise to a tubercle connecting with the posterior pore mentioned in the preceding paragraph.

Teeth: Upper jaw: 2 on each side, well separated but close to symphysis, small, slender, curved. Roof of mouth (on upper pharyngeals?): 6 larger teeth on right side, 5 on left. Lower jaw: 10 on each side, much larger than in upper; 4 in a regular outer row, 6 in an irregular inner line.

Fin Counts: Dorsal 5, anal 5, pectoral 18, caudal 8.

Ovaries: Minute, less than 1 mm. in length.

Food: 1 copepod (length 6 mm.)

Discussion: The proposed new species is very close to Brauer's *vanhoeffeni*, known from two examples from the Indian Ocean. Our example is of the same size as the holotype of *vanhoeffeni*, and so is directly comparable. Body proportions are similar, as is the general character of the bulb. The differences are as follows:

(1). The proximal bulb tentacles are differently arranged and more complex, including the presence of the pair of winglike flanges. (2). The distal bulb tentacles are fewer, shorter and more irregular. (3). The pearl-like papillae studding the bulb are much more close-set and numerous. (4). There are 5, not 6, dorsal rays. (5). There are 18, not 16-17 pectoral rays.

FAMILY CERATIIDAE.

Cryptosparas normani

Regan & Trewavas, 1932.

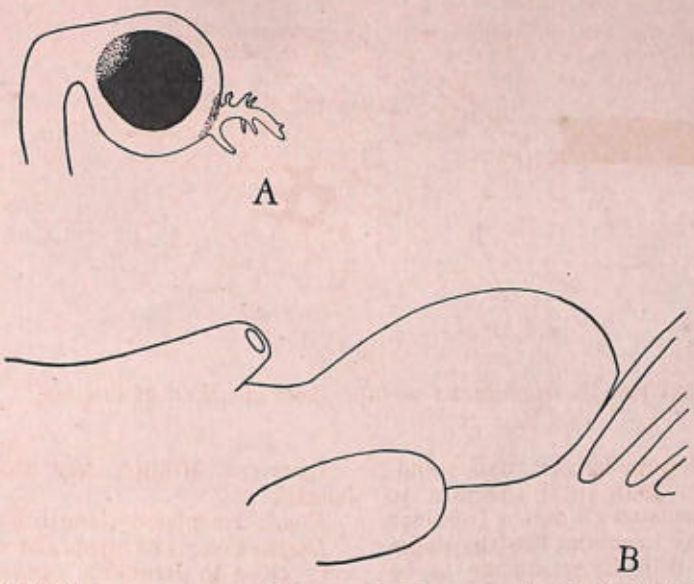
(Text-fig. 14).

References and Synonymy: *Cryptosparas couesii* (*non* Gill), Norman, 1930, p. 354, fig. 44. *Cryptosparas normani* Regan & Trewavas, 1932, p. 98.

Range: South Atlantic, off South Africa; Eastern Pacific, off Galápagos.

Specimens Taken by the Eastern Pacific Expeditions: Two specimens, from 300 and 600 fathoms, off Galápagos Islands, total lengths 14.3 and 66 mm., transitional adolescents.

Discussion: *Cryptosparas normani* known only from the holotype taken off South Africa, is distinguished from *couesii* by Regan & Trewavas by the fact that the pore in front of the dorsal caruncles is at the end of a short tentacle, or elongate papilla, instead of arising directly from the dorsal skin, or from a slight prominence. This papilla is very distinct in our larger speci-



TEXT-FIG. 14. *Cryptosparas normani* Regan & Trewavas. **A**, End of illicium. **B**, Predorsal caruncles.

men, and of approximately the same size as that in the holotype. In our small dried specimen it is also clearly present. In all our Bermuda specimens, on the contrary, the pore is invariably of the typical, inconspicuous *couesii* form. In addition, the illicium bulbs of our Eastern Pacific specimens agree with the figure of *normani* in having the tentacle shorter than in *couesii* and a series of branches along each side, similar to those found in *pennifer* Regan & Trewavas, 1932, from the north of New Zealand. It is possible that these differences may prove to be merely individual variation, but until more material is available it seems best to maintain the several species.

In our Eastern Pacific specimens of *normani* there are more epidermal papillae than the six mentioned by Norman, and they are scattered asymmetrically.

Food and Ovaries: The stomach is empty; intestine crammed with soft black detritus, probably squid. Ovaries of larger specimen, 12 mm. long, moderately developed.

Study Material: Cat. No. 6284; *Arcturus* Oceanographic Expedition; Station 84 T-10; one mile north of Narborough, Galápagos (0° 17′ S. Lat., 91° 34′ W. Long.); 300 fathoms; June 9, 1925; length 66 (52+15) mm.

Cat. No. 6346; *Arcturus* Oceanographic Expedition; Station 86 T-9; 16 miles SW of Narborough (0° 42′ N. Lat., 91° 47′ W. Long.); 600 fathoms; June 12, 1925; length 14.3 (10.3+4) mm.

Mancalius uranoscopus (Murray, 1878).

References: *Ceratius uranoscopus* Murray, 1878, p. 67; Gunther, 1887, p. 54, pl. XI, fig. C. *Mancalius uranoscopus*, Norman, 1930, p. 355; Regan & Trewavas, 1932, p. 99; Parr, 1932, p. 12.

Range: Atlantic, Indian Ocean, Western and Central Pacific Ocean; present specimens first from Eastern Pacific.

Specimens Taken by Eastern Pacific Expeditions: Four specimens from 500 to 750 fathoms, off Cocos and Galápagos Islands, total lengths 24, 24, 24 and 140 mm. respectively. All four appear to be transitional adolescents, even No. 5991 which, although nearly six inches long, has undeveloped ovaries only 7.7 mm. in length.

Remarks: These are the first Eastern Pacific specimens taken, the closest being the type of *Myopsarus myops* Gilbert from Hawaii which, like our large one, lacks the illicium. This is the case with four out of the sixteen previously known individuals.

Our 140 mm. specimen No. 5991 appeared quite dead when brought up, and its struggles in the net had considerably abraded its skin. That life was not wholly extinct, however, was shown a few minutes after it was placed in ice water, when both stalked caruncles waved slowly back and forth alternately. There was no current in the aquarium nor motion of the ship so this was purely a muscular movement.

In Specimen No. 6214, at the very base of the main stem of the illicium, and posterior to where it arises from the skin of the back, is a well developed caruncle. This is quite as large as the third of the posterior group, but is almost hidden from lateral view as it arises from the bottom of the illicial groove. Instead of two, as seems more usual in this species, there are three

caruncles in front of the soft dorsal fin, the third being median, anterior to the paired ones, and only about half their size.

In specimen No. 6286 the accessory caruncle near the illicium stem and the anterior of the posterior group are slightly less developed than in No. 6214, but still of good size and distinct to even a casual glance. The accessory caruncles and the narial spines are wholly absent from the large specimen No. 5991.

Specimen No. 6641 is identical in measurements with No. 6286. The post-illicial caruncle is better developed than in any of the others, but the anterior third dorsal one is absent, represented only by a pore, level with the surface of the skin. In the small individuals there is a short, curved keel along the basal half of the lowest caudal ray, and in No. 6214 this is developed into an incipient ray. If this were larger and slightly more distinct, we should have the ninth caudal ray which occurs normally in several related genera.

Mancalius uranoscopus typhlops Roule & Angel, 1933, 47 mm. in length, from near the Azores, has a stout, ray-like caruncle in front of the caruncles proper. This may be a young stage of *M. tentaculatus* Norman, 1932, 110 mm. long, or more probably, merely another variation in *uranoscopus*.

Study Material: Cat. No. 5991; Col. Pl. 2097; *Arcturus* Oceanographic Expedition; Station 74 OT-2; 60 miles south of Cocos (4° 50′ N. Lat., 87° W. Long.) 750 fathoms; May 29, 1925; total length 140 (100 + 40) mm.

Cat. No. 6214; Col. Pl. 2094; *Arcturus* Oceanographic Expedition; Station 84 PT-1; one mile north of Narborough (0° 17′ S. Lat., 91° 34′ W. Long.); 500 fathoms; June 9, 1925; total length 24 (16.5 + 7.5) mm.

Cat. No. 6286; Col. Pl. 2076; *Arcturus* Oceanographic Expedition; Station 84 T-14; one mile north of Narborough (0° 17′ S. Lat., 91° 34′ W. Long.); 500 fathoms; June 9, 1925; total length 24 (17.5 + 6.5) mm.

Cat. No. 6641; Col. Pl. 6641; *Arcturus* Oceanographic Expedition; Station 74 T-78; 60 miles south of Cocos (4° 50′ N. Lat., 87° W. Long.); 700 fathoms, June 3, 1925; total length 24 (17 + 7) mm.

Family Linophrynidae.

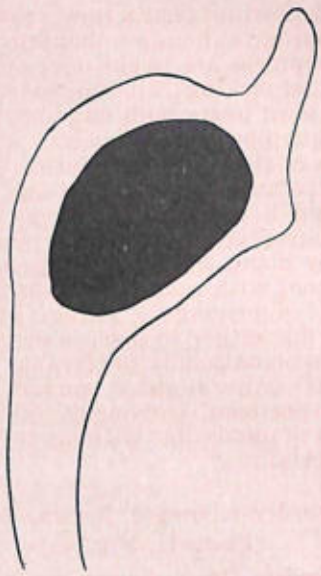
Acentrophryne ?longidens Regan, 1926.

(Text-fig. 15).

Reference: Regan, 1926, p. 3, pl. 1, fig. 2.

Range: Gulf of Panama, and off western Costa Rica.

Specimen Taken by the Eastern Pacific Zaca Expedition: 1 specimen; Cat. No. 28,411; Sta. 210 T-10; 20 mi. south of Cape Blanco, Costa Rica (9° 11′ N. Lat., 85° 08′ 30″ W. Long.); 500 fathoms; Feb. 27, 1938; length 60 (42 + 18) mm; an abnormal, immature female with rudimentary ovaries.



TEXT-FIG. 15. *Acentrophryne ?longidens* Regan & Trewavas. Illicium.

Color: Head and body sooty black; stem of illicium, outer sheath of bulb, and terminal appendage rising from posterior tip of sheath, all translucent and colorless; bulb blue-black.

Measurements and Proportions: Snout to gill opening 26 mm. i. e., slightly less than one-half total length. Illicium, total length 15 mm.; bulb 2.9 mm.; terminal appendage .96 mm.

Teeth: In each half of upper jaw, 5 or 6 small unequal teeth in a single series; in each mandibular ramus, 5 small, unequal outer teeth plus 1 to 3 long, inner fangs near symphysis. No teeth on vomer or pharyngeals.

Fins: D. 3, A. 3, P. 18, C. 8.

Lateral Line System: The papillae on head and upper anterior side are similar to those of *Borophryne*, but the tags are all short, unpigmented, and less variable in length.

Remarks: Most of the body cavity of this specimen, including the inside of the expanded stomach, was filled with a tumor. Through the kindness of Dr. Ross Nigrelli, parasitologist of the New York Zoological Society, an account of the growth follows the present paper (*Zoologica*, Vol. 31, No. 12).

The fish agrees with *Acentrophryne*, previously known only from the 75 mm. type of *A. longidens*, from the Gulf of Panama,

in the following characters: preopercular spine lacking, although sphenotic and mandibular spines are well developed; teeth few; barbel lacking; illicium consisting of a stem with an ovate bulb and short terminal appendage; pectoral 18.

It differs from the description and figure of the type as follows: dorsal and anal each numbering 3 not 4; teeth weak and relatively short; vomerine teeth lacking; illicium only about half as long as in Regan's illustration, with a smaller bulb but longer terminal appendage. These distinctions could be due either to disease or youth. The former explanation is preferable, since the type was only slightly longer than the present specimen. Obviously, certain identification is impossible without further, normal material.

Borophryne apogon Regan, 1925.

(Plate II, Fig. 4).

References: *Borophryne apogon* Regan, 1925, p. 564; 1926, p. 23, pl. 11, fig. 1; Regan & Trewavas, 1932, pp. 18, 106, text-figs. 7, 8.

Range: Tropical Eastern Pacific. The present series includes the first specimen taken outside the Gulf of Panama.

Specimens Taken by the Eastern Pacific Expeditions: Five specimens from 500 to 700 fathoms, taken from the vicinity of Cocos Island and of the Gulf of Panama. The series includes 2 large females, (total lengths 71 and 74.5 mm.), each with a male attached (18.3 and 17.4 mm. respectively), and 1 transitional adolescent female, (37 mm.).

Remarks on Females: *Color*: All three females, including a living large one with attached male, were jet black, the illicium filaments translucent milky white, and the heart of the bulb bluish-purple.

Luminescence: Female No. 28,707a came up alive and swam about strongly. In the darkroom there were occasional flashes of creamy white light, exact source undetermined, and now and then a purplish one from the bulb.

Teeth: Upper jaw: on each side, 5 or 6 long teeth with 8 to 10 small ones, of which some are close to the large teeth and are apparently of a replacement type. Lower jaw: on each side, 3 long teeth, of which the second is an enormous fang, and 8 to 11 small ones, some of a replacement nature. In both jaws the large teeth are interior to the others, which form a very irregular outer row. There is a pair of teeth on the vomer, with 2 subsidiary teeth in one specimen, 1 in the other, and a group of strong upper pharyngeal teeth, 4 or 5 on each side.

Fins: D. 3, A. 3, P. 15. In each female, the tips of all three rays barely project externally, the sheath of dark skin extending to the tip, and the first two bound in a common skin almost to their ends.

Development: The 37 mm. transitional adolescent female differs from the two adults in having relatively longer sphenotic preopercular and mandibular spines, and somewhat fewer teeth in the jaws. The illicium is almost as well developed as in the adult.

Gonads: The two large females, although of similar size and appearance, and termed "adults" for convenience, show decided differences in the development of the ovaries. In 28,707a the ovaries measure about 15 × 9 mm.; the eggs are .38 mm. in diameter, and appear almost ripe. In 28,708a, the ovaries are only about two-thirds as large with the eggs only .10 mm. in diameter and obviously unripe. The attached males, though externally showing little difference, show similar development discrepancies internally, the physiologically younger male being attached to the corresponding female (see page 172). Incidentally it is the older female that has the longer tentacles on the illicium bulb.

Comparison with Type Description: These females differ from the description and figures of the type series, which are of comparable length, as follows: (1). The gill opening, even in the transitional adolescent, is well behind the middle of the length excluding the tail, though slightly in front of the middle of the total length. The type description, reads "gill opening about in the middle of the length," and the illustration shows it at the middle of the standard length. (2). There are subsidiary teeth on the vomer, instead of a single pair, and there are more jaw teeth, especially small ones, than are shown in the plate. (3). The illicium differs from the illustration in small details; the forked tip of the terminal tentacle is shorter than the stem giving rise to it, not longer; however, this is a variable character, not being identical in the two specimens at hand; in one, even the branches of the fork are of unequal length. Also the mass of filaments arising from the bulb are variable; in one case (No. 28,707a, with better developed gonads) they extend well beyond the forked branches when laid against the latter, while in the other they are considerably shorter than the branches; likewise, their number, arrangement, and degree of branching, although similar, are not identical. Unlike Regan's illustration, the filaments extend also on the sides of the bulb immediately underneath the terminal forked tentacles, in addition to those extending down, anteriorly and posteriorly, as shown in the plate. They are much more numerous and branch more complexly than in the neces-

sarily diagrammatic illustration. (4). Dissection and one cleared example show that there are definitely only 3, not 4, rays in both dorsal and anal fins. (5). The pale lateral line organs are on the dark "tags" described by Regan & Trewavas (1932, p. 24). It is to be noted, however, that in our specimens the peduncles are unequal in length, varying from almost sessile to .75 mm. long, and the organs of various sizes do not occur in the same positions in the two specimens. Number and distribution of the organs are also quite variable.

Remarks On Attached Males: Each of the adult females has a male attached slightly to the left of her ventral midline, a little behind the middle of the fish, one at a distance of 15 mm. in front of the anus and genital opening, the other at 10 mm. Both males are fastened upside-down, that is, the body trailing posteriorly with the ventral surface opposed to that of the female.

Each specimen is further along in the course of parasitism than the two described by Regan & Trewavas (1932, p. 18). Each is firmly attached by both jaws, instead of only the lower, so that attachment by a single jaw proves to be invalid as a distinction from *Linophryne*. There is free passage of water into the mouth between the two jaws. No denticles are visible externally and there is no trace of a lateral line, although the cephalic system is apparent. In one (28,708b) there is no external trace remaining of dorsal or anal fins, while in the other the extreme tips of 3 dorsal and 2 anal rays project. Unlike Regan & Trewavas' specimens, where the sphenotic spine does not appear on one side, they are present externally on both sides (although of unequal length) in 28,708b, and on neither side, being sheathed in skin, in 28,707b. Both males were jet black, with conspicuous white nasal areas, while one of the previously recorded males was unpigmented.

Parr (1934, p. 58) queried the validity of identifying as one species two such dissimilar males as those of Regan & Trewavas, on the basis of their being attached to similar females. The present two indicate that the differences, including degree of pigmentation, merely indicate difference in development stage, first, in ordinary growth progress, and second, in degree of parasitic degeneration. None of the free-swimming males probably referable to *Borophryne* (see page 176ff.) is pigmented, and it seems likely that attachment occurs well before adulthood. Our two attached males internally show decided differences in degree of development of the testicles and degeneration of the other organs, the less advanced (No. 28,708b) being attached to the female with less well developed ovaries (see p. 171). In this male, the testicles measure about 3.5 × 1.34 mm. and are kidney shaped. The stomach measures 1.8 and is still conspicuous. In male No. 28,-707b the testicles are more than half again as large, are much better developed, and are folded over on themselves, instead of being of the simple kidney shape. In this specimen, the organs were only exposed, not dissected, but it could be seen that the stomach and liver are both considerably smaller than in 28,708b.

In both males the eyes are directed forward and down which, in the attached position, is forward and *up*, toward the body of the female. There are 8 or possibly 9 nasal lamellae, apparently degenerating, and all except about 3 are invisible through the nostril. Dorsal 3; anal 3; pectoral about 15, the rays free in 24,708b, but almost sheathed in thick webbing in 24,-707b. Caudal 8, the dorsal and ventral pairs completely skin-sheathed.

Male No. 28,708b, along with a small patch of the female abdominal skin to which he was attached, was cleared and stained by the potassium-hydroxide-alizarin method. All of the skeleton with the exception of the rostral denticles is strongly ossified. These denticles are scarcely stained and very soft, although deeply buried in the tissue of the female; they number 4, a fifth, between the outer and central denticles on the left side, being represented by a vestigial stump. The rostral bone itself is strongly ossified. The entire predentary bone is deeply stained, buried in female tissue. The typical *Aceratias*-type, forwardly-directed median denticle is present plus 4 strong, erect denticles on each side. Both jaws are toothless. The remainder of the skeleton agrees very well with the figure and description of *Aceratias indicus* given by Regan & Trewavas, 1932, p. 48, fig. 70.

In female No. 28,707a there are traces of what may be the result of recent abortive attempts of other males to attach themselves. One is about 5 mm. behind the male's present position, and is in the form of an oval, raw, skinless area, with even margins and a longitudinal diameter of 2.2 mm. There are two similar areas near the dorsal fin on the opposite side.

Remarks on Free-swimming Males. It appears certain that some of the *Aceratias* described on p. 176ff. are actually young free-swimming males of *Borophryne apogon*. However, until attached males of *Linophryne* and *Acentrophryne*, as well as large series of free-swimming young, can be studied exhaustively, internally and ex-

ternally, we think it would be premature to refer any of the specimens to particular genera. It appears more profitable to treat the entire series as a unit illustrating general principles of linophrynid male development.

Food: Both the large females had the stomachs greatly distended with food. No. 28,707a contained the much digested remains of a single fish which must have measured at least 60 mm. in length. No. 28,708a held 3 fish, each about 50 mm. long: a *Lampanyctus* freshly swallowed, most photophores and many scales remaining; another myctophid, partly digested; and a third fish almost wholly digested.

Behavior: No. 28,707a, one of the two females with attached males, was alive when it reached the surface, and in an aquarium swam strongly and easily, using the caudal for propulsion and the pectorals only for turning. Her eyes moved slightly as she turned. The illicium was usually extended well forward, but several times it was jerked back and forth, and once flattened into its groove. The jaws moved through a slight arc, but never closed on account of the length of the teeth. Under a hand lens slight muscular twitches could be detected on the part of the parasitic male attached to her ventral surface.

Study Material: Cat. No. 6642: *Arcturus* Oceanographic Expedition: Station 74 T-78; 60 miles south of Cocos (4° 50′ N. Lat., 87° W. Long.); 700 fathoms; June 3, 1925; transitional adolescent female, total length 37 (25+12) mm.;

Cat. No. 28,707a, 28,707b; Eastern Pacific *Zaca* Expedition; Station 234 T-1; 24 mi. W × S of Pinos Pt., Panama (7° 24′ N. Lat., 78° 35′ W. Long.); 500 fathoms; April 4, 1938; female with parasitic male attached, total lengths 74.5 (51.5+23) and 17.4 (10.5+6.9) mm., respectively.

Cat. No. 28,708a, 28,708b; in same net as preceding; female with parasitic male attached, total lengths 71 (50+21) and 18.3 (10.8+7.5) mm., respectively.

Linophryne arcturi (Beebe, 1926).

(Text-fig. 16).

References: *Diabolidium arcturi*, Beebe, 1926, p. 80., fig. *Linophryne arcturi*, Regan & Trewavas, 1932, p. 107.

Range: Tropical Eastern Pacific.

Holotype, the Unique Specimen: Cat. No. 6333; *Arcturus* Oceanographic Expedition; Sta. 74 T-70; 60 miles south of Cocos Island, Costa Rica (4° 50′ N. Lat., 87° W. Long.); 500 fathoms; June 2, 1925; length 38.6 (28.6 + 10) mm.; transitional adolescent female with ovaries little developed.

Color in Life: Brownish-black; illicium with basal bone, basal half of stem, upper part of bulb and stem portion of distal appendage dark brown; distal portion of stem, outer sheath and basal part of bulb, and distal filament all translucent white; all except tip of barbel dark brown; distal 5 mm. translucent white.

Luminescence: The white base of the candle-like organ showed distinct luminescence in the dark room during the first three minutes after capture. In addition, all the larger fangs were dimly outlined with luminescence, apparently resulting from a mucous coating.

Measurements and Proportions: Length 38.6 (28.6+10) mm.; snout to gill-opening 15.7, or slightly more than half length without caudal fin; total length of barbel 33.6, slightly less than total length of fish; length of illicium stem 6.1, of bulb 3, of stem of distal projection 2.9, of distal tentacle 1.1; longest upper fang 3; longest lower fang 3.6.

Illicium: A candle-like structure as in illustration. Bulb within a translucent sheath having a small anterior and larger posterior flange, and a distal projection. The latter consists of a pigmented basal stem longer than the bulb and a shorter unpigmented terminal filament.

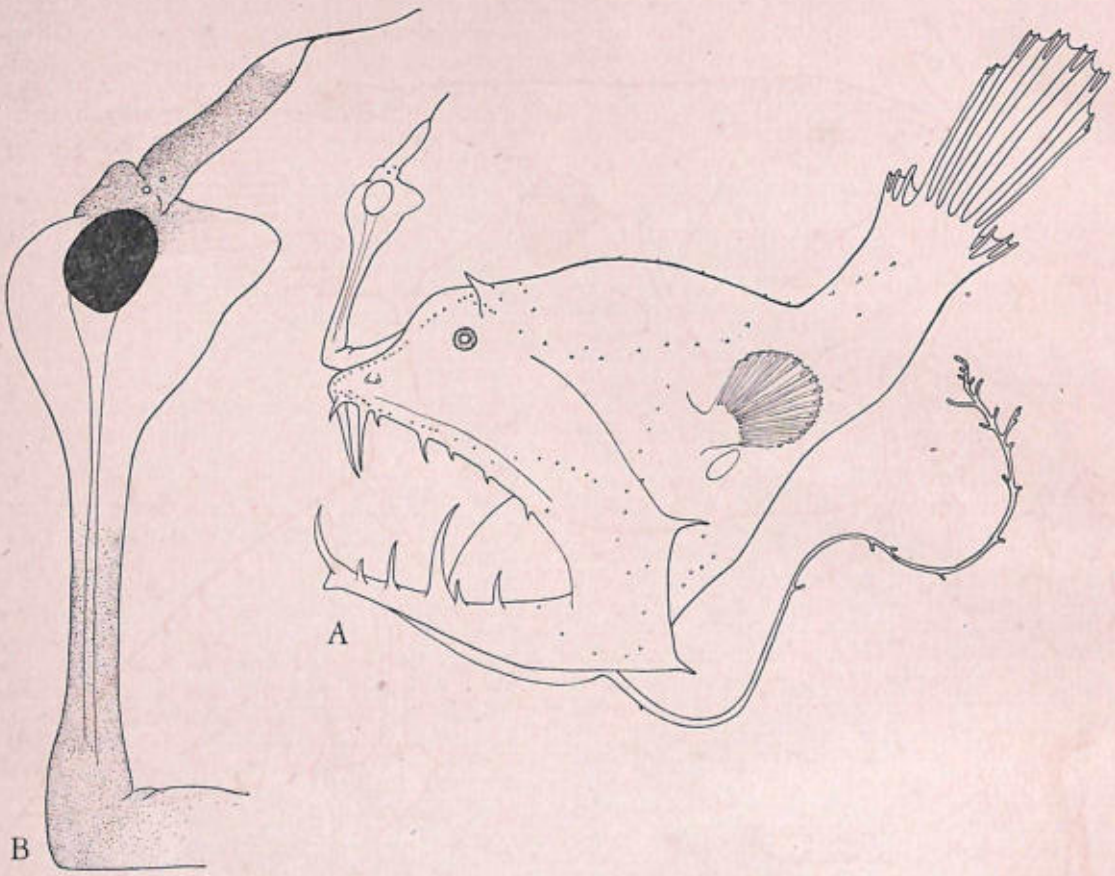
Barbel: The structure is almost as long as the fish, consisting of a single, long, undivided stem, with small, short off-shoots scattered sparingly. The first very minute branch is 6.4 mm. from base. There are no more for a considerable distance, and then 8 irregularly spaced throughout the remainder of the brown pigmented portion, which extends from the base to within 5 mm. of the tip. These nine are all small, the largest only .54 mm. in length, about the diameter of the barbel itself. In structure they consist of a short stem ending in a round bulb. In the colorless, distal 5 mm., the branches are closer together, about 9 or 10 in all, with very slender stalks. In two, there are subsidiary divisions from one of the branches, there being 3 bulbs close together. The barbel ends in a small branch and bulb. The longest of these terminal and subterminal branchlets is 1.1 mm.

Teeth: In each half of upper jaw, 7 to 8 teeth, of which the first and third are longest. In each mandibular ramus 6 or 7, of which the first and fourth are largest. A pair of long, curved vomerine teeth, and a group of 5 or 6 upper pharyngeals on each side.

Fins: D. 3, A. 3, P. 17, C. 8.

Behavior: This fish lived for ten minutes after being taken from the net. Luminescence was observed as described above.

Remarks: Text-fig. 16 is to replace the illustration published with the type description.



TEXT-FIG. 16. *Linophryne arcturi* (Beebe), holotype. **A**, Lateral view. **B**, Illicium.

Linophryne quinqueramosus sp. nov.

(Plate III, Fig. 5; Text-fig. 17).

TYPE.

(The unique specimen).

Department of Tropical Research No. 28,-709; Eastern Pacific *Zaca* Expedition; Station 234 T-1 (7° 24′ N. Lat., 78° 35′ W. Long.); 24 miles W × S of Pinas Pt., Panama; 500 fathoms; April 4, 1938; total length 89 (62+27) mm.; ovaries minute with eggs scarcely developed.

DESCRIPTION.

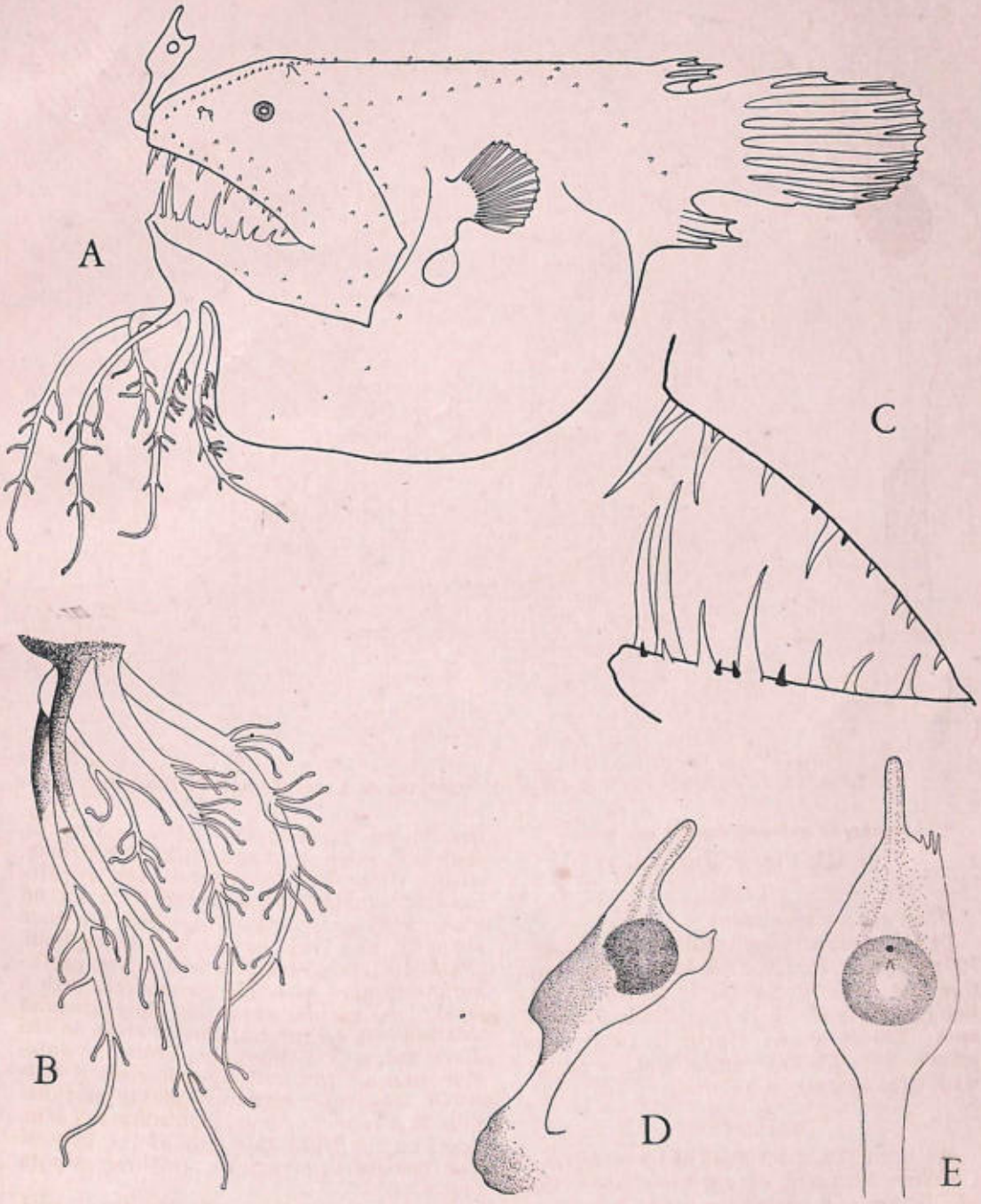
With the characteristics of the genus.

Color: Jet black, except for white details of illicium and barbel, as noted below.

Measurements and Proportions: Snout to gill opening 36 mm., slightly more than half length of fish without tail. Illicium short, measuring 17.7 overall (stem 7.8, bulb 7.1, filament 2.8); longest barbel tentacles about 40; length longest fangs, upper jaw 7.5, lower jaw 8.2.

Illicium: The illicium arises from a deep groove on tip of snout, so deep that the base of this organ takes the place of the symphysis, the large upper teeth arising on each side. Stem short and thick, 15 mm. long, with a wide black basal zone, then a white band of equal width, followed by a second black area anteriorly. This stem expands abruptly, and encloses the blue black bulb. Distal to this posteriorly is a silver protuberance topped by a minute tubercle with a small longitudinal ridge or flange behind and below it. In front of the tubercle, on the distal ridge, is a tiny pore. From the anterior edge of the bulb sheath rises a flattened, transverse structure giving rise distally to a round, opaque, blunt finger, 7 mm. long; on the right side only of the base of this transverse structure are three minute tentacles.

Barbel: From the center of the throat there arise five long tentacles so close together that their bases touch. The proximal 10 mm. of the anterior pair are black; the remainder of this pair, all of the shorter central tentacle, and almost all of the posterior pair are translucent white. The details of the proportions and branching can best be seen from the figure. Each of the short tentacles ends in a shining, white, opaque bulbet, scarcely expanded.

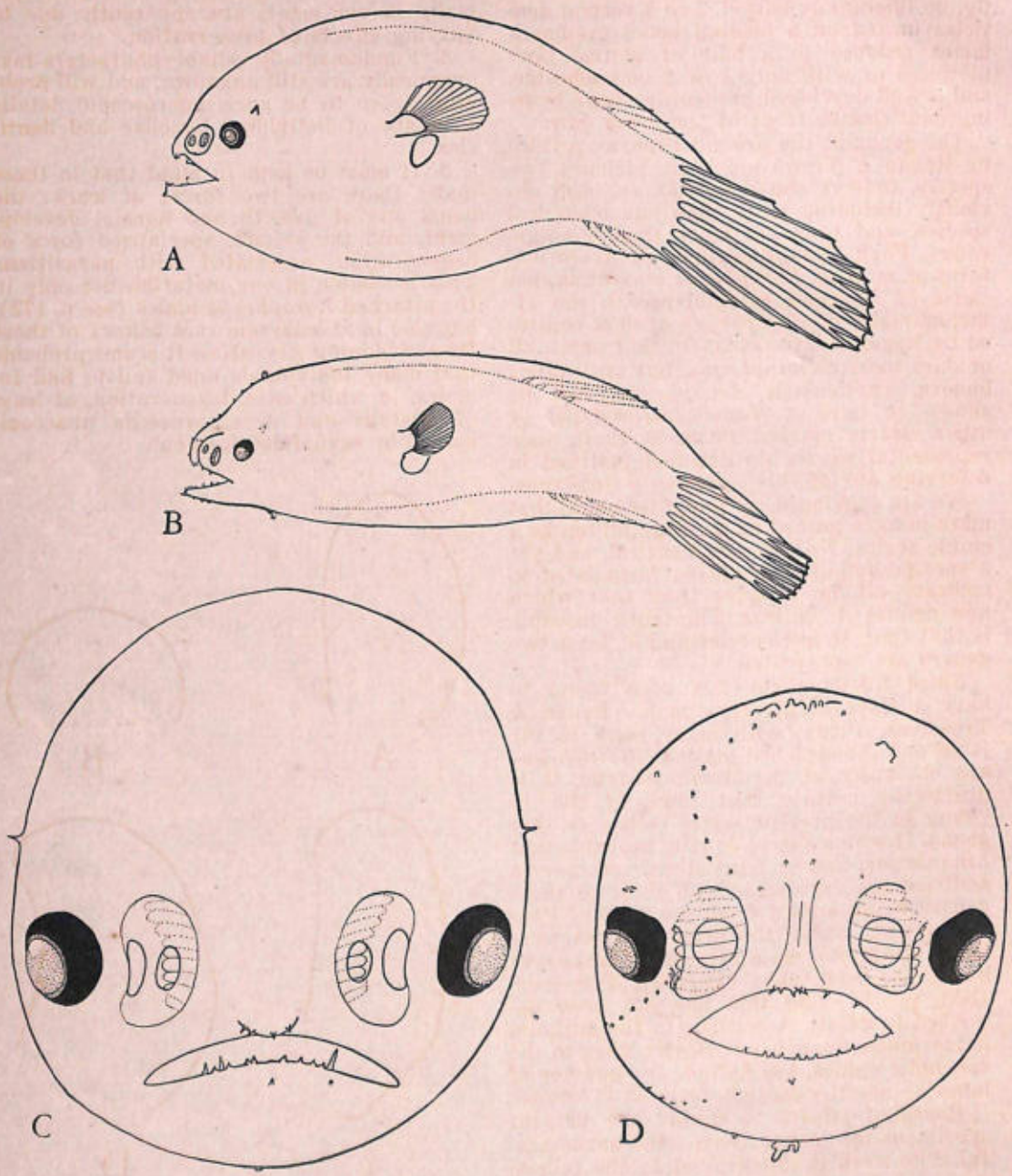


TEXT-FIG. 17. *Linophryne quinqueramosus*, holotype. **A**, Lateral view. **B**, Barbel, left lateral view. **C**, Dentition. Depressible teeth unshaded. **D**, Illicium, left lateral view. **E**, Illicium, posterior view.

Teeth: 12 or 13 teeth in each half of the upper jaw and in each mandibular ramus, including long fangs, replacement teeth, small teeth, and several minute fixed teeth. A pair of teeth on the vomer and a series of 4 or 5 upper pharyngeals on each side.

Fins: D. 3, A. 3, P. 16, C. 8.

Food: The stomach was enormously distended with the following: 1 *Serrivomer*, 330 mm. long; 1 *Sternoptyx*, 25 mm.; 2 *Cyclothone*, 26 and 60 mm.; 5 shrimps, 12-30 mm.



TEXT-FIG. 18. *Aceratias* spp. **A**, Post-larval (Cat. No. 28,756, "*a*" in text). **B**, Transitional adolescent (Cat. No. 28,763, "*h*" in text). **C**, Same specimen as A, front view. **D**, same specimen as B, front view. Note asymmetrical development of papillae.

Remarks: This specimen is perhaps closest to *L. macrodon* Regan, 1926, also from the Gulf of Panama. It differs, however, in the shorter, distally distinct illicium, in the branching of the barbel, and in the larger number of teeth.

***Aceratias* spp.**

(Text-figs. 18, 19).

Ten specimens of young, free-swimming linophrynid males were taken in or near the Gulf of Panama. All have the general char-

acters ascribed by Regan & Trewavas to *Aceratias*, having the characters of the family, no illicium or barbel, 3 to 5 rostral denticles united on a median bone, premaxillaries reduced to a pair of plates, jaws toothless or with only 1 or 2 on each side, and a well developed predentary bone bearing denticles in front of the lower jaw.

The genus at the present time, as revised by Regan & Trewavas, 1932, includes two species, *indicus* and *macrorhinus*, each obviously including more than one biological species, and probably more than a single genus. Parr, 1934, described an *Aceratias*-form of male as *Borophyrne masculina*, because of its close resemblance to the attached males of *Borophryne apogon* recorded by Regan & Trewavas. On that basis, all of ours too are *Borophryne*, but until other genera, particularly *Linophryne*, can be shown to have a *Nannoceratias*-type, or other clearly marked form, as their male representative, we do not feel justified in referring any of this series to *Borophryne*.

We are convinced, on the other hand, that more is to be gained by treating all ten as a single series. No two are identical, and yet a specific definition could be formulated to embrace all, no broader than that which now defines *A. indicus*. The truth probably is that four or five species and at least two genera are represented.

Since *Edriolychnus* has been found to have a *Haplophryne*-type male (Regan & Trewavas, 1932), with many teeth in the jaws, and the attached males of *Borophryne* are obviously of the *Aceratias*-type, it is practically certain that some of the 10 young in the present series belong to that genus. It seems almost equally probable that *Linophryne*, and at least *Acentrophryne* in addition are represented, all three of these genera being known from the Gulf of Panama region where the present males were taken. Only one male attached *Linophryne* has so far been taken (Regan & Trewavas, 1932, p. 19), and this has not been described in detail. According to the authors, it resembles *Borophryne* closely, even to the sphenotic spines, but neither the number of lamellae nor the denticle formula is known.

Repeated efforts to divide the present specimens into genera have been unsuccessful. The work is complicated by the following considerations, in addition to the obvious prime one of paucity of material.

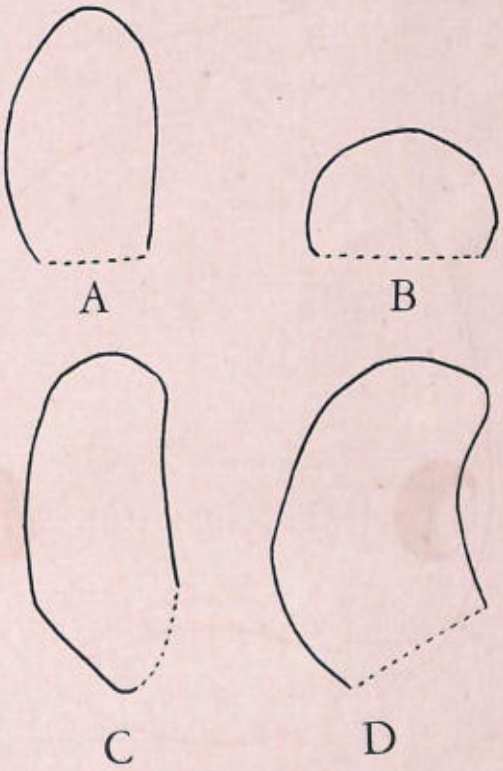
1. General macroscopic characters, including the obvious ones of fin, lamella, and denticle counts, show slight or no differences.

2. Macroscopic differences, such as amount of inflation and eye rotation, are merely growth characters.

3. Other apparent differences, especially in the shape of the inflated envelope, of nostrils and of rostral profile, as well as the frequent lack of cephalic symmetry, (especially in eye size), are apparently due to varying effects of preservation.

4. Fundamentally reliable characters taxonomically are still unknown, and will probably prove to be such microscopic details as shape of individual lamellae and denticles.

5. It must be kept in mind that in these males there are two forces at work: the usual one of growth and normal development, and the second, specialized force of degeneration, associated with parasitism. This is visible in our material, not only in the attached *Borophryne* males (see p. 172), but also in at least one (see below) of these free-swimming *Aceratias*. It seems probable that many individuals must fail to find females, in which case degeneration, at least of nostrils and eyes, proceeds unaccompanied by sexual development.



TEXT-FIG. 19. *Aceratias* spp. General types of lamellae. Each sample taken from middle of a series, where maximum development is attained. **A**, High, narrow type (from Cat. No. 23,761, "*f*" in text). **B**, Low, broad, split type (from Cat. No. 28,762, "*g*" in text). **C**, Very high, narrow type (from Cat. No. 28,763, "*h*" in text). **D**, High, curved, broad type (from Cat. No. 28, 764, "*i*" in text). In each, exterior tip is uppermost and anterior edge toward the right.

TABLE I.

ACERATIAS SPP.

Principal Differences in 10 Specimens Arranged According to Apparent Age.

(Note: Trawling and other data given under **Study** Material, p. 180; see text for further discussion).

	No. 28,756 ("a")	No. 28,757 ("b")	No. 28,758 ("c")	No. 28,759 ("d")	No. 28,760 ("e")	No. 28,761 ("f")	No. 28,762 ("g")	No. 28,763 ("h")	No. 28,764 ("i")	No. 28,765 ("j")
Inflation	Great	Great	Medium	Medium	Medium	Medium	Medium	Slight	Slight	Slight
Stand. lgth. in depth at P.	63%	79%	57%	55%	50%	54%	54%	42%	42%	48%
Eye, rotation	Slight	Slight	Slight	Moderate	Moderate	Moderate	Moderate	Great	Great	Great
Eye-ball, diameter (% of largest)	75%	67%	58%	62%	79%	75%	71%	88%	100%	96%
Denticles, sheathed?	Mostly	Not	Partly	Not	Not	Mostly	Not	Not	Not	Not
Denticles, rostral	4	5	3	5	3	5	5	5	5	3
Denticles, predentary, r. lat.	4	3	3	4	4	3	3	4	3	4
Denticles, predentary, l. lat.	4	3	3	4	3	3	4	6	3	4
Denticles, predentary, shape	Short, thin	Long, thin	Long, wide bases	Long, medium	Medium, stout	Short, stout	Long, stout	Short, medium	Long, stout	Short, stout
Denticles, median predentary, shape	Short, thin	Broken? Points down?	Long, thin	Long, thin	Medium, stout	Medium, stout	Long, stout	Short, thin	Long, stout	Long, stout
Teeth, upper, r.	0	Jaw serrations	0	0	0	0	0	0	0	0
Teeth, upper, l.	0	Jaw serrations	0	0	0	0	0	2	Several	0
Teeth, lower, r.	1	Jaw serrations	2	0	0	0	2	0	0	0
Teeth, lower, l.	2	Jaw serrations	0	0	0	0	0	0	0	0
Lamellae, number	9	8	9	9	9	9	9	9	9	8 or 9
Lamellae, shape (Text-fig. 19)	Low, broad, split	High, narrow	High, narrow	High, curved, broad	Low, broad, split	High, narrow	Low, broad, split	Very high, narrow	High, curved, broad	Low, broad, split
Lat. Line System Papillae	Tiny, few	Tiny, few	Tiny, few	Tiny, few	Small	Medium	Tiny, few	Well developed	Tiny, few	Small
Mental fringe	Rudimentary	None	None	None	None	Present	Present	Present	No	No
Sphenotic spines, lgth., subdermal incl.	Medium	Short	Medium	Medium	Medium	Medium	Medium	Rudimentary	Medium	Long

Since profitable subdivision is not at present possible, the 10 young males are arranged in Table I in order from the apparently youngest to the apparently oldest. However, since various species are involved, the arrangement is only for convenience, and does not represent a truly linear sequence. The characters listed indicate the chief differences both of development and also those which are most likely to prove of taxonomic value. For the present discussion the specimens are lettered for easy reference. Corresponding catalogue numbers, with complete field data, will be found under Study Material. The entire series will be loaned on request to any investigator working on other collections.

In the following paragraphs, the likenesses, differences due apparently to growth, and differences probably of taxonomic importance, are summarized.

A. *Similarities.*

All 10 agree in the following respects:

1. *Size*: The range is only from 17.4 (11.1+6.3) to 21.3 (14.4+6.9) mm. The smallest and the largest are the two youngest specimens.

2. *Lack of Pigment*: Subdermal chromatophores are completely lacking, and only one example, *h*, has readily discernable external pigment; this consists of a faint wash of brown.

3. *General Denticle Arrangement*: 3 to 5 rostral; 3 or 4 predentary plus a median; sometimes 1 or 2 jaw teeth on either or both sides.

4. *Nostril Form*: Both fairly small, on a distinct prominence, with the jutting rostral eminence between. The anterior smaller, elongate, fairly close to the posterior; the latter at a considerable distance in front of the eye.

5. *Lamellae Count*: 9 except for *b*, which has 8, and *j*, which possibly has only 8. In the latter case the lamellae appear to be breaking down (preparasitic degeneration through failure to find female?); the specimen is well preserved.

6. *Fin Counts*: D. 3, A. 3, C. 1+3+3+1, P. 15-17.

7. *Sphenotic Spines*: Present, though of variable length, in all.

8. *General Body Proportions*: Excluding the highly variable depth, the general proportions and fin positions appear very similar, although these measurements, as usual in pediculates, are highly unsatisfactory.

B. *Differences Due to Age.*

The following distinctions we attribute to normal development pattern. Those assigned as characteristics of the youngest are found in fish which show the obvious, ichthyological youth characters of persistence of vestigial finfolds near the vertical fins and imperfectly differentiated pectorals. It must be kept in mind that adequate life history data will doubtless show some of these characters to have specific as well as developmental significance. For example, though young animals are more inflated than old ones, some species will probably prove to show more inflation than others. The series on the basis of previously established definitions (see p. 151) may be divided into post-larvae, adolescents and transitional adolescents.

1. *Amount of Inflation*: The depth at pectoral fin ranges from almost four-fifths of the standard length in the youngest to less than half standard length in the oldest. (Standard length here is measured to end of myomeres, as seen by indirect lighting).

2. *Sheathing of Denticles*: Some of the younger have denticles skin-covered throughout much of their length.

3. *Teeth in Jaws*: It seems likely that these long, thin, loosely inserted, asymmetrical structures are temporary teeth, remaining from the larval stage, such as are found in other groups of fishes.

4. *Size of Nostrils*: The nostrils are smaller in younger fish, although the full quota of lamellae is present. Only 2 or 3 of the typical 9 are visible in the posterior orifices of younger, and around 6 in those of older specimens.

5. *Rotation of Eye*: In the youngest three, the eye is almost normal, scarcely turned; in the oldest three, it is revolved strongly forward and down. Intermediate specimens show intermediate grades of rotation.

6. *Diameter of Eyeball*: The actual size of the eyeball is distinctly larger in the oldest specimens, although specific differences are also probably involved. The regular eye diameter measurement appears, as usual in pediculates, to be totally useless.

7. *Lateral Line System Papillae*: In all except several of the older specimens, the papillae are few, rudimentary, and practically indistinguishable.

8. *Sphenotic Spines*: These spines, although well developed in all, scarcely protrude beyond the dermal envelope in the youngest.

C. *Differences of Probable Taxonomic Value.*

It appears highly probable that the following characters will prove of specific and/or generic value.

1. *Number of Rostral Denticles*: Six specimens have 5, 1 has 4, and 3 have 3 denticles each. However, at least in the case of *a*, having only 4, the fifth is clearly either to be developed or accidentally lost. Similarly, in the cleared and stained attached *Borophryne* (p. 172), 4 are present, with a degenerated (?) stump of a fifth. Regan &

Trewavas' attached *Borophryne* each had 5 denticles (1932, p. 18).

2. *Shape of Forwardly Directed Median Predentary Denticle*: Varies from short and thick to long and slender.

3. *Shape of Paired Predentary Denticles*: From triangular to slender; not correlated with shape of median.

4. *Shape of Individual Lamellae*: In one type (*a, e, g, j*), including both young and old individuals, each lamella appears double, like adjacent sections of orange, the two halves joined along a seam which tends to split. In another (*h*) the lamellae are elongate, the attached edge being the shorter.

5. *Lateral Line System Papillae*: In some older specimens, these tags in the future may furnish good taxonomic distinctions, although there is variation even in the attached *Borophryne* males (p. 172). Only in *f* and *h* of the present series are they moderately well developed.

6. *Mental Fringe*: In specimens *a, f, g* and *h*, there is a tiny, superficial, anomalous, variable, fringe-like structure corresponding in position to the base of the barbel in *Linophryne* females; *f* and *h* have in addition similar appendages in the midline of the top of the head, well behind the level of the sphenotic spines. Perhaps all of these merely represent irregularities in the lateral line papillae, which are highly variable in both sexes of the family Linophrynidae. However, the position of the mental fringes, because of their similarity to that of the *Linophryne* barbel, justifies special notice of their occurrence. As will be seen from the table, the four fish involved do not appear to be linked by other special characters, such as denticle peculiarities.

7. *Length and Shape of Sphenotic Spines.* The actual length of these spines is quite variable, irrespective of the length protruding externally from the envelope, and should prove to have some taxonomic significance. They also show varying degrees and directions of curvature, even on the two sides of the same individual.

Study Material.

All were taken on the Eastern Pacific *Zaca* Expedition.

a. Cat. No. 28,756; Sta. 225 T-1; 11 mi. SW × W of Jicaron I., Panama (7° 08′ N. Lat., 81° 57′ W. Long.); 500 fathoms; Mar. 20, 1938; post-larva; length 17.6 (11.5+6.1) mm.

b. Cat. No. 28,757; Sta. 227 T-1; 20 mi. S.W. of Morro de Puercos, Panama (7° 00′ N. Lat., 80° 40′ W. Long.); 500 fathoms; Mar. 21, 1938; post-larva; length 17.4 (11.1 +6.3) mm.

c. Cat. No. 28,758; Sta. 230 T-1; 71 mi. W × S of Cape Corrientes, Colombia (5° 10′ N. Lat., 78° 42′ W. Long); 500 fathoms; Mar. 26, 1938; post-larva; length 21.3 (14.4 +6.9) mm.

d. Cat No. 28,759; Sta. 227 T-1; in same net with *b;* adolescent; length 18.7 (12.0 +6.7) mm.

e. Cat. No. 28,760; Sta. 227 T-1; in same net with *b;* adolescent; length 19.7 (12.7 +7) mm.

f. Cat. No. 28,761; Sta. 230 T-1; in same net with *c;* adolescent; length 19.5 (12.5 +7) mm.

g. Cat. No. 28,762; Sta. 230 T-1; in same net with *c;* adolescent; length 18.9 (12.4 +6.5) mm.

h. Cat. No. 28,763; Sta. 230 T-1; in same net with *c;* transitional adolescent; length 17.7 (11.5+6.2) mm.

i. Cat. No. 28,764; Sta. 225 T-1; in same net with *a;* transitional adolescent; length 20.3 (12.3+8) mm.

j. Cat. No. 28,765; Sta. T-8; 20 mi. S. of Cape Blanco, Costa Rica (9° 12′ N. Lat., 85° 10′ W. Long.); 500 fathoms; Feb. 27, 1938; transitional adolescent; length 18.7 (11.2+ 7.5) mm.

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EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. *Himantolophus azurlucens*. Holotype. Total length 123 mm.

Fig. 2. Same. Illicium, with single intact terminal tentacle (cf. Text-figs. 3, 4).

PLATE II.

Fig. 3. *Gigantactis perlatus*. Holotype, freshly caught. Total length 42 mm. (Illicium tip in white circle)

Fig. 4. *Borophryne apogon*. Freshly caught female with attached male (No. 28,-707 a, b). Total length of female 74.5 mm.

PLATE III.

Fig. 5. *Linophryne quinqueramosus*. Holotype, freshly caught. Total length 89 mm. (Barbel not shown).

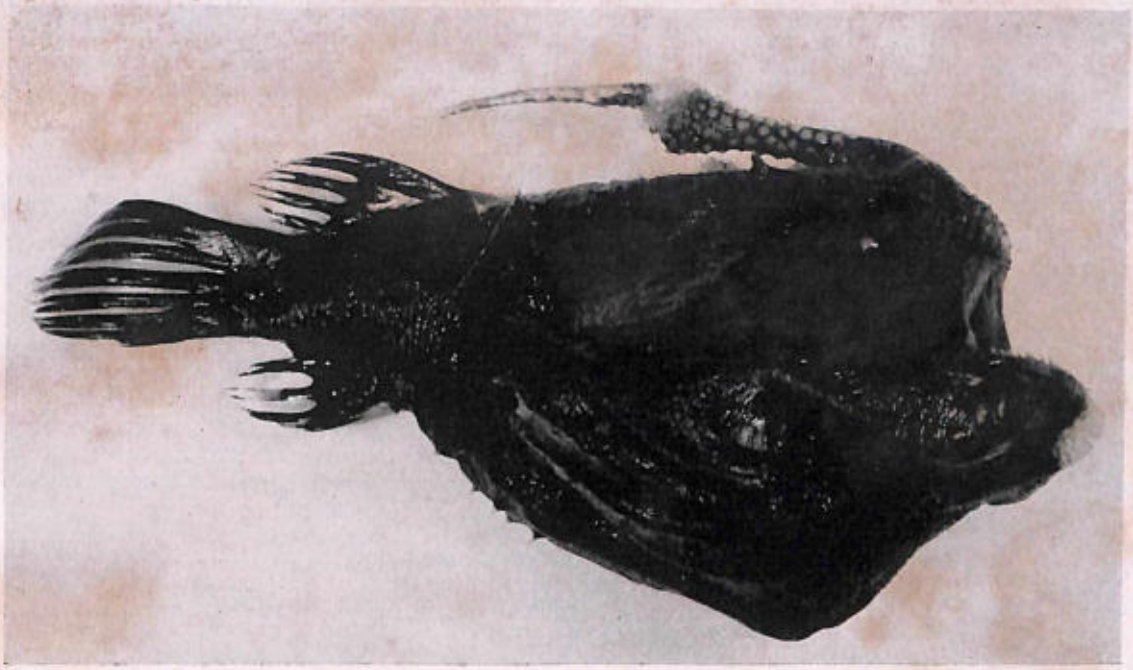

FIG. 1.

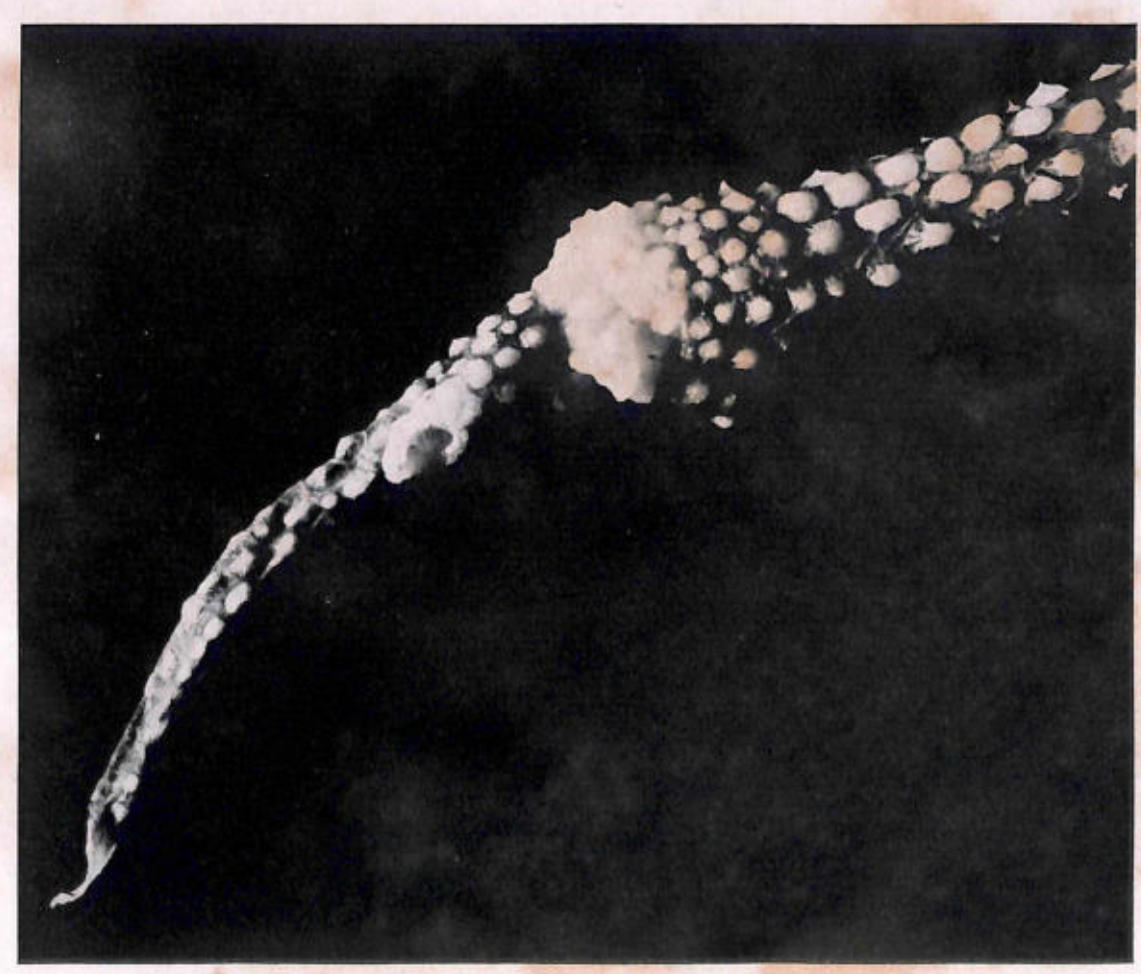

FIG. 2.

DEEP-SEA CERATIOID FISHES.

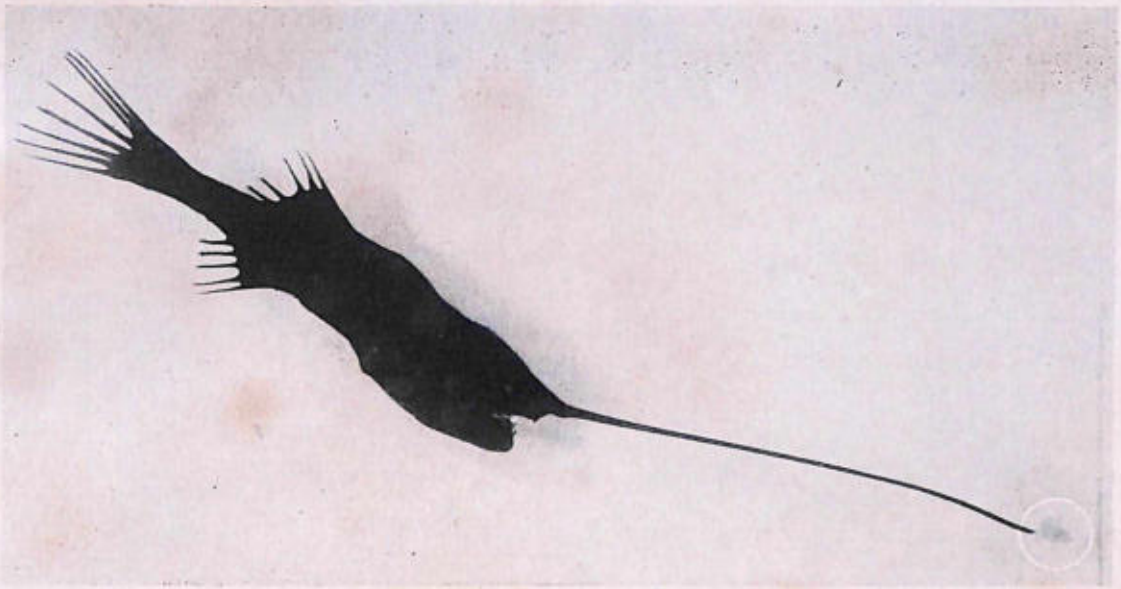

FIG. 3.

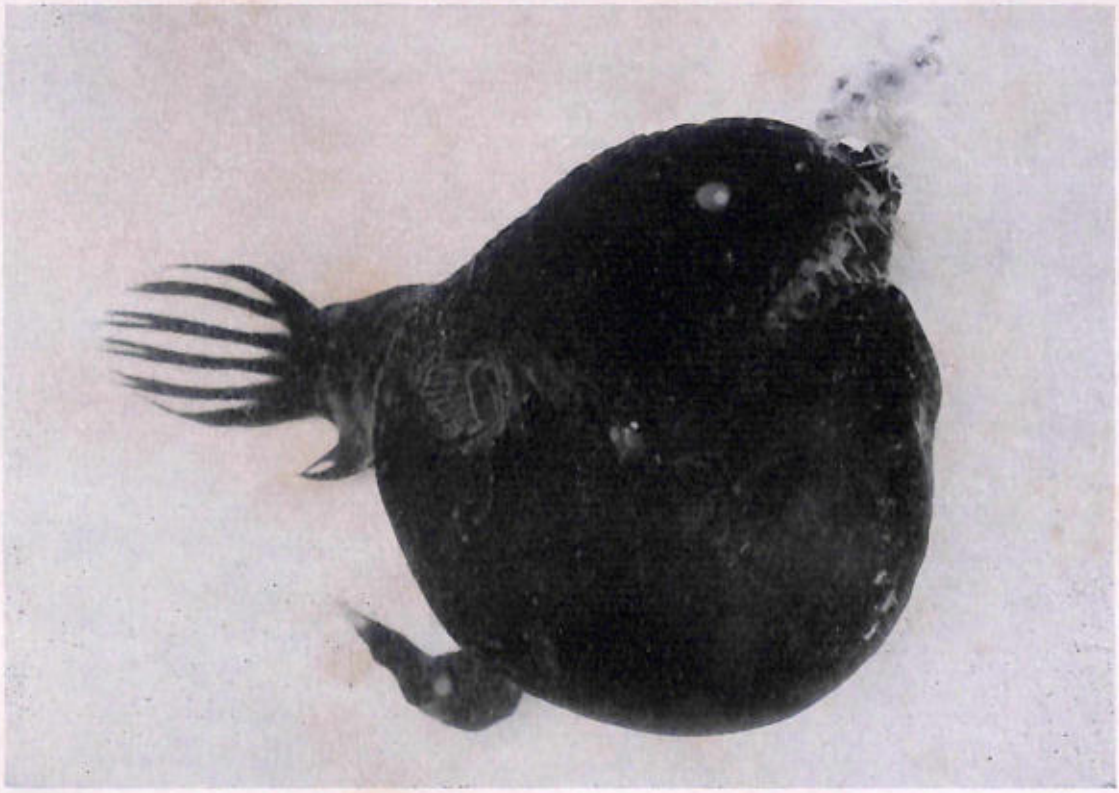

FIG. 4.

DEEP-SEA CERATIOID FISHES.

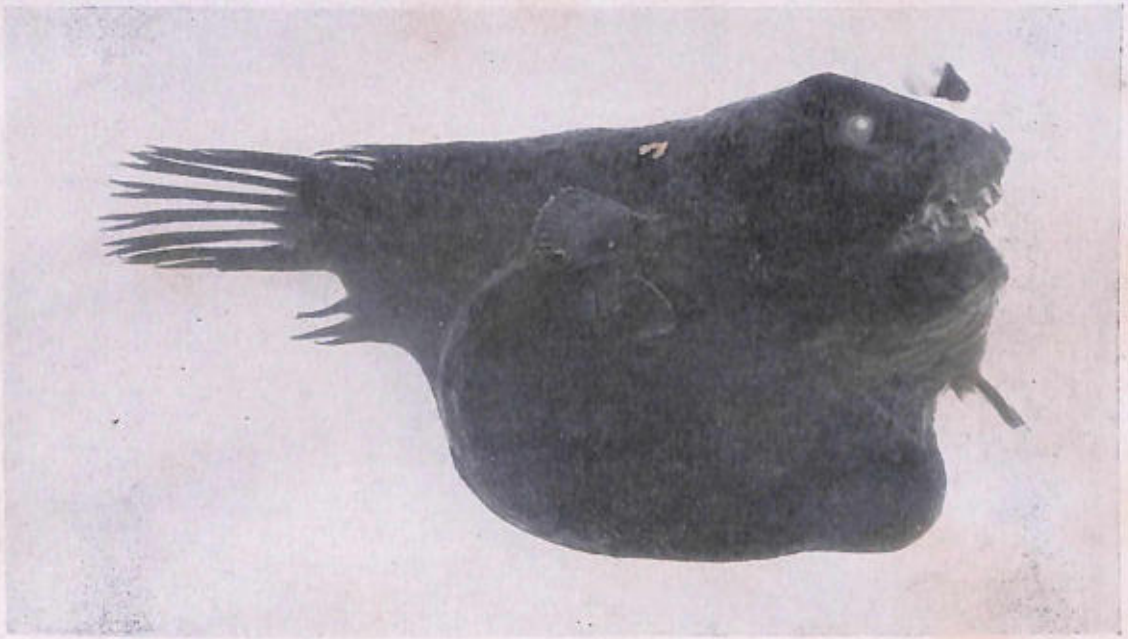

FIG. 5.

DEEP-SEA CERATIOID FISHES.

12.

Spontaneous Neoplasms in Fishes. II. Fibro-carcinoma-like Growth in the Stomach of *Borophryne apogon* Regan, A Deep-Sea Ceratioid Fish.

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(Plates I-IV).

Neoplastic growths in the stomach of fishes are exceptionally rare. Thomas (1931) listed the following cases recorded in the literature: fibromatas of the cod by Bland-Sutton, 1884-1885, and Johnstone (1924); leiomyomatas in various parts of the stomach, by Plehn, 1906, for the trout; Pesce, 1907, for the carp; and Williamson, 1909, for the cod.

Insofar as is known, the neoplasia described below is the first disease to be reported from these interesting deep-sea forms in which the males are parasites on the females. The fish involved was a fully grown but sexually immature female measuring 37 mm. in standard length. It was taken from the Gulf of Panama in 500 to 700 fathoms (see Beebe and Crane, 1947). Externally the belly was swollen as if filled with food, but the autopsy revealed a comparatively large, solid growth in the region of the stomach.

The normal stomach, when filled with food, was a thin-walled translucent structure. Histologically it appeared as shown in Fig. 1. The mucosa was more or less flattened, consisting of a single layer of cells and saccular glands opening into shallow pits. The submucosa consisted of a delicate layer of connective tissue containing elastic fibers, fat and blood vessels. The muscularis and serous coats were also delicately developed. If the stomach were not dilated with food the rugae would be more pronounced.

The abnormal growth was removed from the fish, sectioned in paraffin at 6 and 10 microns, and stained with iron hematoxylin, Delafield's hematoxylin-eosin, Masson's and Mallory's polychrome stains, and Giemsa's stain.

The growth strikingly resembled the fibro-carcinoma reported for human stomachs (see Ewing, 1940). Histologically, it was characterized by a tremendous overgrowth of connective tissue elements and cells of the mucosa, with stenosis occurring particularly in the pyloric region. Epithelial-like cells scattered diffusely over some areas of the submucosa indicated that it may be a carcinoma. As in human cases of fibro-carcinoma, it was very difficult to recognize the cellular elements since they were invariably atypical.

There was no evidence of granulation or inflammatory response. The much thickened submucosa was well supplied with thick-walled blood vessels. In every section examined, the cells within these vessels were predominantly lymphocytes.

The great proliferation of mucosal cells in some regions may be noted by examination of the photomicrograph shown in Fig. 2. All the cells here appeared to be of the mucus type. Higher magnifications of these cells are shown in Figs. 3 and 4. The separation from the basement membrane seen in Fig. 3 may be due to shrinkage. However, details of the proliferating cells are best seen in Fig. 4. The nuclei may be normal or pyknotic in appearance and there was some evidence of mitosis. The cells toward the center of the lumen have undergone a great deal of degeneration but much of the abnormalities in the cytological details were probably due to improper fixation. In other regions the glandular epithelial cells predominated. Still in other areas (Fig. 5) little change was noted for this region of the stomach.

The tremendous hypertrophy of the connective tissue layers of the stomach may be seen in Figs. 2 and 5 and especially in Figs. 6 and 7. The proliferation into the muscularis (Fig. 7) was especially striking. The serous coat was also involved but there was only a slight thickening of the mesothelium.

Just how the epithelial elements infiltrated into the connective tissue layers could not be determined. Fig. 8 shows the organization of mucosal material within this region. Higher magnification of the epithelial cells and the nature of the surrounding region is clearly shown in Fig. 9. The epithelial cells have undergone considerable modifications; the nuclei were varied in size and were hyperchromatic.

The diffusion of single tumor cells with hyperchromatic nuclei into the surrounding

Contribution No. 746, Department of Tropical Research, New York Zoological Society.

regions of the submucosa is shown in Fig. 10. These cells also penetrated through the muscularis into the serosa.

There was no definite evidence as to what the causative factor or factors were, but it should be pointed out that a neosporidian infection was present in the liver and surrounding tissues. Whether or not these protozoan parasites produced the stimulus initiating this growth was difficult to say. However, it is known that parasites of this group are capable of inducing tumor formation (see Nigrelli & Smith, 1938, 1940).

Summary.

A fibro-carcinoma-like growth in the stomach of *Borophryne apogon* Regan, a ceratioid fish taken from the Gulf of Panama in 500 to 700 fathoms of water, is described. Histologically the neoplasis is characterized by a tremendous overgrowth of connective tissue elements and cells of the mucosa. All the coats of the stomach wall are involved. The presence of epithelial-like cells scattered diffusely over some areas of the submucosa indicate that this growth may be carcinoma similar to the fibro-carcinoma reported for human stomachs.

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EXPLANATION OF THE PLATES.

Plate I.

Fig. 1. Photomicrograph of section of normal stomach of *Borophryne apogon*. Stained with Delafield's hematoxylin and counter-stained with eosin. 100×.

Fig. 2. Section through the main part of the stomach. Note the tremendous proliferation of epithelial cells of the mucosa and thickened submucosa. Mallory's. 100×.

Plate II.

Fig. 3. Higher magnification of epithelium of the mucosa shown in Fig. 2. Delafield's hematoxylin-eosin. 6,5×.

Fig. 4. Cells of the epithelium showing proliferation. Note the differences in the staining reactions of the nuclei. The cells are smaller with the neat columnar pattern lost. Great activity is indicated. Delafield's hematoxylin-eosin. 675×.

Fig. 5. Region of the submucosa showing great proliferation of connective tissue. Very few other cellular elements are present in this area and very little is left of the mucosa. Part of the muscular coat is also shown in this section. Mallory's. 100×.

Fig. 6. Section of the stomach near the pylorus. The epithelium is separated from the basement membrane, probably due to shrinkage. No proliferation is present within the lumen but proliferating cells are present in the region which appears to correspond to the submucosa in the normal stomach. Mallory's. 100×.

Plate III

Fig. 7. Region of the muscularis. Connective tissue fibers have penetrated this region and the exact pattern of the muscle fibers has been disrupted. Delafield's hematoxylin-eosin. 157×.

Fig. 8. Section through the main body of the tumor mass. Note the extent of connective tissue and the organization of mucosal material within it. Delafield's hematoxylin-eosin. 100×.

Plate IV.

Fig. 9. Higher magnification showing cellular details of region seen in center of Fig. 8. Epithelial cells have undergone certain changes. In some sections the infiltration of the cells into the connective tissue is well marked. Delafield's hematoxylin-eosin. 675×.

Fig. 10. Details showing epithelial and epithelial-like cells scattered diffusely through the submucosa. Many of the cells are atypical and it is difficult to determine whether or not they are derived from the mucosa, although the evidence strongly indicates that they are. Masson's polychrome stain. 356×.

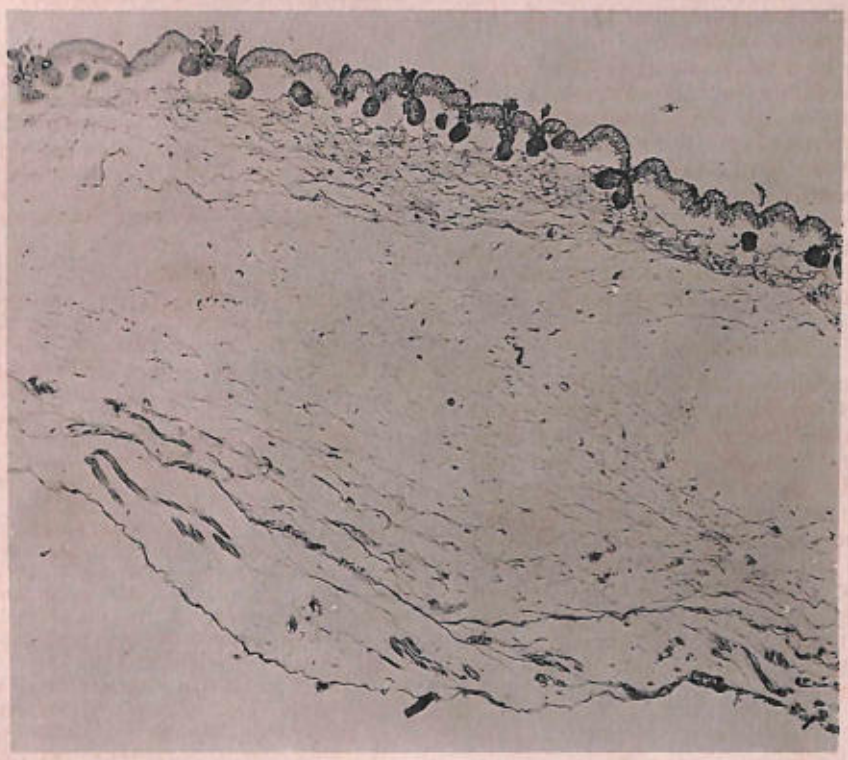

FIG. 1.

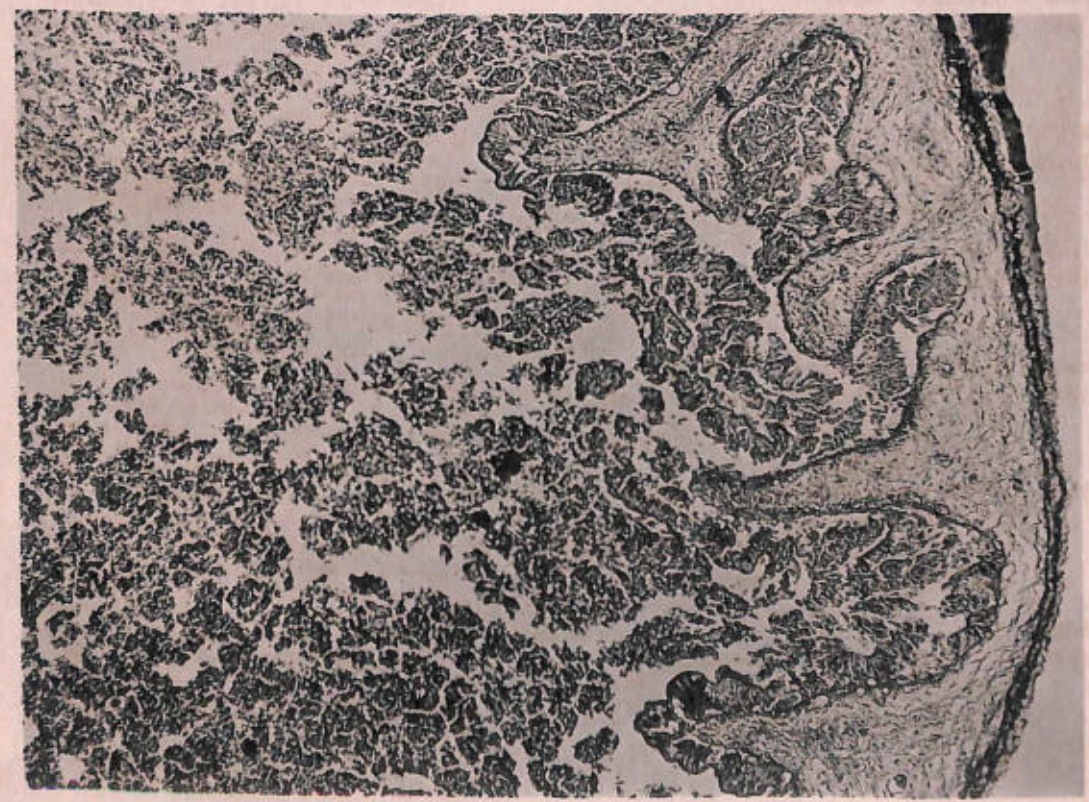

FIG. 2.

FIBRO-CARCINOMA-LIKE GROWTH IN THE STOMACH OF BOROPHRYNE APOGON REGAN, A DEEP-SEA CERATIOID FISH.

FIG. 3.

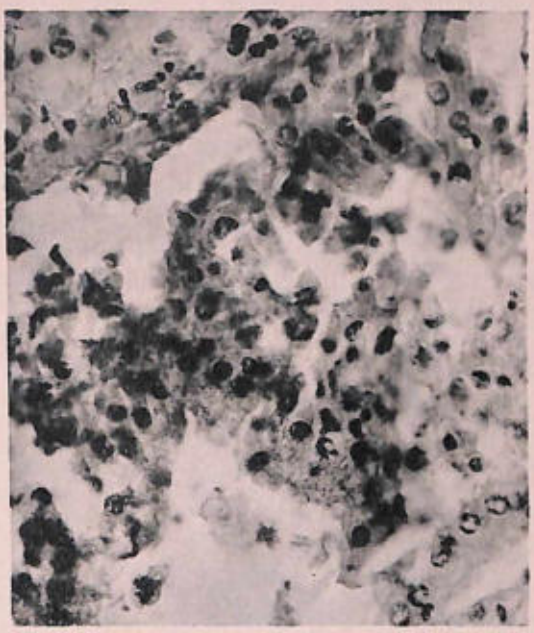

FIG. 4.

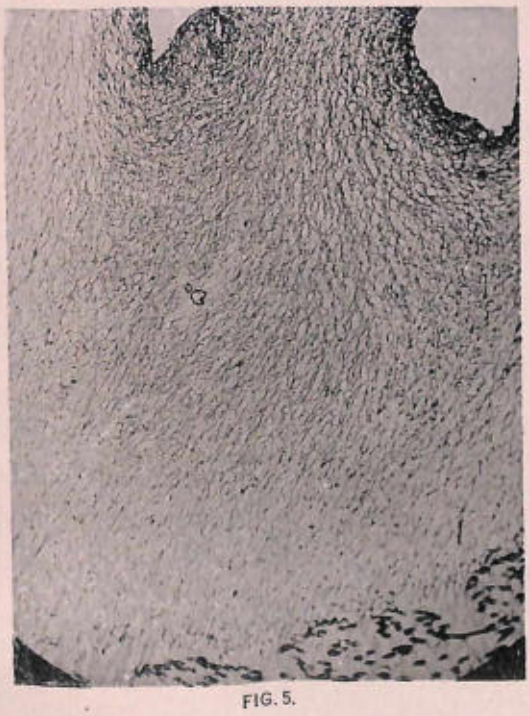

FIG. 5.

FIG. 6.

FIBRO-CARCINOMA-LIKE GROWTH IN THE STOMACH OF BOROPHRYNE APOGON REGAN, A DEEP-SEA CERATIOID FISH.

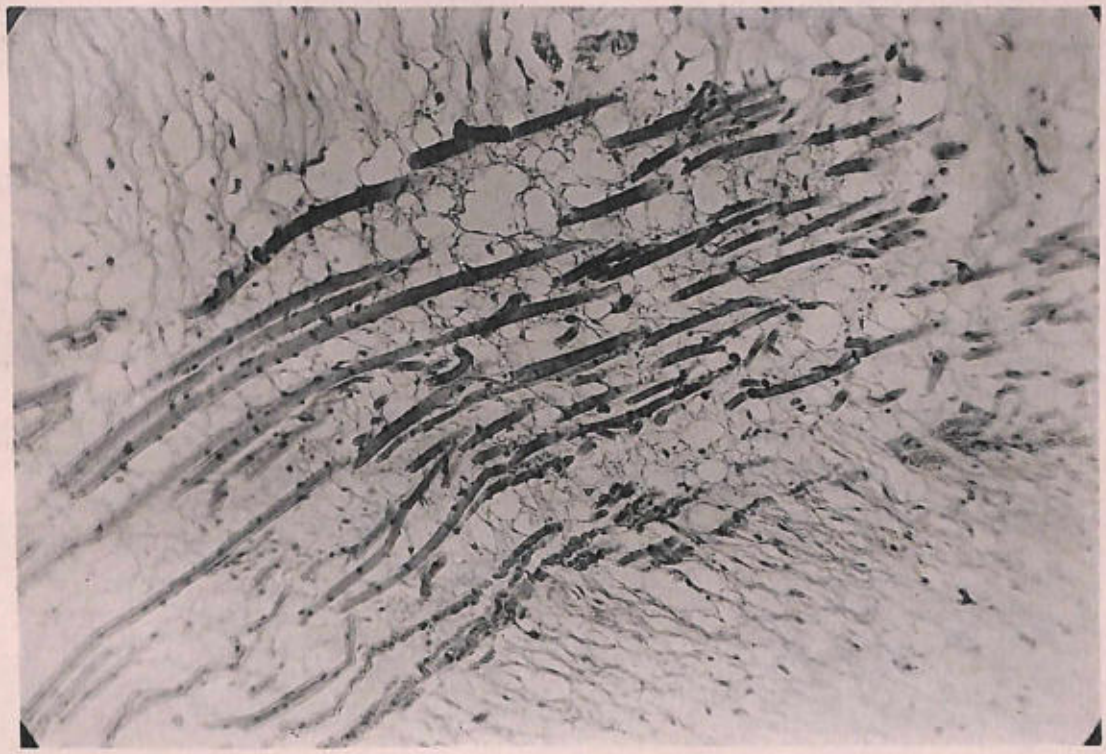

FIG. 7.

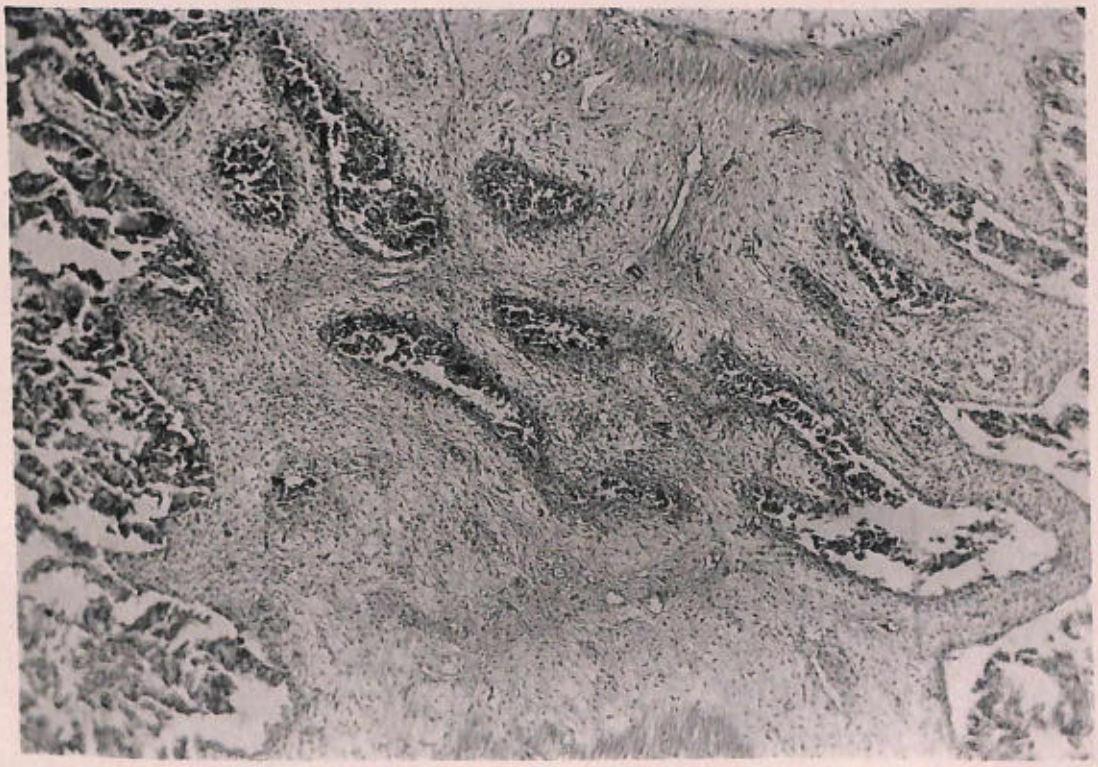

FIG. 8.

FIBRO-CARCINOMA-LIKE GROWTH IN THE STOMACH OF
BOROPHRYNE APOGON REGAN, A DEEP-SEA CERATIOID FISH.

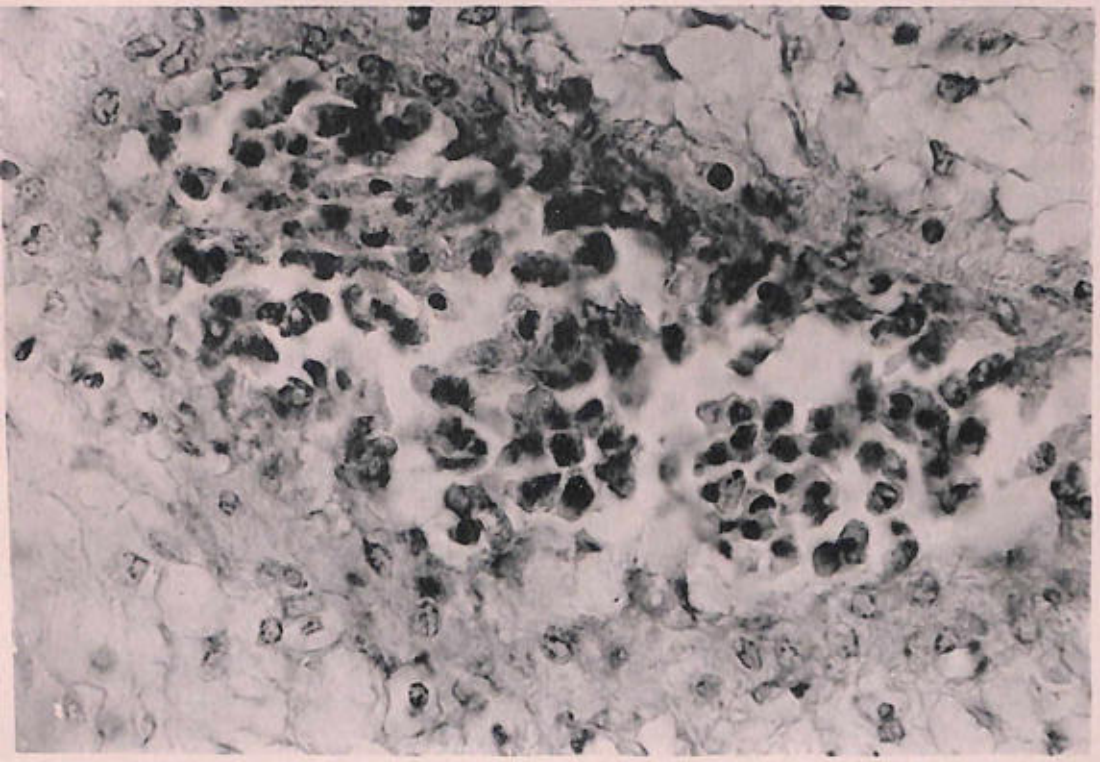

FIG. 9.

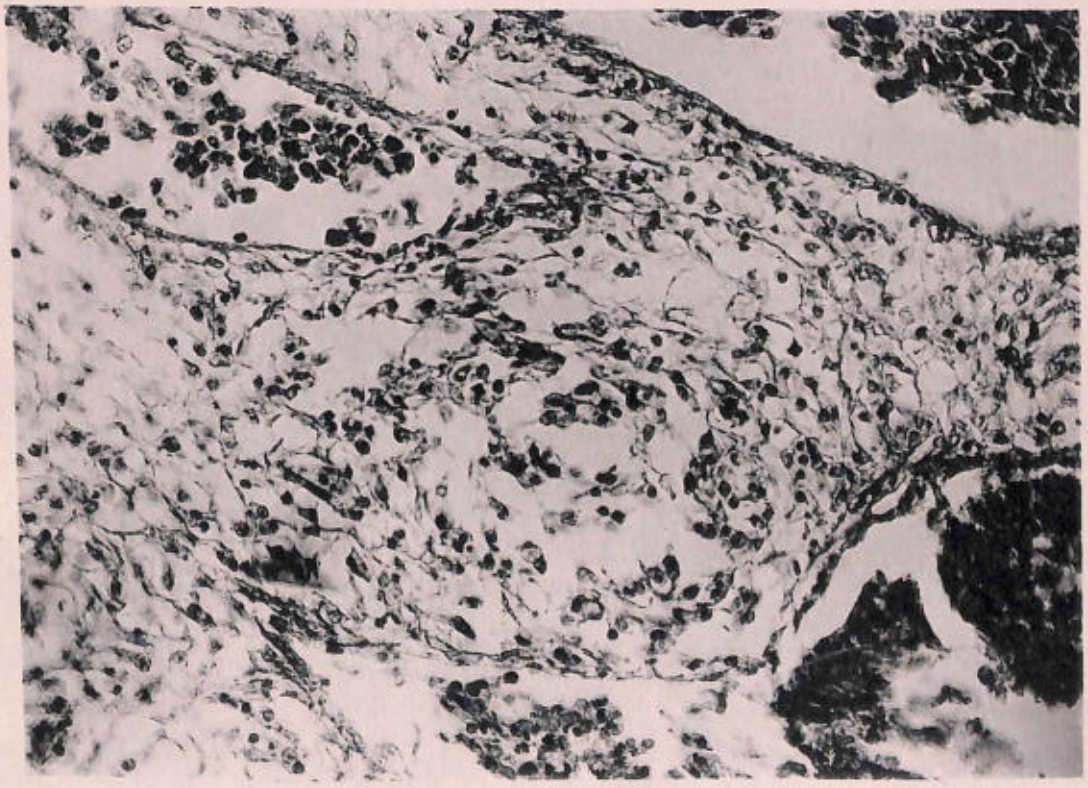

FIG. 10.

FIBRO-CARCINOMA-LIKE GROWTH IN THE STOMACH OF BOROPHRYNE APOGON REGAN, A DEEP-SEA CERATIOID FISH.

13.

Studies on the Genus *Hirudinella*, Giant Trematodes of Scombriform Fishes.

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(Plates I-VIII).

INTRODUCTION.

Nigrelli and Stunkard (1937) reported giant trematodes from the "wahoo," *Acanthocybium solandri;* they were referred without specific identification to the *Distoma clavatum* group of the Hemiuridae. These trematodes belong to the genus *Hirudinella* which Dollfus (1932) named as type of a new family in the Hemiuroidea. Members of *Hirudinella* infect fishes of the sub-order Scombroidei, in particular those of the family Scombridae, and a large number of species have been described. These parasites have been known for more than 200 years; with *Fasciola hepatica* and *Haplometra cylindracea* (Zeder, 1800), they are among the oldest known trematodes. Yet knowledge of the group is very incomplete and there is no agreement concerning the number of species or their differential diagnoses. This situation may be explained by several obvious facts: (1) the hosts are oceanic fishes which range through all tropical and temperate seas; (2) relatively few individuals have been recovered from any single host; (3) the location of the parasites, which usually occur in the stomach but have been found also in the intestine, on the gills and free in the plankton; (4) the early reports were made before there was any adequate knowledge of trematode morphology and consist merely of accounts of size and shape; and (5) the enormous size of the worms and their powerfully muscular bodies, which on contraction may assume unusual shapes and greatly modify the arrangement of internal structures. Combinations of these several features have made it difficult to measure individual variation or to form a definite concept of specific limitations.

Historical accounts of the genus and lists of species were given by Poirier (1885), Moniez (1886, 1891), Blanchard (1891), Buttel-Reepen (1902) and Mühlschlag (1914). More recent papers include those of Manter (1926, 1940), Dollfus (1932, 1940), Chandler (1937), Guiart (1938) and Yamaguti (1938).

Contribution No. 747, Department of Tropical Research, New York Zoological Society.

The earlier accounts were so inadequate that it is quite impossible to recognize the species from the descriptions and often the hosts were not designated or were listed by vernacular names which make positive identification difficult and uncertain. Many of the original specimens are no longer available and those that have been studied were in such poor condition that they contributed little to knowledge of the species. Moreover, the usual method of redescribing a species, by collecting new material from type hosts and localities, is quite inapplicable since the life cycles of the parasites are unknown, there is no assurance of host-parasite specificity, and the final hosts (the only ones known) have no type locality. As noted by earlier authors and discussed by Chandler (1937, p. 353), the features which have been used to distinguish species may be influenced very markedly by age, by different states of contraction and by different methods of preparation. As stated by Chandler, satisfactory studies can be made only on serial sections, which impose a difficult and tedious task. There is, accordingly, no adequate basis for recognizing the many species that have been included in the "*Distomum clavatum*" group of trematodes. A list of these species and their hosts is included in Table I.

MATERIAL AND METHODS.

During the past ten years, the writers have examined 56 specimens of *Hirudinella* taken from 9 different species of scombriform fishes from both the Atlantic and Pacific oceans. The specimens were studied by various methods; alive, as whole mounts, in serial sections or by needle dissections. We are indebted to Dr. William Beebe, Dr. Charles Breder, Jr., Dr. G. M. Smith, Dr. N. R. Stoll, John Tee-Van, Francesca LaMonte and W. W. Doxee for material collected on different expeditions. Through the kindness of Dr. William Beebe and Dr. A. C. Chandler, we have had the opportunity to study the slides of *H. beebei* Chandler, 1937, prepared by Professor Chandler. Most of the material came from *Acanthocybium*

TABLE I.

List of Species of *Hirudinella.*

SPECIES	HOST	LOCALITY
1. *Hirudinella marina* Garcin[1], 1730	*Scomber pelamys*	Atlantic
2. *Fasciola ventricosa* Pallas, 1774	Host not given	Amboyna
Distomum ventricosum (Pallas) Monticelli	.....	.....
D. ventricosum of the following		
Braun, 1893	.....	.....
Stossich, 1900	*Pimelepterus* (*Kyphosus*)	.....
H. ventricosa (Pallas) Baird, 1853	.....	.....
3. *Fasciola clavata* Menzies, 1791	*Scomber pelamys*	Pacific
D. clavatum of the following:		
Baird, 1853	.....	.....
Barbagallo and Drago, 1903	*Pelamys sarda*	Catania
Beneden, van, 1870	*Thynnus vulgaris*	Atlantic
Le Billardière, 1801	.....	.....
Blanchard, R., 1891	*Thynnus vulgaris*	Atlantic
	Pelamys sarda	Atlantic
Brandes, 1891	*Pelamys sarda*	.....
Braun, 1892, 1893a, b, c	.....	.....
Buttel-Reepen, 1900, 1902, 1904, 1905	.....	.....
Carus, 1884	.....	.....
Chatin, 1887	.....	.....
Cobbold, 1860	.....	.....
1867	*Xiphias gladius*	Atlantic
1879	.....	.....
Cooper, 1915	*Thunnus thynnus*	Atlantic
Creplin, 1837	.....	.....
Darr, 1902	"Diamantfisch"	.....
Diesing, 1850	*Pelamys sarda*	Atlantic
	Thynnus vulgaris	.....
	Coryphaena hippuris	Brazil
1859	.....	.....
Dujardin, 1845	.....	.....
Goto, 1891	.....	.....
Jackson, 1888	.....	.....
Jaegerskiold, 1900	.....	.....
Jourdan, 1881	*Thynnus*	Atlantic
Juel, 1889	.....	.....
Krøyer, 1838-1840	*Thynnus vulgaris*	Atlantic
Lander, 1904	.....	.....
Linton, 1898	*Thunnus thynnus*	Atlantic
1901	*Xiphias gladius*	Atlantic
Looss, 1894, 1895, 1896, 1899	.....	.....
Moniez, 1892	.....	.....
Monticelli, 1888, 1893	.....	.....
Olfers, 1816	.....	.....
Osbeck, 1765	.....	.....
Owen, 1835, 1837	.....	.....
Parona, 1887	.....	.....
Poirier, 1885	Ocean bonito (*S. pelamis*)	Atlantic & Pacific
Rudolphi, 1808	.....	.....
Shipley, 1910	*Coryphaena hippuris*	Atlantic
Siebold, von, 1835	.....	.....
Stiles, 1901	.....	.....
Stossich, 1886	.....	.....
Wagener, 1860	.....	.....
Ziegler, 1905	.....	.....
H. clavata (Menzies, 1791) Blainville, 1828	.....	.....
H. clavata (Menzies) of Manter, 1940	*Gymnosarda alletterata*	Galapagos (Pacific)

[1] Also spelled Garsin and Garzin in papers of later authors.

	Species	Host	Locality
4.	*Fasciola fusca* Bosc, 1802	"Dorade" (*Coryphaena hippuris*)	Atlantic
	Distoma fuscum (Bosc) Poirier, 1885	.....	.....
	D. fuscum of the following:		
	Braun, 1893	.....	.....
	Buttel-Reepen, 1902	.....	.....
	Mühlschlag, 1914	.....	.....
	H. fusca (Bosc, 1802) Dollfus, 1932	.....	.....
	H. fusca (Poirier, 1885) Manter, 1926	*Xiphias gladius*	Atlantic
	H. fusca of the following:		
	Guiart, 1938	"Germon" (tuna)	Atlantic
	Legendre, 1940	*Thunnus thynnus*	Atlantic
	Linton, 1940	*Thunnus secundodorsalis*	Atlantic
		Trachurops crumenophthalma	Atlantic
		Trichurus lepturus	Atlantic
		Xiphias gladius	Atlantic
5.	*Fasciola coryphaenae* Bosc, 1802	*Coryphaena hippuris*	Atlantic
	F. coryphaenae hippuridis Tilesius (*in litteris*, Rudolphi, 1809)	.....	.....
	Distoma coryphaenae (Bosc) Rudolphi	.....	.....
6.	*Fasciola scombri pelamidis* Tilesius (*in litteris*, Rudolphi, 1809)	*Scomber pelamis*	Atlantic
7.	*Distoma heurteli* Poirier, 1885	*Thynnus vulgaris*	.....
8.	*Distoma dactylipherum* Poirier, 1885	"un Argonaute d'espèce indeterminée."	Indian Ocean
9.	*Distoma verrucosum* Poirier, 1885	*Thunnus* sp.	Atlantic
	D. verrucosum of the following:		
	Braun, 1892	.....	.....
	Jaegerskiold, 1900	.....	.....
	Lander, 1904	.....	.....
10.	*Distoma personatum* Poirier, 1885	.....	Gulf of Mexico
	D. personatum of the following:		
	Buttel-Reepen, 1902	.....	.....
	Darr, 1902	.....	.....
	Loennberg, 1891	.....	.....
11.	*Distoma pallasii* Poirier, 1885 (*D. ventricosum* of Pallas renamed)	*Delphinus phocaena* (Dolphin)	"Indies"
	D. pallasii of the following:		
	Braun, 1892	.....	.....
	Buttel-Reepen, 1902	.....	.....
	Darr, 1902	.....	.....
	Stossich, 1892	*Phocaena communis* (Porpoise)	Indian Ocean
12.	*Distoma ingens* Moniez, 1886	.....	.....
	D. ingens of the following:		
	Blanchard, 1888	.....	.....
	Braun, 1889, 1892, 1893	.....	.....
	Buttel-Reepen, 1900, 1902	.....	.....
	Hoyle, 1890	.....	.....
	Monticelli, 1888	.....	.....
	H. ingens (Moniez) Darr, 1902	.....	.....
	H. ingens of the following:		
	Mühlschlag, 1914	Albicore	South Atlantic
		Fish	Indian Ocean
13.	*Distoma poirieri* Moniez, 1891	.....	.....
	H. poirieri (Moniez) Dollfus, 1935	"Germon" (*Thynnus alalonga*)	Atlantic
14.	*Distoma siemersi* Buttel-Reepen, 1900	*Sphyraena barracuda*	Atlantic
	D. siemersi of the following:		
	Buttel-Reepen, 1902, 1904, 1905	.....	.....
	Darr, 1902	.....	.....

Species	Host	Locality
15. *Distoma ampullaceum* Buttel-Reepen, 1900 *D. ampullaceum* of the following: Buttel-Reepen, 1902, 1904, 1905 Darr, 1902 Mühlschlag, 1914	*Coryphaena* sp.	Indian Ocean
	.....	.....
	.....	.....
	.....	.....
16. *Hirudinella beebei* Chandler, 1937 *H. beebei* of the following: Manter, 1940	*Acanthocybium petus*	Atlantic
	Acanthocybium solandri	Pacific
17. *Hirudinella spinulosa* Yamaguti, 1938	*Thynnus alalonga*	Pacific
18. *Hirudinella oxysoma* Guiart, 1938	"Germon" (*Thynnus alalonga*)	Atlantic
H. oxysoma of the following: Dollfus, 1940 (Dollfus incorrectly spelled the name *oxystoma*).	*Thunnus thynnus*	Mediterranean
19. *Hirudinella phalloidea* Guiart, 1938	*Coryphaena hippuris*	Atlantic
20. *Hirudinella bonnacouri* Guiart, 1938 (*D. fuscum* Poirier, 1885 renamed)	.....	.....

spp. from both Atlantic and Pacific, although we have made no attempt to distinguish between *A. solandri* (Cuvier and Valenciennes) and *A. petus* (Poey) since there is some doubt whether these names represent two distinct species. Our collection of *Hirudinella*, though limited, is probably the largest yet assembled and has provided the basis for an extended study of the genus, while comparison of our specimens with accounts in the literature permits a consideration of morphological features and specific determinations. Pertinent data on collection, and size of worms are presented in Tables II-V.

In the absence of information concerning the life cycle, host-parasite specificity and/or the possible influence of development in different fish hosts, the limits of specific variation can not be determined with certainty. It is impossible at present to characterize any species of *Hirudinella* completely or even adequately. This fact, however, does not justify the naming of a new species for a specimen which manifests some variation from previously published accounts. The size at which sexual maturity is attained may be a valid specific character, but it it possible that maturity may develop at different sizes in different hosts. It is possible, also, that in different hosts the same species may differ in the ultimate size attained and in the delicacy or coarseness of the various organs, e.g., one may compare gravid specimens of *Fasciola hepatica* from the livers of a guinea pig, a rabbit and a cow. As in many other trematode genera, egg-size in *Hirudinella* is too variable to serve as a reliable specific character. In general, as noted by Moniez (1891), the size of eggs is correlated with the size of the worm.

Our data indicate that the large, thick-bellied worms from *Acanthocybium* (Figs. 1-20, Tables II & III) which become gravid at a length of approximately 17 mm. and may attain a length of 70 mm., belong to one species which we identify as *H. ventricosa* (Pallas, 1774). Study of the morphology has disclosed no feature of difference that can not be explained by differences in degree of development or of muscular contraction. Length of a specimen is not a valid indication of size or degree of maturity as a specimen may extend to more than five times its contracted length. The specimen listed as Cat. No. 7 (Plate I, Fig. 1) was alive when removed from the stomach of a "wahoo" flown to the New York Aquarium. Extended, it measured 170 mm. long by 30 mm. wide and it contracted to a length of only 40 mm. It was purplish in color and the cuticula was so transparent that the internal organs were visible when the worm was compressed between glass plates. When the worm was held up by the anterior end, the cecal contents passed to the posterior end which swelled in balloon-like fashion. When placed in 10% formalin it contracted vigorously and when fixed it measured 98 by 40 mm. with dermal rugae and the shape characteristic of other worms from *Acanthocybium*.

Whether the worms from other fishes represent a different species can not be determined with certainty. With the exception of the two specimens from *Katasuwonus pelamis* taken at Bermuda (Cat. No. 10, Fig. 11) which were immature and may belong to *H. ventricosa*, they are smaller, differ in shape and in the position of the acetabulum, attain sexual maturity at a smaller size, have less powerful suckers and body walls and presumably belong to a dif-

TABLE II.

Hirudinella from *Acanthocybium*.

Cat. No.	Collector	No. of Specimens	Locality	Figure
1	Beebe	2	Long Key, Florida	9-10
2a	Beebe	2	Bermuda	...
2b	Beebe	5	Bermuda	4
2c	Beebe	1	Bermuda	...
2d	Beebe	2	Bermuda	5-6
3	Beebe (*Antares* Exp., 1933)	2	Pearl Island, Panama (Pacific)	...
4	Beebe (Templeton Crocker Exp.)	2	Mexico (Pacific) Clarion Island	7-8
5a	Breder (*Atlantis* Exp.)	4	Yucatan, (Atlantic)	3
5b	Breder	2	La Plata Islands, Equador (Pacific)	...
5c	Breder	3	Equador (Pacific)	...
6	Smith	6	Bermuda	...
7	Erl Roman Formerly of Miami Herald through Miss F. LaMonte	1	Bimini (Atlantic)	1
8	Stoll[2]	1	Marianas Islands (Pacific)	2

[2] The host was listed as a "King Mackerel," possibly *Acanthocybium*.

ferent species. All of them appear to belong to a single species which we identify as *H. marina* Garcin.

Hirudinella marina Garcin[3], 1730.
(Plate VII, Tables IV and V).

Fasciola clavata Menzies, 1791.
Distoma clavatum (Menzies, 1791) Rudolphi, 1808.
Hirudinella clavata (Menzies, 1791) Blainville, 1828.
Fasciola coryphaenae Bosc, 1802.
Distoma coryphaenae (Bosc, 1802) Rudolphi, 1808.
Fasciola fusca Bosc, 1802.
Distoma fuscum (Bosc, 1802) Poirier, 1885.
Hirudinella fusca (Bosc, 1802) Dollfus, 1932.
Hirudinella fusca (Poirier, 1885) Manter, 1926.
Hirundinella bonnacouri Guiart, 1938.
Fasciola coryphaenae hippuridis Tilesius in Rudolphi, 1809.
Fasciola scombri-pelamidis Tilesius in Rudolphi, 1809.
Distomum dactylipherum Poirier, 1885.
Distomum heurteli Poirier, 1885.
Distomum verrucosum Poirier, 1885.
Distoma poirieri Moniez, 1891.
Hirudinella poirieri (Moniez, 1891) Dollfus, 1935.
Distoma siemersi Buttel-Reepen, 1900.

[3] Name spelled Garsin and Garzin by subsequent authors.

Hirudinella spinulosa Yamaguti, 1938.
Hirudinella oxysoma Guiart, 1938.
Hirudinella phalloidea Guiart, 1938.

Hirudinella ventricosa (Pallas, 1774) Baird, 1853.
(Plates I-VI, Tables II and III).

Fasciola ventricosa Pallas, 1774.
Distomum ventricosum (Pallas, 1774) Monticelli, 1893.
Distomum clavatum of Owen, 1834.
Distomum pallasii Poirier, 1885.
Distomum personatum Poirier, 1885.
Distoma ingens Moniez, 1886.
Distomum ingens of Mühlschlag, 1914.
Distomum ampullaceum Buttel-Reepen, 1900.
Hirudinella beebei Chandler, 1937.

Discussion.

The first of the giant trematodes from the stomach of scombriform fishes was found in *Scomber pelamys* of the Atlantic and was described by Garcin (1730), who named the parasite *Hirudinella marina*. His description was accompanied by a figure of the worm and supplemented by a second report, Garcin (1732), with a plate and 3 additional figures. The description is admittedly inadequate but was as good as that of many later specific descriptions that have been universally accepted. Pallas (1774) described a similar but larger and more robust parasite from an unnamed host in the Malay Archipelago and designated

TABLE III.

Some Measurements of *Hirudinella* from *Acanthocybium*.
(In millimeters, except eggs, which are in microns).

Cat. No.	Length	Greatest Width	Width at Acetabulum	Diameter Acetabulum	Diameter Oral Sucker	O.S. to G.P.	Eggs
1	58	22	13	7	3	5	35 × 23
	33	24	14	5.5 × 7.5	2.5	4	34 × 23
							(See Fig. 20)
2a	38	21	10	4.5 × 5.5	..	4.5	31 × 21.5
	31	19	8	5 × 6	..	3.5	38 × 24
2b	57	23	10	4	2.5	2.5	36 × 25
	31	19	7	6	2	4	32 × 21
	44	19	10	6	2	4	32 × 22
	47	19	10	4 × 5	2	3	31 × 20
	31	19	7	6	3	2	35 × 22
2c	31	21	9	4 × 6	..	3.8	33 × 22
2d	32	20	9	6	..	1.3	34 × 21
	31	21	9	6	..	2	35 × 20
3	26	19	9	4	..	3	35 × 22
	28	17	10	3.5 × 4.5	..	2	35 × 22
4	44	23	10	5.5	4	8	34 × 25
	41	22	11	7	3	8.5	37 × 26
5a	52	sectioned, (mature)					
	50						
	19	whole mount					
	12	sectioned, (immature)					
5b	24	15	8				35 × 19.5
	25	12	8				
5c	31	14.5	9				
	32	18	9				
	32	15.5	8				
6	45	17	7	5	..	6	33 × 25
	44	17	7	7	..	6.5	32 × 23
	36	17	8	3	..	..	32 × 24
	15	9	6	3	..	..	immature
	12	3	2.5	..	..	..	immature
	19	10	..	..	..	..	..
7	98	40	(see description later)				
8	48	18	6	..	..	2	..

it *Fasciola ventricosa*. This species was transferred to the genus *Hirudinella* by Baird (1853) and to *Distoma* by Monticelli (1893). It was deliberately renamed *D. pallasi* by Poirier (1885). Menzies (1791) described specimens from *Scomber pelamys* taken in the Pacific Ocean as *Fasciola clavata*. This species was transferred by Rudolphi (1808) to *Distoma* and by Blainville (1828) to *Hirudinella*. Blainville (1828) designated *F. clavata* as type of the genus *Hirudinella*. Bosc (1802) described material from the "dorade," *Coryphaena hippuris*, taken in the Atlantic, as *Fasciola fusca*. Specimens assigned to this species were described by Poirier (1885) as *Distomum fuscum* and Manter (1926) transferred the *Distomum fuscum* of Poirier to the genus *Hirudinella*. Manter studied specimens from the swordfish, *Xiphias gladius*, which he regarded as identical with those described by Poirier. Dollfus (1932) transferred *F. fusca* of Bosc to *Hirudinella*.

The genus *Hirudinella* Garcin was pre-Linnaean and monotypic. According to Opinion 5 of the International Commission on Zoological Nomenclature, which deals with the "Status of Certain Pre-Linnaean Names Reprinted Subsequent to 1757," "A pre-Linnaean name, ineligible because of its publication prior to 1758, does not become eligible simply by being cited or reprinted with its original diagnosis after 1757. To become eligible under the code, such names must be reinforced by adoption or acceptance by the author publishing the reprint." Concerning *Hirudinella* of Garcin, Blainville (1824) stated specifically, "J'admets ce genre pour les fascioles cylindriques qui ont quelque ressemblance avec les sangsues, et entre autres le *Fasc. clavata* Linn." He later (1828, p. 586) designated *H. clavata* as type of the genus. But Art. 30c of the International Rules of Zoological Nomenclature states, "A genus proposed with a single original species takes that species as

TABLE IV.

Hirudinella from Scombriform Fishes Other Than *Acanthocybium*.

Cat. No.	Collector	No. of Specimens	Host	Locality	Figure
9a	Beebe	1	Black Finned Tuna. *Parathunnus atlanticus* (Lesson)	Bermuda	Similar to Figs. 24-25
9b	Beebe	2	*Parathunnus atlanticus* (Lesson)	Bermuda	Similar to Figs. 24-25
9c	Beebe	4	*Parathunnus atlanticus* (Lesson)	Bermuda	Similar to Figs. 24-25
9d	Beebe	1	*Parathunnus atlanticus* (Lesson)	Bermuda	Similar to Figs. 24-25
9e	Beebe	1	*Parathunnus atlanticus* (Lesson)	Tobago	Similar to Figs. 24-25
10	Beebe	2	Ocean Bonito. *Katsuwonus pelamis* (L.)	Bermuda	11
11	Templeton Crocker Exp. (Beebe)	1	Little Tunny. *Euthynnus alletteratus* (Rafinesque)	C. San Lucas, Lower Calif. Pacific	Similar to 24-25
12	Templeton Crocker Exp. (Beebe)	3	California Yellowfin Tuna. *Neothunnus macropterus* (Temminck & Schlegel)	C. San Lucas, Lower Calif. Pacific	Similar to 24-25
13	Templeton Crocker Exp. (Beebe)	1	Pacific Swordfish. *Nakaira mitsukurii* (Jordan & Snyder)	C. San Lucas Lower Calif. Pacific	23
14	Templeton Crocker Exp. (Beebe)	1	Spanish Mackerel. *Scomberomorus maculatus* Mitchill	Port au Prince Bay Haiti	Similar to 11
15	Doxsee	6	Bluefin Tuna. *Thunnus thynnus* (L.)	Point Lookout, L. I.	24-25

type. (Monotypical genera.) (See opinions Nos. 6, 9, 22, 30, 42, 47)." In his paper Blainville (1824) formally validated the generic name *Hirudinella* and by the rules, *H. marina* must be the type species. Opinions 22 and 30, dealing with similar cases, reaffirm the principle that monotypic genera must retain the original species as type, and that the original type takes precedence over any later designated types. Accordingly, the acceptance by Blainville (1824) of *Hirudinella* as a valid generic name also validated *H. marina* as the type species and his later (1828) designation of *H. clavata* as type can not be accepted. A further attempt to designate a new type species was made by Blanchard (1891). Since *H. marina* Garcin is a pre-Linnaean name, Blanchard proposed that *F. ventricosa* (= *D. ventricosum*), the first post-Linnaean name, be accepted as type of the genus. But application of the International Rules renders Blanchard's proposal also untenable. By the Rules of International Nomenclature, the type of *Hirudinella* is *H. marina*. *Hirudinella* Gray, 1850, mollusk, and *Hirudinella* Muenster of Diesing, 1850, leech, are untenable homonyms.

Comparison of our material with accounts in the literature shows that most if not all of the previously described species can be referred to one or the other of the two species we recognize. We have studied the sections of *H. beebei* (the species was described from this one specimen) and can not agree with Chandler's interpretation of certain structures. He stated, (1937, p. 350) "Near point where conical anterior part of body joins expanded posterior part, ceca begin branching in extremely complicated manner, with veritable maze of pockets and anastomosing, interlacing branches, which in cross-section give appearance of a reticulum. Near middle of hind-body a rather large expanded central lumen on each side, without much branching on medial sides, but with very complicated lateral and outer walls. As ceca proceed posteriorly they throw off laterally a series of backward-directed divisions, each with its complicated pockets and anastomosing branches. Longest divisions of ceca terminate at extreme posterior end of body" (See Plate VI, Figs. 16-19). While examination of single sections indicates branching and anastomosis of the intestinal ceca with the formation of a reticulum, careful reading of successive sections shows that the walls of the ceca are

TABLE V.

Measurements of *Hirudinella* from Scombriform Fishes Other Than *Acanthocybium*.

Cat. No.	Length	Greatest Width	Width at Acetabulum	Diameter Acetabulum	Eggs
9a	15	5		5 × 4	34 × 23
9b	15	8	5	5	34 × 23
	8.5	2.5			immature
9c	28	6.5	5	5	38 × 23
	9.5	2	1.5		immature
	13	3	3		immature
	13.5	3.5	3.5		immature
9d	15	6	4	4 × 3	38 × 21
9e	17	5.5			immature
10	37	6	2.5	3 × 3	immature
	20	2			immature
11	16	3.5			immature
12	26	8	3.5	3 × 3	33 × 20
	17	5	3.5	5 × 4	35 × 22
	11	4	4	4 × 4	31 × 23
13	17.5	5	4.5	4.5 × 4.5	36 × 21 (see Fig. 21)
14	18	5	3	3 × 3	immature
15	21	6		5 × 4	
	21	5		5 × 4	
	22	5		5 × 4	44 × 26
	19	4		4 × 3	(see Fig. 22)
	19	5		5 × 4	

collapsed in innumerable folds and plications, but that actual branching does not occur. The cavities of the supposed branches are parts of a continuous lumen and study of other specimens shows that when the ceca are filled, the plications disappear (Plate V, Fig. 14). In some of our sections small connections were found between the posterior ends of the ceca and the excretory vesicle and we believe that this condition is characteristic for the genus. None of the intestinal content, however, was observed in the excretory vesicle.

Furthermore, in specimens from both Atlantic and Pacific, which we identify as *H. ventricosa*, the vitelline follicles are intracecal as well as extracecal. As described for *D. ampullaceum* by Buttel-Reepen, (1902, p. 212), "In der obern Partie liegen die Acini meist dicht zusammen (Fig. 28 *dodr*), während sie sich auf Querschnitten durch die untere Partie in dem spärlichen Parenchym überall zerstreut zeigen." Mühlschlag (1914) reported that in both *D. fuscum* and *D. ingens*, the vitellaria are extracecal and extend from the level of the testes to the excretory vesicle. His figure shows the vitellaria in a cross-section taken near the middle of the body and at that level the vitellaria are always extracecal. In discussing the differences between the specimens he identified as *D. ingens* and those described as *D. ampullaceum* by Buttel-Reepen, Mühlschlag (1914) pointed out that they might readily be regarded as identical, and the features he cited to distinguish between them were either minor histological or positional ones that do not commend themselves as truly specific. All may be explained by differences in age, degree of development, functional activity or muscular contraction. Accordingly, the two features on which Chandler distinguished *H. beebei* from *H. ampullaceum* and *H. ingens*, viz., the form of the digestive system and distribution of the vitellaria, appear inadequate. We are unable to discover any sound morphological character or set of characters to separate these species and regard them as identical with *H. ventricosa*.

The various features used by previous authors to determine species of *Hirudinella* include host, size and shape of the digestive ceca and of the excretory bladder, relation of parts of the copulatory organs, presence of dermal rugae and papillae, thickness of the cuticula and body wall, size of suckers and their openings, position of the genital pore, details of histological organization and size of eggs. When these features concern true morphological differences, they constitute the basis for specific distinction, but when they are only manifestitations of different physiological states, they cannot be criteria of specificity.

Study of our material shows that in most cases the reported differences are merely variations that have no specific value. As noted earlier, the hosts of *Hirudinella* are wide-ranging oceanic fishes and Manter

(1940, p. 536), in discussing the trematode parasites of marine fishes, included *H. clavata*, remarked on their wide distribution and stated, "their occurrence in both the Atlantic and Pacific may have no particular significance." In the absence of information concerning life histories, there is no ground for the assumption of host-parasite specificity. The only known life cycle of a marine hemiurid is that of *Lecithaster confusus*, traced by Hunninen and Cable (1943). This species has a cystophorous cercaria which develops into an unencysted metacercaria in the haemocoele of copepods, and adults occur in a large number of marine fishes, including *Scomber scomber*.

The report by Jourdan (1881), discussed by Poirier (1885), that specimens of *Hirudinella* were found on the gills of fishes and free in the floating material of the Sargasso Sea, may not be significant. The worms may survive for considerable time in sea water and if they had migrated or been regurgitated from the stomach, it is not surprising that they were found on the gills of the fishes or on adjacent vegetation. They are normal parasites of the stomach, but the observation of Jourdan may possibly explain the fact that they often occur singly and that so few individuals are present in a host.

These trematodes are enormous, powerfully muscular worms, capable of great variation as different sets of muscles contract; the motility of the preacetabular region was portrayed in the sketches by Garcin (1739); and like other hemiurid trematodes, discussed by Stunkard and Nigrelli (1934), they may be greatly distorted in the process of killing and preserving. This distortion may affect both the external form and the relations of internal structures. If the authors who have described preserved museum specimens had recognized this fact, the literature would not be burdened with several new species proposed on the differences in shape, in appearance of dermal plications, and other results of muscular contraction. The failure to distinguish between true morphological differences and physiological variation is commonplace and even modern authors are not exempt, as may be observed in the following quotation from Guiart (1938, p. 29), "Toutefois il n'existe certainement aucune relation entre ce Distome (*D. ventricosa*) à corps ovalaire lisse et à ventouse ventrale lisse et celui (*H. phalloidea*) que nous allons décrire, qui présents un corps globuleux très fortement plissé et une ventouse ventrale à bord mamelonné. Celui-ci constitue certainement une espèce nouvelle; en tous cas ses affinitiés seraient avec l'*Hirudinella bonnacouri* nom. nov., plutôt qu'avec l'*Hirudinella pallasii* Poirier 1885." And in a footnote on the same page the author makes the statement, "En 1885 Poirier a bien décrit sous le nom de *Distomum personatum* un *Hirudinella* à abdomen bilobé, récolté au Mexique par Geoffroy, sans indication d'hôte; mais ici l'abdomen est ovalaire et surtout la ventouse ventrale présente un bord lisse; donc rien de commun avec notre exemplaire." *Hirudinella phalloidea* was described from a single specimen, which in our opinion is specifically identical with *H. bonnacouri* and both names are synonyms of *H. marina* Garcin. These specimens are probably distinct from *H. ventricosa* (= D. *personatum*). It appears that certain investigators harbored the opinion that all members of a single species would be identical in morphological aspects, regardless of the manner in which they had been killed. The bulbous enlargement of the posterior portion of the body, so often figured and discussed, is explained by the text-figure of Darr (1902, p. 692) which shows the bending of the lateral excretory canals in this condition and by his Fig. 26, which shows the powerful longitudinal muscles which are inserted around the caudal tip of the body. Retraction of the posterior end of the body is characteristic of the hemiurid trematodes and finds its culmination in the so-called "appendiculate distomes." When living specimens of *Hirudinella* are suspended by the anterior end, if the digestive ceca are filled with blood, this fluid material flows downward and contributes to the caudal enlargement.

Another feature which has occasioned much confusion and discussion is the structure and relations of the musculature which surrounds and comprises the copulatory organs. In the hemiurid trematodes, where the terminal portions of both the male and female ducts are enclosed in a common muscular sac, the relations may be varied and perplexing. This muscular sac has a complex structure, is connected by muscle bands to the body wall at different places, and may be retracted or protruded, especially as the preacetabular portion of the body is extended and contracted. These relations were represented in Figures 6 and 9 of Buttel-Reepen (1900) and Figures F and H in his 1902 paper. If the musculature is retracted, the male and female ducts open into a long, deep and narrow genital sinus, whereas if the mass is protruded (Plate I, Fig. 2), the two ducts open through separate papillae on a common genital protuberance. These small papillae were figured by Bosc (1802) and discussed by Blanchard (1891). In different positions, the copulatory organs and especially the musculature associated with the male papilla manifest greatly altered relations, but these morphological variations have been observed in different individuals

of the same species and result merely from contractions of different sets of muscles. The specimens from *Xiphias gladius* described by Manter (1926) and identified by him as *H. fusca* (Poirier, 1885) agree in essential respects with those we recognize as *H. marina*. Manter distinguished between *H. fusca* and *H. clavata* on the location of the openings of the male and female genital ducts. Our observations show that the reported differences actually represent only differences in the state of contraction of the genital musculature. This musculature and its relation to the "cirrus sac" was discussed by Mühlschlag (1914) and Manter (1926). Mühlschlag (1914) described as *H. fusca* (Bosc, 1802) specimens presumably identical with those of Manter and all of them we regard as identical with *H. marina*. The specimens described by Buttel-Reepen (1903) as *D. siemersi* we assign to the same species, *H. marina*.

With slight emendations we are in accord with the conclusions of Moniez (1891, p. 116). This eminent helminthologist reviewed the descriptions and synonyms of *Distoma clavatum* and summarized the situation as follows, "Il result donc de tout ceci, ce que nous avons déjà exprimé, à savoir: (1) que le véritable *Dist. clavatum* est celui de Garsin et de Menzies, redécrit ensuite par Dujardin, Jourdan, Poirier, etc.: (2) que c'est par erreur qu'Owen a donné ce nom à une espece tout differente, qui j'ai appelée plus tard *Dist. ingens*, nom qui doit etre maintenu; (3) et comme consequence qu'il n'y a pas identite entre les *Dist. clavatum* et *ingens*." In this same publication Moniez admitted the identity of *Dist. clavatum* of Owen and *Dist. ingens*. If the name *Hirudinella marina* is substituted for *D. clavatum* and the name *Hirudinella ventricosa* (Pallas, 1774) Baird, 1853, for *D. ingens*, our conclusions agree entirely with those of Moniez. Baird (1853) had predicated the identity of *D. clavatum* of Owen with *Fasciola ventricosa* Pallas, 1774. The two species recognized by Moniez were redescribed by Buttel-Reepen (1900, 1902) as *Dist. siemersi* and *Dist. ampullaceum*. The worms described by Buttel-Reepen (1900) as *D. ampullaceum* and by Mühlschlag (1914) as *D. ingens* are almost certainly conspecific with those we have studied and referred to *H. ventricosa*. *Dist. personatum* Poirier is probably identical, but his description is too incomplete to permit final identification.

Distomum megnini Poirier, 1885, was regarded by the author as a member of the *D. clavatum* group, but it is so different in internal structure that it cannot be retained in the genus *Hirudinella*. Monticelli (1893) considered it identical with *D. macrocotyle* Diesing, 1858, and included it in the subgenus *Accacoelium*, which was raised by Looss (1899) to generic rank. Stossich (1898) transferred *D. macrocotyle* Diesing, 1858, to the genus *Podocotyle*.

Since both *H. marina* and *H. ventricosa* have been described previously under different names, (q.v., lists of synonymy), further detailed accounts are unnecessary. The data presented in Table II give measurements of our specimens and the morphology agrees essentially with previous descriptions.

We are not in agreement with the opinion of Dollfus (1932, 1940) who erected families to receive the genera *Hirundinella* and *Bathycotyle*. The hemiurid trematodes constitute a well-defined group in the Digenea; they are related to the Azygiidae, but other relationships are yet undetermined and until the life cycles and developmental stages are known, we prefer to regard the units as subfamilies, Hirudinellinae, Bathyycotylinae, etc.

Summary.

Examinations of specimens of *Hirudinella* from 9 different species of scombriform fishes, taken in both the Atlantic and Pacific Oceans, have disclosed the great variation in form and internal arrangements that may be manifested by these large, very muscular trematodes. All of our material is allocated to two species which we identify as *H. marina* Garcin, 1730, and *H. ventricosa* (Pallas, 1774) Baird, 1853. The validity of *H. marina* Garcin, 1730, and its status as type of the genus *Hirudinella*, are established. Comparison of our specimens with accounts in the literature indicates that most, if not all, other described species are merely variants of one or the other of the two species we recognize. The other designated species were described from a single or very few specimens, and are regarded as synonyms. Information is yet too incomplete to permit definitive taxonomic determination and we are not in accord with Dollfus (1932, 1940) in the erection of families for subgroups of the Hemiuriidae.

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EXPLANATION OF THE PLATES.

All photographs by S. C. Dunton, staff photographer of the New York Zoological Society.

Plates I-VI, *Hirudinella ventricosa* (Pallas, 1774) from *Acanthocybium* spp. taken from the Atlantic and Pacific Oceans.

Plate I.

Fig. 1. Living worm pressed between two glass plates. The parasite was taken from the stomach of a fish sent by air to the New York Aquarium from Bimini, W. I. When fully expanded it measured 170 mm. in length and 30 mm. in width. About natural size.

Fig. 2. Parasite from the stomach of a "King Mackerel" (*Acanthocybium*?) taken off the Marianas Islands, Pacific. The specimen was sent by Dr. N. R. Stoll. Note the common genital protuberance with two separate papillae. About 3×.

Fig. 3. Parasites from fish caught off the coast of Yucatan (Atlantic). Worms 1 and 4 were sectioned serially; worm 3 was stained and mounted *in toto*. The smallest form was immature. A little less than twice natural size.

Plate II.

Fig. 4. *Hirudinella ventricosa* from the stomach of *Acanthocybium* captured off Bermuda. A little less than natural size.

Figs. 5-6. These worms were taken from fish caught off Bermuda. Note the numerous minute papullae, especially on specimen 5. These are artifacts formed in the process of fixing. They are rough to the touch and are similar to the structures Poirier (1885) found on the species he described as *D. verrucosum*. About 2×.

Figs. 7-8. From fish taken off Clarion Island, Mexico (Pacific). Beebe-Templeton Crocker Expedition, 1936. Note the extent of contraction at the posterior end, smoothness of the anterior extremity and the terminal position of the oral sucker. About 1½×.

Plate III.

Figs. 9-10. Parasites, similar in appearance to 7 and 8, taken from fish caught off Long Key, Florida. About 1½×.

Fig. 11. One of two specimens from the ocean bonito *Katasuwonus pelamis* (Linnaeus) taken off the coast of Bermuda. About 10×.

Plate IV.

Fig. 12. Gross dissection of a worm taken from *Acanthocybium*. Body wall deflected posterior to the acetabulum, showing musculature of the body wall and the bands which control movements of the acetabulum, with external view of intestinal ceca. 3×.

Fig. 13. Same structures as in Fig. 8, part of body wall removed to expose the testes. 3×.

Plate V.

Fig. 14. Interior of a single cecum with plicated wall, limits of uterus, ovary, Mehlis' gland, testes, copulatory organs and genital pore. 4×.

Fig. 15. Further dissection of anterior portion, showing testes, ovary, and details of male and female genital ducts. 8×.

Plate VI.

Figs. 16-19. Photomicrographs of sections of *Hirudinella beebei* Chandler (1937) taken (16) near the middle region at about the end of the uterine coils, (18) midway between the region shown in 16 and posterior end of the body, and (19) at the posterior end. Figure 17 is an enlargment of the region indicated by arrow in Figure 16. These sections attempt to show the complicated nature of the ceca, which according to Chandler form a . . . "maze of pockets and anastomosing, interlacing branches, which in cross section give appearance of a reticulum." Our studies have shown that the walls of the ceca are collapsed in innumerable folds and plications, but that actually branching does not occur. When the ceca are filled, the plications disappear (see Plate III, Fig. 10). Photomicrographs by Dr. Chandler.

Plate VII.

Figs. 20-22. Photomicrographs of eggs from several specimens of *Hirudinella*. Fig. 20 from parasite found in *Acanthocybium;* Fig. 21, from parasite of the Pacific swordfish (see Fig. 20); Fig. 22 from one of the worms taken from bluefin tuna (see Figs. 24, 25). Each unit represents 7 microns.

Hirudinella marina Garcin, 1730, from other scombriform fishes.

Fig. 23. Parasite from the stomach of the Pacific swordfish, *Makaira mitsukurii* (Jordan and Snyder). Note the nature of the acetabulum. About 3×.

Figs. 24-25. Five of six specimens found in the stomach of a bluefin tuna, *Thunnus thynnus* (Linnaeus), caught off Point Lookout, L. I. About 1½×.

Plate VIII.

Fig. 26. Plate from Buttel-Reepen's (1902) paper in *Zool. Jahr., Syst.*, Bd. 17, Taf. 6 showing drawings of species of *Hirudinella* described by various authors up to that time.

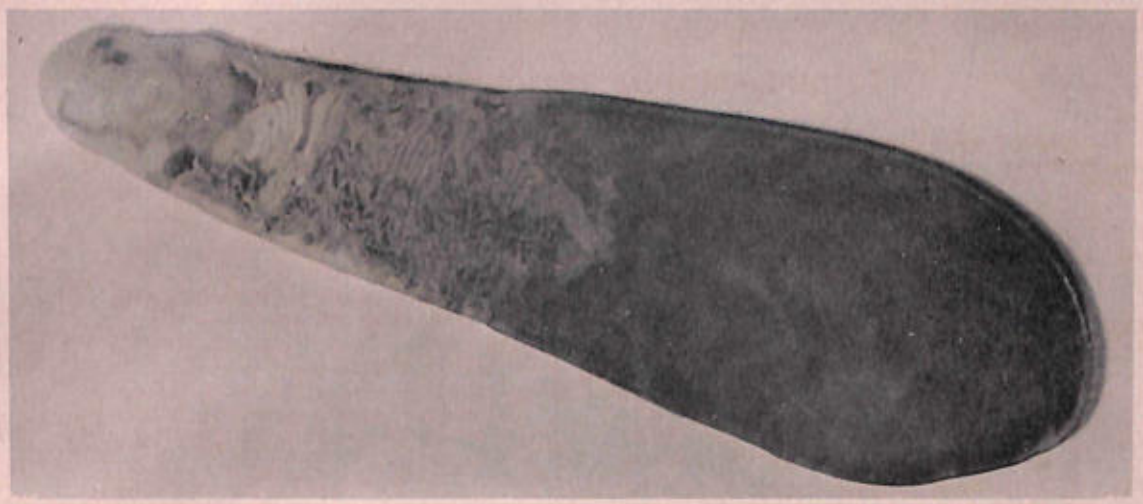
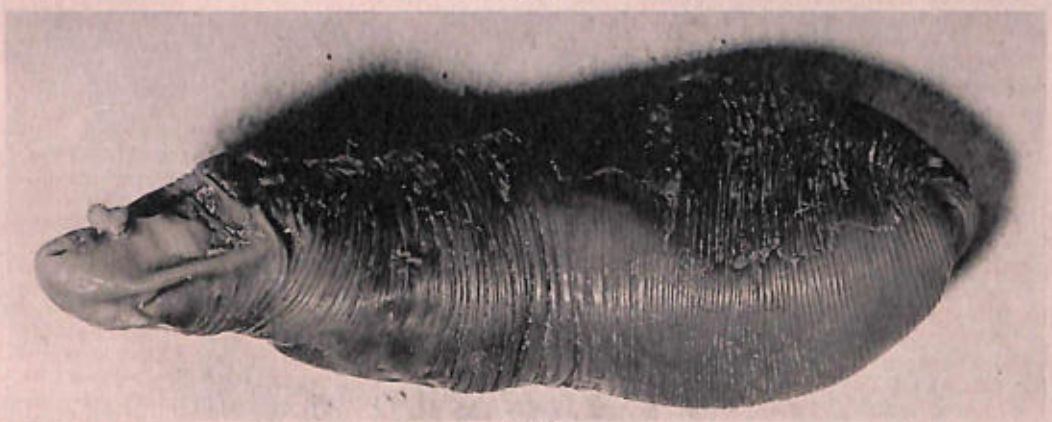


FIG. 1.



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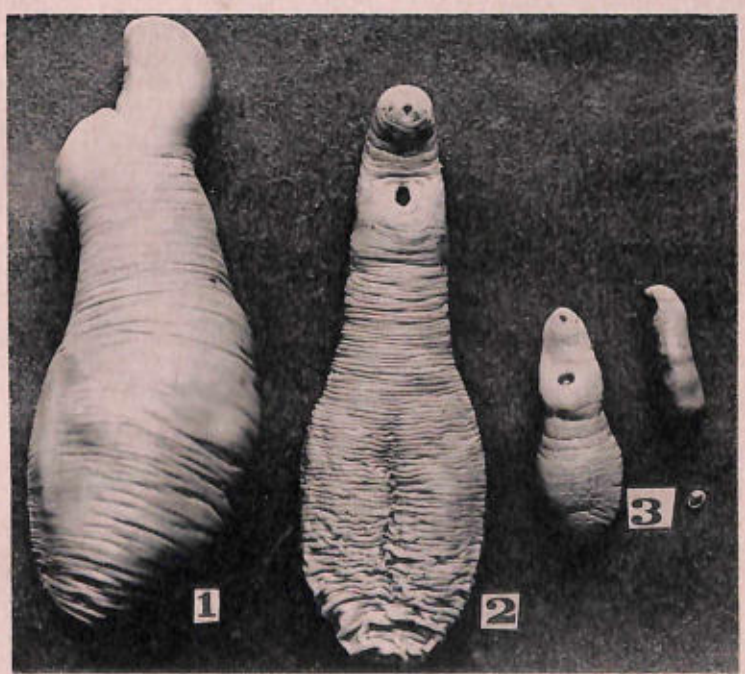


FIG. 3.

STUDIES ON THE GENUS HIRUDINELLA, GIANT TREMATODES OF SCOMBRIFORM FISHES.

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

FIG. 8.

FIG. 9.

FIG. 10.

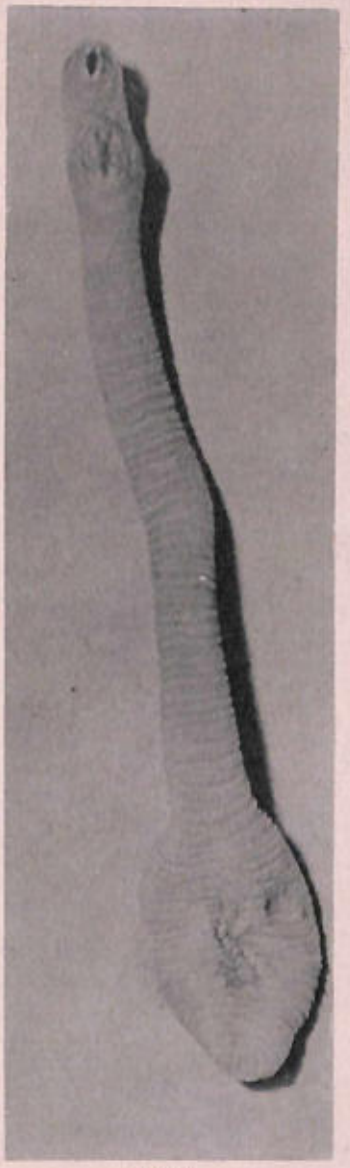


FIG. 11.

STUDIES ON THE GENUS HIRUDINELLA, GIANT TREMATODES OF SCOMBRIFORM FISHES.

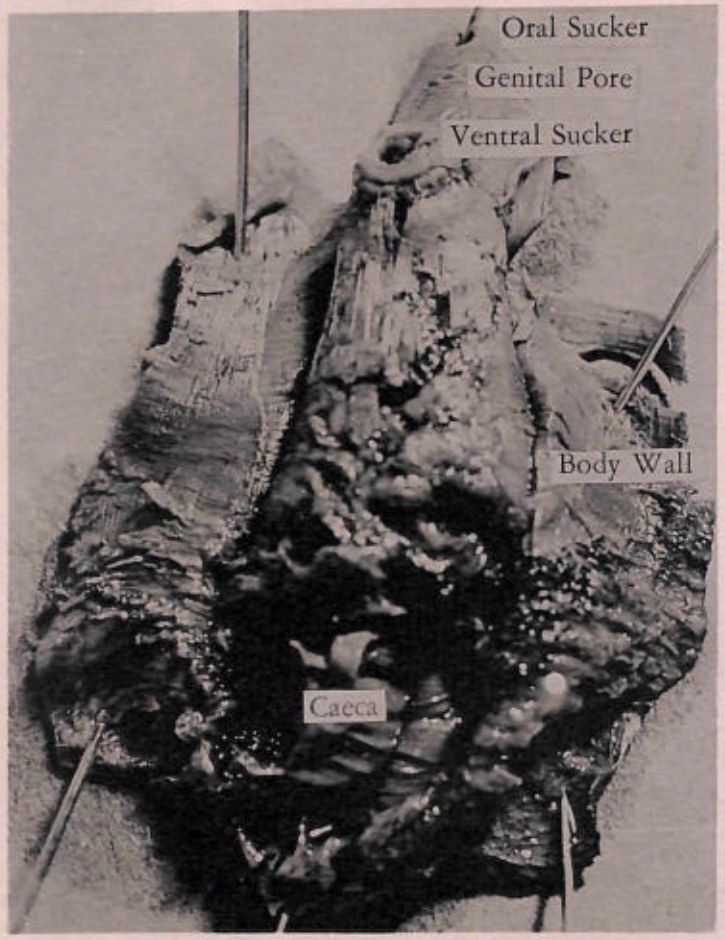


FIG. 12.

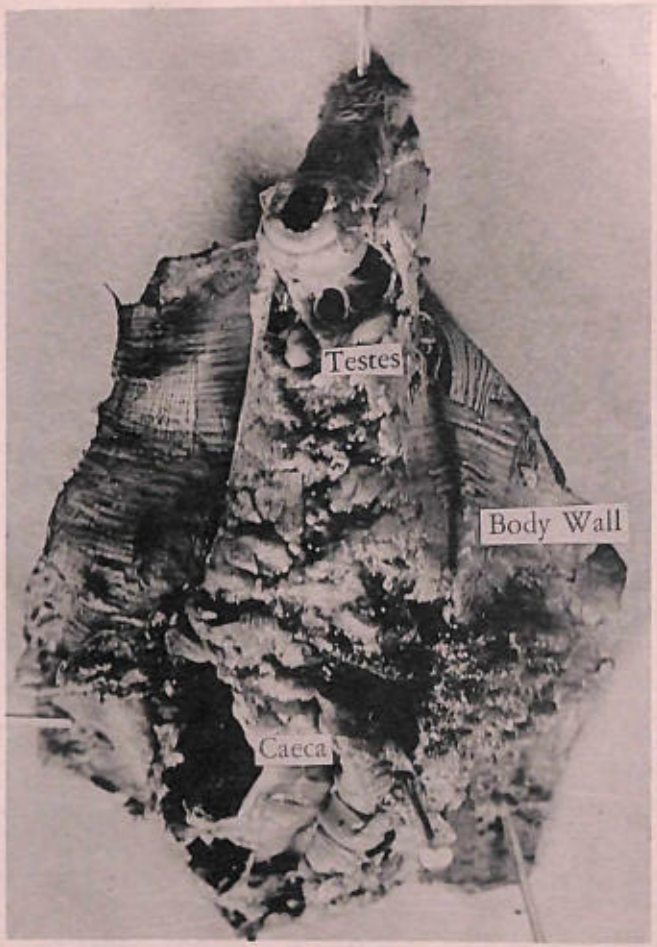


FIG. 13.

STUDIES ON THE GENUS HIRUDINELLA, GIANT TREMATODES OF SCOMBRIFORM FISHES.

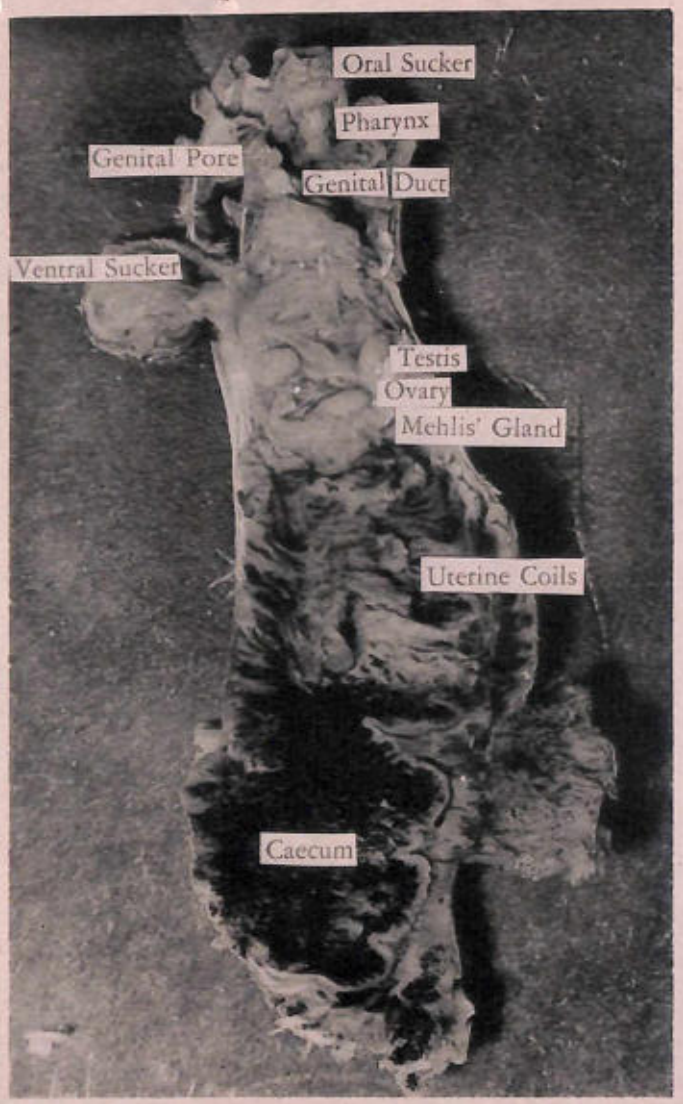


FIG. 14.

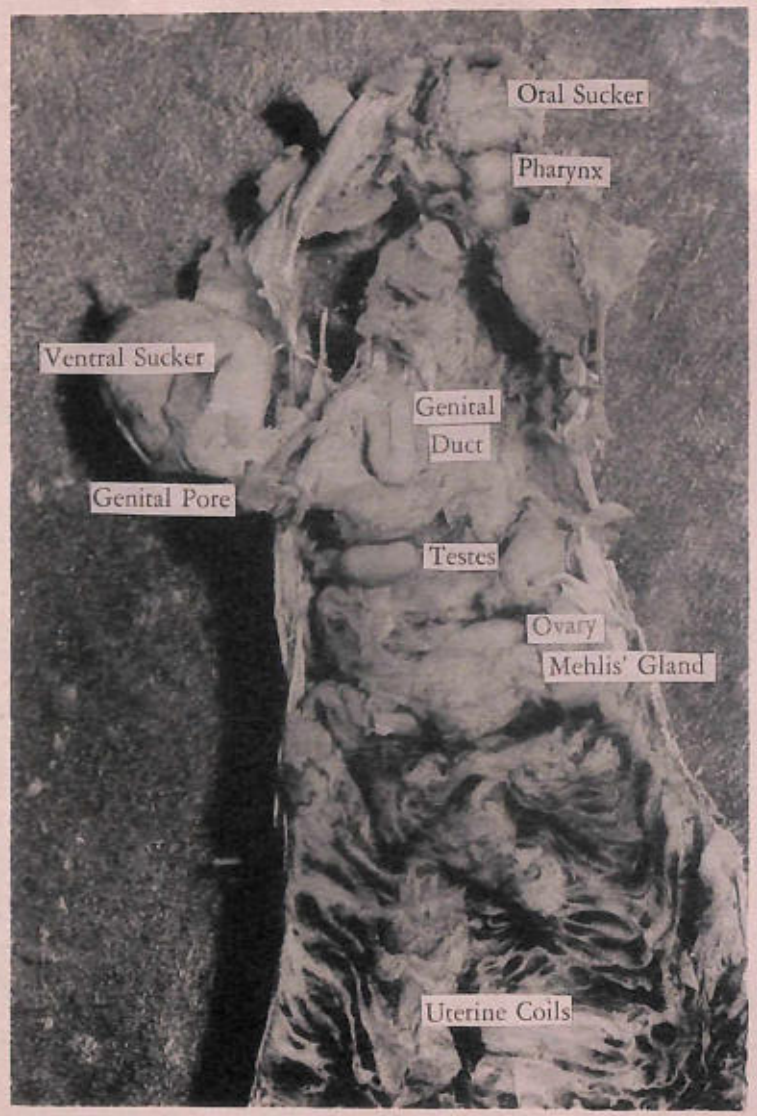


FIG. 15.

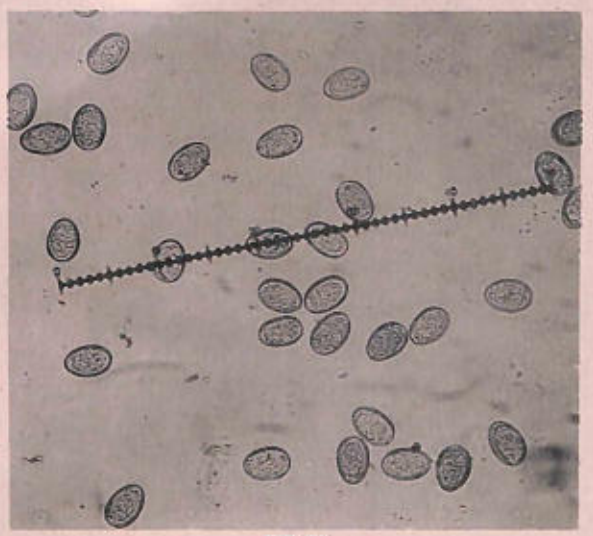
STUDIES ON THE GENUS HIRUDINELLA, GIANT TREMATODES OF SCOMBRIFORM FISHES.

FIG. 16.

FIG. 17.

FIG. 18.

FIG. 19.



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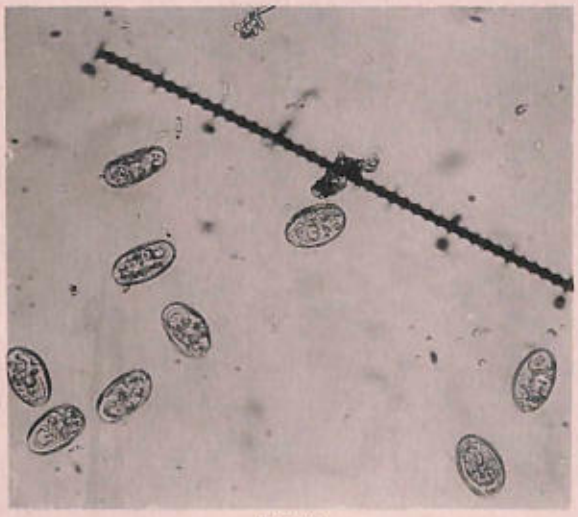
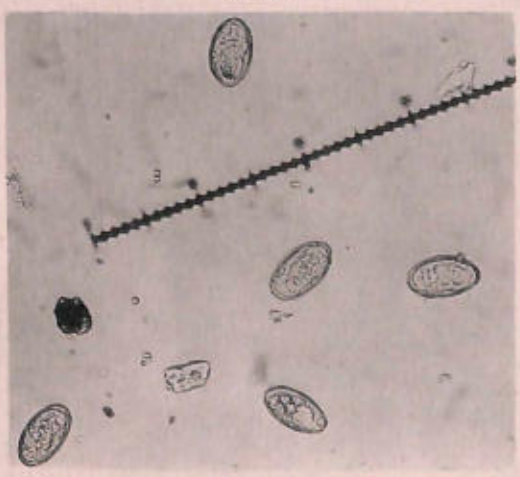


FIG. 21.



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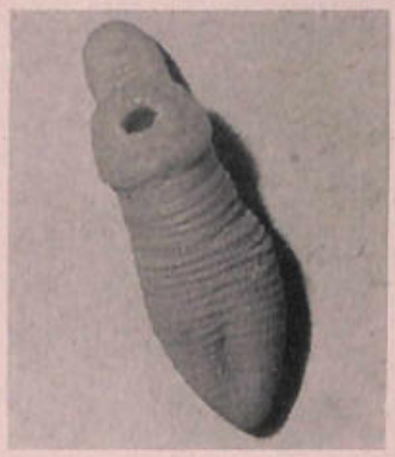

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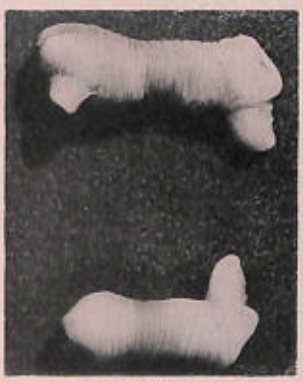
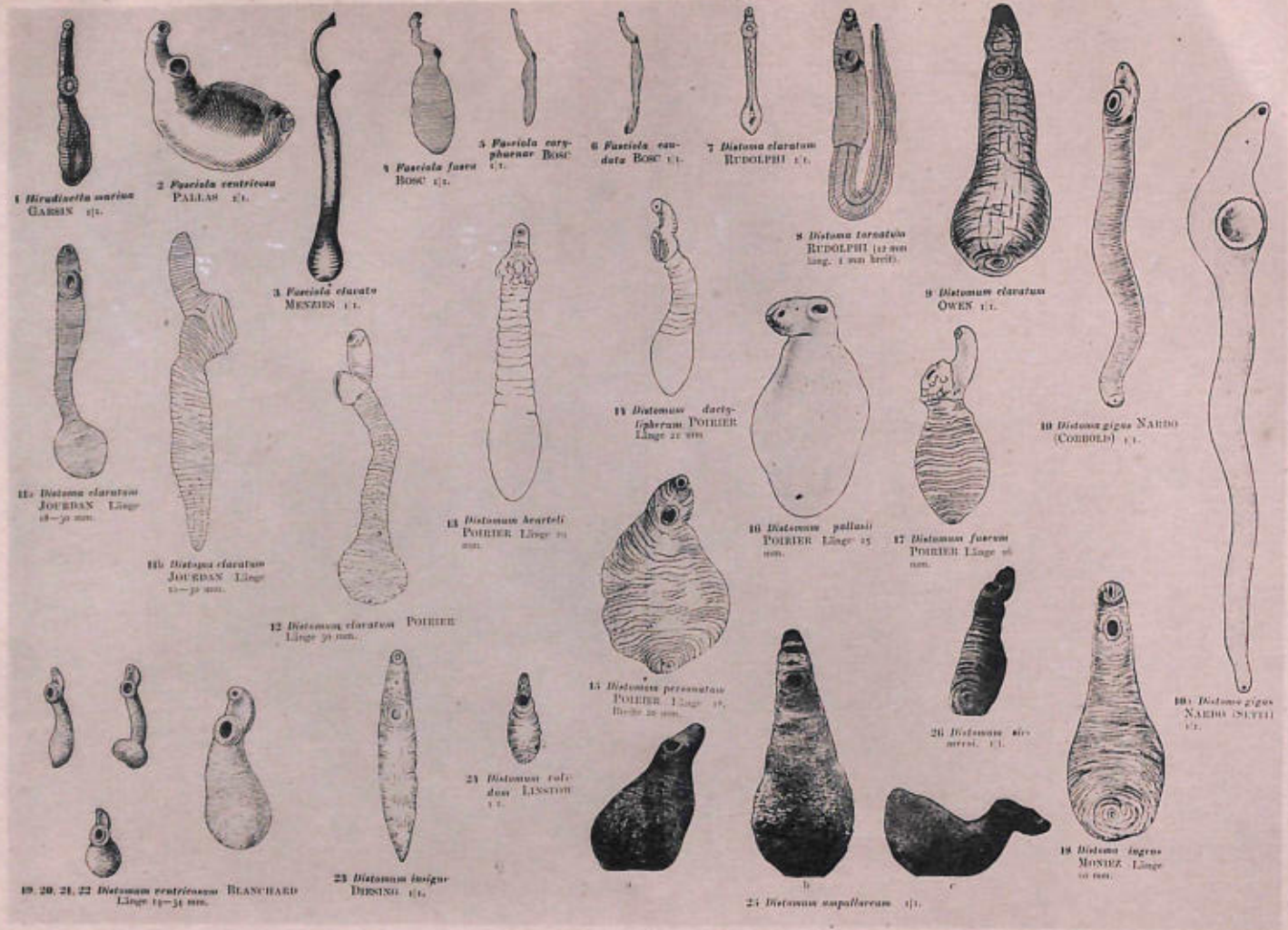


FIG. 24.

FIG. 25.



STUDIES ON THE GENUS HIRUDINELLA, GIANT TREMATODES OF SCOMBRIFORM FISHES.

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