NEW YORK ACADEMY OF SCIENCES

# SCIENTIFIC SURVEY

OF

# PORTO RICO and the VIRGIN ISLANDS

VOLUME XVI—Part 1

A Handbook of the Littoral Echinoderms of Porto Rico and the Other West Indian Islands—*Hubert Lyman Clark*



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# A HANDBOOK OF THE LITTORAL ECHINODERMS OF PORTO RICO AND THE OTHER WEST INDIAN ISLANDS

By Hubert Lyman Clark

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## INTRODUCTION

The Echinoderm fauna of the West Indian region is a very rich one, if all of the Continental and Abyssal forms are included, but the littoral fauna is remarkable only when compared with that of temperate seas. It is markedly less varied than that of the Philippines and compares poorly with that of northwestern Australia. Nevertheless it is sufficiently abundant and diversified to attract the attention of anyone interested in seashore life, and except for the scarcity of crinoids it is fairly representative of the group. The present report, although based primarily on collections made in the waters of Porto Rico and the Virgin Islands, is intended to include (at least in the keys) all of the West Indian echinoderms, so far as they are now known, which a shore collector may hope to find anywhere in the West Indies. Although fewer than half of these have actually been taken in Porto Rico, a number of additional species are known from the Virgin Islands, and nearly if not quite all of these will probably be found at Porto Rico in the course of time. *No species is included in the present list which has been taken hitherto only in depths of ten fathoms or more.*

Until the beginning of the twentieth century, very little was known about the echinoderms of Porto Rico, only a few of the more conspicuous forms having been recorded. In the case of the Virgin Islands, however, the activities of a local apothecary at St. Thomas, Mr. A. H. Riise, inspired by the great Danish zoologists Örsted and Lütken, brought to light (some seventy-five years ago) a considerable echinoderm fauna. Indeed, a very large part of our knowledge of West Indian echinoderms is due to this enthusiastic and patient collector and the eminent zoologists of Copenhagen who studied his material and described the new forms.

The first Porto Rican collections of importance were made by the "Fish Hawk," of the U. S. Fish Commission, in January and February, 1899. These were sent to me for study in 1900 and the following year my report was published (1901, Bull. U. S. Fish Commission, II, pp. 231-263, Pls. 14-17). A considerable and very interesting part of the "Fish Hawk" collection was made by dredging in water of considerable depth (12-225 fms.) and hence there were more than thirty species included in that report which are not to be found in the present volume. In 1900, Mr. George M. Gray, the well-known collector, of the Woods Hole Marine Biological Laboratory, made a collection of twenty-two species near San Juan, Porto Rico, which he kindly permitted me to examine; there were two species not in the "Fish Hawk" collection.

There is a considerable literature on West Indian echinoderms but most of the papers deal with collections made by a single vessel or individual or with the fauna of some one limited area. Besides the "Fish Hawk" report mentioned above, I have published a discussion of the littoral echinoderms of the West Indies (1919, Publ. 281 Carnegie Inst. Washington, pp. 49-74) which gives a list of the known species and shows their geographical range. The two expeditions from the University of Iowa, in 1893 and 1918, made extensive collections of echinoderms in Florida and the West Indies, and the various reports based on them are a most important contribution to our knowledge of West Indian littoral forms, although much of the material was from moderately deep water and hence does not concern us here. So far as completed, these reports, arranged by classes, are as follows:

Crinoids of 1893. H. L. Clark, 1918. Univ. Iowa: Bull. Lab. Nat. Hist., VII, No. 5, pp. 3-16.

Crinoids of 1918. A. H. Clark, 1921. Univ. Iowa: Studies in Nat. Hist., IX, No. 5, pp. 3-28.

Asteroids of 1893. A. E. Verrill, 1915. Univ. Iowa: Bull. Lab. Nat. Hist., VII, No. 1, pp. 3-232.

Ophiuroids of 1893. A. E. Verrill, 1899. Univ. Iowa: Bull. Lab. Nat. Hist., V, No. 1, pp. 1-86.

Ophiuroids of 1918. A. H. Clark, 1921. Univ. Iowa: Studies in Nat. Hist., IX, No. 5, pp. 29-63.
Echinoids of 1893. H. L. Clark, 1918. Univ. Iowa: Bull. Lab. Nat. Hist., VII, No. 5, pp. 16-37.
Echinoids of 1918. H. L. Clark, 1921. Univ. Iowa: Studies in Nat. Hist., IX, No. 5, pp. 103-121.
Holothurians of 1918. E. Deichmann, 1926. Univ. Iowa: Studies in Nat. Hist., XI, No. 7, pp. 9-31.

Another important series of papers, based on the collections made by Messrs. Kükenthal and Hartmeyer in 1907, is as follows:

Westindische Seeigel und Seesterne. L. Döderlein und R. Hartmeyer, 1910. Zool. Jahrb. Suppl. 11, heft 2, pp. 145-156.
Westindische Holothurien. C. P. Sluiter, 1910. Zool. Jahrb. Suppl. 11, heft 2, pp. 331-342.
Ophiures. R. Koehler, 1913. Zool. Jahrb. Suppl. 11, heft 3, pp. 351-380.

The reports on the "Blake" collections and on various collections of the "Albatross" deal so largely with material from deep water that they concern us but little. There are a few scattered local lists and notes made by various individuals in connection with shell collecting or general travel. These have not been disregarded though they need no special mention.

The collections of Echinoderms made by the New York Academy of Sciences parties in 1914 under the leadership of Dr. Roy Waldo Miner, and 1915, led by Dr. Miner and Dr. Raymond C. Osburn, were identified and labelled by Dr. Willard G. Van Name, but it has been thought desirable that they should be reëxamined in connection with the preparation of the present report. This has been a distinct privilege, for most of the specimens are well preserved and Dr. Van Name's careful work has greatly lightened the labor of studying so large an amount of material. It is seldom that a collection is so satisfactorily labelled and prepared for study. There are altogether 550 specimens, representing 50 species, of which 11 are now for the first time recorded from Porto Rico.

This makes the total number of species, at present known from the island, at least sixty-seven; several additional brittle stars are known to occur but their specific identity is still doubtful, imperfect specimens only having as yet been taken. In addition to these, there are a dozen forms known from the Virgin Islands but not yet recorded from Porto Rico. At other West Indian Islands, notably Jamaica, Antigua, Barbados and Tobago (not to mention the Tortugas) considerable shore collecting has been done, and more than thirty echinoderms have been found that may well be expected to occur on the Porto Rican coast. Additional scattered records warrant the belief that still other species may possibly occur bringing the total number of echinoderms included in the body of this report to one hundred and fifty while nineteen additional forms are mentioned, for one reason or another, in the introductory paragraph to the class concerned; and these are also included in the keys. *It must be understood clearly, however, that the keys are based only on the included species and will prove misleading or worthless if used for other material.* With this understanding, it is hoped that the report will be a usable and trustworthy guide to the Echinoderm fauna of the shores of Bermuda, southern Florida and the Gulf States, the eastern coast of Mexico and Central America, the northern and northeastern coasts of South America, and the West Indian islands. Reference to a published figure, or figures, is given under each species, if any is available; in other cases, figures are published herewith. In the Appendix will be found a glossary of such technical terms and abbreviations as need explanation.

For the honor and privilege of preparing the report, I take pleasure in thanking Dr. Roy Waldo Miner of the New York Academy of Sciences. I also wish to thank Dr. Willard G. Van Name for his coöperation in the identification of the Academy's Porto Rican collection.

## CRINOIDEA

### Sea lilies; feather stars

One of the most perplexing problems that arises in preparing a report on West Indian shallow-water echinoderms is to determine whether any crinoids should be included and if so which ones. Naturally I turned for advice to the world's authority on the group, Mr. Austin Hobart Clark, and he, with his customary generous helpfulness, has written me as follows:

> "Crinoids are sure to be found in abundance in certain places about Porto Rico whenever anyone takes the trouble to hunt for them. There should be plenty of them about the northeastern portion of the island, and elsewhere about exposed headlands. If I were you I would include the following species as without doubt occurring in shallow water about the island, the comatulids particularly, in large tide pools and partly submerged caves.

| Name | Range in depth |
|---|---|
| *Nemaster grandis* | 0-62 meters |
| *Nemaster iowensis* | 1-334 meters |
| *Nemester rubiginosa* | 0-161 meters |
| *Nemaster discoidea* | shallow water to 355 m. |
| *Leptonemaster venustus* | shallow water to 479 m. |

| Name | Range in depth |
|---|---|
| *Comactinia echinoptera* | 0-508 meters |
| *Analcidometra armata* | 5.5-64 meters |
| *Antedon dübenii* | 0-168 meters |
| *Holopus rangii* | 9-219 meters |
| *Cenocrinus asteria* | shallow water to 585 m. |
| *Neocrinus decorus* | shallow water to 1219 m. |
| *Endoxocrinus parræ* | shallow water to 526 m. |

"With the single exception of *Analcidometra armata*, all of these have been secured by fishermen in ordinary fishing operations. The first two have been reported as swimming at the surface at night."

I am sorry that I cannot share my friend's enthusiastic optimism over the certainty that crinoids will be found "in abundance" about Porto Rico in shallow water along shore. On the contrary, after much collecting of comatulids on the coasts of tropical Australia, and after much futile search for them at Tortugas, at numerous points on the Jamaican coast, and again at Tobago,[1] I am convinced that comatulids will rarely be collected along shore in the West Indies. As for the stalked forms, it is not at all probable that they will ever be taken unless dredging or trawling is done, except as they may occasionally become entangled in a fisherman's line.

If we get down to facts, instead of hopes, as a basis for determining what crinoids should be included in this report, we note first that there are no crinoids of any sort in the present collections of the New York Academy of Sciences. The following seven species are, however, actually known to have been taken in the West Indian region in less than ten fathoms:

*Nemaster iowensis*
*Nemaster rubiginosa*
*Comactinia echinoptera*
*Analcidometra armata*
*Antedon dübenii*
*Coccometra hagenii*
*Holopus rangii*

These species are therefore included in this report as members of the littoral fauna, but in my opinion their occurrence in very shallow water is quite accidental and the probability that the shore collector in Porto Rico, or any other West Indian island, will ever meet with one is, to say the least, remote. As the other six species listed above by Mr. A. H. Clark may, with hardly less probability, be washed ashore or brought in by some deep water fisherman, they are included (in parentheses) in the following key, as possibilities. There is also included *Tropiometra carinata* (Lamarck) though it is really a southern species not known in shallow water north of Tobago, where it is common.

[1] Excepting only *Tropiometra carinata*.

### Key to the Crinoids

A. Without a stalk on which the calyx and arms are borne; dorsal pole with cirri.
  B. Mouth at side of disk; oral pinnules with a "comb" of coarse teeth on inner margins near tip.
    C. More than 10 arms; distal cirrus segments carinate dorsally.
      D. Pinnules unicolor without a conspicuous spot in the middle of each segment.
        E. No black median dorsal line on arm.
          F. Arms 150-200 mm. long; cirri with 30-35 segments.... *(Nemaster grandis).*
          FF. Arms 90-130 mm. long; cirri with fewer than 20 segments .......................... *Nemaster iowensis.*
        EE. A median black line, sometimes broken, on dorsal side of arm .......................... *Nemaster rubiginosa.*
      DD. Pinnules with a dark spot at middle of each segment...... *(Nemaster discoidea).*
    CC. Only 10 arms.
      D. Cirri slender with distal segments compressed and with a small dorsal spine.................. *(Leptonemaster venustus).*
      DD. Cirri relatively short and stout of 8-12 segments, not even carinate dorsally.................... *Comactinia echinoptera.*
  BB. Mouth approximately central; no combs on oral pinnules; 10 arms.
    C. Color very dark purple or yellow and purple; arms stout and rather rigid; each brachial with a high median keel........... *Tropiometra carinata.*
    CC. Not as above.
      D. Distal cirrus segments with a high, median transverse ridge *Analcidometra armata.*
      DD. Distal cirrus segments not as above.
        E. First pinnule stouter than the others, most of its segments longer than broad........................ *Antedon dübenii.*
        EE. First pinnule of more than 30 bead-like segments, extraordinarily flexible..................... *Coccometra hagenii.*
AA. With a stalk on which calyx and arms are borne, or sessile, without dorsal cirri.
  B. Stalk long and slender with whorls of cirri.
    C. First two post-radial segments of arm not united by syzygy. *(Neocrinus decorus).*
    CC. First two post-radial segments united by syzygy.
      D. Proximal pinnules serrate.................. *(Cenocrinus asteria).*
      DD. Proximal pinnules smooth.............. *(Endoxocrinus parræ).*
  BB. Stalk short and thick, or animal sessile................ *Holopus rangii.*

The above key is compiled from the numerous papers and reports of Austin Hobart Clark, which should be consulted for further information in regard to these species as well as for all other Recent crinoids.

## Order *ARTICULATA*

## Suborder PENTACRINOIDA

## Section *Comatulida*

## Family COMASTERIDÆ

### Nemaster iowensis (Springer)

*Actinometra iowensis* Springer, 1902, Amer. Geol., XXX, p. 98.
*Nemaster iowensis* A. H. Clark, 1909, Vid. Med., p. 118. 1931, Bull. 82, U. S. Nat. Mus., i, Pt. 3, Pl. 18.

The curiously erratic occurrence of this comatulid is most tantalizing to the collector who desires to secure one; it has been taken once at the Dry Tortugas, Florida, in water only three feet deep, and a specimen is known from the Bahamas; all other known specimens have been taken by dredging or trawling in the Lesser Antilles or near Barbados, and nearly all are fragmentary. The Tortugas specimen was about a foot across and of a rich golden-brown color in life.

### Nemaster rubiginosa (Pourtalès)

*Antedon rubiginosa* Pourtalès, 1869, Bull. M.C.Z., i, p. 356.
*Nemaster rubiginosa* A. H. Clark, 1921, Univ. Iowa: Studies in Nat. Hist., ix, p. 9. 1931, Bull. 82, U. S. Nat. Mus., i, Pt. 3, Pl. 19, figs. 42-45.

This species is described as more slender than the preceding, in all parts, and always possesses on the dorsal side of each arm a black line which may, however, be broken into a series of dashes or dots. It is known from a few scattered stations, in the Bahamas, Tortugas, Virgin Islands, Montserrat, Barbados and northern Brazil, but it has not yet been taken in less than 9 fms. While it may be found in the strictly littoral region, it is probably only accidental there.

Attention should be called to the fact that the comatulids taken by the "Fish Hawk" at the eastern end of Porto Rico, and recorded by me in 1901 (U. S. Fish Comm. Bull., ii, p. 235) as *Actinometra rubiginosa* (Pourtalès) are regarded by Mr. A. H. Clark as *Comactinia echinoptera* and not as *Nemaster rubiginosa* (see A. H. Clark, 1931, Bull. 82, U. S. Mus., i, pt. 3, pp. 231 and 397; on both pages the date of H. L. Clark's paper is misprinted, as it should be 1901).

### Comactinia echinoptera (J. Müller)

*Alecto echinoptera* J. Müller, 1841, Arch. für. Naturg., i, p. 143.
*Comactinia echinoptera* A. H. Clark, 1909, Vid. Med., p. 149. 1931, Bull. 82, U. S. Nat. Mus., i, Pt. 3, Pls. 42-44.

"In the bewildering diversity of arm structure," Mr. A. H. Clark says, this species "exceeds all other crinoids"; but fortunately the cirri are characteristic and reasonably constant in number and form. While Comactinia is supposed to occur in very shallow water along shore, near Charleston, South Carolina, and at various points southward to Rio de Janeiro, Brazil, most specimens have been taken by dredging and I have failed to find one definite statement of collecting a specimen along shore. Mr. A. H. Clark however gives the bathymetrical range as "from the shore line down to 508 meters," and hence I suppose specimens may occasionally occur in the neighborhood of the low-tide mark.

The color in life is said by Pourtalès to be purple or yellow or some combination of those colors. Preserved specimens rarely show any indication of bright colors, but range from dull yellowish or pale brown to a darker brown, with or without black or blackish longitudinal stripes, dorsally on the arms; many specimens become almost white in alcohol. In size there is great diversity, the length of arms ranging up to 150 mm., but South Carolina specimens are only one-third that size. A. H. Clark says that "as a general rule the size increases proportionately with the depth, the smallest examples being those taken along the shores and the largest, those from about 200 meters or over."

Specimens of this comatulid were taken by the "Fish Hawk" in Porto Rican waters in 1899 and are listed by me under the names *Actinometra meridionalis* and *A. rubiginosa*. The specimens were all fragmentary and none was taken at a depth of less than 16 fms.

### Family Tropiometridæ

**Tropiometra carinata** (Lamarck)

*Comatula carinata* Lamarck, 1816, Anim. s. Vert., ii, p. 534.
*Tropiometra carinata* A. H. Clark, 1907, Smiths. Misc. Coll. (Quarterly), i, p. 349. 1908, Bull. M.C.Z., i; No. 8, Pl. 2.

This dull, inactive comatulid is common on the flat in Buccoo Bay, Tobago, which is covered with eel-grass and coralline algæ, and at very low tides is barely underneath the water. Here, in very warm water, Tropiometra, attached to a coral fragment, remains as inert as a living animal can well be. It is also present under rocks on Buccoo Reef. A full account of its habitat, habits, reactions, and appearance has been published by me (1917, Publ. 251, Carnegie Inst. Washington, pp. 111-119). Except for its occurrence at Tobago, the only West Indian records for Tropiometra are at Trinidad (depth not known), and at St. Lucia in deep water.

Large individuals of this crinoid have the arms 100 mm. long, but most specimens are only 125-150 mm. across when the arms are extended. The color is diversified deep purple and dark yellow; young ones are yellow with little purple; most adults are deep purple with little or no yellow, rarely sprinkled with silvery white dots.

### Family Colobometridæ

**Analcidometra armata** (Pourtalès)

*Antedon armata* Pourtalès, 1869, Bull. M.C.Z., i, p. 356. Hartlaub, 1912, Mem. M.C.Z., xxvii, Pl. 7, figs. 1-7; Pl. 13, fig. 7.

*Analcidometra armata* H. L. Clark, 1918, Univ. Iowa: Studies in Nat. Hist., vii, No. 5, p. 9.

Besides the characteristic cirri, the first pinnule of the arm furnishes a good recognition mark for this little comatulid. It is the longest of the pinnules and very stout, especially at the base, giving the second brachial the appearance of an axillary. Nothing is recorded as to the color. Specimens have been taken at a few stations ranging from the Bahamas to Barbados, several of which were in less than ten fathoms. It is not impossible therefore that individuals will be discovered at the Virgin Islands and in Porto Rico.

### Family Antedonidæ

**Antedon dübenii** Bölsche

*Antedon dübenii* Bölsche, 1866, Arch. für Naturg., i, p. 92. P. H. Carpenter, 1888, "Challenger" Comatulæ, Pl. 38, Figs. 1-3.

This little feather star, with arms only 30-40 mm. long, has been taken at various points east and south of St. Thomas, the most northwestern point at which it has been found, but I find no satisfactory record of its occurrence along the shore anywhere. The small size, the rather stout first pinnule and the short cirri with few segments, distinguish it from any of the other small West Indian comatulids. There is no record of the color in life.

**Coccometra hagenii** (Pourtalès)

*Comatula (Alecto) hagenii* Pourtalès, 1869, Bull. M.C.Z., i. p. 111.

*Coccometra hagenii* A. H. Clark, 1908, Proc. Biol. Soc., Washington, xxi, p. 128. 1915-21, Bull. 82, U. S. Nat. Mus., i, Pt. 1, Figs. 284, 375, 499; Pt. 2, Figs. 298, 331, 756.

This has been called the commonest species of crinoid in the West Indies and is often present in extraordinary numbers. Professor C. C. Nutting (1895, Univ. Iowa: Studies in Nat. Hist., iii, p. 164) says that "the bottom must have been actually packed with them in spots". The small size (arms up to 100 mm. in length) and the curious first pinnule make the species easy to recognize. It ranges from North Carolina southward, perhaps as far as Barbados, in shallow or moderately deep water but has not been recorded as yet in less than 8 fms. It seems to be particularly common around southern Florida in 75-125 fms. Pourtalès says the color in life "is pale greenish", but Professor Nutting says "brownish". The arms may be somewhat banded or striped with brown. The "Fish Hawk" found this feather star at the western end of Porto Rico in 97-120 fms.

## Suborder HOLOPOIDA

### Family Holopidæ

#### **Holopus rangii** d'Orbigny

*Holopus rangii* d'Orbigny, 1837, Mag. Zool., Ann. vii, Cl. x, p. 6, Pl. 3.

This extraordinary animal is one of the great rarities of West Indian zoölogy. A single small specimen has been taken in 100 fms. of water off Bahia Honda, Cuba; a fragment was dredged by the "Blake" off Montserrat, in 120 fms.; the original specimen was taken at Martinique, depth not known; and several specimens were found in comparatively shallow water off Barbados, fifty years or more ago; one or more of the latter were from water less than 10 fms. in depth. There are no recent records of its occurrence, but as it is small and inconspicuous this need not cause great surprise. The largest specimen known is about 40 mm. high and 30 mm. in diameter; the stalk is 12-15 mm. in diameter and makes up one-half of the height. The smallest specimen, with no stalk, is completely sessile and is so unlike the adult in appearance that some skepticism as to its identity is defensible.

## ASTEROIDEA

### Sea-stars; starfishes

The littoral sea-stars of the West Indies are not numerous but several are more or less conspicuous and are often found in curio shops or in assortments of tropical souvenirs. The big Oreaster, formerly known as Pentaceros, is the most commonly seen, but both Astropectens and Luidias are frequently treasured because of their distinctive forms. The shell collector who gathers only such souvenirs of his visit to the West Indies overlooks the smaller and less conspicuous sea-stars, but to the real nature lover the little Asterinas and curious Linckias found under and among the fragments of coral rock are of much greater interest.

The New York Academy collection contains but eight species of sea-star and these are the most common and widespread forms; all are known from Jamaica and all but one from Florida, while seven are found in Trinidad and Tobago at the other end of the West Indian region. But there are half-a-dozen other species which are recorded from Cuba, Jamaica, or Porto Rico itself, besides two or more debatable forms whose actual status is still undetermined, which must be included in this report. The perplexing forms are in the genera Astropecten and Echinaster, both of which are common in shallow water throughout the West Indian region. There are certainly two species of Astropecten rather easily distinguished from each other, but whether a third well-known form is really a valid species, a subspecies, or a variety, is still doubtful. There are unquestionably two species of Echinaster on the coast of southern Florida; one of these seems to be confined to the Gulf coast of Florida, Alabama and Louisiana, but the other extends eastward and southward, perhaps to Brazil. Whether the common Echinaster of Jamaica is to be considered a form of this species or regarded as distinct is still debatable, so little field work has been done by competent observers, but for the present I am recognizing it under a different name. In the light of such evidence as we have, it seems best to include in the body of this report, as well as in the key, 17 nominal species, for those which are least likely to be found in shallow water are the very ones which require some special discussion either of name, structure or occurrence. Verrill (1915, p. 63) lists "*Enoplopatiria marginata* (Hupe) Verrill" from the "West Indies", but there is no evidence, or even probability, that this Brazilian species occurs there.

The most important reference work on the West Indian sea-stars is Verrill's "Report on the Starfishes of the West Indies, Florida and Brazil" published in 1915 by the University of Iowa (Bull. Lab. Nat. Hist., vii, No. 1, 232 pp., 29 pls.) but this uses an unsatisfactory classification and is not altogether infallible. The classification used in the present report is that so carefully worked out by W. K. Fisher, the best living authority on sea-stars.

### Key to the Asteroids

A. Disk and rays more or less flattened, the upper surface covered with close-set paxillæ; marginal plates, at least the inferomarginals, well-marked.

B. Superomarginal plates, large, forming a conspicuous border to rays and disk.

C. Inferomarginal plates more or less bare; large erect spines on basal superomarginals............*Astropecten antillensis*

CC. Inferomarginal plates uniformly, though not closely, covered with spinelets.
- D. No large erect spines or tubercles on inner margin of basal superomarginals.......... *Astropecten articulatus*
- DD. A large erect spine (or at least a tubercle) on inner margin of at least some of the basal superomarginals. *Astropecten duplicatus*

BB. Superomarginal plates aborted.
- C. Rays 5 (very rarely 6).
  - D. Upper surface smooth, the paxillæ close-set, bearing crowded low granules................. *Luidia clathrata*
  - DD. Upper surface not smooth; paxillæ not very close-set, bearing low spinelets, of which the central one is often very much enlarged into an erect spine...... *Luidia alternata*
- CC. Rays 9; upper surface smooth; paxillæ close-set bearing crowded low granules.................. *Luidia senegalensis*

AA. Disk and rays not as above; no paxillæ; if marginal plates are well marked the disk is large and the rays relatively short and wide.
- B. Disk large; rays short and wide; general form stellate or pentagonal.
  - C. Size large; disk high with numerous stout blunt spinelets or tubercles.......................... *Oreaster reticulatus*
  - CC. Size small; general form more or less pentagonal and flattened; all spinelets very small and slender.
    - D. Plates of upper surface distinct, imbricated, with usually a few minute spines on proximal margin.
      - E. Actinal intermediate plates each with 3 or 4 spinelets ............................ *Asterina folium*
      - EE. Actinal intermediate plates, each with a single spinelet or rarely 2........... *Asterina hartmeyeri*
    - DD. Upper surface covered by a thick granular skin with no spinelets ........................ *Stegnaster wesseli*
- BB. Disk relatively small; rays more or less cylindrical and elongated.
  - C. No spinelets on upper surface.
    - D. Plates of the rays arranged in regular longitudinal series ......................... *Ophidiaster guildingii*
    - DD. Plates of the rays not in regular series.
      - E. Some dorsal plates, irregularly placed, larger than normal, much more convex, often swollen so as to appear like a nodule............ *Linckia bouvieri*
      - EE. No swollen dorsal plates........... *Linckia guildingii*
  - CC. Upper surface with conspicuous spinelets.
    - D. No pedicellariæ; rays 5.
      - E. Rays relatively short, thick and blunt; dorsal spinelets few and large; color not bright red.... *Echinaster sentus*

EE. Rays longer, more slender and tapering; spinelets smaller and more numerous.
F. Spinelets on rays 1 mm. or more in length, in 7-9 longitudinal series. *Echinaster echinophorus*
FF. Spinelets on rays about .5 mm. in length, in 11-15 series............. *Echinaster spinulosus*
DD. Pedicellariæ abundant; rays 4-9, usually 7........... *Stolasterias tenuispina*

NOTA BENE: For convenience, the three species of Asterinidæ (Asterina, Stegnaster) are given in the above key immediately after Oreaster and preceding Ophidiaster. In the following pages, they are placed in their correct position in the order Spinulosa, after the Ophidiasteridæ.

## Order *PHANEROZONIA*

### Family ASTROPECTINIDÆ

#### **Astropecten antillensis** Lütken

*Astropecten antillensis* Lütken, 1859, Vid. Med., p. 47. Döderlein, 1917. Siboga Ast., Pl. 2, figs. 9, 10; Pl. IX, figs. 7-8a.
NON H. L. Clark, 1901, U. S. Fish. Comm., Bull. ii, p. 236.

This species is known from St. Thomas and elsewhere in the Virgin Islands, and from Guadeloupe. My records from Jamaica (1898, Johns Hopkins Univ. Circ., xviii, No. 137, p. 5) and from Porto Rico (1901, l. c.) are errors due to a misunderstanding on my part as to the characters distinguishing Lütken's species. The writer was misled by incorrectly labelled specimens in the Adams collection at Amherst College. All of the specimens were probably *articulatus*.

Verrill considered *antillensis* as "very closely allied" to *duplicatus* and possibly only a local variety, but since the difference in the inferomarginal plates is quite striking and apparently constant, I believe *antillensis* is entitled to stand as an independent species. It is apparently a common form in the Virgin Islands for Kükenthal and Hartmeyer found it at both St. John and St. Croix, while Lütken's specimens were from St. Thomas. But it is apparently not common elsewhere as it was not taken anywhere by the University of Iowa's parties in either 1893 or 1918, nor have I ever encountered it. It does not seem to reach a large size, R=50-60 mm., being about the maximum known. Nothing is recorded as to the color in life; dried specimens are dull light yellowish, or nearly white.

#### **Astropecten articulatus** (Say)

*Asterias articulata* Say, 1825, Jour. Phila. Acad., v, p. 141.
*Astropecten articulatus* Müller & Troschel, 1842, Syst. Ast., p. 72.

*Astropecten cingulatus* Sladen, 1883, Journ. Linn. Soc. London (Zoöl.), xvii, p. 266. See Döderlein, 1917. Siboga Ast., Pl. 2, figs. 1, 2, 7, 8; Pl. 9, figs. 1, 5, 6.

This was the first Astropecten described from the West Indian region but the limits of its diversity are still undetermined. There is no doubt that the typical form has well developed spinelets on the outer margin of the superomarginal plates, on the distal part of the ray; but in a great many specimens these spinelets are reduced in size and number and are often entirely wanting. Both Verrill and Döderlein recognize *cingulatus* Sladen as a distinct species but I am not able to find any constant character or combination of characters by which it is distinguishable from specimens of *articulatus* which lack superomarginal spines. In view of the additional fact that the range of Sladen's form is identical with that of *articulatus,* so far as the West Indian region and the North American coast are concerned, I am satisfied that it is not entitled to recognition. Nor can I consider Verrill's *comptus* (1915, p. 176) from off Cape Hatteras, and also from off West Florida, as any more worthy. We must appreciate the fact that a wide ranging, variable species is bound to produce individuals (under certain conditions, large numbers of individuals) which are strikingly different from variants in other directions and even quite different from the typical form.

In size *articulatus* runs up to R = 100 mm. (Döderlein lists one specimen with R = 108 mm.), but it is rare to find specimens in which R exceeds 75 mm. The proportions vary considerably, for in mature specimens R=4–6.5 r or br, r and br being usually just about equal, though occasionally br is appreciably greater. As for color, there are no trustworthy records as to what it is in life; museum specimens range from nearly white through light yellowish brown to dark purplish or reddish brown. The range of *articulatus* is from North Carolina to Uruguay, from low-water mark to about 80-90 fms. It has been reported from southern New Jersey but I agree with Verrill that the record needs confirmation. It is not recorded as yet from Porto Rico or the Virgin Islands, unless the specimens which I listed in 1901 from the "Fish Hawk" collection as *antillensis* are, as I think possible, *articulatus*.

### **Astropecten duplicatus** Gray

*Astropecten duplicatus* Gray, 1840, Ann. Mag. Nat. Hist., vi, p. 181. Döderlein, 1917, Siboga Ast., Pl. 2, figs. 3-6; Pl. 9, figs, 2-4a.

Although typical specimens of this form are easily recognized and appear very different from typical examples of *articulatus,* there is no doubt of the existence of specimens which it is not easy to place with certainty.

Such specimens lack the conspicuous conical spines on the inner end of the basal superomarginals; sometimes they are wholly lacking on more than half of these plates and occasionally those which are present are reduced to low tubercles. The existence of such specimens has led Döderlein to treat *duplicatus* as merely a subspecies of *articulatus,* but my own experience leads me to question the advisability of doing that. The general form and appearance of the two species is unlike, although it is difficult to put the differences into words; one might say that *duplicatus* is less flattened, more spiny, more compact, with relatively small disk, narrower rays and narrower paxillar areas; but numerous individuals of both species belie such specific statements. The presence of the inner spines (or at least tubercles) on the basal superomarginals is really the distinctive feature of *duplicatus;* in this particular it is quite like *antillensis* (hence confusion between the two species has no doubt been frequent). The entire absence of such spines is presumptive evidence that the specimen is *articulatus.* I have not personally seen an individual either alive or as a museum specimen which caused me any serious perplexity, but my experience with Astropecten in life is unfortunately too limited to make it conclusive.

In life *duplicatus* is ordinarily of a reddish-brown color; the superomarginals are often quite red; the paxillar area and lower surface more gray; sometimes the reddish tint is faint or quite wanting and such individuals are quite gray or light brown; but really light colored individuals are rare. Dry specimens may be either dark grayish-brown, sometimes very dark, or ordinary light brownish-yellow, "museum color" as it has been so aptly called. Adult specimens have the rays 75-100 mm. long, with the breadth at base 15-18 mm. The largest specimens I have seen, measured (in dried condition) R=112 mm., br=20, and R=120 mm., br = 18. These sea-stars occur on sandy bottoms in shallow water but only occasionally in less than 3 or 4 feet. They are often abundant at depths of 3-10 fathoms, seeming to be somewhat gregarious. They have been taken at many points on the Florida coast, especially about the Keys and the Tortugas, on the Mexican coast at Vera Cruz, on the southeastern coast of the United States, perhaps as far north as South Carolina, at the Bahamas, Jamaica, St. Thomas, Porto Rico, Dominica, St. Vincent, Tobago and Trinidad. The record from Brazil needs confirmation though it is not unlikely that the southern range extends at least to the Amazon's mouth.

The Academy collection contains a single specimen of *duplicatus* with R = 50 mm. It was taken by R. C. Osburn, June 27, 1915, at Don Luis

Cayo, in Salinas Cove. The "Fish Hawk" took this species at both the eastern and western ends of the island, in 6-15 fathoms of water.

## Family LUIDIIDÆ

### **Luidia clathrata** (Say)

*Asterias clathrata* Say, 1825, Jour. Phila. Acad., v, p. 142.
*Luidia clathrata* Lütken, 1859, Vid. Med., p. 37. A. Agassiz, 1877, Mem. M. C. Z., v, Pl. 20.

The Luidias are among the most easily recognized of sea-stars, because of the flattened and regularly tessellated upper surface and the long, relatively narrow rays. The three West Indian species are very distinct from each other and intergrading specimens seem to be entirely lacking. The commonest of the three species is *clathrata,* which in life is usually of a bluish-gray color with the median area of each ray darker than the margins, so that there appears to be a dark longitudinal band along the middle of each ray; the distinctness of this, however, varies very much—it is not always noticeable. Specimens collected by me at Port Royal, Jamaica, were light brownish underneath and along the sides of the rays, with the dorsal surface dull, dark greenish-gray, the median lines on the rays being scarcely visible. A specimen I took at Montego Bay, Jamaica, was cream-color in life, with indistinct, dusky median areas on the rays. Verrill, 1915, says that all living specimens seen by him in Bermuda were "pale salmon" or "rose-salmon", while those from Florida and North Carolina are gray.

Possibly these differences in color are associated with differences in habit and habitat, for Verrill reports that the animals live concealed beneath the surface of the sand, his observations apparently being based on Bermudan specimens; and the specimen collected by me at Montego Bay was beneath the surface of pure white sand in about one fathom of water; it was accidentally dug out by the restless feet of a bather! On the other hand, the dark-colored specimens found at Port Royal were living on the surface of brown sand near mangroves. Adult specimens have R = 100 mm. or more with br 17 or 18 mm.; the largest specimen of which I know has R = 145 mm. and br 20.

This sea-star is known from Bermuda, North Carolina and Florida, Jamaica, Haiti, Porto Rico and St. Thomas. I find no reliable records from elsewhere in the West Indies, but it is said to occur at Rio de Janeiro, Brazil. Verrill states that it has been reported from southern New Jersey. These extreme records seem to me to require confirmation. The bathymetrical range is from the shore line down to 50 fathoms. Specimens which I have taken were perfectly inert and showed no activity whatever, but Verrill asserts that "when disturbed it glides away very rapidly beneath the surface of the sand, by means of its large, flattened, muscular ambulacral feet which it uses like paddles. It can also swim, by their aid, free of the sand or on its surface". Presumably these remarkable statements are based on observations made in Bermuda.

The Academy collection contains no example of this species but the "Fish Hawk" found it on the northern coast and at the eastern end of Porto Rico in 4½-11 fathoms.

### **Luidia alternata** (Say)

Plate I

*Asterias alternata* Say, 1825, Jour. Phila. Acad., v, p. 144.
*Luidia alternata* Lütken, 1859, Vid. Med., p. 42.
*Luidia variegata* Perrier, 1876, Arch. Zool. Exp., v. p. 257.

This handsome sea-star is unmistakable by the elegance of its form and the beauty of its coloration. In life, the lower surface is yellow of a lighter or darker shade while the upper side is dark (greenish, purplish or blackish), irregularly banded or variegated with yellow or cream-color. The larger marginal spines are often dark at the base and light distally. Verrill has described a variety *bicolor* from moderately deep water (20-60 fms.) in which the dark shade is said to be chocolate-brown, but it is not altogether clear whether this color is that of living or preserved specimens. It is, however, an interesting fact that in this species the colors are little affected by alcohol or by other methods of preservation. In size, *alternata* somewhat exceeds *clathrata,* adult specimens having R=120-130 mm. and br about 18; the largest specimen of which I know has R=175 mm. and br 25.

This species is less common than *clathrata,* but is by no means rare. It is not known from Bermuda or the Bahamas but otherwise its range seems to be, like that of *clathrata,* from the southeastern coast of the United States and the Gulf of Mexico to Brazil. The bathymetrical range is from the shore line down to nearly 100 fms. It is absent from the Academy collection, but the "Fish Hawk" took a small specimen in 10 fathoms at the eastern end of Porto Rico. It is not yet known from any point between Montserrat and Brazil.

### **Luidia senegalensis** (Lamarck)

*Asterias senegalensis* Lamarck, 1816, Anim. s. Vert., ii, p. 567.
*Luidia senegalensis* Müller & Troschel, 1842, Syst. Ast., p. 78.
*Luidia marcgravii* Lütken, 1859, Vid. Med., p. 43. Verrill, 1915, Univ Iowa: Bull. Lab. Nat. Hist., vii, Pl. 5, Fig. 1.

This sea-star is the most remarkable of all West Indian shore forms because of the constancy with which it has nine rays. Verrill says there are "rarely eight" but I have, myself, never seen a specimen with fewer or more than nine. This number is so unusual for a sea-star that it makes *senegalensis* the most unmistakably recognizable of any West Indian species. Nevertheless there still seems to be some doubt whether the West Indian 9-rayed Luidia is identical with, or distinct from, the 9-rayed Luidia of the West African coast. Verrill adopted Lütken's name for the West Indian species, not because examination of specimens had convinced him the two forms were distinct but because Lütken considered them so, and as Verrill says, "He was certainly a very expert authority on starfishes". On the other hand, Döderlein, who is the present European authority on sea-stars and no less able than Lütken, in his monograph on the genus Luidia (1920) relegates Lütken's name to the synonymy of *senegalensis*. I am following him therein, though I have never seen an African specimen.

The color of this Luidia is the ordinary bluish- or greenish-gray color of *clathrata;* indeed, were it not for the difference in the number of rays the two species would be hard to distinguish. I have never seen or heard of a light-colored form of *senegalensis,* however, the color seeming to be as uniform as the number of rays. In size, this species is considerably larger than either of the preceding two, as R=125-150 mm. in adults, and a specimen which I secured from a fisherman at Montego Bay, Jamaica (presumably from water several fathoms deep), has R=210-215 mm.; in life this individual was certainly 18 inches across. Naturally the arms are relatively narrower than in *clathrata,* but the difference is not very striking.

This sea-star is reported to be common (Verrill says it "seems to abound most") on the coast of Brazil. It is not rare along the shores of Jamaica, though I have not found it at Port Antonio. Verrill (1915) says he does not know of its occurrence in Florida but we have specimens in the Museum of Comparative Zoölogy from the western coast of the southern part of that peninsula (Sanibel Island). It is recorded from the island of Hayti, from Porto Rico, from Guadeloupe and from Trinidad. The bathymetrical range appears to be very small; I find no records of specimens having been dredged or collected at any considerable depth.

The Academy collection contains one specimen, and apparently the smallest on record; R=about 10 mm. The upper surface is dusky, with the margins of the rays and the lower surface pale yellowish. It was dredged (depth not stated) off the mouth of Guanica Harbor, July 2, 1915, by R. C. Osburn. The "Fish Hawk" took large examples of this species at Mayagüez, Puerto Real and Catano, P. R.

### Family OREASTERIDÆ

#### Oreaster reticulatus (Linnæus)

*Asterias reticulata* Linnæus, 1758, Syst. Nat., ed. X, p. 661.
*Oreaster reticulatus* Müller & Troschel, 1842, Syst. Ast., p. 45.
*Pentaceros reticulatus* A. Agassiz, 1877. Mem. M. C. Z., v, Pl. 16.

This is undoubtedly the best known of West Indian sea-stars, since it has been taken to many parts of the world in the past 175 years as a typical curio and souvenir of the region. Although it is somewhat variable in both form and color, the diversity is on the whole remarkably small, and the specific characters are well maintained. Small specimens are deep olive-green above, the color of the papular areas being a duller shade than that of the rest of the dorsal surface; the lower surface is cream-color, sometimes with blotches of greenish or dusky. As size increases the green becomes less and less evident, being replaced by yellowish- or reddish-brown, but some adults have more or less of a greenish or olive shade. As a rule, large specimens are brownish-red or dull orange-red, or even deep red, with the spines similar or different, sometimes yellow. Yellowish-brown, orange-yellow and even yellow specimens occur. The papular areas are often of a duller shade than the skeletal parts and the contrast between the two is in some specimens very striking.

The size of this Oreaster is notable, as it is much the heaviest of West Indian sea-stars. Verrill says that specimens occur up to 500 mm. in diameter. The largest I have seen has R=210 mm. with the disk 80 mm. high. The height of the disk, however, varies greatly with the condition of the specimen and with the method of preservation. The proportion of R to r varies considerably but it is often 2 to 1 or slightly more. Specimens with 6 rays or with only 4 are not extraordinarily rare.

The range of *reticulatus* is from South Carolina and the Bahamas on the north (it is not known at Bermuda), and the Tortugas on the west, to the Abrolhos Reefs, Brazil, on the south, and the Cape Verde Islands on the east. It is particularly common in the Bahamas and among the Florida Keys, and is recorded from eight of the West Indian Islands. The bathymetrical range is very small.

There are two specimens in the Academy collection, taken in July, 1914, by R. W. Miner, but the exact locality is not recorded. The "Fish Hawk" brought back specimens from Ponce, Mayagüez and San Juan. Mr. George M. Gray tells me the species is very common at the last mentioned port. He noted two rather well marked varieties there, differing in the form of the rays, the relative height of the disk, the heaviness of the skeleton, and the spininess of the lower surface.

## Family Ophidiasteridæ

### **Ophidiaster guildingii** Gray

Plate II

*Ophidiaster guildingii* Gray, 1840, Ann. Mag. Nat. Hist., vi, p. 284.

It is somewhat remarkable that no figure of this species has been published hitherto, for it has been repeatedly taken in various parts of the West Indian region. It occurs under rocks near low tide mark, like *Linckia guildingii,* but is far less common, and never reaches so large a size. In color, however, it is often very similar to young Linckias, being dull purplish-red variegated with a lighter shade or with whitish. In mature specimens the ground color ranges from pale yellowish through orange and scarlet to brownish-red, more or less blotched with bluish, purple, maroon or brown; these colors are, however, never bright so it is not a conspicuous sea-star. Rarely individuals are found of an almost uniform shade of reddish, purplish or brownish. It is a small species, mature specimens having R=45-55mm. with br 8-9; the proportion of R to br shows some diversity, as R=5-7 br in different individuals. Verrill says that a "medium sized specimen" has R=60 mm. but I have never seen one so large. He further states that in this individual R=12 r, but in specimens I have examined R rarely equals 8 r.

This species is characteristic of the West Indian region from the Tortugas to Barbados. It is not yet known from Bermuda or the Bahamas, nor does it seem to occur on the Gulf coast of America nor on the shores of South America. It is not yet decided whether it occurs in the eastern Atlantic; probably however the Ophidiasters of that region are the closely allied Mediterranean species, *ophidianus.* The bathymetrical range appears to be very small.

The Academy collection contains one small specimen, of a dull whitish color, with R=25 mm. It was taken on the reef outside Cayo Maria Langa, entrance of Guayanilla Harbor, Ensenada, June 25, 1915, by R. W. Miner and H. Mueller. The "Fish Hawk" took three specimens at Ponce.

### **Linckia bouvieri** Perrier

*Linckia bouvieri* Perrier, 1875, Arch. Zool. Exp., iv, p. 414.
*Linckia nodosa* Perrier, 1875, Arch. Zool. Exp., iv, p. 417. Verrill, 1915, Univ. Iowa: Bull. Lab. Nat. Hist., vii, No. 1, Pl. 29, figs. 1a, 1b.

It is with much misgiving that I include this species here, as it has only once been recorded from water less than ten fathoms in depth. It seems to be a well-marked but rare species ranging from the West Coast of Florida to the Cape Verde Islands and São Thomé. There is no record of the color of Florida specimens; those from the eastern Atlantic are said to be "violet" when "fresh." I have been unable to find any character by which to distinguish specimens from these widely separated regions. Adults have R=90-100 mm., with br about 12; the largest recorded specimen has R=125 mm.

There are no records from the West Indian Islands, excepting Cuba (off Havana, 110 fms.), nor from the South American coast; but as the species seems to prefer water of considerable depth, 20-130 fathoms, it is not strange that it has not been more often collected. There are no specimens in the Academy collection nor did the "Fish Hawk" encounter it, so there is no reason to consider it a member of the Porto Rican fauna.

### Linckia guildingii Gray

*Linckia guildingii* Gray, 1840, Ann. Mag. Nat. Hist., vi, p. 285. A. Agassiz, 1877, Mem. M. C. Z., v, Pl. 4, Figs. 1-6.

This sea-star is of great interest because of its very wide distribution and the extraordinary degree to which it relies on asexual reproduction. Though it is one of the commonest species in the West Indies, adult specimens are very rarely seen there. Even half-grown individuals are by no means common and those found are almost invariably asymmetrical. Young and half-grown specimens often have 4, 6 or 7 rays instead of 5, but in adults the number is almost always 5. These peculiarities of the immature specimens is due to autotomy which appears to begin very early in life and continues for an indefinite period. It seems to consist, at first, of a transverse division of the whole animal, resulting in a 2-rayed and a 3-rayed specimen. These immediately regenerate the lost rays but not rarely produce 4 instead of 3 and 2. Consequently, 7- and 6-rayed specimens appear. As the animal increases in size, instead of dividing, it may sever one ray from the rest of the animal and on the proximal end of such a ray 4 or 5 new rays bud out; ultimately a new mouth and other essential organs arise in their normal position. Apparently reproduction by eggs occurs only when the animal is full-grown and these curious processes of autotomous division have ceased. Rays which have given rise to "buds" at the severed end are often referred to as "comet forms" or simply "comets." They are generally small but occasionally there is found a comet of which the parent ray is 75 mm. or more in length.

The color of this sea-star when young is dull reddish, brownish or purplish, variegated with lighter or darker. It is thus very inconspicuous in the crannies and on the lower surface of the rocks among which it lives. Large individuals are unicolor, sometimes of a reddish brown or even a fine violet color (one from the Bahamas), but generally a light yellow brown. Such individuals are found in the open on the reef flat or on neighboring sandy bottoms. Apparently the change in color is associated with change in habitat. Adult individuals reach a large size—a rather symmetrical 6-rayed specimen from the Tortugas has R=112 mm. and br=15; a symmetrical 5-rayed adult found in the open at Tobago has R=75 and br 8 mm.; most specimens from the Pacific have R=150-180 mm.; the largest specimen known to me is from Bermuda and has five unequal rays, distorted by drying, the longest about 215 mm. with the diameter about 22. The above figures show that the rays are usually nine or ten times as long as thick.

The distribution of this sea-star is as remarkable as its asexual reproduction. In the western Atlantic and Caribbean regions it is known from Bermuda, the Bahamas, Florida and Mexico, to Brazil, with actual records from Cuba, Jamaica, Porto Rico, St. Thomas, St. Kitts, Guadeloupe, St. Vincent, Barbados and Tobago. But it has also been taken at the Cape Verde Islands, Lower Guinea, Zanzibar, Mauritius, Madagascar, the Red Sea, Ceylon, Andaman Islands, Queensland, Samoa, Tonga and the Society Islands. It has not yet been definitely shown to occur at Hawaii and it is not known from the western coast of America where it is replaced by *L. columbiæ*.

The Academy collection contains 3 specimens of *guildingii*, of which two are "comets." The largest has the parent ray 54 mm. long, and the new rays about 20 mm. It was taken at Mangrove Island, Parguera, Ensenada, June 27, 1915, by R. W. Miner, H. Mueller and M. A. Howe. A second specimen has 6 rays, one 22 mm. long, four 17 mm. and one only 5 mm. It was discovered at the mangrove island and coral reef at entrance of Montalva Bay, Ensenada, June 27, 1915, by Miner, Mueller and Howe. The third specimen has one ray 13 mm. long with four at its proximal end, 5-7 mm. It was collected on the reef outside Cayo Maria Langa, entrance of Guayanilla Harbor, Ensenada, June 25, 1915, by Miner and Mueller. The "Fish Hawk" took *guildingii* at Ensenada Honda (Culebra) and Ponce. Mr. Gray found it at San Juan.

## Order *SPINULOSA*

### Family Asterinidæ

#### **Asterina folium** (Lütken)

*Asterina minuta* var. 1 Gray. 1840, Ann. Mag. Nat. Hist., vi, p. 289; non *Asterina minuta* Nardo, 1834.
*Asteriscus folium* Lütken, 1859, Vid. Med., p. 60.
*Asterina folium* A. Agassiz, 1877, Mem. M.C.Z., v, p. 106; Pl. 14, figs. 7-9.
*Asterina minuta* Döderlein, 1910, Zool. Jahrb., Suppl. 11, p. 152.

No greater contrast in body form can well be imagined in a single class of animals than that between the three preceding species and the three sea-stars of the present family. Instead of long, slender cylindrical arms and a small disk to which they are attached, where R=8-12 r, we have here nearly or quite pentagonal, markedly flattened animals with rays rarely equal to 2 r and usually R=1.2-1.3 r; not infrequently individuals occur in which, at least in life if not in the dry specimens, R and r are equal. These little, flat, disk-like sea-stars are very characteristic of the West Indian reefs, as indeed of tropical reefs generally. The present species is the most common of the West Indian forms but owing to the small size, the inconspicuous coloration, and the secretive habits, it is seldom seen save by the ardent collector. The color of very small specimens is nearly white; as size increases, however, the upper surface becomes cream-color, then yellow, and finally reddish-yellow, or more commonly the yellow shade becomes greenish and the adult animal olive- or bluish-green or even quite blue. These blue specimens are striking as that color is so unusual among marine animals. Adult *folium* is from 17 to 25 mm. across; that is R=10-14 and r=7-11 mm. Specimens with 4 or 6 rays are not particularly rare.

This sea-star lives closely appressed to the under surface of fragments of rock or coral, and in protected crevices at or just below the low tide level. It is known from Bermuda, the Bahamas, Florida, the Tortugas, Old Providence, Curaçao, Jamaica, Porto Rico, St. Thomas, Antigua, Guadeloupe, Barbados and Tobago. Hence it is probably to be found at all West Indian islands. The bathymetrical range is very small.

The Academy collection contains but a single specimen, and this is only a small one (R=8 mm.) of a dirty whitish color. It was taken on the outer reef south of the entrance to Guanica Harbor, June 11, 1915, by R. W. Miner and H. Mueller. The "Fish Hawk" collection also contained but a single specimen, which was taken at Ponce.

**Asterina hartmeyeri** Döderlein

Plate III

*Asterina minuta* var. 2 Gray, 1840, Ann. Mag. Nat. Hist., vi, p. 289; NON *Asterina minuta* Nardo, 1834.

*Asterina minuta* H. L. Clark, 1898, Johns Hopkins Univ. Circ., xviii, No. 137, p. 6.

*Asterina hartmeyeri* Döderlein, 1910, Zool. Jahrb. Suppl. 11, p. 154.

This species of Asterina, only half as large as the preceding, was first detected by Gray, who with his extraordinary systematic sense and keen eye for specific characters, recognized the constant difference between it and *folium* in the armature of the actinal intermediate plates. This difference proves to be very constant and I have never seen an intergrading specimen, yet it must be admitted that the exact relation between the two species is still puzzling. They certainly occur in the same regions and apparently in the same locality but whether in the same actual habitat or not we do not know.

There has been no little confusion over the name of this species for, curiously enough, no one has hitherto realized that the choice by Nardo of *Asterias minuta* Gmelin for the type species of his genus Asterina, invalidates Gray's *Asterina minuta* from the very start. Lütken gave *folium* a valid name but I have persisted hitherto in the error of using *Asterina minuta* Gray for the present species, even criticising Döderlein for giving it a "quite superfluous" name, *hartmeyeri*. Oddly enough, Döderlein did not propose this name because *minuta* was invalid but because he proposed to use that name for *folium* and hence must have a new name for this little, closely related species. Now, however, the nomenclatural snarl seems to be untangled: there is no valid *Asterina minuta*, for *Asterina minuta* Nardo is *Asterina gibbosa* Pennant, an earlier name; *Asterina minuta* var. 1 Gray is *Asterina folium* Lütken (the doubts of Perrier and Döderlein to the contrary notwithstanding); and *Asterina minuta* var. 2 Gray is *Asterina hartmeyeri* Döderlein, the present species. Verrill recognized but one West Indian form which he called *folium*.

In color, *hartmeyeri* is, even in life, nearly white; large specimens have a yellowish or a pinkish tinge which ordinarily disappears on preservation. In size, this species rarely exceeds 10mm. in diameter; the largest specimen I have seen has R=7 mm. with r about 5. The form is more uniformly stellate and less markedly pentagonal than in adult *folium*. The limits of its distribution are not yet known. It has been taken hitherto only in Jamaica, Porto Rico, Barbados and Tobago. It does not seem to occur at Bermuda nor did either Hartmeyer or I find it at the Tortugas.

The Academy collection contains a single specimen of *hartmeyeri*, the only one as yet known from Porto Rico. It is dirty whitish in color and has R=5 mm. It was taken on the coral reefs at Ballena Point, Ensenada, June 12, 1915, by R. W. Miner and H. Mueller.

**Stegnaster wesseli** (Perrier)

*Asterina wesseli* Perrier, 1876, Arch. Zool. Exp., v, p. 231.
*Stegnaster wesseli* Sladen, 1889, "Challenger" Ast., p. 778. Verrill, 1915, Univ. Iowa: Bull. Lab. Nat. Hist., vii, No. 1, Pl. 3, figs. 3-3a.

The extraordinary thing about this sea-star is that the only other species of Stegnaster known occurs in New Zealand. That the two are really genetically related seems improbable, yet if they are not, we have here a most remarkable case of convergence in structure. The West Indian species is much smaller than the New Zealand form, as it is usually less than 30 mm. across. The largest specimen I have seen has R=19 and r 15 mm., but Verrill records one with R=20 and r 16 mm. Preserved specimens are usually whitish or yellowish; but in life the small ones are white, becoming yellowish, reddish-yellow and, when fully grown, quite distinctly orange. There is a perfectly hexamerous specimen among those taken by me at Tobago.

This interesting sea-star is not rare in Jamaica and I also found it fairly common in Tobago. Verrill records it from the Bahamas, Florida and Colon and it is also reported from Barbados. It has not yet been taken in Porto Rico.

Family Echinasteridæ

**Echinaster sentus** (Say)

*Asterias sentus* Say, 1825, Jour. Phila. Acad., v, p. 143.
*Echinaster sentus* Lütken, 1871, Vid. Med., p. 284. A. Agassiz, 1877, Mem. M.C.Z., v, Pl. 10.

As already stated, the West Indian species of Echinaster are still confused and I am not at all sure that they should not all be regarded as one. But in the present state of our knowledge it seems to me much better to recognize three species, realizing that the actual relation of these forms to each other has still to be determined. Hence I am using the old name of Say for the stout form with short, often blunt, rays, and few, large spines on the dorsal surface. It usually has R=60-75 mm. when adult, with br about 20 mm. The largest specimen I have seen has R=80 mm., r and br about 20. Verrill records a 4-rayed specimen with R=53 mm. The color in life has not been properly recorded and I have never seen living specimens. To judge from preserved material, it seems that fully grown specimens are very dark colored, either deep red, red-brown or dark purple; when younger, the color seems to be lighter and is possibly red of some shade, but it does not appear in dried specimens like the bright red of the next species (*echinophorus*).

This is the common Echinaster of the southeastern coast of the United States from North Carolina to Key West and the Tortugas. It is also known from Yucatan, Cuba, the Bahamas, Porto Rico and St. Thomas. Records from east or south of these last islands need confirmation.

The Academy collection contains eleven specimens of which none is adult and eight are certainly young. These young ones have R=20-35 mm., with the rays somewhat more pointed than in adults; the color is dull brown with a red tinge; they were taken at Ensenada, June 23, 1915, by R. W. Miner. A light brown specimen with a yellow tinge has R=30, r=8 and br 9 mm.; it is notable for the few, very large spines, only 2-6 in each longitudinal series on a ray, and these 3-4 mm. high; it was taken at a mangrove island at Parguera, Ensenada, June 27, 1915, by R. W. Miner. A lighter colored and somewhat less stout specimen of about the same size was taken at the west end of the reef between Pardas Bay and Harbor entrance, Ensenada, June 18, 1915, by R. W. Miner and H. Mueller. The largest specimen (R=45 mm., r and br=12), light brown with a reddish tinge, was collected on a mud flat near a house boat, east end of San Antonio railroad bridge (Miramar) San Juan. The "Fish Hawk" took 11 specimens of *sentus* at San Juan and Puerto Real and at three dredging stations at both the eastern and western ends of the island. These were recorded by me as "*crassispina* Verrill" but the type of that species is from Brazil and Verrill says it is not *sentus*, as one might suppose.

### **Echinaster echinophorus** (Lamarck)

Plates IV and V

*Asterias echinophora* Lamarck, 1816, Anim. s. Vert., ii, p. 560.
*Echinaster echinophorus* Perrier, 1875, Arch. Zool. Exp., iv, p. 364.

Reversing the position which I took in 1919 (Publ. 281, Carn. Inst. Wash., p. 54) I am recognizing now the distinctness of the Echinaster found in Jamaica from that which occurrs in Porto Rico. I am led to do this because the specimens in the Academy collection are just like those taken by the "Fish Hawk," and are obviously the same species as that found among the Florida Keys. The Jamaican Echinaster, on the other hand, is instantly recognizable by the slender, more terete rays, the smaller and much more numerous spines, and the bright red color. This color is very striking both in life and in preserved specimens, and shows surprisingly little diversity, either with locality or age. Dried specimens are a much lighter and more yellowish-red than the living individuals, but there is no doubt of their redness. R=4.5-6 r and br is just about the same as r. The largest specimen I have seen has R=65 mm., br=13.

Whether or not this bright red Echinaster is confined to Jamaica, I do not know. For the present I am considering it Lamarck's *echinophorus,* which Verrill lists as abundant on the Brazilian coast, and also appearing in Yucatan. He places my specimens from Jamaica under *sentus,* but I cannot at present agree to this.

**Echinaster spinulosus** Verrill

*Echinaster spinulosus* Verrill, 1869, Proc. Boston Soc. Nat. Hist., xii, p. 386. 1915, Univ. Iowa : Bull. Lab. Nat. Hist., vii, Pl. 4, Figs. 1, 2.

This species is apparently restricted to the western coast of Florida, where it is said to be abundant. It occurs not only along shore but has been dredged in the Gulf of Mexico, south of Alabama, in 23-32 fms. The largest specimen listed by Verrill has R=80 mm. and r=14; R nearly 6 r; br is about the same as r. Two specimens in the Museum of Comparative Zoölogy collection show some diversity in proportions; one has R=57 mm. and r=11, hence R exceeds 5 r; the other has R=60 mm. and r=15, hence R= only 4 r. Verrill says that the color in life is reddish-brown; preserved specimens are purplish-brown or often, when dried, yellowish-brown. No specimens in the Academy collection approach this form at all, and it is of course quite unlikely that it occurs in Porto Rico.

## Order *FORCIPULATA*

### Family Asteriidæ

**Stolasterias tenuispina** (Lamarck)

*Asterias tenuispina* Lamarck, 1816, Anim. s. Vert., ii, p. 561.
*Coscinasterias tenuispina* Verrill, 1914, Harriman Exp. Ast., p. 45. 1915, Univ. Iowa : Bull. Lab. Nat. Hist., vii, Pl. 26, fig. 2; Pl. 27, fig. 4.
*Asterias (Stolasterias) tenuispina* Sladen, 1889, "Challenger" Ast., p. 583.
*Coscinasterias* (*Stolasterias*) *tenuispina* Fisher, 1926, Ann. Mag. Nat. Hist., (9) xviii, p. 197.

Like the preceding species, Stolasterias has a very limited distribution in the West Indian region and is quite unknown in Porto Rico, but unlike any other sea-star included in this report it is common in the Mediterranean Sea and is really a member of that fauna. It is like *Linckia guildingii* in its addiction to autotomous reproduction, but it uses only the ordinary method of fission; and, so far as known, comet forms do not occur. Owing to irregularities in the regeneration that follows fission, individuals with only 4 rays sometimes occur, while specimens with 6, 7, 8 and even 9 rays are met with. In fact the majority of specimens have 7 rays. The rays are nearly always unlike in size and hence it is very rare to find a symmetrical specimen. The largest specimen I have seen is a symmetrical 5-rayed individual from Bermuda, with R=135 mm. and br 18; R=7.5 br. A specimen with 8 unequal rays has the largest ones about 90 x 12 mm. In life the ground color is yellow-brown, with markings of darker brown, and of bluish or violet; the lower surface and the numerous pedicellariæ are cream-color or whitish. Verrill says, "It is usually some light shade of violet or pale purple," but I do not recall having seen unicolor specimens.

Verrill records this species from Madeira, Canary Islands, Cape Verdes and Brazil as well as from Cuba and Bermuda. The record from Cuba needs confirmation. The occurrence of *tenuispina* in Bermuda seems to me almost certainly the result of accidental introduction from Europe. If the species occurs in the Cape Verde Islands, as is reported, its appearance in Brazil is not at all hard to understand.

## OPHIUROIDEA

Brittle-stars; serpent-stars; basket-fish

The number and variety of brittle-stars found in the West Indian region are so great that it has been very difficult to determine which species should be included in the present report, for many of the littoral species extend into water of considerable depth, and it is by no means unlikely that some known as yet only from deep water will be found in the shallows or on the reefs along shore. When I wrote my former report on the echinoderms of Porto Rico (1901), I included all of the 49 species collected by the "Fish Hawk" and mentioned half-a-dozen others that probably occurred. But of the 49 species 17 were taken only in water exceeding 10 fms. in depth and hence they are not included here. On the other hand, our knowledge of the West Indian littoral fauna has been so much extended in the past 30 years that there are many forms which are to be added to my 1901 list, especially since the present report covers a much greater area. A number of species of brittle-star seem to have restricted ranges so that forms found only on the Florida coast, or only at Tobago, have to be included, in order to make the report usable everywhere in the West Indian region.

After much consideration, I am treating, in the body of the report, no fewer than 65 species from 9 families, and I have added 3 others to the keys. A word in regard to these and to several species which I might be expected to include, but have not, is in order here.

First, however, I wish to offer to the United States National Museum, and to Mr. Austin Hobart Clark in particular, my sincere thanks for making it possible for me to reëxamine the critical species of my 1901 report, enabling me to discover and correct errors made by me when I had had but little experience with brittle-stars and when no material for comparison was available to me. I wish to thank Mr. Clark and the National Museum further for enabling me to examine the specimens from Trinidad which Kœhler mistook for *Ophiophragmus wurdemanii*, and also for providing the two photographs of *Ophiocnida cubana* which I am using in this paper. This cordial coöperation by our great National Museum has added greatly to the pleasure of preparing the present report.

Although *Astrocyclus cœcilia* has not yet been actually reported in less than 10 fms., it is so persistently associated with gorgonians which occur at a lesser depth that it will probably be found some day washed up on the shore. As it is an easily recognizable form, I am including it in the key. The northern *Ophiacantha bidentata* was recorded by me from 220-225 fms. off the western end of Porto Rico but the identification is not certain. A much more perplexing record is Koehler's (1914) of a dry specimen from "St. Augustine, Florida. No depth mentioned." I do not believe that *bidentata* occurs along the Florida coast except possibly in deep water. However, I have included the species in the key but not in the body of the report. I am omitting altogether *Amphiodia riisei*, as I find no trustworthy shallow-water West Indian record. Moreover, the specimens which I called *riisei* in 1901 prove to be not Amphiodia at all. They represent a species of Amphioplus which a hasty review of the described forms leads me to think is not as yet named. The specimen which I recorded as *Amphioplus stearnsii* proves to be a young Ophiocoma, lacking all granules on the disk. Because of this condition, which was very perplexing to me in 1901, I believe this is a young *riisei*, in spite of the color, which resembles that of *pumila*. The big Ophiactis which I made the type of a new species, *longibrachia*, is, I think, a very large *mülleri*, but these large specimens of Ophiactis from the West Indies need a very careful revision. Too few of them have yet been taken to permit us to reach any final conclusion. I recorded from Mayagüez 3 specimens of *Amphipholis subtilis*, but reëxamination of the material shows it is really quite unidentifiable. Hence I can find no reason for including *subtilis*, even in the key. Finally, I am including in the key but not in the body of the report, *Ophiopsila polysticta,* known as yet only from near Barbados, and probably from a depth of more than 10 fms.

The large number of species to be included has made it necessary to give a number of keys instead of a single key to all the West Indian brittle-stars. The first key is to be used to determine the family to which a given specimen belongs, and this is followed by the use of the key for the proper family. It seems better to let the family keys follow directly after the first key, rather than to interpolate them at the proper points in the report. In using these keys it must be remembered that they are based solely on the 69 species included. They cannot be used for any more inclusive group, nor in any other area than the West Indian region.

In addition to those listed in the Introduction (pp. 5-6), the most important papers for reference purposes are Kœhler's, 1914, Bull. 84, U. S. Nat. Mus., and H. L. Clark's, 1918, Bull. M. C. Z., 62, No. 6. Both of these papers are primarily concerned with West Indian brittle-stars.

In the present report the sequence of species is the same in the text as in the keys

Key to the 9 Families of littoral West Indian Ophiurans

A. No upper arm-plates.
  Arms simple, undivided....................................Ophiomyxidæ
  Arms dichotomously branched......................Gorgonocephalidæ
AA. Upper arm-plates present and well formed, though in *Ophiocryptus* they are concealed under a coat of fine granules.
  B. Arm-spines relatively long (longer than an arm-segment) and projecting from side arm-plates, often hollow; oral papillæ large and conspicuous, 7 or more on each of the five jaws; dental papillæ similar or usually wanting altogether...Ophiacanthidæ
  BB. Not as above.
    C. Arm-spines short, solid, scarcely or not exceeding the segment, usually projecting more or less; oral papillæ small, 2-8 (rarely 10) on each jaw; no dental papillæ; no supplementary upper arm-plates......................Amphiuridæ
    CC. Not as above.
      D. Arm-spines long, glassy; no oral papillæ; a conspicuous cluster of small dental papillæ at apex of jaw; no supplementary upper arm-plates..........Ophiotrichidæ
      DD. Not as above.
        E. Disk covered with a very fine, almost microscopic scaling, without granules; arm-spines relatively long, but usually more or less appressed; large supplementary upper arm-plates present; one large, flat, nearly circular tentacle-scale......
        Ophiochitonidæ

EE. Not as above.

F. Both oral papillæ and dental papillæ present; arm-spines big and conspicuous...Ophiocomidæ

FF. No dental papillæ; arm-spines very small, appressed.

Disk closely covered with granules concealing the underlying scales; 4 genital slits in each interbrachial area...... Ophiodermatidæ

Disk covered with plates or scales; only 2 genital slits in each interbrachial area .....................Ophiolepididæ

### Key to the Ophiomyxidæ

Only one species of this family occurs in shallow water in the West Indies.

### Key to the Gorgonocephalidæ

Only 1 madreporite.................................*Astrophyton muricatum*

A madreporite in each interbrachial area................(*Astrocyclus cæcilia*)

### Key to the Ophiacanthidæ

A. Arms 6; disk with scales many of which bear small erect spinelets.

Arm-spines 3 (basally may be 4), uppermost (or next to top, when 4 are present) distinctly longest, equalling 1½ segments........ *Ophiacantha oligacantha*

Arm-spines 4, subequal, not exceeding a segment................ *Ophiacantha ophiactoides*

AA. Arms 5.

B. Disk covered with granules only.........(*Ophiacantha bidentata*)

BB. Disk covered with granules and small spinelets.............. *Ophiotreta littoralis*

BBB. Disk covered with apparently naked skin.

Disk pentagonal; when dry fine scales and large radial shields are visible; upper arm-plates not more than twice as wide as long........................*Ophiomitrella glabra*

Disk circular covered by naked skin without scales; upper arm-plates 3 times as wide as long.....*Ophioblenna antillensis*

### Key to the Amphiuridæ

A. Jaws with a pair of block-like oral papillæ at apex (which may appear like one block) and one (rarely 2) small, scale-like or spine-like papillæ at each distal angle.

B. Disk covered above and below with a close coat of scales, often very fine.

C. Tentacle-scales 2; disk-scaling fine; arm-spines 6......... *Amphiura palmeri*

CC. Tentacle-scales single (rarely 2 on a few basal pores).
D. Disk 4-8 mm. across; oral shields as long as wide or longer; arm-spines 7, decreasing to 5; upper arm-plates elliptical or nearly circular; no dusky spot on upper arm-spines.................... *Amphiura fibulata*
DD. Disk 3-4 mm.; oral shields as wide as long or wider; arm-spines 5 or 4; upper arm-plates, rounded triangular with proximal angle truncated; a dusky spot on upper arm-spines.............. *Amphiura stimpsonii*
BB. Disk without scales on the interbrachial areas orally and even (in some species) dorsally also.
C. Upper surface of disk fully covered with scales........... *Hemipholis elongata*
CC. Upper surface partly, or wholly (except for radial shields) bare.
D. Oral shields longer than wide; a single small tentacle-scale present; arms moderately long and slender.... *Ophionephthys limicola*
DD. Oral shields wider than long; no tentacle-scales; arms excessively long and slender...... *Ophionema intricata*
AA. Jaws not as above.
B. Jaws with 3 or more oral papillæ on each side, distal one usually largest, innermost may be block-like; tentacle-scales often 2.
C. Disk with a marginal series of distinct erect (though often low and blunt) spinelets in the interbrachial areas.
D. Marginal papillæ of disk, thick, blunt, not spiniform.
E. Radial shields broad, length twice width or less; no longitudinal stripe on lower surface of arm.
F. Basal under arm-plates swollen; no longitudinal stripe on upper surface of arm.
G. Oral surface of interbrachial areas covered by scales not bearing granules.. *Ophiophragmus wurdemanii.*
GG. Oral surface of interbrachial areas with the scales concealed by a coat of granules .... *Ophiophragmus filograneus*
FF. Basal under arm-plates not swollen; a conspicuous longitudinal stripe on upper side of arm ............... *Ophiophragmus pulcher*
EE. Radial shields narrow, length two or three times the width; a conspicuous longitudinal stripe on lower surface of arm........ *Ophiophragmus septus*
DD. Marginal papillæ of disk spinulose and very acute.... *Ophiophragmus lütkeni*
CC. Disk with no marginal series of spinelets though many disk-scales along the margin may be turned up on edge, making a sort of marginal border.

D. Outermost oral papilla, low, wide and opercular, with its fellow of the adjoining jaw capable of completely closing outer half of mouth slit.

E. Disk smoothly covered with scales.

F. Arms long, ten times disk diameter or more.

G. Disk scales very small; middle arm-spine pointed; arms very slender... *Amphipholis gracillima*

GG. Disk scales rather coarse; middle arm-spine very blunt; arms not so slender *Amphipholis pachybactra*

FF. Arms short, only 3 or 4 times disk-diameter *Amphipholis squamata*

EE. Disk covered with scattered blunt spinelets of unequal size concealing the scales............ *Ophiostigma isacanthum*

DD. Outermost oral papilla not opercular though it may be much the largest.

E. Jaws with 3 oral papillæ on each side, of which the outermost is commonly the largest.

F. Disk covered with scales which bear no spinelets.

G. Tentacle-scales 2.

H. Arm-spines slender and pointed.

I. Radial shields short and wide, often nearly circular; basal part of arm more or less carinate on upper surface; 16-20 marginal scales in each interbrachial area, dorsally, in a specimen 9 mm. across disk .......*Amphiodia gyraspis*

II. Radial shields about twice as long as wide; basal part of arm not carinate; about 12 marginal scales in each interbrachial area of 9 mm. specimen ...*Amphiodia limbata*

HH. Arm-spines short and blunt or even truncate.

I. Disk scales and radial shields smooth; arms rather stout; uppermost arm-spines flat, wide, rounded.

J. Arms 7-8 times disk-diameter; adoral plates do not meet proximal to oral shields.

K. Disk scales 10-25 per square millimeter; radial shields less than twice as long as wide; upper arm-plates square cut on lateral margins ........ *Amphiodia planispina*

KK. Disk scales about 50 per square millimeter; radial shields about thrice as long as wide; upper arm plates rounded laterally ........ *Amphiodia rhabdota*

JJ. Arms 15 times disk-diameter; adoral plates meet fully proximal to oral shields............ *Amphiodia tymbara*

II. Disk scales and radial shields rugose; arms very slender; arm-spines small and blunt.. *Amphiodia trychna*

GG. Tentacle-scale single.

H. Disk covered with fine scales among which the primary plates are distinguishable and often conspicuous *Amphiodia pulchella*

HH. Disk covered with very fine scales among which no primary plates can be distinguished............. *Amphiodia repens*

FF. Disk covered with scales bearing more or less numerous spinelets.

G. Tentacle-scales 2; radial shields narrow, 2-3 times as long as wide; arms not conspicuously banded........... *Ophiocnida scabriuscula*

GG. Tentacle-scales 2, only at base of arm; radial shields subtriangular, not twice as long as wide; arms conspicuously banded.........*Ophiocnida cubana*

EE. Jaws with 4 or 5 small oral papillæ on each side, of which the outermost is very seldom the largest.

F. Interbrachial areas below covered with scales; oral shields much longer than wide.

G. Tentacle-scales 2; interbrachial areas below with a complete covering...... *Amphioplus abditus*

GG. Tentacle-scale single; interbrachial areas sparsely covered with minute scales...........*Amphioplus thrombodes*

FF. Interbrachial areas below naked; oral shields as wide as long or wider................. *Amphioplus coniortodes*

BB. Jaws with 1 or 2 oral papillæ on each side (on some jaws exceptionally 3) and no block-like papillæ at apex; tentacle-scale single, large.

C. Upper arm-plates more or less fan-shaped, the proximal angle truncate to some extent; arms 6; arm-spines each with a dusky spot on upper side..................*Ophiactis algicola*

CC. Upper arm-plates transversely ellipsoidal, 1.3-4 times as wide as long, broadly in contact.

D. Upper arm-plates not at all swollen, the distal margin even, without a notch or a dark spot on each side; colors not simply green and white.

E. Arms 6; size small (3-4 mm. across disk), arms short (3-5 times disk diameter); oral papilla single, large, nearly circular; more or less blue in coloration...........................*Ophiactis cyanosticta*

EE. Arms 5; size large (7-15 mm.), arms long (6-7 times disk diameter); 2 oral papillæ on each side; no blue..............................*Ophiactis mülleri*

DD. Upper arm-plates swollen, the distal margin notched or with a dark spot on each side; 5 arms in adult, 6 in young; oral papillæ usually 2 on each side but occasionally 1 or none; colors green and white, no blue *Ophiactis savignyi*

### Key to the Ophiotrichidæ

A. A median line, white, black or colored, on upper surface of arm, at least on distal portion.

B. Disk more or less covered with spiny stumps or acicular spinelets, or both.

C. Radial shields small, at least the inner ends, like disk, covered with minute spinelets...............*Ophiothrix angulata*

CC. Radial shields large and bare, the narrow interradial areas between with a few acicular spines......*Ophiothrix suensonii*

BB. Disk with only low, rough granules...............*Ophiothrix lineata*

AA. No median line on arm, even at tip.

B. Arms beautifully and regularly cross-banded with narrow lines of white or yellow..........................*Ophiothrix örstedii*

BB. Arms not so banded.
C. Disk covered with large, bare radial shields and relatively few distinct scales each of which carries a single, low, thorny stump; arms short............*Ophiothrix brachyactis*
CC. Not as above............Some varieties of *Ophiothrix angulata*

### Key to the Ophiochitonidæ

A. General coloration more or less green (olive-gray in preserved specimens); middle arm-spine much longer than the others, more or less club-shaped; disk scaling relatively coarse.........*Ophionereis olivacea*
AA. Not as above.
B. Arm-spines moderately long, greatly exceeding an arm-segment; disk pearl gray, generally marked with a net-work of dark lines; arms sharply banded with dark brown, the bands usually about one segment wide....................*Ophionereis reticulata*
BB. Arm-spines short little exceeding a segment; disk reddish-white in life, gray or yellowish in preserved material, variegated with several shades of brown; arms banded but distal boundary of bands indistinct and 2 or 3 segments are thus included in each band...................................*Ophionereis squamulosa*

### Key to the Ophiocomidæ

A. Tentacle-scales 1 or 2, but if 2, the inner is not long, flat and spine-like.
B. Disk granules nearly or quite spherical (sometimes wanting in young individuals); color very dark (except in some young individuals).
C. Tentacle-scales 2 (single oftentimes on individual pores or near tip of arm); black or blackish, unicolor or variegated with cream-color or whitish; no red.......*Ophiocoma echinata*
CC. Tentacle-scale single (2, often on basal pores); black or deep-brown, orally tinged with rust-red; no white or whitish. *Ophiocoma riisei*
BB. Disk granules, some or all, at least near disk margin, higher than thick, tending to be spiniform; not very dark colored.......... *Ophiocoma pumila*
AA. Tentacle-scales 2, the inner long, flat and spine-like, lying diagonally across lower surface of arm.
B. Disk and basal part of arms, above and below, more or less freely sprinkled with black dots........................*Ophiopsila riisei*
B. No such sprinkling of black dots.
C. Disk without scales or spots; arm-spines 8, arms banded.... *Ophiopsila vittata*
CC. Disk with scales, spotted or variegated; arm-spines 6.
D. Middle arm-spines smallest, at least, proximally; more or less orange color on disk..... *Ophiopsila hartmeyeri*
DD. Middle arm-spines not smaller than upper; radial shields white; no orange........(*Ophiopsila polysticta*)

### Key to the Ophiodermatidæ

A. Upper surface of arms not covered with granules; oral shields (except in very young specimens of one or two species) bare.

B. Upper arm-plates single and undivided, or occasionally in large specimens divided into 2 or 3 parts.

C. Radial shields, all covered by fine granulation of disk (150-200 granules per sq. mm.); colors most diverse.

D. Arm-spines 8-10, the lowest obviously the widest and longest, about equal to the segment................ *Ophioderma appressum*

DD. Not as above.

E. Arms short, 3-4 times disk diameter; arm-spines 7-9, subequal, about 2/3 as long as joint; usually more or less green, often a blue-green, in coloration ....................*Ophioderma brevicaudum*

EE. Arms longer, 4-5 times disk diameter; arm-spines 7-10.

F. Arms not noticeably carinate at base, nor very attenuate at tip; arm-spines subequal, more or less pointed, equal to rather more than half an arm segment.............. *Ophioderma brevispinum*

FF. Arms somewhat carinate at base, quite attenuate distally; arm-spines flat, blunt, longer and closer together than in *brevispinum*................*Ophioderma januarii*

CC. Radial shields bare, or in certain individuals (especially of *O. phœnium*), 1 or more may be covered.

D. Color gray or gray-brown, often dark; no red or green; arms usually banded.............*Ophioderma cinereum*

DD. Colors brighter, red of some shade, or green, or both, being evident.

E. Disk brick-red, arms green, or disk and arms either red or green; arms not banded or only faintly so..................*Ophioderma phœnium*

EE. Disk and arms variegated with purplish-red or deep rose-red and cream-color, whitish or pale gray; arms often distinctly banded........... *Ophioderma rubicundum*

BB. Upper arm-plates broken up into 7 or more smaller plates, usually symmetrically arranged.

C. Each upper arm-plate divided into many small pieces, the number and arrangement of which are difficult to determine; color slate-gray above, little changed by preservation ................................*Ophioderma guttatum*

CC. Each upper arm-plate divided into a single transverse series of 7 or 9 plates; color in life brilliant vermilion-red, wholly lost on preservation; museum specimens are buff or cream-color ........................ *Ophioderma squamosissimum*

AA. Upper and under surfaces of both disk and arms covered with a fine coat of granules; color pale gray above, white beneath; arms faintly banded ................................ *Ophiocryptus dubius*

KEY TO THE OPHIOLEPIDIDÆ

A. Upper arm-plates with no supplementary pieces; disk convex, rough with slightly swollen plates...................... *Ophiozona impressa*

AA. Upper arm-plates with a small supplementary piece on each side.

B. Disk flat and smooth; arm-spines 4-6............ *Ophiolepis elegans*

BB. Disk convex, rough; arm-spines minute, 2 or 1................. *Ophiolepis paucispina.*

## Order *PHRYNOPHIURIDA*

### Family OPHIOMYXIDÆ

#### **Ophiomyxa flaccida** (Say)

*Ophiura flaccida* Say, 1825, Jour. Phila. Acad., v, p. 151.

*Ophiomyxa flaccida* Lütken, 1859, Add. ad. Hist. Oph., pt. 2, pp. 79, 138. H. L. Clark, 1919, Publ. 281 Carnegie Inst. Wash., Pl. 1 (colored).

This large and active brittle-star shows extraordinary diversity of coloration: usually of a dull shade of green or yellow-brown, it is sometimes more or less conspicuously variegated with cream-color, and often the coloration is very bright, ranging on the one hand through orange-brown to orange or even bright yellow, and on the other through deep brown and red-brown to lighter and brighter shades even to rose-red; the arms are commonly banded on the distal half with a few irregular markings of whitish. Living, it is, when full grown, about 25 mm. across the disk and the arms are nearly or quite 4 times as much, but, because of the softness of the disk, specimens shrink greatly when dried. The distribution is from Bermuda on the north to Brazil on the south; it is known from Bermuda, the Bahamas, southern Florida, Jamaica, Haiti, Porto Rico, St. Thomas, St. Lucia, Tobago and the northern and northeastern coasts of South America. It is often common under slabs of rock on reef flats and along shore in very shallow water, but it also occurs down to depths of over 100 fms.

The Academy collection contains 5 specimens, all adults and all from Mangrove Island, Parguera, Ensenada, collected June 27, 1915, by R. W. Miner, H. Mueller and M. A. Howe. Two are dark colored and were probably olive-green in life while the other three are much lighter and were probably orange or yellow. The "Fish Hawk" collection contained one specimen from Ensenada Honda (Culebra) and Mr. Gray found the species at San Juan.

### Family Gorgonocephalidæ

**Astrophyton muricatum** (Lamarck)

*Euryale muricatum* Lamarck, 1816, Anim. s. Vert., ii, p. 538.
*Astrophyton muricatum* Müller and Troschel, 1842, Syst. Ast., p. 122. Döderlein, 1911, Japan. Euryalæ, Pl. 5, fig. 1.

This remarkable animal, very similar in appearance to the "basket-fish" or "sea-spiders" of the North Atlantic coasts, is easily recognized among the West Indian littoral ophiurans by the many-times divided arms, the interlacing and curving inward of which give the curious form that has suggested the name "basket-fish" or, better, "basket-star." Related species occur in deep water but this is the only one that is seen washed up on the beach, sometimes still clinging to the horny coral upon which it is commonly found, and sometimes free; in the latter condition the arms are generally rolled inward so tightly over the mouth that the whole animal has the form of a compact, flattened hemisphere. The color is usually yellowish-brown, but varies more or less and is sometimes dirty whitish. Verrill, 1899, gives the color as light chocolate brown with irregular blotches of darker brown on the disk; he describes a young one as chocolate color variegated with white, the arms banded with brown and yellowish-white. As for size, the disk in adults is 25-30 mm. across, while the arms, if completely extended, would be 5 or 6 times as much; when the arms are curled inward in a normal degree of contraction the "basket" is about 130-150 mm. across. This Astrophyton seems to be an inhabitant chiefly of the northwestern part of the West Indian region. It is known only from the Bahamas, the southeastern coast of the United States, including the Tortugas, and from Jamaica. It has not yet been reported from Porto Rico but Verrill says the range extends to St. Croix. It has been reported from Brazil but this record and that from St. Croix require confirmation.

## Order *LÆMOPHIURIDA*

### Family Ophiacanthidæ

**Ophiacantha oligacantha** H. L. Clark

*Ophiacantha oligacantha* H. L. Clark, 1918, Bull. M.C.Z., lxii, p. 265; Pl. 7, fig. 5.

This species is known only from a single small specimen taken by me at the Tortugas (Garden Key) in June, 1917. It was living in coralline algæ along shore. It resembles the following species in having *six* arms, and it is not unlikely that each is the young of some much larger species.

The type of the present species is 3 mm. across the disk and the arms are 15 mm. long. The color is yellow-brown and the arms are irregularly banded.

**Ophiacantha ophiactoides** H. L. Clark

*Ophiacantha ophiactoides* H. L. Clark, 1901, Bull. U. S. Fish Com., ii, p. 249; Pl. 15, figs. 5-8.

This little brittle-star is recorded as yet only from Porto Rico, and the adult is still unknown. There are six arms in each of the two specimens which have been collected and this is probably a species character, though it is possibly only an evidence of immaturity. The original specimen was very pale yellowish-green, the arms banded with brown; the specimen at hand is pale yellowish-brown, with no evident banding of the arms. Each of the two specimens is about 2 mm. across the disk, with the arms about 8 mm. long.

The Academy collection contains the second known specimen of this little Ophiacantha. It was taken at the mangrove island and coral reef at the entrance to Montalva Bay, Ensenada, June 27, 1915, by R. W. Miner, H. Mueller and M. A. Howe. The original specimen was taken by the "Fish Hawk," on coral sand, in 10 fms., at Gallardo Bank.

**Ophiotreta littoralis** (Koehler)

*Ophiolimna littoralis* Koehler, 1913, Zoöl. Jahrb. Suppl. 11, p. 370; Pl. 21, figs. 1-3.

*Ophiotreta littoralis* H. L. Clark, 1915, Mem. M.C.Z., xxv, p. 216.

This is another species of which little is known, as so few specimens have been taken. It reaches a diameter of 10 mm. and the arms are at least four times as long. Nothing is recorded as to color, either in life or as preserved specimens, so it is probably not distinctive. It has been taken at "La Havane" (presumably a littoral station at Havana, Cuba) and at St. Thomas. It is not in the Academy collection.

**Ophiomitrella glabra** (H. L. Clark)

*Ophialeœa glabra* H. L. Clark, 1901, Bull. U. S. Fish. Com., ii, p. 249, Pl. 15, figs. 1-4.

*Ophiomitrella glabra* H. L. Clark, 1915, Mem. M.C.Z., xxv, p. 210.

The original and only known specimen of this brittle-star was taken by the "Fish Hawk" at Playa de Ponce. There is no record of the depth at which it occurred but as all the other echinoderms collected at Ponce are strictly littoral forms, it seems very possible, if not certain, that this species is also a shallow-water form. The type was 12 mm. across the disk; all of the arms were broken but they were evidently rather stout.

The color was uniformly dark brown, with a few spots and blotches of yellowish-white on the interbrachial areas below; the under surface of the arms and the mouth parts were whitish. When preparing the key to the Ophiacanthids for this report, my attention was called to the absence of any well marked characters by which this species (*O. glabra*) can be distinguished from the next, the long lost Ophioblenna. The resemblances are very striking and suggest the possibility of identity.

### **Ophioblenna antillensis** Lütken

*Ophioblenna antillensis* Lütken, 1859, Add. ad Hist. Oph., ii, p. 137; Pl. 4, figs. 4a-4d.

Mr. A. H. Clark (1921) has well expressed the situation as concerns this species: "The greatest mystery connected with the Caribbean ophiurans concerns the genus Ophioblenna. The only known species, *O. antillensis,* was described in 1859 from two specimens collected at Water Island, St. Thomas. In spite of all the collecting that has since been done in the West Indies and even at Water Island itself, no others have ever come to light." The larger of the original specimens was 20 mm. across the disk and the arms were about 90 mm. long. The color was brown; the disk with whitish dots and fine lines, the arms with light bands. The resemblance to *Ophiomitrella glabra* in many details is very striking—even suggesting identity.

## Family Amphiuridæ

### **Amphiura palmeri** Lyman

*Amphiura palmeri* Lyman, 1882, Challenger Oph., pp. 123, 143. 1875. Illus. Cat. M. C. Z., No. 8, pt. 2, Pl. 3, figs. 35-37 (as *A. flexuosa?* Ljn.).

*Amphiura kükenthali* Koehler, 1913, Zoöl. Jahrb. Suppl. 11, p. 356: Pl. 20, figs. 1-4.

There are records of the discovery of this species at Barbados in deep water and off Georgia in 262 fms. but as a shallow-water form it has been taken only on the southeastern coast of the United States, particularly Florida and the Tortugas, and at St. Thomas. It is not known from Porto Rico, unless, as Koehler (1914, p. 48) suggests, the specimen which I recorded from Fish Hawk St. 6066 as *A. flexuosa* is this species; that specimen, however, was taken in 162-171 fms. The disk of *palmeri* may be 8 mm. across and the arms over 60 mm. long. The disk is pale yellowish or gray, the arms yellowish or light brown, in dry specimens. I find no satisfactory character by which Koehler's *kükenthali* may be distinguished from *palmeri.* The distinguished French author is simply mistaken in supposing (in 1913) that the interbrachial areas below are bare in *palmeri.*

In 1914, when he discusses and figures the latter species, showing that these areas are well covered with scales, he seems to have forgotten *kükenthali* altogether.

**Amphiura fibulata** Koehler

*Amphiura fibulata* Koehler, 1913, Zoöl. Jahrb. Suppl. 11, p. 359. 1914, Bull. 84 U. S. Nat. Mus., Pl. 7, figs. 3-5.

This Amphiura is known only from near Key West, Florida, where a single specimen was taken in a little over five fathoms of water. The color is not given by Koehler other than to say that on the upper surface of the arms is "a very light yellowish stripe, which can hardly be distinguished on the specimen in alcohol." The disk was 8 mm. across and the arms were "much longer" than 70-75 mm.

**Amphiura stimpsonii** Lütken

*Amphiura stimpsonii* Lütken, 1859, Add. ad Hist. Oph., ii, p. 116. Koehler, 1914, Bull. 84 U. S. Nat. Mus., Pl. 7, figs. 1, 2.
*Amphiura vivipara* H. L. Clark, 1918, Bull. M. C. Z., lxii, p. 268; Pl. 1, figs. 1, 2.

Koehler records from Key West six specimens of this small species and says it has been reported "at various littoral stations in the West Indies." The "Fish Hawk" took a single small specimen at Mayagüez, "on the reefs," and I dredged a specimen 6 mm. across the disk at the Tortugas, in 7-8 fms., in June, 1917. This individual was very pale yellow in life with a longitudinal stripe of bright orange on the upper surface of the arm. This recalls the similar stripe in *A. fibulata*. The range of *stimpsonii* extends to Brazil, where it has been taken in 35 fms. It is also recorded from Barbados in 69 fms. and from the west coast of Florida in 42 fms. It is not represented in the Academy collection.

Under the name *Amphiura vivipara,* I redescribed small specimens of this brittle-star in 1918, being impressed with the fact that they were viviparous, at least at Tobago. They superficially resemble *Amphipholis squamata* very closely and for that reason I entirely overlooked Lütken's little-known species, so well figured and redescribed by Koehler in 1914. We found small specimens of *stimpsonii* very abundant in the coralline algæ at Buccoo Bay, Tobago. They are also common at the Tortugas in a similar habitat. More intensive collecting will no doubt reveal the presence of the species generally throughout the West Indies, under suitable conditions. The small specimens are only 3-4 mm. across the disk and the arms are only 15-20 mm. long. The color of disk is grayish, usually with a few blackish spots; arms and lower surface pale yellowish to distinctly yellow; arms indistinctly banded distally with dusky; arm-spines frequently dusky or with a dusky spot, otherwise whitish. A variety (*annulata*), found with the ordinary form, has fine transverse lines of red on the upper surface of the arms. These lines gradually disappear in preserved material. Large individuals, 6 mm. or more across the disk, apparently live in deeper water, as indicated by the one mentioned above, which I dredged at the Tortugas. This specimen is so much like the smaller ones that I am puzzled now as to why I did not recognize their identity in 1918.

### **Hemipholis elongata** (Say)

*Ophiura elongata* Say, 1825, Jour. Phila. Acad., v, p. 146.
*Hemipholis elongata* Lyman, 1865, Illus. Cat. M. C. Z., No. 1, p. 137, Pl. 1, figs. 1-3 (colored; as *H. cordifera*).

Large specimens of this handsome brittle-star may have the disk 10 mm. across and the arms nearly or quite 90 mm. long. The disk is gray of some shade, often with an olive tinge, and sometimes so dark as to appear almost black; in dry specimens it is much lighter; the arms are brownish, faintly banded with a slightly darker shade. The distribution is extensive as it has been taken at Charleston, S. C., and at Desterro, Brazil. It has also been recorded from Florida and Trinidad.

The Academy collection adds this fine species to the recorded fauna of Porto Rico. An individual, 7 mm. across the disk, with arms 60-65 mm. long, very dark olive-gray with faintly banded arms, was taken, June 23, 1915, by R. W. Miner, but there is no record as to exact locality or depth.

### **Ophionephthys limicola** Lütken

*Ophionephthys limicola* Lütken, 1869, Add. ad Hist. Oph., pt. 3, pp. 24, 25, fig.

This species was based on specimens taken at St. Thomas many years ago. It had not been encountered since until, in June, 1917, I took two specimens at Loggerhead Key, Tortugas, in shallow water. The disk is missing in all of the five available specimens but it must reach a diameter of at least 10 mm. to judge from the scars at the base of the arms; the length of the arms is 120-130 mm. Lütken says the disk was 13 mm. across in his specimen but he could not estimate the arm length. Riise wrote him that the color in life was yellow-green, with a darker green stripe, and the arms yellowish. In preserved material the arms and mouth-frame are pale brown or cream color without markings. Riise took his specimen in 12 feet of water on a muddy bottom.

### **Ophionema intricata** Lütken

*Ophionema intricata* Lütken, 1869, Add. ad Hist. Oph., pt. 3, pp. 27 (fig.), 94, 98.

I have already given (1918, Bull. M. C. Z. 62) a full account of the rediscovery of this extraordinary brittle-star at Tobago. The extreme length of the arms, twenty times the disk diameter, is but one of several remarkable features. St. Thomas and Tobago are the only places at present known where Ophionema occurs, but intensive collecting in suitable mud will probably reveal it in many other regions. The disk is 6-8 mm. across and the arms 140-150 mm. long. The disk is black with the radial shields white in marked contrast; the upper surface of the arms is pale yellowish or nearly white with an irregular, and often broken, longitudinal band of deep purple on each side; on the under surface of the arm, except basally, there are frequent splashes of faint purple, giving a somewhat irregularly-banded appearance to the under side of the arms.

**Ophiophragmus wurdemanii** (Lyman)

Plate VI, text-figure 1

*Amphiura wurdemanii* Lyman, 1860, Proc. Boston Soc. Nat. Hist., vii, p. 196.
*Ophiophragmus wurdemanii* Lyman, 1865, Illus. Cat. M. C. Z., No. 1, pp. 12, 132.

This species is known from Charlotte Harbor, Florida, and Beaufort, N. C., but it has not yet been found at any West Indian island. The specimens recorded by Koehler (1914, Bull. 84, U. S. Nat. Mus., p. 42; Pl. 8, figs. 1, 2) as "*Ophiophragmus wundermani*" are not this species but are *Amphiodia limbata*, as a reëxamination has shown. When adult, *wurdemanii* is about 10 mm. across the disk and the arms are 100-125 mm. long. The color varies a good deal between light and dark extremes; the disk is either cream-color, grayish or light brown, while the upper surface of the arms is variegated dusky and cream-color; at one extreme the arms are cream-color with scattered irregular cross-marking of dusky, while at the other the arms are dusky or deep gray with scattered markings of cream color.

FIG. 1.—*Ophiophragmus wurdemanii* (Lyman), natural size, upper side. Specimen from Beaufort, N. C.

**Ophiophragmus filograneus** (Lyman)

*Ophiocnida filograna* Lyman, 1875, Illus. Cat. M. C. Z., No. 8, pt. 2, p. 20, figs. 88, 89.
*Ophiophragmus filograneus* H. L. Clark, 1918, Bull. M. C. Z., lxii, p. 274; Pl. 2, figs. 4, 5.

This curious long-armed brittle star is known as yet only from the west coast of Florida between Puntarasa and Cedar Keys. It is common in Tampa Bay where it lives buried in mud. In adults the disk is 6 mm. across and the arms 80 mm. long. Nothing is recorded as to color but dry specimens are deep gray above, more or less variegated with whitish, and dirty whitish below.

**Ophiophragmus pulcher** H. L. Clark

*Ophiophragmus pulcher* H. L. Clark, 1918, Bull. M. C. Z., lxii, p. 274; Pl. 8, fig. 1.

This handsome species is known only from the Tortugas, Florida, where I secured 5 specimens, in June, 1917, on Bird Key reef-flat in 2-3 ft. of water, and near Loggerhead Key in 5-7 fms. These specimens ranged in size from less than 3 to 7½ mm. across the disk; in the young ones the arms are only about 7 times the disk diameter but in adults they are 10-12 times the disk. In life, the disk is uniformly gray, the arms yellowish-white; at intervals of 4-6 segments, one or two upper arm plates are bright green and there is also a narrow longitudinal stripe of green running the whole length of the arm but rather faint proximally. In young specimens this stripe is bright orange red. Oral surface nearly white but certain under-arm plates are dusky, or greenish or bright green. In dry specimens the green persists well but the red has faded completely.

**Ophiophragmus septus** (Lütken)

*Amphiura septa* Lütken, 1859, Add. ad Hist. Oph., pt. 2, p. 120.
*Amphipholis septa* Lütken, 1872. Of. Kong. Danske vid. selsk. Forh., Pl. 2, figs. 3*a*, 3*b*.
*Ophiophragmus septus* Lyman, 1865, Illus. Cat. M. C. Z., No. 1, p. 132.

This species was originally taken at St. Thomas but has not been seen in that region since. Off Cape Hatteras, in 52 fms., the "Albatross" took 2 specimens, Feb. 29, 1884, which Koehler has described and figured (1914, Bull. 84 U. S. Nat. Mus., p. 67, Pl. 6, figs. 4-7) as "*Amphiodia erecta.*" He compared them with *O. lütkeni,* but he apparently did not think of *septus.* In April, 1916, I found this species at Sandy Point, Buccoo Bay, Tobago. It was not common but several were secured by digging in the mud where it lived with *lütkeni,* Ophionema, and Amphiodias. Adult specimens are 9 mm. across the disk and the arms are about 10 times that. The disk in life is gray, the arms yellowish, more or less clouded or blotched with yellowish green, and having a longitudinal stripe of a darker shade on the upper surface. There is also a similar stripe on the lower side of the arm but this seems to fade away after preservation.

**Ophiophragmus lütkeni** (Ljungman)

*Amphipholis lütkeni* Ljungman, 1871, Öfv. Kongl. Vet. Akad. Förh., xxviii, p. 636.
*Amphiodia lütkeni* Koehler, 1914, Bull. 84 U. S. Nat. Mus., p. 69, Pl. 6, figs. 1, 2.
*Ophiophragmus lütkeni* H. L. Clark, 1918, Bull. M. C. Z., lxii, p. 277.

This species was originally collected at Tortola, Virgin Islands, in 10 fms. It has been encountered since only at Sandy Point, Buccoo Bay, Tobago, where I found it common in two or three feet of water, buried in soft sandy mud, in company with *O. septus, Ophionema intricata* and species of Amphiodia. No doubt search in similar localities, with a spade and a sieve, will reveal the presence of this and other brittle stars of like habits at many other islands. The disk is 5-6 mm. across in adults and the arms 80-90 mm. in length. The upper surface of the disk is pale cream-color with many scales and the radial shields more or less gray or dusky. The upper arm plates are a deep gray, variegated or imperfectly and irregularly banded with cream-color. Arm spines nearly white. Lower surface cream color, the distal parts of the arms somewhat variegated with dusky. The coloration is little affected by preservation.

### **Amphipholis gracillima** (Stimpson)

*Ophiolepis gracillima* Stimpson, 1852, Proc. Boston Soc. Nat. Hist., iv, p. 224.
*Amphipholis gracillima* Ljungman, 1867, Öfv. Kongl. Vet. Akad. Förh., xxiii, p. 314. H. L. Clark, 1915, Mem. M. C. Z., xxv, Pl. 6, figs. 5, 6.

This is one of the wide-ranging species, having been taken at Charleston, S. C., Bermuda, and at Rio de Janeiro, Brazil, as well as at the intermediate points of Tampa Bay (Florida), St. Thomas, and Tobago. Its bathymetrical range seems to be very small: shore line to 6½ fathoms. The disk is gray and the arms pale brown, in preserved specimens. Adults have the disk 7 or 8 mm. across, while the greatly elongated arms are nearly 18 times as much.

There is no representative of this species in the Academy collection although several Amphiodias are labelled as such. It has been reported from Porto Rico but the record requires confirmation.

### **Amphipholis pachybactra** H. L. Clark

*Amphipholis pachybactra* H. L. Clark, 1918, Bull. M. C. Z., lxii, p. 284; Pl. 1, figs. 3-5.

This species was taken by me at Sandy Point, Buccoo Bay, Tobago, in April, 1916, and it has not yet been reported from any other place. It lives in mud with Ophionema, Ophiophragmus and other amphiurids and hence only special and extensive collecting will ever discover it. The color in life is pale yellow with a greenish tinge and the arms are unicolor, but in some specimens the disk is dusky and the arms are more or less variegated with dusky.

**Amphipholis squamata** (Delle Chiaje)

*Asterias squamata* Delle Chiaje, 1828, Mem. Anim. s. Vert. Napoli, iii, p. 74.
*Amphipholis squamata* Verrill, 1899, Trans. Conn. Acad., x, p. 312. H. L. Clark, 1904, Bull. U. S. Fish. Com. for 1902, Pl. 6, figs. 33, 34; Pl. 7, figs. 43, 44.

This is probably the most widely distributed species of brittle star in the world as it has been taken in all seas, excepting only the colder regions of the two hemispheres. It is common at low-water mark but it extends its range outward into water nearly 200 fms. deep. As its habits are secretive, it is easily overlooked, for it prefers the interior of dead molluscan shells, particularly bivalves, or crannies in coral rock, or the shelter of coralline algæ. Various attempts have been made to distinguish, as separate species, the individuals collected in particular regions, such as the West Indies, Chile, and Australia, but the similarities are much greater than the differences and satisfactory diagnoses for these supposed species have yet to be made. The color of the disk is pale gray or nearly white, with the distal ends of the radial shields white: this patch of white at the base of each arm is usually quite distinctive. The arms are pale brown, yellowish or white. The disk is less than 4, and usually less than 3 millimeters in diameter, and the arms are only about five times as much, though there is some diversity in arm-length. Very young specimens may have 6 arms, and show evidence of autotomy. The species is viviparous and the newly born young have the disk bright orange-red and the arms white.

Intensive collecting has revealed this species at Bermuda, the Tortugas, Jamaica, and Tobago, and there is little doubt that it occurs at every West Indian island.

The "Fish Hawk" failed to secure it in Porto Rico, but the Academy collection contains two small but typical specimens: one was taken June 22, 1915, at a spot "across mouth of Guanica Harbor," by R. C. Osburn; the other was collected at Mangrove Island, Parguera, Ensenada, June 27, 1915, by R. W. Miner, H. Mueller and M. A. Howe.

**Ophiostigma isacanthum** (Say)

*Ophiura isacantha* Say, 1825, Jour. Phila. Acad., v, p. 150.
*Ophiostigma isacanthum* Lyman, 1865, Illus. Cat. M. C. Z., No. 1, p. 103. Koehler, 1913, Zool. Jahrb. Suppl. 11, Pl. 20, figs. 6, 7.

This little brittle star ranges from Bermuda, Florida, and the Tortugas, to Tobago and Brazil. Its dull color and curious rough disk render it very inconspicuous so that it is no doubt quite generally overlooked. It has a considerable bathymetrical range, as it has been taken at 115 fms. although it is most common near low-water mark. The color is grayish on the disk, light or dark as the case may be (rarely brown-violet), while the arms, and sometimes the disk, are brownish with slight indications of banding and of spots on the upper arm plates. The disk rarely exceeds 7 mm. across, with arms 4 or 5 times as much. Young individuals (and occasionally mature ones) may have 6 arms, and there is reason to believe that autotomous reproduction occurs.

The Academy collection contains 2 small specimens; one, very light colored, was taken July 10, 1915, southwest of Point Brea, by R. C. Osburn; one, darker, taken July 21, 1914, at Condado Bay, inside Don Hermanos bridge, halfway up the bay, San Juan, by R. W. Miner. The "Fish Hawk" took four small specimens at the eastern end of the island in 20-23 fms.

### Amphiodia

The species of this genus are apparently in a state of flux, as many of them are ill-defined and hover on the border lines that separate them from Amphipholis on the one hand or from Amphioplus on the other. While many of the species have three oral papillæ more or less equal, others have the distal papilla distinctly larger, and it may be very conspicuous. The species are so numerous and so little known that complete specimens are necessary for accurate identification and unfortunately the members of the genus are particularly prone to shedding the disk on very slight provocation. When roughly handled, especially if the sexual products are near maturity, the disk is cast off. It is even supposed that in some species this is the normal method of setting free the eggs and sperm. This extraordinary habit is not confined to Amphiodia, it occurs in many other Amphiurids (notably Ophionepthys and Ophionema) but it is particularly noticeable in the West Indian members of this genus. As a result there are several species, which have been taken in damaged or incomplete condition and it cannot be determined to what known forms they should be assigned. In the Academy collection there are represented two species of which this is true. Both are young as well as diskless—at least the small size leads one to suppose they are young. One (Field No. 2347, A. M. N. H. No. 1191) was taken "Cayo Caribe to Cayo Parguera," June 25, 1915, by R. C. Osburn; it has 3 or 4 arm-spines and 2 tentacle-scales, and it is quite possible that it is a very young *gyraspis*. The other (Field No. 2369, A. M. N. H. No. 1173) was taken "off the mouth of Guanica Harbor, southeast of bell-buoy," July 4, 1915, by R. C. Osburn; it has 3 peculiar, flat, truncate arm-spines and 2 tentacle-scales. It may possibly be a young *limbata*. The known Amphiodias of West Indian shores are as follows:

**Amphiodia gyraspis** H. L. Clark

*Amphipholis goesii* H. L. Clark, 1901, Bull. U. S. Fish Com., ii, p. 247. (Non Ljungman, 1871).
*Amphiodia gyraspis* H. L. Clark, 1915, Mem. M. C. Z., xxv, p. 245; Pl. 7, figs. 1-4.

This species is known as yet only from Porto Rico. It appears to be very common at the western end of that island, in water 4.5 to 76 fathoms deep, the "Fish Hawk" having taken 60 specimens at 9 stations. In nearly all, the disk is missing but in those in which it is present it reaches a diameter of 9 mm. with the arms about ten times as much. As the largest specimen has the arms 160 mm. long, it is probable that the disk of fully grown specimens exceeds 12 mm. The disk is grayish and the arms brownish in preserved specimens, as is so often the case in the Amphiurids. Not having seen specimens of either *Amphipholis goesii* or *gracillima* (which are apparently identical), when I was working up the "Fish Hawk's" collection, and not being familiar with the very characteristic mouth parts of Amphipholis, I determined these Porto Rican specimens as *goesii*. Greater familiarity with amphiurids convinced me that I was wrong and that *gyraspis* is an Amphiodia and not an Amphipholis. The outer mouth papilla is often distinctly the largest but it does not have the characteristic form and opercular character of the same papilla in Amphipholis. The Academy collection contains no example of this species, unless as already suggested, the small diskless specimen, No. 1191, is a young one.

**Amphiodia limbata** (Grube)

*Ophiolepis limbata* Grube, 1857, Arch. für. Naturg., 23, i, p. 343.
*Amphiodia limbata* H. L. Clark, 1915, Mem. M. C. Z., xxv, p. 247; Pl. 8, figs. 3, 4.

This species is known from Brazil and from Barbados (rather deep water) and one small specimen was taken by the "Fish Hawk" in Porto Rico, in 4-7.5 fms. of water on fine sand, in San Juan harbor. It appears to be common in Trinidad as 10 specimens taken there by the Albatross in 1884, and identified by Koehler (1914, Bull. 84 U. S. Nat. Mus., p. 42, Pl. 8, figs. 1, 2) as *"Ophiophragmus wundermani,"* prove on reëxamination to be this species. When adult, *limbata* is 9-10 mm. across the disk and the arms are 6 times as long. The color of the disk in dry specimens is pale gray (or white) and the arms are pale cream-color or pale brown without markings. The species is not represented in the Academy collection unless as already suggested the small diskless specimen, No. 1173, is a young one.

**Amphiodia planispina** (von Martens)

*Amphiura planispina* von Martens, 1867, Monatsb. K. Preuss. Akad. Wiss. Berlin, p. 347.

*Amphiodia planispina* Verrill, 1899, Trans. Conn. Acad., x, p. 313. H. L. Clark, 1915, Mem. M. C. Z., xxv, Pl. 8, figs. 8, 9.

This species was originally described from Brazil and there are specimens in the Museum of Comparative Zoölogy from Rio de Janeiro and Desterro. In 1901, I recorded a diskless Amphiodia from Porto Rico as this species and a reëxamination of the specimen justifies the identification; but the record, of course, requires confirmation. In 1921, Mr. A. H. Clark recorded a diskless specimen from Barbados—again confirmation is necessary. I collected a large and perfect Amphiodia at the Tortugas in 1917 which I have reported (1918) as *planispina,* but it is not typical. This specimen is 10 mm. across the disk and has the arms 70 mm. long. In life, the disk was gray with a yellow tinge and the arms were yellowish-white with some scanty dusky mottling on the upper surface. In typical *planispina* this dusky purplish color is a conspicuous feature of the upper side of the arms.

**Amphiodia rhabdota** H. L. Clark

*Amphiodia rhabdota* H. L. Clark, 1918, Bull. M. C. Z., lxii, p. 288; Pl. 8, fig. 4.

This species is known only from a single specimen taken in mud and eel-grass roots, in 2-3 ft. of water at Bush Key, the Tortugas, Florida, June 18, 1917. It is 6 mm. across the disk and the arms are 40-45 mm. long. The disk is gray and the arms yellowish-white, with a distinct but sometimes interrupted dusky longitudinal stripe on the upper surface; there are also faint, irregular, dusky markings on the upper arm-plates. Most of the under arm-plates have a median longitudinal dash of brownish-red.

**Amphiodia tymbara** H. L. Clark

*Amphiodia tymbara* H. L. Clark, 1918, Bull. M. C. Z., lxii, p. 290; Pl. 2, fig. 6.

Here is still another of the extraordinary amphiurids living in the sandy mud of Buccoo Bay, Tobago. Only one specimen was found. It is 8 mm. across the disk while the arms are at least 150 mm. long. Color, in life and as preserved, variegated gray and white above, nearly white below. No doubt, at some future date, a spade and a sieve will reveal this species as an inhabitant of many other West Indian islands.

**Amphiodia trychna** H. L. Clark

*Amphiodia trychna* H. L. Clark, 1918, Bull. M. C. Z., lxii, p. 289; Pl. 3, figs. 1-3.

This is still another species based on a single specimen, which was taken in April, 1916, in sandy mud in 2-3 ft. of water at Sandy Point, Buccoo Bay, Tobago. It is only 3½ mm. across the disk and the arms are about 10 times as much. The disk is pale gray, the under surface, side arm-plates and arm spines, whitish, the upper surface of the arms strikingly variegated and barred with white, dusky and very deep gray.

**Amphiodia pulchella** (Lyman)

*Amphiura pulchella* Lyman, 1869, Bull. M. C. Z., i, p. 337. 1875, Illus. Cat. M. C. Z,. No. 8, pt. 2, Pl. 5, fig. 75.
*Amphiodia pulchella* Verrill, 1899, Univ. Iowa: Bull. Lab. Nat. Hist. v, p. 25.

This species is very imperfectly known and it is hard to see why Verrill should have selected it, as he did, for the type of his genus Amphiodia. There is no specimen in the Museum of Comparative Zoölogy; the fate of Lyman's type is unknown. Koehler (1914) reports specimens from the Tortugas (neither Hartmeyer nor I found it there), from St. Lucia and from off Uruguay! But he gives no data about them, saying Lyman's description and figures are sufficient. Lyman's type was a trifle over 3 mm. across the disk and the arms were about 7 times that. The disk was greenish-gray, in alcohol, the arms lighter.

There is no example of this species in the Academy collection but the "Fish Hawk" took a damaged specimen at San Antonio Bridge, San Juan, of what appears to be *pulchella*. A reëxamination justifies the identification, but of course the record needs confirmation, as the condition of the specimen precludes certainty.

**Amphiodia repens** (Lyman)

*Amphiura repens* Lyman, 1875, Illus. Cat. M. C. Z., No. 8, pt. 2, p. 18; Pl. 3, figs. 38-40.
*Amphiodia repens* Verrill, 1899, Trans. Conn. Acad., x, p. 313.

This small Amphiodia seems to be common throughout the whole West Indian region. It is recorded from Bermuda, Florida, and Brazil, and I have myself taken it at the Tortugas, Jamaica, and Tobago. The bathymetrical range appears to be small, down to about 15 fms. It is usually less than 4 mm. across the disk and the long, slender arms are fully 7-8 times as much. The disk is light gray, the arms whitish.

The Academy collections add this species to the fauna of Porto Rico, as specimens were taken on two separate occasions. One was collected

June 25, 1915, "Cayo Caribe to Cayo Parquera", by R. C. Osburn and the other July 21, 1914, at Condado Bay, inside Dos Hermanos bridge, halfway up the bay, San Juan, by R. W. Miner. The former has no disk but the latter is a small, typical specimen, 3 mm. across.

**Ophiocnida scabriuscula** (Lütken)

*Amphiura scabriuscula* Lütken, 1859, Add. ad Hist. Oph., pt. 2, p. 118.
*Ophiocnida scabriuscula* Lyman, 1865, Illus. Cat. M. C. Z., No. 1, p. 135. H. L. Clark, 1915, Mem. M. C. Z., xxv, Pl. 9, figs. 3, 4.

This well-marked species is known from Florida, Tortugas, St. Thomas, Guadeloupe, Tobago, and Brazil. It is found along shore and its bathymetrical range appears to be small. This is probably the brittle-star which Grave (1898, Johns Hopkins Univ. Circ., 18, No. 137, p. 8) listed as *Amphiura palmeri* from Folly Point and East Harbor, Jamaica, as the brief description he gives fits this species fairly well and obviously does not fit Amphiura. He says the disk was 9 mm. across and the color was light yellow, which corresponds well with adults of *scabriuscula*. There are no records as yet from Porto Rico, but it is almost sure to be found there.

**Ophiocnida cubana** A. H. Clark

Plate VII

*Ophiocnida cubana* A. H. Clark, 1917, Proc. Biol. Soc. Wash., xxx, p. 69.

This species is known only from a single specimen taken in May, 1914, by Mr. John B. Henderson Jr. at Ensenada de Santa Rosa, western Cuba, in 1-3 fms. This individual is obviously young, measuring less than 5 mm. across the disk. In the original description it is compared with *Ophiocnida filogranea* Lyman, which it is quite unlike (and which is considered by me an Ophiophragmus), but no reference is made to *O. scabriuscula* (Lütken), which it resembles rather obviously. It may be only a young one of that species.

**Amphioplus abditus** Verrill

*Amphipholis abdita* Verrill, 1871, Amer. Jour. Sci. (3) ii, p. 132.
*Amphioplus abditus* Verrill, 1899, Trans. Conn. Acad., x, p. 314. Koehler, 1907, Bull. Sci., xli, p. 11, figs. 24, 25.

It is doubtful whether this species should be included in this report as its range seems to be confined to the coast of the United States from Woods Hole, Mass., to the west coast of Florida, although there is one record from the coast of Panama (Albatross St. 2146). Ordinarily confined to shallow water along shore, where it lives in mud or muddy sand, it has been taken in fairly deep water, down to 75 fathoms. As it may very likely be discovered in the Bahamas and Cuba, if not further east, it seems pertinent to include it here. Adult specimens are 8-9 mm. across the disk, with the arms about 10 times as much. The color of the disk is pale gray, the arms nearly white, but occasionally specimens are collected which are altogether gray or pale brown. There is some reason to think that the color is associated with the color of the mud in which the animals are living.

**Amphioplus thrombodes**[2] H. L. Clark

*Amphioplus thrombodes* H. L. Clark, 1918, Bull. M. C. Z., lxii, p. 292; Pl. 7, figs. 1, 2.

This species is based on two specimens taken with the preceding and following species near a mangrove key at Key West, Florida, in June, 1917, living in sandy mud in ½ ft. of water. The disk is 4-5 mm. across, the arms 40-50 mm. long. The color of the disk is pale gray, the arms white or nearly so; in the larger specimen many upper arm plates are obscurely blotched or shaded with light dusky purple.

**Amphioplus coniortodes** H. L. Clark

*Amphioplus coniortodes* H. L. Clark, 1918, Bull. M. C. Z., lxii, p. 291; pl. 7, figs. 3, 4.

This is another species based on a single specimen. The disk is 6-7 mm. in diameter, the arms 75-85 mm. long. The disk was very pale gray in life and the arms nearly white with a brown tinge near base; many upper arm plates were more or less dusky purple of a light shade, nearly always with a whitish spot at center. The colors of the dry specimen are not very different. This individual was taken in sandy mud, in ½ ft. of water, near a mangrove key at Key West, Florida, in June, 1917.

**Ophiactis algicola**[3] nom. nov.

*Ophiactis loricata* H. L. Clark, 1901, Bull. U. S. Fish Com., ii, p. 246 (NON Lyman).

*Ophiactis lymani* H. L. Clark, 1918, Bull. M. C. Z., lxii, p. 303; Pl. 4, figs. 5, 6. (NON Ljungman, 1871, öfv. Kongl. Vet. Akad. Förh., xxviii, p. 629. NON Koehler, 1926, Arkiv für. Zool. 1926, *19A*, No. 2, p. 24; Pl. 5, figs. 1, 2).

It is a curious thing that Dr. Koehler, whose recent death is a most serious and lamentable loss to the study of echinoderms, published excel-

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[2] For *Amphioplus stearnsii* Ives of my Porto Rican report (1901), see *antea*, p. 32.

[3] *Alga*=sea weed, *colo*=to inhabit or dwell in=referring to its habit of living in coralline algæ.

lent photographs of Ljungman's type of *Ophiactis lymani,* with hardly a word of comment except to refer his readers to his own notes on that species, published in 1909. He apparently overlooked the revision of the genus Ophiactis, published in 1918, in which many specimens from Tobago and the Tortugas were referred to *lymani* and serious doubt was expressed as to whether Koehler's specimens really were *lymani.* However, the publication, in 1926, of figures of Ljungman's holotype proves that my West Indian specimens are not his species but are an as yet unnamed form for which the name *algicola,* in allusion to its favorite habitat, is here proposed. The characters given in the key to the species of Ophiactis (1918, pp. 298, 299) as applying to *lymani,* refer wholly to *algicola,* and with the photographs given, and the notes on pp. 303, 304, will serve for an adequate diagnosis of the species. Ljungman's *lymani,* judging from Koehler's photographs, has extraordinary distinctive upper and under arm plates. It falls in the section of my key with *virens, arenosa* and *brachyaspis;* in fact it is so near the last that the question arises whether that species is not based on a specimen of *lymani.* But this and the question of the identity of Koehler's specimens from near the Cape Verde Islands must await the collecting of further material, before reliable answers can be given. Ljungman's *lymani* is not included in this report as it is not known from less than 10 fms.

The little brittle star herewith christened *Ophiactis algicola* is common in coralline algæ at Tobago and the Tortugas. I have also found specimens from Bermuda in the collection of the Museum of Comparative Zoölogy. The little Ophiactis taken by the "Fish Hawk" at Mayagüez, which I recorded as *loricata,* appears on reëxamination to be *algicola,* but the condition is poor and the identity is not indisputable. It seems probable that *algicola* will be found throughout the West Indies under suitable conditions. It is always a small brittle star, the disk rarely exceeding 3 mm., and there are 6 short arms. The color is gray or brown variegated with lighter and darker shades; there is no green; the arms are banded with dark gray or reddish; there is generally a distinct dusky spot on the upper side of two or three of the upper arm spines in each series. This is very characteristic but unfortunately is not always very obvious.

### **Ophiactis cyanosticta** H. L. Clark

*Ophiactis cyanosticta* H. L. Clark, 1918, Bull. M. C. Z., lxii, p. 307; Pl. 4, figs. 3, 4.

This little six-armed species has the disk 3 mm. across or less, the arms 10 mm. long. The color in life is dull bluish-green variegated with whitish, with irregular spots and markings of dull blue. Preserved specimens are not conspicuously different. In the coralline algæ of Buccoo Bay, Tobago, this Ophiactis is abundant in company with *O. algicola* and *O. savignyi*. I did not find it at the Tortugas, nor is it as yet recorded from any other place than Buccoo Bay.

### **Ophiactis mülleri** Lütken

*Ophiactis mülleri* Lütken, 1856, Vid. Med., p. 12. H. L. Clark, 1915, Mem. M. C. Z., xxv, Pl. 11, figs. 5, 6.

*Ophiactis dispar* Verrill, 1899, Univ. Iowa: Bull. Lab. Nat. Hist., v, No. 1, p. 31; Pl. 8, figs. 3-3c.

*Ophiactis longibrachia* H. L. Clark, 1901, Bull. U. S. Fish Com., ii, p. 246, Pl. 14, figs. 1-5.

This is probably the most perplexing and exasperating of West Indian brittle stars for it seems to be impossible to separate young specimens or even those half-grown from *O. savignyi,* yet adult *mülleri* are very different from adult *savignyi*. To add to the confusion really adult specimens of *mülleri* are so rare that only very few have come into the hands of students of the group. They have a disk diameter of 10-15 mm. (hence this is the largest known species of the genus) and they always have 5 arms, which are at least 7-8 times as long as the disk-diameter if they are quite unbroken. The coloration is varied but apparently is not green and white like *savignyi,* yet Verrill describes *dispar* as green and white; possibly Verrill had both large *savignyi* and small *mülleri* before him, when writing. My *longibrachia* from Porto Rico was almost black on the disk with the arms purplish-brown; oral frame and lower surface of basal part of arms pale yellowish. A large specimen taken at the Tortugas, which I believe to be *mülleri,* when alive had the disk gray at center becoming rusty-red at margin, and the interbrachial areas below were bright pinkish-red; interadially on the disk, there was some black and white variegation; oral surface, white with a reddish tinge; upper surface of arms buff, variegated with black, light and dark brown, and white. In this specimen, now dry, the red and brown shades have disappeared and have been replaced by an evident greenish tinge. It is not impossible that these large specimens which I am calling *mülleri* are merely fully grown individuals of *savignyi*. They are usually dredged in moderately deep water (5-75 fms.). Koehler certainly never appreciated the difficulty of distinguishing *mülleri* and *savignyi*. In his paper on West African echinoderms (1914, Beitrage Kennt. Meeresfauna Westafrikas: Echinoderma I, p. 185) he naïvely remarks (p. 185) that there are two 6-armed species of Ophiactis on the West African coast, *savignyi* and *mülleri,* and that they may even be taken at the same stations, but that they may be distinguished "facilement" because *savignyi* has such large radial shields and 2 oral papillæ. Alas, the size of the radial shields affords no reliable character at all, and *mülleri*, if my understanding of the species is correct, always has 2 oral papillæ, while *savignyi* often has 1 or none!

In view of this uncertainty as to the nature and limits of the species, it is futile to discuss the distribution. Koehler records it from West Africa and it may occur there. So far as my own knowledge goes I think it is to be found anywhere between South Carolina and Brazil but generally in water 2 fms. deep or more. I have never taken it along shore.

### **Ophiactis savignyi** (Müller and Troschel)

*Ophiolepis savignyi* Müller and Troschel, 1842, Syst. Ast., p. 95.
*Ophiactis savignyi* Ljungman, 1867, Öfv. Kongl. Vet. Akad. Förh., 23, p. 323.
Lütken, 1859, Add. ad Hist. Oph., pt. 2, Pl. 3, figs. 7*a*, 7*b* (as *O. reinhardtii*).

Next to *Amphipholis squamata*, this is probably the most ubiquitous of brittle stars, as it is tropicopolitan in its distribution. Moreover, as asexual reproduction by autotomy is continually going on, the number of individuals is greatly in excess of those of *A. squamata*. Where conditions are favorable *savignyi* is exceedingly common, but it is ordinarily so small and so secretive it is easily overlooked. It delights to live in and among sponges or coralline algæ, especially when young. Mature specimens are found in the crevices and crannies of coral rock. Adults ordinarily have 5 arms, sometimes 6; the disk is 5-7 mm. in diameter and the arms are 5 or 6 times as long. The color is variegated green and white, the outer ends of the radial shields almost always white. In the young, the green may sometimes be replaced by brown, the white by yellowish, and even in adults green may be inconspicuous or lacking. The young almost always have 6 arms, in two groups, 3 larger and 3 smaller, or only 2 in one group and 4 in the other. Comet forms, however, such as occur in *Linckia guildingii*, do not occur. Very small young ones of a light color are often found in the interior of light colored sponges, where they seem to be markedly gregarious.

It is quite natural that the Academy collections contain 62 individuals of this very common brittle star. They were taken at a dozen different stations which it seems unnecessary to enumerate, as there is no doubt *savignyi* is to be found anywhere around Porto Rico, where there are sponges and coral rock. It is perhaps worth mentioning that 3 adults were taken (apparently dredged) off the mouth of Guanica harbor, southeast of the bell-buoy, July 4, 1915, by R. C. Osburn, and 45 very small, light colored ones were collected at Guayanilla playa wharf, Ensenada, June 25, 1915, by R. W. Miner and R. C. Osburn; these were probably found in the sponges or other growth on the wharf piles.

## Family OPHIOTRICHIDÆ

### **Ophiothrix angulata** (Say)

*Ophiura angulata* Say, 1825, Jour. Phila. Acad., v, p. 145.
*Ophiothrix angulata* Ayres, 1852, Proc. Boston Soc. Nat. Hist., iv, p. 249. Lyman, 1865, Illus. Cat. M. C. Z., No. 1, Pl. 2, figs. 1-3 (colored).

This is perhaps the most abundant of the typically West Indian brittle stars. Its range extends from Beaufort, North Carolina, to southern Brazil. Its bathymetrical range is also considerable for while it abounds in very shallow water, it has been taken at a depth of 200 fms. off Havana, Cuba. The color is so varied that no fewer than six varieties have been named, based on color alone. The ground color is ordinarily brown or purple of some shade, usually rather light, but sometimes quite dark; some individuals are distinctly pinkish, reddish or yellowish. Green seems to be relatively rare and never of a marked tint. But whatever the ground color, there is, in the vast majority of specimens, a longitudinal stripe on the upper surface of the arms. In one color variety and in scattered individuals this is lacking, but there is usually, even in such cases, an indication of it on the distal part of the arm—at least at the very tip. As a rule, this stripe is white, commonly bounded by a line of color on each side, but in rare cases it is yellow, red or even black. In such cases the indications are that the colored boundary lines have crowded out the white, and coalesced. Whatever the color, *angulata* can always be distinguished from the other West Indian species of Ophiothrix by the absence of their distinctive characters.

The six color varieties of *angulata* which have been named are as follows:

1. *O. a.* var. *atrolineata* H. L. Clark, 1918, Bull. M. C. Z., lxii, p. 316; Pl. 5, fig. 3.

   The dorsal line on the arm is black instead of white, a rare variation. The type specimen was taken at Buccoo Bay, Tobago.

2. *O. a.* var. *megalaspis* H. L. Clark, 1918, Bull. M. C. Z., lxii, p. 316; Pl. 8, fig. 3.

   The radial shields are large, smooth, triangular, and sharply defined. The general coloration is pink or rose with the white longitudinal line on the arm bounded by a dull rose-purple stripe. The known specimens of this variety were taken in 51-101 fms. in the Gulf of Mexico; evidently it is a deep-water variety.

3. *O. a.* var. *phoinissa* H. L. Clark, 1918, Bull. M. C. Z., lxii, p. 317.
   The general color of this variety is deep crimson, with the white line on the arms limited to the extreme tip, or to regenerating parts, or even wanting. The specimens on which this variety is based were dredged at the Tortugas in 6-8 fms. of water or were collected at Coutoy, Cuba.
4. *O. a.* var. *phlogina* H. L. Clark, 1918, Bull. M. C. Z., lxii, p. 318.
   This variety cannot be certainly recognized in preserved material but when living or freshly killed it is very striking. The color then is uniform, brilliant orange-red. It is known as yet only from the Tortugas in 6-8 fms. In preserved material the color becomes pale pink, purplish or whitish.
5. *O. a.* var. *pœcila* H. L. Clark, 1918, Bull. M. C. Z., lxii, p. 319.
   This is the most difficult to diagnose of all the varieties of *angulata,* yet at Tobago it was breeding when typical *angulata* was not. It is a small form (disk about 3-5 mm. across) and intergrades not only with typical *angulata* but with the varieties *phlogina* and *violacea.* Its colors are varied but the arms are banded and lack (except oftentimes on the extreme distal part) the longitudinal white band characteristic of *angulata.*
6. *O. a.* var. *violacea* Müller and Troschel, 1842, Syst. Ast., p. 115.
   The German authors regarded this as a distinct species but it has commonly been treated as identical with *angulata.* It may however be considered a variety and in that case the name should be used for specimens in which the ground color is violet or deep blue. Such individuals are by no means rare.

As for size, *angulata* is a rather small species, the disk rarely exceeding 12 mm., the arms 5 or 6 times as much. It has been taken, as already stated, on the United States coast as far north as Beaufort, N. C., and is very common near Charleston and on the coast of Florida. It is known from Yucatan and Panama and from many points on the coast of Brazil. There are records from Bermuda, the Bahamas, the Tortugas, Cuba, Jamaica, Haiti, Porto Rico, St. Thomas, St. Lucia, Barbados, Tobago, and Trinidad.

The Academy collection contains 50 specimens from more than 20 stations, which it is quite unnecessary to list, since there is no doubt that *angulata* may be found everywhere on the Porto Rican coast when the conditions are at all suitable.

### Ophiothrix suensonii Lütken

*Ophiothrix suensonii* Lütken, 1856, Vid. Med., p. 16. 1859, Add. ad Hist. Oph., pt. 2, Pl. 4, figs. *2a-e*.

This is undoubtedly one of the most beautiful of West Indian brittle stars and has stirred the enthusiasm of every collector who has been so fortunate as to find an adult specimen. The arm-spines are conspicuously long, thorny and glassy, while the disk is flat with large smooth radial shields and a few long spinelets. The ground color ranges from lavender to pink or red, while on the dorsal side of the arm is a conspicuous longitudinal stripe of deep purple or crimson, sometimes so dark as to be almost black. In very large specimens, the disk may be nearly 20 mm. in diameter while the arms are about 120 mm. in length, but most specimens, even when mature, are much smaller than this.

This fine species lives altogether on gorgonians. Where these occur in abundance, there *suensonii* also abounds. Where there are no gorgonians, *suensonii* will rarely if ever occur. Its known geographical range is from Bermuda, the Bahamas, the Tortugas, the east coast of Mexico, and the north coast of South America to Brazil. It is recorded from Cuba, Jamaica, Haiti, Porto Rico, and St. Thomas, as well as from Barbados and Tobago. The bathymetrical range is very considerable, from 1 to 262 fms.

The Academy collectors brought back twenty-one specimens from Porto Rico, of which one lot is worthy of note. It was taken one mile south of Caño Gordo Island, near Guanica, June 23, 1915, by Dario Morcilio; there are 13 adults, none very large, but several are of an unusually dark purplish color.

### Ophiothrix lineata Lyman

*Ophiothrix lineata* Lyman, 1860, Proc. Boston Soc. Nat. Hist., vii, p. 201. H. L. Clark, 1915, Mem. M. C. Z., xxv, Pl. 12, fig. 4.

This handsome species seems to be confined to southern Florida and the Tortugas. The only record that I have found of its occurrence elsewhere is Mr. A. H. Clark's (1921) statement that one specimen was taken at Pelican Island, Barbados, in 4 fms., from gorgonians and corals. As 13 specimens of *O. suensonii* were taken at the same place under like conditions, I think this specimen must be a peculiar individual of that species. All the specimens of *lineata*, concerning whose habitat there is record, were found in the interior of large sponges, Siphonochalina and similar forms; for this peculiar habitat the brittle star seems particularly adapted. The color in life is a somewhat purplish-red with a conspicuous dark red line on the upper surface of the arm; in large specimens, this line may be more or less interrupted; the colors are little altered by preservation. Fully grown specimens are 12 mm. across the disk and the arms are about 120 mm. long, but I have seen few as large as that. In smaller specimens the arms are not only actually but relatively shorter; they may be only 5-6 times the disk diameter.

### Ophiothrix örstedii Lütken

*Ophiothrix örstedii* Lütken, 1856, Vid. Med., p. 15. 1859, Add. ad Hist. Oph., pt. 2, p. 149; Pl. 4, figs. 3*a-c*.

Although the ground color of *örstedii* shows considerable diversity, ranging from dark gray or brown to purple on the one hand, or to greens, greenish-blue or even cobalt blue on the other, the transverse white lines on the upper surface of the arms are an infallible mark of this handsome species. Even when the ground color is so strikingly unusual as in the variety *lutea* from Tobago (See H. L. Clark, 1918, Bull. M. C. Z., lxii, p. 314; 1919, Publ. 281 Carnegie Inst. Wash., Pl. 2) these fine transverse lines of white (or whitish or yellowish sometimes) are an unmistakable clue to the species. In size, *örstedii* ranks a little above *angulata*, as the disk may be more than 14 mm. in diameter and the arms exceed 80 mm. It is not so common as *angulata*, nor so widespread in distribution. It is not known from Bermuda nor from the United States coast north of Florida, nor is it recorded from south of Tobago; but there are records for the Bahamas, Cuba, Jamaica, Porto Rico, St. Thomas, Barbados and Tobago. The bathymetrical range is large, as specimens have been dredged in over 200 fms.

The Academy collection contains 29 specimens from 10 or more localities, but it seems unnecessary to list these stations as the species is known from all sides of Porto Rico and no doubt is present wherever conditions are suitable.

### Ophiothrix brachyactis H. L. Clark

*Ophiothrix brachyactis* H. L. Clark, 1915, Mem. M.C.Z., xxv, p. 269; Pl. 12, figs. 1, 2.

This is a relatively rare species previously known from only two localities, the Tortugas and Tobago. It is small, with the disk less than 5 mm. across and the arms less than 18 mm. long. The whole animal is distinctly flattened, arms as well as disk. The color is bluish-gray or pearl-gray and the arms may be indistinctly banded with lighter and darker shades. Because of this inconspicuous coloration and the small size, there is no doubt that *brachyactis* has long been confused with *angulata*. It is quite probable that it is not so rare as it seems. The Academy collection contains a notable example of this Ophiothrix—notable because it is the largest yet found. The disk is 4.5 mm. across and the arms are nearly 14 mm. long. The very flattened appearance is striking. This specimen, the first known from Porto Rico, was taken off Guanica Harbor (due south of the bell-buoy), July 4, 1915, by R. C. Osburn.

## Order *CHILOPHIURIDA*

### Family OPHIOCHITONIDÆ

#### **Ophionereis olivacea** H. L. Clark

*Ophionereis olivacea* H. L. Clark, 1901, Bull. U. S. Fish Com., ii, p. 248; Pl. 14, figs. 10-13.

This rare species is known only from the original specimen taken by the "Fish Hawk" at the eastern end of Porto Rico, in 6 fms., and from a young individual which I found in 1917 near Key West, Florida, in coralline algæ. The type was 6 mm. across the disk and the arms were about 33 mm. long. The color is olive-green, spotted on the disk with yellow; the arms are banded with a darker shade of green; the oral surface is very light. The Key West specimen is only a little more than half as large and lacks the yellow spots on the disk.

#### **Ophionereis reticulata** (Say)

*Ophiura reticulata* Say, 1825, Jour. Phila. Acad., v, p. 148.
*Ophionereis reticulata* Lütken, 1859, Add. ad Hist. Oph., pt. 2, p. 110; Pl. 3, figs. 6*a-c*.
*Ophionereis dubia* H. L. Clark, 1901, Bull. U. S. Fish Com., ii, p. 248. (NON Müller and Troschel.

This is another of the common brittle stars of the West Indian region, abundant at Bermuda and ranging thence to Tobago, the northern coast of South America, and Brazil. It delights in clean sand under coral slabs and wherever any intensive shore collecting has been done on such bottoms this Ophionereis has been found. It is also recorded from depths out to and beyond the 100 fms. line. It is easily recognized by the whitish or pale yellow arms, with conspicuous narrow bands of brown or blackish, and the bluish-gray disk which is ordinarily marked with a net-work of dark lines; but there is no little diversity in the extent and character of the disk markings. Specimens with no markings whatever on the disk are not rare. Occasionally specimens are seen in which the ground color is tinged with red. After reëxamination of the specimens, I think the Ophionereis which I recorded in 1901 from Porto Rico as *O. dubia* must be referred to *reticulata*. The reddish color is extraordinarily deep but it is possible that it is more or less artificial. At any rate, the specimens are not *dubia.* Adult specimens of *reticulata* have the disk 10-12 mm. across, not often more, while the arms may be 7 or 8 times as long.

The Academy collection contains half a dozen specimens of this brittle star, taken at various points in or around Guanica harbor. Three half grown specimens and one young one have no lines on the disk, but one adult and one young individual are typical. The "Fish Hawk" took 21 specimens at seven stations, three of which were at depths of over 20 fms.

### **Ophionereis squamulosa** Koehler

*Ophionereis squamulosa* Koehler, 1914, Bull. 84 U. S. Nat. Mus., p. 44. 1913, Zool. Jahrb. Suppl., 11, Pl. 21, figs. 4-6 (as *O. squamata*).

This is a small species, the great majority of specimens taken having the disk less than 4 mm. across; the largest specimen I have seen has the disk 6 mm. in diameter and the arms about 40 mm. long. In life the disk and arms are a reddish-white (the red tint is lost more or less wholly in preservation), the disk with scattered spots and blotches of brown or dusky, the arms with frequent ill-defined but well-marked bands of the same dark shade; in a typical case every third or fourth upper arm plate is deep dusky in marked contrast to the plate adjoining it proximally, but the plate distal to it is quite dusky and the next one may be slightly so; thus the distal boundary of the band is very indistinct. Occasionally the ground color of both disk and arms is distinctly brown rather than white. Koehler's idea that the scaling of the disk is coarser than in *reticulata* is not supported by examination of numerous specimens; only in certain individuals does this hold true. This species is recorded from St. Thomas, and from the Brazilian coast near Parahiba. It is very common in coralline algæ at Tobago and the Tortugas, and will probably be found throughout the West Indies when suitable areas are intensively searched.

## Family Ophiocomidæ

### **Ophiocoma echinata** (Lamarck)

*Ophiura echinata* Lamarck, 1816, Anim. s. Vert., ii, p. 543.

*Ophiocoma echinata* L. Agassiz, 1835, Mem. Soc. Sci. Nat. Neûchatel, i, p. 192. Lütken, 1859, Add. ad Hist. Oph., pt. 2, Pl. 4, figs. 7*a-d*.

These big black brittle stars are among the most common and conspicuous animals of the tropical shores of the West Indian region. The color is more or less nearly black, usually with a brown or gray tinge; the disk is often conspicuously marked with cream color. In full grown adults the disk may exceed 30 mm. in diameter and in such specimens the arms may be 125-150 mm. long. It ranges from Bermuda, the Bahamas, Florida and the Tortugas, and Panama, to Brazil and the eastern Atlantic. The bathymetrical range is insignificant.

The Academy collection contains 32 specimens from various stations but only one calls for comment. This is a small individual only 3 mm. across the disk. It was taken among rocks opposite Fort San Geronimo, San Juan, July 16, 1914, by R. W. Miner and is labeled "*O. riisei*". The disk is well covered with granules which would not be the case with *riisei* at such an age; moreover, the basal pores of the arms have 2 tentacle-scales, and the color is variegated with whitish, especially orally. The "Fish Hawk" brought back over one hundred specimens of *echinata* from Porto Rico, taken at four shore stations and at one dredging station in 6 fms., where tangles were used.

### **Ophiocoma riisei** Lütken

*Ophiocoma rïisei* **Lütken, 1859, Add. ad Hist. Oph., pt. 2, pp. 141, 143; Pl. 4, figs. 6*a-d*.**

It is really remarkable how constant the characters of this fine species are, even though it is found under the same slabs of rock with *echinata*. I have never seen a specimen that showed any indication of hybridization or any variation toward any other species of the genus. It resembles most closely the Indo-Pacific species *schoenleinii*, but the latter never shows the characteristic rusty-red shades of *riisei*. While adult specimens of this West Indian form appear to be quite uniformly black, young ones always have a red-brown cast which is particularly marked in very young specimens. In young individuals, moreover, there are irregular markings, on the disk, of darker and lighter shades of red-brown, and the arms are faintly banded with the same color. There is never any white in the coloration. The bright rust-red tentacles of the arms, especially near the disk, are very characteristic. The largest specimen I have seen is 32 mm. across the disk with arms 160 mm. long. A remarkable feature of this species is the late stage at which the disk-granules appear, usually not until the individual is 5 mm. or even more across the disk. Such specimens do not seem to be Ophiocomas at all and give great difficulty in identification. In Jamaica, *riisei* breeds in May or possibly earlier, while *echinata* is not breeding until July. This probably accounts for the absence of hybrids. There is no doubt that *riisei* is less common, though about as widespread as *echinata*. It does not occur in the eastern Atlantic but it is found in Bermuda, on the coast of Honduras, at Curaçao, and in Brazil, not to mention the various West Indian Islands where it has been taken.

The Academy collection contains 19 specimens from half a dozen places, of which the most notable is a superb adult 30 mm. across the disk, with arms about 175 mm. long. This specimen was taken at the west end of the reef between Pardas Bay and Harbor Entrance, Ensenada.

### **Ophiocoma pumila** Lütken

*Ophiocoma pumila* Lütken, 1859, Add. ad Hist. Oph., pt. 2, pp. 141, 146; Pl. 4, figs. 5*a-d*.

This species is much less conspicuous than the preceding two but it is equally common and widespread, ranging from Bermuda and Florida to Brazil and São Thomé in the Gulf of Guinea. Verrill records a specimen from off Havana in 200 fms. but this is certainly exceptional as the usual habitat of *pumila* is in nooks and crannies of coral rock or among coralline algæ, close to low water mark. It is particularly partial to algæ, amongst which its greenish and brownish coloration renders it very inconspicuous. The disk diameter seldom exceeds 15 mm. but the arms may measure 10 times that. Asexual reproduction by autotomy is characteristic of the young, which closely resembles *Ophiactis savignyi* in having 6 arms and in being green and white in color. The two species may occur together, though ordinarily they do not, and it is no easy matter to separate the very young individuals. The green color becomes less and less marked as *pumila* matures, and in adult specimens only brown of various shades, and white, remain except at the distal ends of the arms where the green often persists.

The Academy collection contains 16 specimens from a dozen different places. Most of them are young with 5 rays but a few are full grown. One very fine one from the outer reef, south of entrance to Guanica harbor, is 16 mm. across the disk.

### **Ophiopsila riisei** Lütken

*Ophiopsila riisei* Lütken, 1859, Add. ad Hist. Oph., pt. 2, p. 136; Pl. 5, figs. 2*a-c*.

This is a fairly common brittle star at the Tortugas, and Mr. Lyman says it is very common at Cape Florida. I have not found it in Jamaica or Tobago and it is not known from Bermuda. It has been recorded from the Bahamas, Porto Rico, St. Thomas, St. Bartholomew, the east coast of Central America, the north coast of South America, and Brazil. It ranges from low-water mark to 200 fms. It does not reach a large size, adults having the disk 10-12 mm. across and the arms 100-130 mm. long. The coloration is very distinctive; the ground color is brown, sometimes grayish, but usually of a reddish shade, sometimes quite a bright red brown;

but the red shades fade out in dry material as a rule. Whatever the ground color, however, the disk above, the interbrachial areas below, and even the basal part of the arms in some individuals, are speckled with fine, distinct dots of black; in dry material these fade to brown, but they are almost always obvious. The arms are more or less indistinctly banded.

The Academy collection contains half a dozen specimens, all but one of which are from the vicinity of Guanica. The other specimen is from Point Brea. One specimen is immature, the others are typical adults. The "Fish Hawk" took two specimens at the eastern end of Porto Rico in 20-23 fms.

### **Ophiopsila vittata** H. L. Clark

*Ophiopsila vittata* H. L. Clark, 1918, Bull. M. C. Z., lxii, p. 330; Pl. 8, fig. 2.

This rare species is based on 3 specimens taken at the Tortugas, in June, 1917. They were dredged in 6-8 fms., southeast of Loggerhead Key. No other specimens have yet been reported. The disk is about 7 mm. in diameter, the arms 75-80 mm. long. The color of the disk is yellowish-gray, the radial shields white; arms, very pale yellow banded with red-brown rings; upper arm plates sparsely but regularly spotted along the lateral margins with minute dots of reddish-brown.

### **Ophiopsila hartmeyeri** Koehler

*Ophiopsila hartmeyeri* Koehler, 1913, Zool. Jahrb. Suppl. 11, p. 368; Pl. 21, figs. 7, 8.

This is not a common species and occurs usually in water of some depth (15-88 fms.) but the type was taken on the south coast of St. Thomas, apparently in shallow water. Adult specimens have the disk 6 mm. across and the arms perhaps ten times as much. The disk is reddish or orange-yellow, with the radial shields lighter, sometimes almost white; the upper surface of the arms is marked with lines and blotches of purplish or dusky. This species is known as yet only from Florida, St. Thomas, Montserrat, Barbados, and Brazil.

## Family Ophiodermatidæ

### **Ophioderma appressum** (Say)

*Ophiura appressa* Say, 1825, Jour. Phila. Acad., v, p. 151.
*Ophioderma appressa* Lütken, 1859, Add. ad Hist. Oph., pt. 2, p. 86; Pl. 1, figs. 4*a-d* (as *O. virescens*).

This is one of the commonest of West Indian brittle stars, being found in practically all places where collections have been made, from Bermuda to Brazil and the eastern Atlantic (Senegal, Angola). The largest specimens have the disk 25 mm. across and arms about 125 mm. long, but such individuals are rare and the great majority have the disk 10-15 mm. in diameter. The coloration is so diversified as to be of no value for identification. Most specimens are some shade of gray or brown, the arms more or less distinctly banded with lighter and darker shades. In some specimens this banding is very conspicuous. The most striking variety is one, variegated bright green and white, as yet unnamed I believe, although it is common; in extreme cases the disk is wholly white and the white arms are prettily banded with green; all sorts of intergrades occur between this and uniformly green or greenish individuals.

The Academy collection has 18 specimens of *appressum* but all save one young one are dull colored. They were taken at 8 different stations but offer nothing of special interest. The "Fish Hawk" and Mr. Gray found *appressum* generally common.

### Ophioderma brevicaudum Lütken

*Ophioderma brevicaudum* Lütken, 1856, Vid. Med., p. 8. 1859, Add. ad Hist. Oph., pt. 2, Pl. 1, figs. 3*a-c*.

This species, which can usually be identified by the short, thick arms, is also often recognizable by the blue-green and reddish in the variegated color. But this color distinction shows a regrettable lack of constancy. Typical specimens have the disk prettily variegated with a rather deep red and blue-green or greenish-blue; the arms are more or less distinctly banded and marked with blue or blue green. In some specimens the colors, excepting red, are retained well by the drying out, and even in alcohol there may be little change. On the other hand, many specimens lack bright colors and tend to be rather dull, and alcoholic specimens frequently become more or less bleached. Large specimens are nearly 20 mm. across the disk, but 14 mm. is fully adult. The arms are 2.5 to 4 times the disk diameter. The range of *brevicaudum* is from Bermuda and the Bahamas to the eastern Atlantic. The bathymetrical range is very small, the species seeming to prefer to live close to low-water mark.

The Academy collection contains 16 specimens of *brevicaudum* from 9 stations. They show very great diversity of color, but none has the bright blue-green which has just been described as characteristic. The most notable is a specimen from Condado rocks, directly opposite Fort San Geronimo, San Juan, which has the disk dirty whitish and rose-red; there are also 4-6 bands of rose-red on the upper surface of the arms; this must have been a very pretty brittle star when living.

**Ophioderma brevispinum** (Say)

*Ophiura brevispina* Say, 1825, Jour. Phila. Acad., v, p. 149.
*Ophioderma brevispina* Lütken, 1859, Add. ad Hist. Oph., pt. 2, Pl. 1, figs. 6*a-c* (as *O. serpens*).

This species is so easily confused with *appressum* that it is not certain whether it occurs as far to the east and south as that species. Verrill says it appears at the Bermudas but I have seen no specimens from there. In fact, all the specimens of typical *brevispinum* that I have seen are from Florida, the Tortugas, Cuba, Jamaica, Hayti, Porto Rico, and St. Thomas. I did not find it at Tobago. The plain colored variety, *olivaceum,* ranges as far north on the United States coast as Buzzards Bay, a very notable extension of the range of what is a very typical tropical genus. In size *brevispinum* is much smaller than *appressum,* most specimens measuring about 10 mm. or less across the disk; the largest I have seen is 15 mm. and has arms about 70 mm. long. The coloration is as varied and indistinctive as that of *appressum* but it is more prevailingly green. Few specimens are handsomely colored but in a lot collected at the Tortugas one has the disk deep purplish-brown in sharp contrast to the arms which are greenish-white banded with dull greenish, and in a lot from Miami, Florida, several have the disk white in sharp contrast to the dull green, faintly banded arms; another has similar arms but the disk is the green-blue of *brevicaudum;* and a third is notable for a rosy-reddish disk with a few wide bands of the same shade on the arms. The variety *olivaceum* is dull olive-brown or olive-green, the disk frequently variegated with lighter and darker shades. It is an interesting fact that 4-armed and 6-armed specimens of *brevispinum* are encountered more frequently than in any other normally 5-rayed ophiuran, so far as my observation goes.

The Academy collection contains only 3 small specimens of *brevispinum,* one from Don Luis Cayo, Salinas Cove, one from off the mouth of Guanica Harbor, and one from a mangrove island at Parquera. The "Fish Hawk" brought back 27 specimens from 7 stations.

**Ophioderma januarii** Lütken

*Ophioderma januarii* Lütken, 1856, Vid. Med., p. 7. 1859, Add. ad Hist. Oph., pt. 2, Pl. 1, figs. 5*a-c*.

This is a Brazilian species, included in this report because of its occurrence at Tobago, where a single specimen was taken by me in Buccoo Bay. It is a handsome, active species, with slender, flattened, attenuate arms. Although it is very difficult to separate small specimens of *januarii* from *brevispinum* in an artificial key, the two species are quite unlike, especially in life. The upper surface of the southern species is variegated with shades of brown or gray; the lower surface is pure white. In the dry Tobagoan specimen, the gray shades are markedly green, and the lower surface is no longer white. The disk of an adult *januarii* measures 15-18 mm. across and the arms are about 5 or 6 times as much. It is hardly likely that this southern species will be found in Porto Rico.

**Ophioderma cinereum** Müller and Troschel

*Ophioderma cinereum* Müller and Troschel, 1842, Syst. Ast., p. 87. Lütken, 1859, Add. ad Hist. Oph., pt. 2, Pl. 1, figs. 1*a-c* (as *O. antillarum*).
*Ophiocryptus hexacanthus* H. L. Clark, 1915, Journ. Ent. Zoöl., vii, p. 64, =*cinereum* juv.

This is a very large species, full grown adults having the disk 35 mm. across; the arms are relatively short, only 4 times the disk diameter. The color is dull, varying from a light to a very deep ashy brown; light colored specimens generally have the arms distinctly banded and often have spots or markings on the disk; dark colored specimens are often unicolor. Like the other common members of the genus, *cinereum* ranges from Bermuda to Brazil, but it is not known from the eastern Atlantic. It is very common and reaches a large size in Tobago.

The Academy collection contains but a single specimen, an adult taken at the coral reefs at Ballena Point, Ensenada, June 12, 1915. The "Fish Hawk" brought home 63 specimens from Ensenada Honda (Culebra) and Puerto Real.

**Ophioderma phœnium** H. L. Clark

*Ophioderma phœnium* H. L. Clark, 1918, Bull. M. C. Z., lxii, p. 333; Pl. 6, figs. 1, 2. 1919, Publ. 281 Carnegie Inst. Wash, Pl. 3, fig. 1.

This very handsome species is, so far as we know at present, found only on Buccoo Reef, Tobago. It measures 20-23 mm. across the disk when adult, and the arms are about 4 times as much. Typically the disk is red and the arms green, but some specimens are all red and some are all green; moreover there is no little diversity in the shades, both of the greens and the reds.

**Ophioderma rubicundum** Lütken

*Ophioderma rubicundum* Lütken, 1856, Vid. Med., p. 8. 1859, Add. ad Hist. Oph., pt. 2, Pl. 1, figs. 2*a-c*.

This is a notably handsome species with a wide range but it is far from common, apparently living normally in water a little too deep for the shore collector and not deep enough for the dredge. It has been taken at the Bahamas, Cape Florida, Tortugas, Colon, Jamaica, Porto Rico, St.

Thomas, Guadeloupe, Barbados, and Tobago. Large specimens are 20 mm. across the disk and have arms rather more than 5 times as long. The color is variegated red and whitish or pale gray; there are usually at least two shades of red, both with a purple tinge but one deeper than the other; the mottling of the arms often appears like banding, especially distally. The markings on the upper arm-plates are often very beautiful when examined with a lens.

The Academy collection contains a small but typical *rubicundum* from off Guanica Harbor, and there is also a superb specimen, 15 mm. across the disk, very richly variegated with shades of deep purplish red and creamy white, from the Mangrove Island, at Parguera, Ensenada. The "Fish Hawk" secured three specimens of this species at Ensenada Honda (Culebra), Ponce and Station 6097, 9.5-12.5 fms.

### **Ophioderma guttatum** Lütken

*Ophioderma guttata* Lütken, 1859, Add. ad Hist. Oph., pt. 2, p. 95; Pl. 1, figs. 8*a*, *b*.

This is one of the rarer members of the genus; originally taken at St. Thomas, it has since been found only at Jamaica and Tobago. It is fairly common on Buccoo Reef, Tobago, but in Jamaica, only a very few specimens have been taken, on the north coast at Port Antonio and Montego Bay. Full grown adults are nearly 30 mm. across the disk, with arms 150 mm. long. The color is a clear lead gray above, and dull reddish-yellow or buff underneath.

### **Ophioderma squamosissimum** Lütken

*Ophioderma squamosissimum* Lütken, 1856, Vid. Med., p. 8. 1859, Add. ad Hist. Oph., pt. 2, Pl. 1, figs. 7*a*, *b*. H. L. Clark, 1918, Bull. M. C. Z., lxii, p. 335; Pl. 4, fig. 1; Pl. 6, figs. 3, 4. 1919, Publ. 281 Carnegie Inst. Wash., Pl. 3, fig. 2.

It is doubtful whether a more brilliantly colored animal is to be found on West Indian reefs than this gorgeous brittle star. Unfortunately it seems to be exceedingly rare for aside from the unique holotype, from an unknown West Indian locality, the only known specimens are the five we secured at Tobago in 1916. These were all found (but only by long and intensive searching) on the least exposed parts of Buccoo Reef. They measure 17-22 mm. across the disk and the arms are about 4 times as long. The brilliant vermilion color is very fugacious, and has entirely disappeared from the carefully prepared dry specimens, though it persisted for some months.

**Ophiocryptus dubius** H. L. Clark

*Ophiocryptus dubius* H. L. Clark, 1918, Bull. M. C. Z., lxii, p. 336; Pl. 3, figs. 4, 5.

This species is based on a single small brittle star found under a stone in shallow water in Buccoo Bay, Tobago. It is 4.5 mm. across the disk and the arms are about 12 mm. long. Color in life, pale gray above, nearly white beneath; upper surface of arms with faint indications of 2 or 3 dusky transverse bands. It is possible that the genus Ophiocryptus is based simply on very young Ophiodermas, but only the collecting of more material can settle the matter. There seems to be no doubt that my *Ophiocryptus hexacanthus* is simply a very young *Ophioderma cinereum*, and it seems to me highly probable that the same is true of the present form.

Family OPHIOLEPIDIDÆ

**Ophiozona impressa** (Lütken)

*Ophiolepis impressa* Lütken, 1859, Add. ad Hist. Oph., pt. 2, p. 101; Pl. 2, figs. 3*a*, *b*.

*Ophiozona impressa* Lyman, 1865, Illus. Cat. M. C. Z., No. 1, p. 64.

This is a common brittle star throughout the West Indian region from Bermuda to Brazil. Its bathymetrical range extends down to 160 fms. Large specimens are 15 mm. across the disk and the arms are nearly 5 times as much. The lower surface is white or cream-color while the upper side is prettily variegated with brown and cream-color or yellowish; the arms are distinctly banded with light and dark brown.

The Academy collection contains 3 typical adult specimens, 2 from near the entrance to Guanica Harbor and 1 from near the entrance to Guayanilla Harbor. The "Fish Hawk" took 5 specimens at Ponce.

**Ophiolepis elegans** Lütken

*Ophiolepis elegans* Lütken, 1859. Add. ad Hist. Oph., pt. 2, p. 105. Lyman, 1865, Illus. Cat. M. C. Z., No. 1, Pl. 2, fig. 5 (colored).

This handsome and graceful species delights in pure sand and seems to be particularly adapted, by its very flattened form, to the life it leads. It is not certainly known from east of St. Thomas and it is quite possible that it is confined to the northwestern part of the West Indian region. It is recorded from South Carolina, Florida, Cuba, Yucatan, Jamaica, Porto Rico, and St. Thomas. The bathymetrical range extends down to about 40 fms. The disk is usually about 10-12 mm. across with the arms only a little more than 3 times as long, but a large specimen from Charleston, S. C., is 21 mm. across. This big individual is also very dark-colored above (all specimens are very white or light colored underneath), a finely variegated slate gray of two shades. Usually the dorsal surface is greatly variegated with various shades of cream-color and gray and brown; in small specimens the arms are distinctly banded but in larger individuals the bands are less and less distinct.

The Academy collection contains 26 specimens of *elegans*, of which 22 are from Condado Bay, San Juan, while the others also appear to be from San Juan harbor. The "Fish Hawk" took but a single specimen and that a small one dredged at Station 6086 in 14¾ fms.

**Ophiolepis paucispina** (Say)

*Ophiura paucispina* Say, 1825, Jour. Phila. Acad., v, p. 149.
*Ophiolepis paucispina* Müller and Troschel, 1842, Syst. Ast., p. 90. Lütken, 1859, Add. ad Hist. Oph., pt. 2, Pl. 2, figs. 2*a*, *b*.

This little brittle star, because of its small size and secretive habits, is no doubt often overlooked; nevertheless it is recorded from eight places from Bermuda to Brazil (inclusive) as well as from at least two points in the Gulf of Guinea. It lives in the sand under rocks or among sea-weeds, and its bathymetrical range seems to be but a few fathoms. The largest specimen I have seen is 6 mm. across the disk and the arms are about 15 mm. long, but few individuals reach such a size. The colors are very inconspicuous and harmonize well with the sand. The disk is frequently more gray than the arms, while the latter are more or less distinctly banded with brown of two shades.

The Academy collection adds this Ophiolepis to the fauna of Porto Rico, as the "Fish Hawk" did not secure a specimen. At the coral reefs and lagoons, four miles east of Talleboa, a typical adult specimen of *paucispina* was taken July 29, 1914, by R. W. Miner.

## ECHINOIDEA

Sea-urchins; sand-dollars; heart-urchins

The littoral sea-urchins are so well known and the line between them and the deep-water forms is so easy to draw that there is little room for difference of opinion as to what species should be included in this report. The only case regarding which I am in doubt is that of Brissopsis. In my Porto Rican report of 1901 (p. 254) I record *Brissopsis lyrifera* from Fish Hawk station 6059, off the west end of Porto Rico in only 7 fms. Mortensen (1907, Ingolf Ech., pt. 2, p. 163) has shown that these are not *lyrifera* but an undescribed species to which he gave the name *elongata*. As he records a specimen from Puerto Cabello, Venezuela, it seems necessary to include the species in this report, although I am inclined to question whether the depth recorded for the Porto Rican specimens is correct; if correct, it must be exceptional, as Brissopsis is really a genus of moderately deep water, especially in the tropics. Even including Brissopsis there are only 19 species of Echini to be treated and as these are distributed in 15 genera, the use of the key will afford very little difficulty, even to a beginner.

### Key to the Echini

A. Mouth provided with jaws; ambitus more or less circular.
- B. Periproct at apical pole; test not flattened; primary spines conspicuously big.
  - C. Primary spines, not more than one to each plate, solid and stout, abruptly much bigger than all other spines........ *Eucidaris tribuloides*
  - CC. Not as above.
    - D. Primary spines very long, slender and hollow, black or very dark (in young individuals banded, light and dark) ........................ *Centrechinus antillarum*
    - DD. Not as above.
      - E. Ambitus circular; pore-pairs in arcs of 3 or in 3 vertical series.
        - F. Periproctal plates normally 4; oral primary spines with "shiny, pink, vitreous shoes".. *Arbacia punctulata*
        - FF. Periproctal plates numerous; no "shoes" on oral primaries.
          - G. Buccal membrane heavily plated; pore-pairs in regular arcs of 3............ *Lytechinus variegatus*
          - GG. Buccal membrane not plated; poriferous areas of ambulacra very wide with pore-pairs in 3, more or less distinct, vertical series...... *Tripneustes esculentus*
      - EE. Ambitus elliptical; pore-pairs in arcs of 5 or more.
        - F. Pore-pairs in arcs of 6, or even 7; many spines on abactinal system; colors not as in *viridis* ..................... *Echinometra lucunter*
        - FF. Pore-pairs in arcs of 5; few spines on abactinal system; primary spines light brownish, more or less green distally, and with purple tips ..................... *Echinometra viridis*
- BB. Periproct on oral surface; test more or less depressed, usually quite flattened; no noticeable primary spines.
  - C. Test without lunules or marginal notches.
    - D. Test well arched, with lower surface deeply concave, its margin thick, at least 25% of test length...... *Clypeaster rosaceus*

DD. Test flattened, with lower surface flat, its margin rarely thicker than 10% of test length..*Clypeaster subdepressus*

CC. Test with lunules or marginal notches or both.

D. Genital pores 5; test very solid.

E. Test elevated equally both anterior and posterior to abactinal system; interradial lunule very large ..........................*Encope emarginata*

EE. Test highest back of abactinal system; interradial lunule moderate or small..........*Encope michelini*

DD. Genital pores 4; test more fragile.

E. Lunules 5.................*Mellita quinquiesperforata*

EE. Lunules 6...................*Mellita sexiesperforata*

AA. Mouth without jaws; ambitus elliptical; usually a well-marked antero-posterior axis.

B. Peristome oblique without a lip; ambulacra not petaloid; periproct oral, close to peristome............*Echinoneus cyclostomus*

BB. Peristome transverse with a well-marked lip on posterior margin; ambulacra petaloid on dorsal surface; periproct posterior.

C. Subanal fasciole wanting; petals deeply sunken, to an extreme degree................................*Moira atropos*

CC. Subanal fasciole present; petals not deeply sunken.

D. Ambulacrum III more or less distinctly sunken and petaloid dorsally; posterior petals not longer than anterior ...........................*Brissopsis elongata*

DD. Ambulacrum III not petaloid and little or not sunken; posterior petals may be much the longest.

E. Anal fasciole, arising from subanal on each side of periproct, well marked; primary tubercles and spines in interambulacra 1 and 4, within peripetalous fasciole, very conspicuous............ *Plagiobrissus grandis*

EE. Anal fasciole wanting; no conspicuous spines or tubercles in interambulacra 1 and 4.

F. Subanal plastron distinct with subanal fasciole complete.................*Brissus brissus*

FF. Subanal plastron indistinct with subanal fasciole incomplete.............*Meoma ventricosa*

## Order *CIDAROIDA*

### Family Cidaridæ

**Eucidaris tribuloides** (Lamarck)

*Cidarites tribuloides* Lamarck, 1816, Anim. s. Vert., iii, p. 56. A. Agassiz, 1872, Rev. Ech., pt. 2, Pls. 1*d* and 2, figs. 1-3 (as *Cidaris tribuloides*).
*Eucidaris tribuloides* Döderlein, 1887, Jap. Seeigel, p. 42.

Although there are several species of Cidaridæ common in the West Indian region, only this one ever comes into really shallow water. It sometimes occurs in great numbers but ordinarily it is found singly under or among rocks near low-tide level. On one occasion at Port Antonio, Jamaica, in Feb. 1909, there were hundreds, if not thousands, of Eucidaris in shallow water on "grassy" bottom (sandy bottom covered with short eel-grass) south and southwest of Navy Island. But I have never seen this abundance repeated either at Port Antonio or at any other place. This sea urchin is of moderate size; the largest of which I have record is 56 mm. in diameter. The primary spines are usually about equal to the diameter of the test but are often less than that and often are much more, especially in specimens from water of moderate depth. Such long-spined specimens are frequently mistaken for one of the deep-water species. The color of *tribuloides* is usually a light brown or fawn-color, striped or shaded with darker brown and often marbled with white; the primaries are often encrusted with sponges or bryozoa, and similar foreign growths, concealing their natural coloration. In some specimens there is something of an olive-green tinge, while in others red is a more or less notable shade.

Eucidaris occurs at Bermuda, near North Rock, but is rare. It is common in the Bahamas, on the Florida coast, and among the keys. It is reported from the Carolina coast but not along shore. It occurs in numbers throughout the Greater Antilles, and is recorded also from St. Thomas, Antigua, Barbados, and Tobago. It has been taken at Swan Island, on the east coast of Central America, the north coast of South America, and Brazil. There seems to be no doubt of its occurrence also at Ascension and the Cape Verdes, and probably at many other points in the eastern Atlantic.

The Academy collection contains ten examples of Eucidaris, ranging from 7 to 30 mm. in diameter. Several of these deserve special mention. The specimen 30 mm. in diameter has the primaries 32 mm. long and very blunt, practically truncate; it was taken at Ensenada by C. L. Van Bogaert. A smaller specimen from inside Cayo Maria Langa, near mouth of Guayanilla Harbor, taken by R. C. Osburn, June 25, 1915, has even more notable primaries, for many of them actually flare at the tip and might be called coronate. Another small specimen from Guanica Harbor, due south of the bell-buoy, taken by R. C. Osburn, July 4, 1915, also has coronate primaries. Two small adults from rocks opposite Fort San Geronimo, San Juan, are notable for their short, thick primaries; in one case, these are overgrown with soft, fine algæ. A specimen from Condado Rocks, opposite Fort San Geronimo, San Juan, 27 mm. in diameter, has spines 35 mm. long, strikingly banded with deep dull purplish-red and dark dull yellow. A specimen from just outside Guanica Harbor is 20 mm. in diameter, while the primaries are 25-29 mm. long; they are thickest 3-4 mm. from the base, and then taper to a more or less blunt point; a typical one is 28 mm. long, more than 2 mm. thick at base, 3 mm. thick 4 mm. from base, and less than 1 mm. at tip. The contrast between such a spine and the coronate primaries already mentioned is so striking as to warrant the supposition that they belonged to different species!

The "Fish Hawk" brought back many specimens of Eucidaris from Arroyo and Mayagüez where it seems to be common. It was also dredged at three stations in water 6-14 fms. deep.

## Order *CENTRECHINOIDA*

### Family CENTRECHINIDÆ

#### **Centrechinus antillarum** (Philippi)

*Cidaris* (*Diadema*) *antillarum* Philippi, 1845, Arch. für. Naturg. 11 (i), p. 355.
*Centrechinus antillarum* H. L. Clark, 1918, Univ. Iowa: Bull. Lab. Nat. Hist., vii, No. 5, p. 24. Nutting, 1895, Univ. Iowa: Bull. Lab. Nat. Hist., iii, p. 224, unnumbered plate, fig. 1 (young Centrechinus labelled "Aspidodiadema sp.").

This conspicuous big sea-urchin, which is nearly or quite black when alive, deep purple-brown or red-brown with almost black spines when dry, is one of the best known of West Indian echinoderms. Adults may be 100 mm. in diameter with spines 300-400 mm. long. These spines are slender, hollow, covered with crowded whorls of microscopic spinelets, pointing distally, and terminate in needle-like points, which pierce human skin without the slightest difficulty. As the mucus on the spines is an irritant poison the effect of touching one of them is much like being stung by a hornet, but is even more painful to many persons. The tip of the spine breaks off in the wound and is ultimately (in normal cases) absorbed. The pain decreases after a few minutes and ordinarily disappears in half an hour or less. There is no swelling accompanying the wound. Of course the degree of poisoning and of pain varies with the person affected. Stories are told of serious injury, and even the death of small children, resulting from falling into a group of these urchins and thus receiving multiple wounds. It is probable that such stories are exaggerations; nevertheless anyone who has once suffered from a single spine finds it easy to believe that death would result from too many such wounds!

This sea-urchin ranges from Bermuda, the east coast of Mexico and the north coast of South America, to Tobago, Brazil, and the eastern Atlantic. Closely allied species occur on the west coast of Mexico, in Hawaii and throughout the Indo-Pacific region clear to the Red Sea and Mozambique.

All were formerly considered a single species (*Diadema setosum*) but there is no doubt that the West Indian form is quite distinct. In some places, as at Buccoo Reef, Tobago, it is exceedingly abundant and hundreds, perhaps thousands, occur in groups of half a dozen to twenty or more. While not really active, they move about freely. More commonly, they are found a few together beneath or close to some large rock fragment or coral head. They are particularly fond of the vicinity of growing corals. Young specimens are much lighter colored than adults, often a purplish-red, and the spines are conspicuously banded with white. These banded spines are found on individuals sometimes as much as 40-50 mm. in diameter, but the spines are usually uni-color and very dark when that size is reached. Albino or partially albino individuals are occasionally seen.

The Academy collection contains from San Juan, Guayanilla and Ballena Point, Ensenada, seven young specimens with banded spines. There are no adults, presumably because the adults are so common, so well known, and such a nuisance to collect and prepare. The "Fish Hawk" brought back Centrechinus from Ponce, Mayagüez and Arroyo.

### Family Arbaciidæ

**Arbacia punctulata** (Lamarck)

*Echinus punctulatus* Lamarck, 1816, Anim. s. Vert., iii, p. 47.
*Arbacia punctulata* Gray, 1835, Proc. Zoöl. Soc. London, p. 38. A. Agassiz, 1872, Rev. Ech., pt. 2, Pl. 2, fig. 4.

One of the best known of sea-urchins, this species has a remarkable range. It does not appear north of Cape Cod but it is common, and in some seasons abundant, in the Woods Hole region. Thence it ranges southward to Florida, the north coast of Cuba, and Yucatan. It is not known from Jamaica or Porto Rico or any of the Lesser Antilles until the southern end of the chain is reached, where it occurs at Tobago and Trinidad. It seems possible, if not probable, that this far-southern group has reached its present home via the northern coast of South America and not via the Antilles.

Northern specimens as a rule have shorter spines than those from the south but there are many exceptions and I do not find it feasible to separate a southern variety. As a rule, *punctulata* is 40-50 mm. in diameter when fully grown; Jackson, in his interesting and important memoir on Arbacia (1927, Mem. Boston Soc. Nat. Hist., viii, p. 448) gives 53 mm. in diameter as the maximum size. As regards the spines, the extremes may be represented by two specimens, one 40 mm. in diameter, with spines about 15 mm. long and 1.5 mm. thick at base, the other 21 mm. in diameter, with spines 24 mm. long and less than .75 mm. in diameter at base. Similar extremes in color also occur. While northern specimens have the test commonly a deep brown, with a reddish cast, and the spines lighter and often a dull brownish red, in the south there are two extremes; on the one hand, the test is a light wood-brown, with the spines very light (a dingy cream-color) at base becoming dull reddish-purple at tip, and on the other, test and spines are deep reddish purple, or almost black in certain individuals. Both these extremes are observed in specimens from Florida. Specimens from Cuba, Yucatan, and Tobago, are very dark and have slender, relatively long, spines.

## Family Echinidæ

### Lytechinus variegatus (Leske)

*Cidaris variegata* Leske, 1778, Add. ad Klein, p. 85.
*Lytechinus variegatus* A. Agassiz, 1863, Bull. M. C. Z., i, p. 24. 1872, Rev. Ech., pt. 2, Pl. 2, figs. 5 and 6; Pl. 4*a*, figs. 4 and 5 (as *Toxopneustes variegatus*).

This sea-urchin is notable as one of the few echinoderms in which it is possible to recognize geographical subspecies. It has a wide range from Bermuda and the Carolina coast to the east coast of Mexico and Central America and thence throughout the West Indies to Brazil. A form also occurs in the Cape Verde Islands (see H. L. Clark, 1925, Cat. Rec. Ech. B. M., p. 121). The typical form is that which occurs in the greater Antilles and is abundant in Jamaica and Porto Rico. Its coloration is green and white but the proportions of the two colors is very variable; either one may be predominant to a marked degree. Jackson (1914, Publ. 182 Carnegie Inst. Wash., p. 148, unnumbered plate, figs. 8 and 9) has described and figured a very handsome form of this green and white Lytechinus, which he found at Montego Bay, Jamaica. Even in Jamaica, however, individuals are found in which the primary spines and sometimes their tubercles also are tinged with rose-red or purple. On the southeastern coast of the United States this tendency to a rose-red or purplish-red coloring becomes very marked and is often associated with thicker, coarser spines, so that typical specimens are very different in appearance. More than seventy years ago, Holmes (1860, Post Plio. Foss. So. Car., pl. 2, fig. 2), and three years later Mr. Agassiz (1863, Bull. M. C. Z., i, p. 24) designated this form as a distinct species to which the name *carolinus* was given; but intergradation with the West Indian form is so complete it can only be considered a sub-species at best. In Bermuda, evolution has been working along a different line and here we find the vast majority of specimens have slender primary spines and a deep red-violet or purple coloration, entirely unlike either Jamaican or Carolinian specimens. This form was described by Mr. Agassiz (1863, Bull. M. C. Z., i, p. 24) as *Lytechinus atlanticus,* but again intergradation with the West Indian form is complete (some Brazilian specimens cannot be distinguished from typical *atlanticus*) and we must therefore consider the Bermudan form as, at best, a subspecies.

In size, the subspecies seem to run a little smaller than the typical form; the largest *atlanticus* I have seen is 75 mm. in diameter, the largest *carolinus* is 80 mm., while typical specimens from Jamaica and Tobago run up to 85-87 mm.

While *variegatus* is often found under and among rocks, especially when young, and is often taken even on mud, the habitat it prefers is a "grassy" bottom (i. e. a rather firm sandy bottom covered with short eel or turtle grass) in shallow water. On such bottoms it often abounds to such an extent that it is difficult to walk about without stepping on the urchins. As they generally cover themselves partially or sometimes wholly with bits of grass and similar material, they are not always easily seen. Apparently this foreign material is held in position in part by pedicellariæ and in part by the tube feet. Whether it is for concealment, a sort of protection from enemies, or for protection from the rays of the tropical sun, or for some other purpose, we have no knowledge as yet.

As already stated, *variegatus* seems to be abundant in Porto Rico. The "Fish Hawk" brought back 28 specimens from half a dozen ports (Ponce, Arroyo, Boqueron Bay, San Juan, Catano and Hucares). The Academy collection contains 23 specimens, ranging from young ones only 5 or 6 mm. across to an adult 65 mm. in diameter. One of 3 small adults from Maria Langa Cayo, near the mouth of Guayanilla Harbor, is notable for having the primaries quite white. Other specimens from several stations approach *carolinus* in coloration. Besides localities already mentioned, the Academy specimens come from the following places: Parguera. Ensenada; Ballena Point, Ensenada; Guanica.

### **Tripneustes esculentus** (Leske)

*Cidaris esculenta* Leske, 1778, Add. ad Klein, p. xvii.

*Tripneustes esculentus* Bell, 1879, Proc. Zoöl. Soc. London, p. 657. A. Agassiz, 1872, Rev. Ech., pt. 2, Pl. 6*a*, figs. 1 and 2 (as *Hipponoë esculenta*).

This is the largest of the regular Echini of the West Indian region, specimens from Bermuda and the Bahamas running up to a diameter of 145-150 mm. Conditions at Bermuda seem to be very favorable to Tripneustes as the finest specimens I have ever seen are from there. The distribution of this urchin is similar to that of the preceding species but it seems to range farther south and east. It has been taken at Trinidad Island in the South Atlantic and at Ascension, as well as on the West Coast of Africa. The spines in life are almost uniformly white, but the test is often dark purplish in contrast to them; occasionally the test is brown, sometimes quite pale, and rarely the aboral part shows a distinctly yellow-green tinge.

Young individuals live under rocks and in out of the way crannies; hence very small specimens are rarely seen. Adults live out in the open on grassy bottoms along with Lytechinus. Wherever Tripneustes is common in the West Indies, sexually mature adults are used more or less extensively for food by the natives. Of course the only edible portion is the "roe" (gonads), and it is customary to take the roe of several individuals and bake them in a half of the test of one. When fresh and properly seasoned and cooked, the result is as palatable as any fish roe, and better than many. The name "sea-egg" very commonly applied to Tripneustes (as well as to other sea-urchins) does not, however, refer to the food value, but is probably based on the appearance and texture of the bleached, bare test after the spines have fallen off, following death. Such "eggs" are naturally always empty! In Barbados, it has been necessary to pass laws regulating the gathering and sale of sea-eggs, for the persistent demand threatened the local extinction of Tripneustes.

Jackson (1914, Publ. 182 Carnegie Inst. Wash., pp. 149-154) has published a very interesting study of this species in which he demonstrates that it shows a tendency to break up into recognizable groups associated with locality, as indicated by the character of the abactinal system. Given 500 specimens, it would be possible simply by examining the oculo-genital ring to determine whether they came from Bermuda, the Bahamas, Florida or Jamaica. It is not practicable, however, to designate such groups by name, since it would not be possible to determine to which group a single individual (or even a dozen) belonged. But they may well be "incipient species" and their discovery by Jackson is most interesting and important.

The Academy collection contains but 5 specimens of Tripneustes: a small one, 23 mm. in diameter, taken among rocks, at the eastern side of the harbor entrance, under the lighthouse, Ensenada, June 14, 1915, by R. W. Miner and H. Mueller; a half-grown individual from the west end of the reef between Pardas Bay and harbor entrance, Ensenada, June 18, 1915; and 3 adults about 120 mm. in diameter, with no data.

The "Fish Hawk" brought home 15 specimens of Tripneustes from Ponce, Arroyo, Aguadilla, and Guanica.

Family ECHINOMETRIDÆ

**Echinometra lucunter** (Linnæus)

*Echinus lucunter* Linnæus, 1758, Sys. Nat., ed. 10, p. 665.
*Echinometra lucunter* Lovén, 1887, Bih. Svensk. Vet.-Akad. Handl., xiii (4), No. 5, p. 157. A. Agassiz, 1872, Rev. Ech., pt. 2, Pl. 10*a*, figs. 2-4 (as *E. subangularis*).

The commonest of West Indian sea-urchins, rivalled possibly by *Lytechinus variegatus,* is this "rock-boring" species, which is found, often in vast numbers, wherever suitable coral rock occurs. Jackson (1914, Publ. 182 Carnegie Inst. Wash., pp. 154-157) has published some interesting observations on it, made at Montego Bay, Jamaica. It is a curious fact that, in Jamaica and Porto Rico, *lucunter* does not reach nearly so large a size as in either Bermuda or Brazil. Just what is lacking in the West Indian area it is difficult even to guess. But the fact remains that whereas Bermuda specimens are frequently 85-88 mm. in length (the ambitus in Echinometra is elliptical not circular) and Brazilian specimens may measure 83 mm., I have seen no specimens from the West Indies or Florida which were over 65 mm. long. The largest specimen I have measured is from Bermuda; it is practically 90 mm. long, 75 mm. wide and 47 mm. high. There is great diversity in *lucunter* in the relative thickness of the primary spines and in their actual length; the two extremes may be represented by spines 27 mm. long and 1.5 in diameter, and 25 mm. long and 3 mm. in diameter. As regards color there is very great diversity in the shade, though the general appearance in life is ordinarily red-brown, the red more or less in evidence in different specimens. At one extreme are light-colored individuals, nearly white on the buccal membrane, becoming cream-color nearer the ambitus and thence passing into a very pale brown with a reddish tinge, the distal parts of the spines quite pink or red, though of a dull light shade. At the other extreme are individuals which, although the buccal membrane may be light, are very dark, in many cases almost black. It is not a true black, however, but a very deep brown, purple or green. One interesting color form has the primary spines quite green, usually of an olive shade, with the tips in many cases more or less markedly purple. Individuals of this type have not rarely been labelled *"viridis"* solely because of the color, but they are certainly not that species, nor in any sense connecting links with it.

The distribution of *lucunter* is even wider than that of the West Indian

Lytechinus and Tripneustes, for it ranges from Bermuda, Florida, the east coast of Mexico and the north coast of South America, to the West Coast of Africa and even to St. Helena. These urchins cling closely to surf-beaten rocks and live in all sorts of cavities and crannies in their surface. Apparently they have some power of rock-boring and in some places fit quite snugly into the cavities they have deepened and modified, if not actually excavated. They prefer very shallow water and on certain reef-flats covered by only a few inches of water at low tide, they are oftentimes excessively abundant.

The Academy collection contains 101 specimens of *lucunter* from San Juan, Ensenada, Guayanilla, Montalva Bay, Parguera, between Pardas Bay and Ensenada, Guanica, Ponce, the beach at Playa opposite Talleboa Station, four miles east of Talleboa, and Caja de Muertos Island. They show great diversity in size and color, but none is notable in any way. The "Fish Hawk" brought back 105 specimens, equally diverse, from Ponce, Arroyo, Boqueron Bay, Fajardo, San Juan and Aguadilla.

### Echinometra viridis Agassiz

*Echinometra viridis* A. Agassiz, 1863, Bull. M.C.Z., 1, p. 22. Lütken, 1864, Vid. Med. f. 1863, Pl. 1, figs. 1 (five figures of *E. michelini*).

There has been some doubt expressed as to the validity of this species, because of the unfortunate figure given by Mr. Agassiz in the Revision (1872, Rev. Ech., pt. 2, Pl. 10*a*, fig. 1), which is a photograph of the less common thick-spined form. Typical specimens of *viridis* look very different from this. Lütken's figures of *E. michelini* are not much better, as *viridis* usually has the ambitus more nearly circular. A particularly fine specimen from Jamaica has the test (35 mm. long, 32 mm. wide and 17.5 mm. high) a rather dark purplish-brown, with the large buccal area lighter; the secondary spines and the base of the primaries are a light brown or fawn-color with a reddish tinge; the primaries rapidly become greenish and distally are bright olive green, terminating rather abruptly in deep violet or purple tips. The primary spines are more than 30 mm. long and less than 2 mm. thick at base, whence they taper rapidly at first and then gradually to a very slender but truncate tip. A stout-spined specimen from the Tortugas (42 mm. long by 36 mm. wide) is the largest *viridis* I have seen; the primaries are only 15 mm. long and are 2.25 mm. thick at base; they taper little on the basal half, but abruptly near tip. The coloration is typical. There are but 5 pore-pairs in the arcs composing the poriferous areas of both these large specimens, whereas, as already stated in the key, in *lucunter,* even when small, the abactinal arcs have 6 pore-pairs.

At the Tortugas *viridis* is rather rare and the few specimens found were not associated with *lucunter* but were under rocks on the reef-flat by themselves. At Jamaica it is no more common and at Tobago we did not find it at all. There are several specimens in the Museum of Comparative Zoölogy, from Key Biscayne, Florida, and one from Hayti. The "Fish Hawk" took two specimens at Playa de Ponce, Porto Rico, and Lütken's specimens of *E. michelini* were from the Danish West Indies and Puerto Cabello, Venezuela. There are no trustworthy records from east of those points. Kükenthal and Hartmeyer took specimens at Coral Bay, St. John, U. S. Virgin Islands, at Port Henderson, Jamaica, and on Bird Key Reef, Tortugas, but not at Barbados. Apparently then, *viridis* is found only west of longitude 64° E, but it is not yet known from either Mexico or Central America; and the only record for Cuba is the one mentioned by Mr. Agassiz in the Revision (p. 117). There is no specimen from Porto Rico in the Academy collection.

## Order *EXOCYCLOIDA*

### Family Clypeastridæ

#### Clypeaster rosaceus (Linnæus)

*Echinus rosaceus* Linnæus, 1758, Sys. Nat., ed. 10, p. 665.
*Clypeaster rosaceus* Lamarck, 1801, Anim. s. Vert., p. 349. A. Agassiz, 1872, Rev. Ech., pt. 2, Pl. 11*d*, figs. 1, 2 (as *Echinanthus rosaceus.*).

This is probably one of the best known of the marine invertebrates of the West Indies, sharing with the sea-star, Oreaster, the popularity of curio shops and the general collectors' shelves. Whether with the spines on or with the bare test bleached, it is a striking object, the five large petals making an attractive pattern on the upper side. The color in life is a reddish, yellowish, or greenish-brown, usually rather bright but sometimes quite dark. The largest specimen I have ever seen is in the British Museum, from St. Vincent, and measures 150 mm. in length, 127 mm. in width and 50 mm. in height. There is great diversity in form; some specimens have the width 85% of the length while others have it as little as 73%; a specimen 130 mm. long is only 45 mm. high (about 35%) while another, 123 mm. long, is 55 mm. high (about 45%).

The range of *rosaceus* is from South Carolina and the Bahamas to Barbados, but it does not seem to be common east of the Greater Antilles and we did not find it at Tobago. It is not known from the Mexican or

South American coast, nor has it yet been found in Bermuda. The Academy collection contains a single typical specimen from San Juan, while the "Fish Hawk" brought back a single specimen from Fajardo.

### **Clypeaster subdepressus** (Gray)

*Echinanthus subdepressa* Gray, 1825, Ann. Phil. xxvi, p. 427.
*Clypeaster subdepressus* Agassiz, 1836, Mem. Soc. Sci. Nat. Neûchatel. i, p. 187. A. Agassiz, 1872, Rev. Ech., pt. 1, Pl. 11*b*, figs. 1 and 2.

Less common than the preceding species, this Clypeaster is still well known, its large size and very flat test making it a noticeably interesting object. The color in life is yellowish or reddish, or very deep, brown, and there is little change in preservation. Normal adult specimens are 150-175 mm. long by 120-140 mm. wide; the greatest width is posterior to the middle. A specimen in the Museum of Comparative Zoölogy from an unknown locality, 248 mm. long by 214 mm. wide, is only 25 mm. high; it is thus not only extraordinarily large but exceptionally wide proportionately, and exceptionally flat. There is considerable diversity in the thickness and solidity of the test. Specimens from the Tortugas seem to be considerably more solid than those from farther east.

No specimens of *subdepressus* are known as yet from Porto Rico, but since there are records from Cuba, Jamaica and St. Thomas, it is almost certain that this Clypeaster will sooner or later be found at Porto Rico. There are records from Swan Island and Brazil, and even from the eastern Atlantic, but none from Bermuda, Bahamas or the more eastern West Indian Islands.

## Family SCUTELLIDÆ

### **Encope emarginata** (Leske)

*Echinodiscus emarginatus* Leske, 1778, Add. ad Klein, p. 136.
*Encope emarginata* Agassiz, 1841, Mon. Ech., Mon. Scut., p. 47, Pls. 7 and 8 (as *E. valenciennesii*) and 10.

The Encopes are so solid it is hard to believe there can be much living activity in such a stony object, but the West Indian species, especially the present one, are less heavy than one or two of those from the Pacific coast of Mexico. The genus is strictly tropical American, with four of the six species found on the Pacific side. The present species is known from the northern and eastern coasts of South America, as far south as Uruguay. There are records from Trinidad and Martinique, which seem reliable, but other reports from Nicaragua and South Carolina are quite improbable. It is very unlikely that any species of Encope occurs in Porto Rico.

In color, *emarginata* is not unusual; nothing is recorded of its appearance in life; dry specimens are dull brown, often very dark. There is extraordinary diversity in the form of the test and in the size and form of the lunules. A typical Venezuelan specimen is 125 mm. long by 115 mm. wide and the lunules are big and wide, the interradial one being 40 mm. long by 15 wide. The largest specimen I have seen is 141 x 126 mm. and the lunule is 30 x 10 mm. On the other hand, another specimen, 88 mm. long, is 93 mm. wide, and the lunule is only 18 x 5 mm. The marginal lunules are commonly quite closed in, but they are often widely open, and are sometimes only deep, wide notches.

**Encope michelini** Agassiz

*Encope michelini* Agassiz, 1841, Mon. Ech., Mon. Scut., p. 58; Pl. 6*a*, figs. 9 and 10.

This species seems to be confined to the Gulf of Mexico, as all trustworthy records are from Florida, the Tortugas, Alabama and Yucatan. It is not found along shore as a rule, but is fairly common in 5-10 fms. The color in life is a deep violet-brown which is little altered by preservation. The largest specimens at hand are from Tampa Bay, Florida; the maximum size is 138 x 136 mm., with the interradial lunule, 15 x 4 mm. In this individual, the anterior marginal lunules are represented only by very shallow depressions, but the posterior pair are 10 mm. deep and only 2-3 mm. wide. In a specimen from Alabama, 135 x 136 mm., the anterior lunules are notches 15 mm. deep and 2-4 mm. wide, while the posterior pair are 18 x 4 mm. The test is not always so nearly equal in length and breadth as these two big specimens indicate. A fine specimen from Yucatan is 98 mm. long and only 92 mm. wide. As a rule, the paired lunules are not closed in, but remain as deep, narrow notches; in no specimen at hand are the anterior pair (much less, the posterior) closed, but in one Florida specimen they are very near that condition and it probably is a rare variant.

**Mellita quinquiesperforata** (Leske)

*Echinodiscus quinquiesperforatus* Leske, 1778, Add. ad Klein. p. 133.
*Mellita quinquiesperforata* Meissner, 1904, Bronn's Thierreich, ii, p. 1384. A Agassiz, 1872, Rev. Ech., pt. 1, Pl. 12*c*, figs. 1 and 2 (as *M. testudinata*).

The common "key-hole urchin" of the Florida coast is too well-known to require any description. The test is always very flat but shows some diversity in the relative length and width. It is occasionally as long as wide but only very rarely does the length exceed the width; ordinarily the width is markedly greater than the length, often by as much as ten per cent. The largest specimens I have seen are Pleistocene fossils from South Carolina, about 150 mm. long by 160 mm. wide. No recent specimens that I have seen approach this size; the largest one is 106 x 108 mm.; specimens exceeding 100 mm. in either length or breadth are rare. There is no satisfactory information about the color in life, but dry specimens show considerable diversity, as some are pale yellow-brown, some are gray with or without a decided violet tinge, and some have a markedly greenish cast.

Oddly enough, *quinquiesperforata* is not known from Bermuda or the Bahamas, though the dead tests are dredged as far north as Nantucket, and the species is abundant on the Carolina and Florida coasts. It is present in Cuba and Jamaica, on the eastern coast of Central America, the northern and eastern coasts of South America, and at Trinidad, but has yet to be taken at any of the Lesser Antilles.

The Academy collection contains no example of this species, but the "Fish Hawk" brought back ten specimens from Ponce, Arroyo, Mayagüez, Puerto Real and near San Juan.

### **Mellita sexiesperforata** (Leske)

*Echinodiscus sexiesperforatus* Leske, 1778, Add. ad Klein, p. 135.

*Mellita sexiesperforata* Meissner, 1904, Bronn's Thierreich, ii, p. 1384. Agassiz, 1841, Mon. Ech., Mon. Scut. Pl. 4, figs. 4-7; Pl. 4*a*, figs. 11, 12 (as *M. hexapora*).

Although perhaps rather more fragile than the preceding species, *sexiesperforata* has a somewhat wider range, as it appears at Bermuda and in the Bahamas as well as on the Atlantic and Gulf coasts of the United States and the eastern coasts of Mexico and Central America; thence it ranges clear to Uruguay with intermediate stations at Cuba, Jamaica, St. Christopher, Martinique, Barbados, St. Vincent and Tobago. It is more common for the length to exceed the width in this species than in the preceding, but individuals wider than long undoubtedly predominate. The largest specimens I have seen are from Bermuda; three typical specimens measure 100 x 96 mm., 110 x 115 mm. and 115 x 116 mm. The color in life, when young, is a lovely silvery gray but with growth this becomes more brown and adults seem to be pale fawn-color or yellowish-brown. In preserved specimens, green tints often predominate, as is true of nearly all Clypeastroids.

There are no specimens of Mellita in the Academy collection but the "Fish Hawk" brought home a specimen of this species from Arroyo and dredged 4 smaller ones in 14 fms. off the eastern end of Porto Rico.

## Family ECHINONEIDÆ

### Echinoneus cyclostomus Leske

*Echinoneus cyclostomus* Leske, 1778, Add. ad Klein, p. 109. Westergren, 1911, Mem. M. C. Z., xxxix, No. 2, Pls. 1-5.

From the point of view of the evolution of sea urchins this is probably the most interesting of West Indian echini for it seems to be one of the last two living genera of Holectypoids that flourished in Jurassic and Cretaceous times. The presence, as shown by A. Agassiz (1909, Amer. Jour. Sci. (4) xxviii, pp. 490-492; pl. 2), of jaws in very young individuals (under 4 mm. in length) and their rapid and complete resorption so that they are wholly wanting in individuals 5-6 mm. long is the most extraordinary characteristic of this curious echinoid. It is a very sluggish, inconspicuous animal, living buried in coral sand under rocks on the reef-flats of the tropics throughout the world. The largest recorded specimen is in the British Museum and measures 44 mm. in length, 36 mm. in width, and 21 mm. in height. Most specimens are 20-30 mm. long; the proportions are very variable. The color in life is very light, almost a pale cream-color tinged with reddish or a reddish-yellow, with the tube-feet bright red in marked contrast. Preservation completely alters this coloration, both spines and tube-feet becoming brown of some shade. A complete monograph on Echinoneus was published by A. M. Westergren in 1911 (Mem. M. C. Z., xxxix, No. 2) with numerous illustrations, including a colored plate, showing the appearance of the animal in life.

There is no specimen of Echinoneus in the Academy collection, nor did the "Fish Hawk" bring back even one specimen. But Mr. Agassiz records it in the "Revision" as from Porto Rico, the material being in the Copenhagen Museum. It has also been taken at St. Thomas. It is common in Jamaica and there are records from Bermuda, the Tortugas, Cuba, Hayti, Antigua, Guadeloupe, Barbados, and Tobago. As already stated, it is also found throughout the tropics of the old world.

## Family HEMIASTERIDÆ

### Moira atropos (Lamarck)

*Spatangus atropos* Lamarck, 1816, Anim. s. Vert., iii, p. 32.
*Moira atropos* A. Agassiz, 1872, Rev. Ech., pt. 1, p. 146; Pl. 23.

In some particulars, notably the depth to which the petals are sunken into the dorsal surface of the test, this remarkable urchin is one of the most highly specialized members of the class. It is particularly adapted to its life buried in soft mud or muddy sand, the great compression of the entrance to the petals enabling the animal to maintain currents of water, from which the sediment has been strained, over the tube-feet of the petals, which probably perform respiratory and excretory functions. Nothing has been published as to the appearance in life of Moira, but it is not at all likely that preservation alters it much. The color of dried specimens is dirty-white or very pale brown, or grayish. The largest specimen of *atropos* seen is 57 mm. long, 46 mm. wide, and 43 mm. high. But proportions vary greatly. Another specimen 55 mm. long is 51 mm. wide and only 38 mm. high. The height is usually 70-80% of the length, but a specimen in the British Museum, 40 mm. long, is only 23 mm. high. Moira is common on the Carolina coast and around the Florida peninsula, along the Gulf Coast to Texas. It is also recorded from Jamaica, St. Thomas, St. John and Guadeloupe. The Academy collection adds this interesting species to the known fauna of Porto Rico, for an excellent specimen, 30 mm. long, was taken by R. C. Osburn, June 29, 1915, off Guanica Playa.

### Family Spatangidæ

**Brissopsis elongata** Mortensen

*Brissopsis elongata* Mortensen, 1907. Ingolf Ech., pt. 2, p. 163; Pl. 3, figs. 14, 15, 19; Pl. 4, figs. 1, 4, 13.

*Brissopsis lyrifera* H. L. Clark, 1901, Bull. U. S. Fish Comm., ii, p. 254 (non Forbes).

Nothing is known of this heart-urchin beyond Mortensen's account. He examined the "Fish Hawk" material and being familiar with the European Brissopsis was able to point out the well-marked characters which distinguish the West Indian species. He also recorded specimens in the Copenhagen Museum, from Puerto Cabello, but from what depth is not known. His largest specimen (as figured) is about 50 x 43 x 26 mm. and the color would seem to be very light.

The "Fish Hawk's" specimens are labelled as from Sta. 6059, which is off western Porto Rico, in 7 fms. on a bottom of sticky mud. It seems as though some mistake in the station number had been made since the depth of 7 fms. is so inconsiderable for a tropical Brissopsis. There is no Brissopsis in the Academy collection.

**Plagiobrissus grandis** (Gmelin)

*Echinus grandis* Gmelin, 1788, Linn. Syst. Nat., ed. 13, i, pt. 6, p. 3200.

*Plagiobrissus grandis* H. L. Clark, 1917, Mem. M. C. Z., xlvi, p. 207. A. Agassiz, 1872, Rev. Ech., pt. 1, Pl. 21, figs. 4 and 5 (as *Metalia pectoralis*).

There is no doubt that this is the finest of the West Indian spatangoids, and it might well claim to be the most remarkable and perhaps the handsomest of all West Indian echini.

There is no record of the color in life but the best dry specimens, fully clothed with spines, are uniformly pale reddish-brown. The largest at hand measures 220 mm. long, 160 mm. wide, and 60 mm. high; the long spines of the dorsal surface are mostly 60-80 mm. long, but some exceed 90 mm.

If not extremely rare, Plagiobrissus must be remarkably local, for very few specimens are known except those taken in the Bahamas, near Nassau, chiefly by C. J. Maynard. There is a specimen in the British Museum from Dominica and fragments of a specimen taken by the "Challenger" on the Brazilian coast. There is a specimen from Tampa, Florida, and a small specimen from Bahia, Brazil, in the Museum of Comparative Zoölogy. Mr. Agassiz records a specimen from "Mexico" in the Revision. And that is all. There is no evidence that this splendid animal occurs in either Porto Rico or the Virgin Islands.

### Brissus brissus (Leske)

*Spatangus brissus* (var. *unicolor*) Leske, 1778, Add. ad Klein, pp. xx, 182.
*Brissus brissus* H. L. Clark, 1917, Mem. M. C. Z., xl, p. 218. A. Agassiz, 1872, Rev. Ech., pt. 2, Pl. 22, figs. 1 and 2 (as *Brissus unicolor*).

This is another of the very few echinoderms which are found both in the Mediterranean Sea and in the West Indies. The distribution has been given as "from Malta to Jamaica, from the Azores to St. Helena". In the West Indian region it ranges from Bermuda, the Bahamas, and the Tortugas, to Barbados and Tobago. Oddly enough it has not yet been recorded from Porto Rico or the Virgin Islands, but there can be little doubt that it will be found there, as it is common in Jamaica and is known from Hayti. It is not yet known from Brazil but probably occurs there.

In the West Indies, even when quite large, Brissus lives buried in sand under rocks, very commonly in company with Echinoneus, and hence it easily escapes the observation of the casual collector. It is a remarkable fact that West Indian specimens are only about half as large as those of the eastern Atlantic. The largest West Indian specimen I have seen is 70 mm. long, 55 mm. wide and 38 mm. high, while many specimens from the eastern side of the Atlantic are 115-120 mm. long and one in the British Museum from Malta measures 135 x 100 x 65 mm. It would be interesting to know why West Indian conditions are not favorable to full growth. The color of Brissus in life is pale brown and preservation produces very little change.

**Meoma ventricosa** (Lamarck)

*Spatangus ventricosus* Lamarck, 1816, Anim. s. Vert., iii, p. 29.
*Meoma ventricosa* Lütken, 1864, Vid. Med. f. 1863, p. 120. A. Agassiz, 1872, Rev. Ech., pt. 2, Pl. 20, fig. 8; Pl. 22, figs. 3 and 4.

This big spatangoid is a striking feature of the bottom fauna on sand near reefs and cays in water a fathom deep or more. The color in life is reddish-brown of a lighter or darker shade; preservation alters the color but little. Most adult specimens are about 125 mm. long but the largest individual I have seen is one in the British Museum from the Bahama Islands; it is 188 mm. long, 158 mm. wide, and 100 mm. high. There is not a great deal of diversity in the form and proportions of the test. Apparently Meoma is confined to the northwestern portion of the West Indian region. It is common in the Bahamas, around southern Florida, in Jamaica, and in the Virgin Islands. There is an old specimen from Honduras in the Copenhagen Museum and one from Guadeloupe in Paris. There are no other records of which I know. The Academy collection contains no specimen and the "Fish Hawk" failed to find Meoma in Porto Rican waters. It probably will be found there ultimately, however.

## HOLOTHURIOIDEA

### Holothurians; sea-cucumbers

The preparation of this section of the present handbook has been greatly facilitated but somewhat complicated by the publication of Dr. Deichmann's recent admirable report on "The Holothurians of the Western Part of the Atlantic Ocean" (1930, Bull. M. C. Z., lxxi, No. 3) including, as it does, all of the West Indian region. In my paper on "The Distribution of the Littoral Echinoderms of the West Indies" (1919, Publ. 281 Carnegie Inst. Wash., p. 73), I listed 24 holothurians but Dr. Deichmann gives more than twice that many, which appear to be littoral in the strictest sense, from the region covered by this report. The question naturally arises whether all of these should be included herein.

After a careful examination of the list, I have decided that nine species are of such uncertain validity either as species or as littoral members of the West Indian fauna, it will be best to omit them from the body of the report, although including them in the key. One of these is *Holothuria imperator* Deichmann, which is known as yet only from the original material taken on the coast of Yucatan; the depth at which these specimens were collected is not recorded, and as none is yet known from Florida or the West Indies, *imperator* may well be omitted from further consideration. A very similar case is that of *Phyllophorus dobsoni* Bell based on a single specimen in the British Museum from the Bay of Honduras. Two species of Cucumaria are scarcely qualified for a place in the West Indian list; one is *C. pulcherrima* (Ayres), which Dr. Deichmann records from both north and south of the West Indian region and designates as "undoubtedly a tropical form"; but I doubt very much if it occurs as a littoral species in the region covered by this report; the other is *C. vicaria* Sluiter which is a dubious species based on a single very small specimen (13 mm. long) from Barbados, depth unknown. Of Thyone there are 4 species, which I am unwilling to include without further and more satisfactory evidence; *fusus* (O. F. Müller) a European species whose West Indian occurrence rests dubiously on 4 very small and youthful Thyones from Tobago; *pervicax* Théel, described from a single specimen from Brazil, and stated by Dr. Deichmann to range "from Bahia to Florida" and "found also in Vineyard Sound", but very imperfectly known and probably not littoral in the West Indies; *gemmata* (Pourtalès), a case similar to *pervicax*, almost certainly not a littoral West Indian species; *sabanillæsis* Deichmann known only from two specimens taken in 1884 at Sabanilla, Colombia, "shallow water". Finally there is *Pseudocolochirus mysticus* Deichmann, the type of which is from deep water off Alligator Reef, Florida, while specimens are in the National Museum from Albatross Station 2691, 10 fms.; it has not yet been collected at a lesser depth.

From the key, as well as from the body of the report, I am omitting the small and undoubtedly youthful holothurians which Sluiter (1910) recorded from Bird Key Reef, Tortugas, as *Holothuria magellani* Ludwig and Deichmann (1926) listed from Falmouth Harbor, Antigua, as *Mesothuria verrilli* Theél. These individuals, like *Stichopus ecnomius* H. L. C. from Montego Bay, Jamaica, are obviously too youthful to show specific or even generic characters clearly. When we know the growth changes of the various West Indian species of Aspidochirota, it is possible we shall be able to assign such young individuals to their proper species. Meanwhile, in a report of the present nature, it is best to ignore them.

The following key, then, includes 50 species of holothurians, of which 9 will not be found in the body of the report. It is unfortunate that the identification of these echinoderms is possible only by means of the compound microscope, with which the minute calcareous particles or deposits in the skin must be examined. A very small bit of skin dissolved in some caustic ("Zonite" is particularly satisfactory) will yield the necessary deposits for examination. As a rule a magnification of 90 diameters will answer but there are many cases where it is necessary to magnify 4 or 5 times as much as that. The terms used in referring to the important particles are curiously arbitrary and often quite inappropriate, but as they are firmly established in literature it would be difficult to avoid their use. The following brief descriptions will help a beginner to understand to what the various names, here arranged alphabetically, refer. It should be understood of course that the character of the deposits is fairly constant, but by no means perfectly so, for any given species.

ANCHORS—deposits which are actually minute anchors in form; they have normally two arms which may be either smooth or serrate on the outer side; the *vertex* is where these arms unite with each other and with the *shaft;* the *stock* is the expanded, opposite end of the shaft.

ANCHOR-PLATES—perforated plates, more or less concave on one side, which accompany the anchors; the latter lie lengthwise of the plates on their outer surface; the long axis of both plate and anchor is at right angles to the long axis of the animal. Usually the end of the plate near the stock of the anchor is narrower than the other, and in many cases it is crossed by a curved arch called the "*bridge*".

BASKETS—curious, concave (or convex) bodies, commonly consisting of two curved rods crossing each other at right angles with their ends united by a ring of calcareous material; this ring usually carries teeth which may point either vertically or horizontally. Other projections on either ring or cross-rods may complicate the structure greatly. Baskets may be so shallow as to be hardly more than concave plates or so deep as to become nearly spherical.

BUTTONS—perforated plates of a very definite character but rarely resembling any normal button! A typical button is an elliptical, relatively thick, smooth plate, narrowed at each end, about twice as long as wide, with three pairs of perforations passing through it. These perforations show great diversity in size—they may be very small holes, or they may occupy two-thirds (or more) of the button. In many cases buttons are much longer and have as many as 6 pairs of holes; at the other extreme are short, reduced buttons with only 4, 3 or 2 perforations. Again, many buttons, instead of being smooth, have knobs on the surface and these knobs may be conspicuously developed on both surfaces; in extreme cases the button thus becomes transformed into a swollen, irregular ellipsoid. Buttons are often incomplete or irregular in shape, and in a few cases it is hard to say whether a given deposit is more properly called a button or a perforated plate.

C-SHAPED BODIES—as the name indicates are delicate curved rods shaped like the letter C; as a rule the terminal points are acute.

Miliary granules—a term employed to cover all the very small particles, in the body wall, with non-distinctive forms, often occurring in large, sometimes in incredibly large, numbers. In the simplest form, they are literally granules—spherical or ellipsoidal—but they are often more elongated and appear as short rods with rounded ends; these rods may be notched along the sides, or ornamented by surface sculpturing; or they may become more elongated, curved, with flattened and expanded ends, which may be perforated or not; or the rods may be widened and flattened into little disks which may be perforated, forming the so-called "doughnut-shaped" bodies, or these may be incompletely formed, giving rise to short, stout C-shaped particles. The one unfailing character of miliary granules is their small size, which ranges from 5 to 50 microns.

Perforated plates—as varied in form and size as may be; on the one hand they pass into miliary granules, while on the other they become scales, a millimeter or more across, easily visible to the unaided eye. They may be flat or concave; thick or thin; with entire or undulated, or notched, or serrate or dentate margins; the perforations may be large or small, regular or irregular, with entire (smooth) or dentate margins. We may group here as irregular plates, the flattened rods, sometimes branched, which have the ends and other projecting parts expanded and often perforated. These are sometimes very characteristic of a species, especially if they are the only deposits present.

Rosettes—a particular form of plate, fundamentally made up of a rod whose ends have divided dichotomously, the ends thus arising, again dividing in the same way. The branches are usually somewhat curved and their tips very blunt and rounded. If the tips coalesce, an ordinary perforated plate of small size is formed. Many rosettes are so small as to be really miliary granules, but in some cases they are good-sized plates.

Tables—the most inappropriate name applied to calcareous particles, for it is only when considered upside down that these objects bear any resemblance to a table! "Tables" are, except perforated plates and miliary granules, the most widely distributed form of holothurian spicule, and their size and shape is correspondingly varied. Typically they consist of a disk and spire, the *disk* being a perforated circular or squarish plate from which arise 4 vertical rods (pillars) connected at middle and top by horizontal bars, composing the *spire;* the tip of the spire often carries sharp projections or teeth, both vertical and horizontal. These tables lie in the skin with the spires pointing outward; they may be so numerous as to form a layer, the disks overlapping one another and the projecting spires making the skin of the holothurian rough to the touch. From this typical form, diversity proceeds either toward greater simplicity or greater complexity. The cross-bars connecting the vertical pillars disappear, the pillars themselves reduce, and finally all that is left of the spire are two or more knobs on the outer surface of the disk. Or reduction of the disk may occur, until it is merely a calcareous ring supporting the base of the spire, and in a few cases even this ring has disappeared. On the other hand, the disk may enlarge until it contains a hundred perforations, or the spire may be made up of six or eight pillars bearing numerous teeth not only at the top but on the sides also. Increase of disk may be associated with reduction of spire, or increasing complexity of spire may be associated with a reduced disk.

WHEELS—deposits of a truly wheel-like appearance, usually with 6 spokes. They are found in only a very few holothurians and show relatively little diversity except in size.

The following key is compiled very largely from Dr. Deichmann's report but differs slightly in the arrangement of the species and in the emphasis placed on certain details:

KEY TO HOLOTHURIANS

A. Pedicels (tube-feet) present, more or less abundantly on the ventral, and usually also on the dorsal surface.
  B. Tentacles peltate, the branches all arising near the tip and forming a circular disk there.
    C. Only a single tuft of gonads present, that on the left side; body form and deposits very diversified.
      D. No large, conspicuous calcareous teeth at anus.
        E. Deposits in the form of buttons present.
          F. Buttons and tables present; buttons knobbed.
            G. Buttons regular and complete.
              H. Tables very complicated as reticulated spheres......*Holothuria cubana*
              HH. Tables with knobbed margin but not specially complicated..*H. pseudofossor*
            GG. Buttons irregular, often incomplete.
              H. Near tip of appendages are some relatively gigantic tables with long, solid conical spires...*H. princeps*
              HH. No such tables.........(*H. imperator*)
          FF. Buttons smooth.
            G. No marked difference between dorsal and ventral sides; general form more or less cylindrical; no calcified anal papillæ.
              H. Tables large; disk squarish, with 9 subequal perforations; appendages more like papillæ than pedicels; skin rough.............*H. impatiens*
              HH. Not as above.
                I. Pedicels small, scattered, mostly on ambulacra........*H. arenicola*
                II. Pedicels large, abundant; numerous papillæ also on dorsal surface ..........*H. densipedes*
            GG. Ventral surface flattened, with numerous pedicels; dorsal side with few ap-

pendages; calcified anal papillæ often present; color bright brown....*H. parvula*

EE. No buttons.

F. Tables wanting; only branched rods with curved ends, in skin.............*H. glaberrima*

FF. Tables present, but lack disk altogether..... *H. surinamensis*

FFF. Tables present, normal, but disks may be small; other deposits, rosettes or perforated plates.

G. Perforated plates with 2-4 large holes and blunt teeth on margin collected in little heaps visible to the naked eye; 1 stone canal; color variegated, with pedicels yellow.................*H. grisea*

GG. Not as above

H. Rosettes abundant, distinctly in heaps .................*H. floridana*

HH. Rosettes wanting; but numerous small, perforated plates, scattered in skin; color, dark above, yellowish or light red (in life) beneath. *H. mexicana*

DD. Five large, conspicuous anal teeth; deposits rosettes, granules or short rods.............*Actinopyga agassizii*

CC. A tuft of gonads on each side of dorsal mesentery; body more or less quadrangular, the flattened ventral side with very numerous pedicels.

D. Tables present; also C-shaped bodies.

E. C-shaped bodies small about as long as tables are high .......................*Stichopus badionotus*

EE. C-shaped bodies large, twice as long as tables are high .........................*S. macroparentheses*

DD. Tables wanting.....................*Astichopus multifidus*

BB. Tentacles dendritic, the branching quite irregular.

C. Tentacles more than 10, normally 20.

D. Deposits, thick discoidal bodies with serrate margins, few perforations and a number of minute conical knobs .......................*(Phyllophorus dobsoni)*

DD. Deposits, tables, or plates derived from table disks.

E. Tables with 4 central, and about 12 marginal, perforations in disk...................*P. seguroensis*

EE. Table disks more or less elongate with 2 subequal central perforations.

F. Margin of disk, dentate; spire often reduced to 4 knobs....................*P. occidentalis*

FF. Margin of disk smooth.

G. Posterior prolongations of calcareous ring long and well-developed....*P. ȧestichadus*

GG. Posterior prolongations of calcareous ring short.
H. Disks of tables oval, with 8 large and 2 small perforations; spire well developed.............*P. parvus*
HH. Disk margin undulating; 4 perforations; spire rudimentary.....*P. tritus*
CC. Tentacles 10.
D. Ventral side not flattened into a distinct sole nor dorsal side covered partly by scales.
E. Pedicels numerous all over the body.
F. Tables present in body-wall proper.
G. Spire of 4 pillars; disk irregular with 7 or 8 perforations.........*Thyone briareus*
GG. Spire of 2 pillars.
H. Disk thin with 4 large perforations (often 4 small ones also); spire high with tapering pillars ending in a few small teeth......*(T. fusus)*
HH. Disk thick with only 4 perforations; spire low with thick pillars ending in numerous stout teeth.. *T. pseudofusus*
FF. No tables in body-wall proper, though they may be found in pedicels as supporting rods, or in the introvert.
G. Supporting rods of pedicels often like tables; knobbed buttons present..... *T. micropunctata*
GG. Supporting rods not like tables.
H. Deposits elongate, perforated, nearly smooth plates.............*T. cognata*
HH. Deposits mostly 4-holed, knobbed buttons.
I. Tentacles of equal size; pedicels with distinct end-plates.
J. Skin soft; buttons few, with large perforations; baskets few, often incomplete ...........*T. suspecta*
JJ. Skin stiff; buttons numerous; baskets large, well-formed ....*T. surinamensis*
II. Ventral tentacles smaller; end-plates of pedicels reduced or wanting.
J. Pedicels uniformly spread over body, usually con-

tracted to low warts... *(T. pervicax)*

JJ. Pedicels in distinct double rows on ambulacra, scattered on interambulacra.

K. Baskets very small, much smaller than buttons are wide, with blunt, inconspicuous teeth; smooth perforated plates present..... *(T. sabanillaensis)*

KK. Baskets large, about as broad as buttons, with about 8 large conical teeth; no smooth perforated plates.... *(T. gemmata)*

EE. Pedicels either confined to ambulacra or those on interambulacra scattered and less conspicuous.

F. Dorsal appendages well developed, not few and papilliform.

G. Deposits consist chiefly of tables with spire of 2 pillars, often reduced...... *(Cucumaria pulcherrima)*

GG. Deposits chiefly plates and baskets; no tables ...................... *(C. vicaria)*

FF. Dorsal appendages and those around mouth and anus, few and papilliform.

G. Skin rigid with numerous deposits.... *Pentaeta pygmœa*

GG. Skin soft with few deposits........... *(Pseudocolochirus mysticus)*

DD. Ventral side flattened into sole; dorsal side with scales, more or less concealed by a thick layer of deposits.. *Thyonepsolus braziliensis*

AA. Pedicels wanting.

B. Respiratory trees present; tentacles with only 2 pairs of digits.. *Caudina obesacauda*

BB. Respiratory trees wanting; tentacles with more than 2 pairs of digits.

C. Deposits anchors and plates; tentacles pinnate.

D. Arms of anchors smooth; vertex with minute knobs; a distinct bridge across posterior end of anchor-plates.

E. Large (up to 1 M); stock of anchor branched or deeply cleft.......................... *Euapta lappa*

EE. Small (not over 150 mm.); stock of anchor undivided ...................... *Synaptula hydriformis*

DD. Arms of anchor serrate; vertex smooth; no bridge on anchor-plates.
- E. Radial pieces of calcareous ring perforated for passage of nerve.
  - F. No anchor-plates with more than 9, usually with 7, large dentate perforations.
    - G. Anchors in posterior part of body large, up to $400\mu$ in length.................. *Leptosynapta multigranula*
    - GG. No anchors more than $200\mu$ long.
      - H. Anchor-plates more or less circular, the large perforations practically devoid of teeth; no miliary granules ..................*L. circopatina*
      - HH. Anchor-plates oblong, the large perforations with at least a few teeth on margins.
        - I. Anchor-plates, $110\text{-}140\mu$ long; miliary granules slender curved rods with branched tips .............*L. crassipatina*
        - II. Anchor-plates only $90\text{-}100\mu$ long; miliary granules of diverse forms, many being little disks with or without a central perforation ..........*L. parvipatina*
  - FF. Many anchor-plates with more than 10 large dentate perforations.
    - G. Miliary granules very numerous........ *Eupatinapta acanthia*
    - GG. Miliary granules wanting.......*E. multipora*
- EE. Radial pieces of calcareous ring not perforated but merely notched on the anterior margin..... *Epitomapta roseola*

CC. Deposits, 6-spoked wheels gathered in little heaps; tentacles peltatodigitate.
- D. Size small, usually under 75 mm.; small, curved rods scattered in the skin.................*Chiridota rotifera*
- DD. Size large, up to 250 mm.; curved rods in skin very numerous, forming a layer....................*C. peloria*

## Order *ASPIDOCHIROTA*

### Family Holothuriidæ

#### **Holothuria cubana** Ludwig

*Holothuria cubana* Ludwig, 1875, Arb. Zool.-Zoot. Inst. Würzburg, ii, p. 104, Pl. 7, fig. 34. Deichmann, 1930, Bull. M. C. Z., lxxi, p. 54; Pl. 1, figs. 1-8.

It is a curious fact that for more than half a century Ludwig's species lay unrecognized and it is only because of Dr. Deichmann's careful studies that its status has been established. It is probable that it is fairly common throughout the West Indian region but because of its secretive habits it is not often collected. It lives buried in sand beneath rock fragments, and the sand tends to attach itself to the skin. The color aids in the concealment, for it is a grayish-white with the lower side lighter. There are often 6 pairs of indistinct dusky spots on the back while there may be rusty stains ventrally. The body is flattened with the back somewhat arched, and the mouth is ventral, surrounded by 20 very small white or pale yellow tentacles. All the appendages are small and generally, in preserved material, strongly contracted. Large specimens may be 150 mm. long, but most are from 80 to 100 mm.

This species has been recorded from Bermuda, Florida, Cuba, Barbados, and Curaçao. In the Academy collections there are 3 small but typical specimens, 30-40 mm. long, light brownish-gray in color with yellowish tentacles. They were taken by R. W. Miner, July 21, 1914, at Condado Bay, San Juan, and are the first known from Porto Rico.

### **Holothuria pseudofossor** Deichmann

*Holothuria pseudofossor* Deichmann, 1930, Bull. M. C. Z., lxxi, p. 57; Pl. 1, figs. 9-14.

This species is known as yet only from Montego Bay, Jamaica, where it is fairly common. It is very similar to *cubana* in color and form, but is not quite so large (only up to about 100 mm.). The pedicels are fairly large and the skin, at least on the dorsal side, is very glutinous so that a coat of sand is normally adherent to it. In these particulars, the species differs from *cubana,* as well as in the wider buttons and the smaller, simpler tables.

### **Holothuria princeps** Selenka

*Holothuria princeps* Selenka, 1867, Zeits. f. w. Zool., xvii, p. 332; Pl. 18, figs. 67-69. Deichmann, 1930, Bull. M. C. Z., lxxi, p. 58; Pl. 2, figs. 1-8.

This seems to be a rather rare, or perhaps very local, species. I have never encountered it and it is recorded only from Florida and San Domingo. The Florida localities (Pensacola, Charlotte Harbor) are on the west coast and far north of the Tortugas, but the occurrence of the species in San Domingo seems to destroy the significance of that fact. In body form, *princeps* seems to be less flattened than the preceding species, and it also has more numerous appendages, both pedicels and papillæ. It reaches a larger size (200 mm.) and is darker colored—yellow with darker patches dorsally. The distinctive character, however, is found in the large tack-like tables near the tips of the appendages.

**Holothuria impatiens** (Forskål)

*Fistularia impatiens* Forskal, 1775, Desc. Anim., p. 121; Pl. 39, fig. *b*.
*Holothuria impatiens* Gmelin, 1788, Linn. Syst. Nat., ed. 13, i, pt. 6, p. 3142. Deichmann, 1930, Bull. M. C. Z., lxii, p. 64; Pl. 3, figs. 17, 18.

Here we have a notoriously widespread and diversiform species, found in suitable habitats throughout the tropical seas of both hemispheres, with the possible exceptions of the western coasts of Africa and America. West Indian specimens, however, are much smaller and much less diversified in color than those from the East Indian region, where individuals 400 mm. long occur, and a great variety of shades, browns, grays, and yellows, is found in perplexing diversity. In the western seas, *impatiens* is rarely over 200 mm. long and the color is fundamentally gray, usually of a bluish or purplish shade; the ground color is often uniform but it is frequently mottled with brownish, and less commonly with whitish. In no case that I have seen has the coloration been conspicuous or notable in any way.

Living under rock fragments and slabs as it does, *impatiens* is somewhat gregarious and it is not uncommon to find several under one sheltering fragment. The possession and free use of conspicuous and voluminous white Cuvier's organs is a notable and unpleasant characteristic of the species. The range of *impatiens* in the West Indian region is from Florida and the east coast of Central America to Barbados and Tobago. It does not seem to have made its way to Bermuda nor to the South American coast. In the Academy collection there are two typical specimens from Mangrove Island, Parguera, taken June 27, 1915. The "Fish Hawk" brought back specimens from Culebra and Ponce. At the Virgin Islands, also, *impatiens* has been taken.

**Holothuria arenicola** Semper

*Holothuria arenicola* Semper, 1868, Holothurien, p. 81; Pl. 20; Pl. 30, fig. 13. Deichmann, 1930, Bull. M. C. Z., lxxi, p. 66; Pl. 4, figs. 1-9.

This is another tropicopolitan species, but very different from *impatiens* in habits and appearance. It lives buried in sand beneath rock fragments or among such fragments which are themselves buried. The appendages are pedicels only and are small and scattered, usually quite inconspicuous. Large specimens are 250-300 mm. long in life and 30-40 mm. in diameter at the middle, tapering towards each end. In color we find some diversity; the ground color is dirty whitish or pale gray more or less stained (at least in Brazilian and West Indian specimens) with rusty-yellowish; in some specimens the rusty ground color is very marked. In typical *arenicola* there is a double series of dusky spots or blotches on the dorsal surface (as shown in Semper's Plate 20), but the number, size and distinctness of these spots shows great diversity. Miss Deichmann calls attention to the existence of a smaller form in which the spots are much smaller and scattered over the entire surface, and she inclines to the view that the two forms do not occur at the same locality. She also suggests, and my own observations cause me to agree with her, that the yellowness or darkness of the ground color is associated with special local conditions of the habitat.

In the West Indian region this tropicopolitan holothurian is found from Bermuda, and the Tortugas, to Brazil. It is common in Jamaica and at Tobago. In the Academy collection there is a very young specimen (25 mm. long) with no other label than Porto Rico. The "Fish Hawk" brought back only a single specimen from Culebra. The species has been taken at the Virgin Islands. Most West Indian records are under the name *H. rathbuni*.

### **Holothuria densipedes** H. L. Clark

*Holothuria densipedes* H. L. Clark, 1901, Bull. U. S. Fish Comm., 2, p. 257; Pl. 17, fig. 1.

The holotype of this species, taken by the "Fish Hawk" on the lighthouse reef at Playa de Ponce, Porto Rico, remains unique. Dr. Deichmann considers it merely an aberrant specimen of the preceding species, *arenicola*, but I find it very difficult to agree to that. Of course, if no further specimens are found at Playa de Ponce, or elsewhere, we shall have to discard the species, but until a real effort has been made to secure specimens in the vicinity of Ponce, it seems best to maintain the name. The original specimen was 88 mm. long and 20 mm. in diameter. The color was brown with a few scattered dull purple or blackish blotches; the papillæ had a reddish tinge while the pedicels were much lighter with a touch of yellow.

### **Holothuria parvula** (Selenka)

*Mülleria parvula* Selenka, 1867, Zeits. f. w. Zool., 17, p. 314; Pl. 17, figs. 17, 18.
*Holothuria parvula* Deichmann, 1930, Bull. M. C. Z., lxxi, p. 70; Pl. 4, figs. 14-22.

This little holothurian ranges from Bermuda, where it is very common, and the Tortugas, to Barbados and Tobago. It is not yet recorded from either Central or South America. It is a small species, not exceeding 75 mm. in length and usually under 60, with the ventral side flattened and quite distinct from the more arched back. It lives clinging to the under surface of rocks on reef-flats and in very shallow water. The color in life is a bright brown with the numerous pedicels of the lower surface deep yellow; preserved specimens are not noticeably different. There are three or four very characteristic features of this species which deserve special mention. The most notable is its habit of asexual reproduction by autotomy, a trait it shares with a very few other holothurians, notably *H. surinamensis*. Crozier (1917, Amer. Nat., li, pp. 560-566) has pointed out that in the present species autotomy seems to occur normally only in very young individuals. Another feature that *parvula* shares with *surinamensis* is the presence of a peculiar fluorescent green pigment in the skin. It differs markedly from *surinamensis* in the possession of copious, white Cuvierian organs, which it uses freely. Finally it possesses a tendency to form calcified anal papillæ which in many individuals become hard enough and sufficiently obvious to remind one of Actinopyga. Hence it has very commonly happened that such specimens were called *A. parvula* while those individuals which lacked these "anal teeth" were called *H. captiva*. There is no specimen of *parvula* in the Academy collection but the "Fish Hawk" took two very small specimens at Hucaires. It has also been taken at St. Thomas.

### **Holothuria glaberrima** Selenka

*Holothuria glaberrima* Selenka, 1867, Zeits. f. w. Zool., xvii, p. 328; Pl. 18, figs. 57, 58. Deichmann, 1930, Bull. M. C. Z., lxxi, p. 69; Pl. 4, figs. 10-13.

Here we have a very different holothurian from those so far listed, for it lacks tables as well as buttons in the body wall, and it delights to live, not on reef-flats and in sheltered areas, but among the rocks where the surf breaks and sea-weeds grow. It is quite gregarious, large numbers sometimes occurring together in a very small area. The very numerous pedicels of the ventral side enable them to cling very tightly to the rocks where the dull or dark color renders them inconspicuous, even if they were not hidden by sea-weed. The color, from light brown to almost black, is without blotches or spots. The large, densely branched tentacles are generally very dark, darker than the color of the body. The size in life is sometimes very considerable, up to 180-200 mm., but the great majority of preserved specimens are 75-100 mm. long.

This is an exclusively West Indian species. It has not been found at Bermuda or the Tortugas but it is known from the Bahamas, Cuba, Jamaica, Hayti, Porto Rico, St. Thomas, Antigua, Barbados, and Trinidad. Miss Deichmann records it from Honduras. I did not find it at Tobago but that is probably because of the lack of a surf-beaten habitat at Buccoo Bay, where nearly all my collecting was done. In Porto Rico, *glaberrima* seems to be common. The Academy collection contains 16 specimens of which half are very light, and half dark, colored. They were taken near San Juan, Guanica, and Parguera. The smallest is only 28 mm. long. The most noteworthy are 3 very large individuals, 100, 140 and 170 mm. in length and very light colored, taken among the "rocks south of Lighthouse Beach, Guanica harbor, June 21, 1915." The "Fish Hawk" found *glaberrima* only at Hucaires.

**Holothuria surinamensis** Ludwig

*Holothuria surinamensis* Ludwig, 1875. Arb. Zool.-Zoot. Inst. Würzburg, ii, p. 111; Pl. 7, fig. 27. Deichmann, 1930, Bull. M. C. Z., lxxi, p. 63; Pl. 3, figs. 12-15, 19.

This is one of the common holothurians of Bermuda and Jamaica, ranging thence eastward and southward to Tobago, Trinidad, Surinam, and Brazil. It seems to be abundant at Antigua where Fisher made interesting observations on its habits and habitats (see Deichmann, 1926, Univ. Iowa Stud. Nat. Hist., xi, No. 7, p. 12). It is reported from Florida but I agree with Dr. Deichmann in doubting this record, as I did not find any specimens at the Tortugas where there are plenty of suitable habitats. It lives in very shallow water along shore, usually among corals or under rock fragments, but sometimes among corallines and eel-grass. It is brown in color, the extremes being a light yellowish shade, a deep reddish-chocolate and a distinctly purple-brown; the ground color may be more or less blotched or marbled with a different shade. The tentacles and tips of the rather scattered appendages are light-colored, whitish or yellowish. Most individuals are about 100 mm. long but fully grown ones may be twice that. Asexual reproduction by autotomy is more common than in any other known holothurian (see Crozier, 1917, Amer. Nat., li, pp. 560-566) and occurs even in large individuals. The fluorescent greenish pigment in the skin is also an exceptional feature of this species.

The Academy collection contains 17 specimens of *surinamensis*, of which 15 small and medium sized specimens were collected at a mangrove island near Parguera; the others were taken near San Juan. The "Fish Hawk" took numerous specimens at Ponce, Boqueron Bay, San Juan, Puerto Real and Guanica. The species is also known from St. Thomas.

**Holothuria grisea** Selenka

*Holothuria grisea* Selenka, 1867, Zeits. f. w. Zool., xvii, p. 328; Pl. 18, figs. 52-56. Deichmann, 1930, Bull. M. C. Z., lxxi, p. 76; Pl. 5, figs. 1-4.

In no particular has Dr. Deichmann's work been more clarifying than in the separation of *grisea, floridana* and *mexicana* from each other. All three are common in Jamaica, and my observations of them in life satisfy me that Dr. Deichmann's treatment of the trio is sound and trustworthy. The present species, *grisea,* is in my opinion the smallest, the lightest colored, and the most variable as well as the most widespread, of the three. Dr. Deichmann gives its maximum size as much greater than that of *floridana,* but my own impression is that adult *floridana* in life may be well over 250 mm. while the *griseas* with which I have met rarely exceeded 200 mm. Probably the difference in color is more significant and constant. The general impression given by a typical *grisea* in life and often when preserved is, as the name indicates, gray[4]; usually there are at least two shades, and the lighter may be either the ground color or in blotches on a darker ground; the tentacles and pedicels, and even the tips of the papillæ, are more or less yellow, often in rather sharp contrast. In specimens living in clean and well aërated water, patches and spots of flesh-red often show clearly, but, in my experience, the reds and yellows are rarely so conspicuous that (as Dr. Deichmann quotes Fisher) the animal is "a complete harlequin with bright red and yellow colors". Very old specimens and those sometimes taken on or near muddy bottoms are usually dull, and especially when preserved in alcohol show little or no trace of red, yellow, or even light gray. In body form and habitat, *grisea* shows almost as great diversity as in color. Young specimens and small adults usually have the ventral side somewhat flattened and densely covered with pedicels; there is a conspicuous difference between the dorsal and ventral sides, but I cannot quite agree to call the latter "a regular sole", as Dr. Deichmann does. The larger the specimen, the more cylindrical the body, as a rule, and the less difference there is between the dorsal and ventral sides. Young *grisea,* and most adults up to 150 mm. or so, live among rock fragments or under slabs of rock or coral. They seem to prefer areas where the water is in considerable motion but they may occur anywhere on the reef-flat. Occasionally large individuals are found on the flats, or on eel-grass (sometimes muddy) bottoms and they then resemble *floridana* quite closely, but the calcareous particles in the skin will serve as a final means of distinguishing them.

There is no doubt that *grisea* and *floridana* have been hitherto much confused with each other, so that the limits of the range of each cannot be regarded as definitely determined. So far as our present knowledge

[4] Fisher's observations in Antigua contradict this: see Deichmann, 1926, p. 16.

goes, *grisea* is common in Jamaica, Porto Rico, St. Thomas, Antigua, and Tobago. It occurs at the Tortugas and on the coast of southern Florida, at Colon, Curaçao, the coast of Colombia, and in Brazil. It is recorded also from the eastern Atlantic but I have never seen African specimens.

There are two typical specimens in the Academy collections, one from San Juan and one from Guanica, but they call for no comment. The "Fish Hawk" took *grisea* at Arroyo and Hucares.

### **Holothuria floridana** Pourtalès

*Holothuria floridana* Pourtalès, 1851, Proc. Amer. Assoc. Adv. Sci., 5th meeting, p. 12. Deichmann, 1930, Bull. M. C. Z., lxxi, p. 72; Pl. 5, figs. 5-9.

This species, known and described long before either *grisea* or *mexicana*, has been confused with both and more particularly with the Indo-Pacific species, *atra*. Edwards long ago (1908. Biometrika, vi, pp. 236-301, Pls. 1-5) separated it definitely from *atra* but unfortunately confused it with *mexicana* and I have followed him in this error. Let us hope Miss Deichmann's work will prevent such blunders henceforth. In length *floridana* is commonly under 300 mm. and the diameter of a specimen that long will be 25-35 mm. The color, so far as my experience goes, is fairly uniform, brown of some shade, usually reddish, some individuals being almost dull brick red. Dr. Deichmann calls the color "very variable" from "almost white" to "very dark brown", but she obviously refers to the large series of preserved specimens she has examined, and I am inclined to think much of their diversity is artificial. In habitat, *floridana* prefers open flats more or less covered with eel-grass and it is often very common in such places. Its range seems to be limited to the western end of the Caribbean region. It is common in Jamaica but is not yet known from Porto Rico or St. Thomas. It is recorded from Cuba and Swan Island and as far south as Colon, while it is reported to be abundant on the Florida coast. There are no specimens in the Academy collection nor did the "Fish Hawk" find it at Porto Rico.

### **Holothuria mexicana** Ludwig

*Holothuria mexicana* Ludwig, 1875, Arb. Zool.-Zoot. Inst. Würzburg, ii, p. 101; Pl. 7, fig. 47. Deichmann, 1930, Bull. M. C. Z., lxxi, p. 74; Pl. 5, figs. 15-20.

Although this species has been badly confused with the preceding, it is really totally distinct. The body-wall differs from that of the other West Indian holothurians in being thick, firm and rigid; preserved specimens often become very hard. Moreover this is the largest West Indian holothurian as its length may exceed 500 mm. and such a specimen would be 60-75 mm. in diameter. Again, the color in life is very distinctive, the upper surface ranging from deep ochre-yellow to almost black, while the lower surface ranges from nearly white to deep rose, usually without—but sometimes with—large irregular blotches of ochre or brown. In alcohol the rose color is usually faded, the lower surface appearing as dirty whitish, cream-color or dull yellow. The pedicels are not very numerous, rather uniformly distributed, often very dark, so that they stand out rather conspicuously on the lighter areas. Dr. Deichmann says young specimens (presumably preserved material) are "sand-colored with small dark spots on dorsal side". Very large, and presumably old, individuals are very deep blackish-brown below, as well as above.

In habitat, *mexicana* is like *floridana* though apparently preferring deeper water as a rule. However, it is common in Jamaica, on eel-grass bottoms (particularly around Port Royal) in very shallow water and Fisher found it in a similar habitat in Barbados. According to Dr. Deichmann its range is eastern as compared with *floridana*, extending from Cuba to Curaçao and Barbados. It is apparently not known from Florida or the Central American coast. It is common in Antigua and is apparently very common in Porto Rico.

The Academy collections contain 7 specimens of *mexicana*, all adult, and showing the usual diversity of color; one is still rose-colored underneath. They were collected at or near San Juan, Guanica, and Ballena Point. The "Fish Hawk" brought home 20 specimens from Culebra, Fajardo, Boqueron Bay, Guanica, Puerto Real, Mayagüez and San Juan.

### **Actinopyga agassizii** Selenka

*Mülleria agassizii* Selenka, 1867, Zeit. f. w. Zool., xvii, p. 311; Pl. 17, figs. 10-12.
*Actinopyga agassizii* Verrill, 1867. Trans. Conn. Acad., I, p. 347.
Deichmann, 1930, Bull. M. C. Z., lxxi, p. 78; Pl. 5, figs. 21-29.

This is the only West Indian species of a genus characteristic of the Indo-Pacific region. It is readily recognized by the five conspicuous anal teeth, considered in connection with the numerous (25-30) tentacles, the large size, robust, somewhat depressed, form, and marked contrast between the upper and lower surfaces. Dorsally there are numerous papillæ of very diverse sizes while ventrally there are 3 broad bands of very numerous pedicels. In life, the length is 250-300 mm., seldom more, with a width of about 50, but of course preserved specimens are hardly two-thirds as much. The color, which is not much affected by alcohol, is yellow-brown above, mottled with different shades of brown and dusky in irregular and diverse patterns; the lower surface is variegated dusky and dirty whitish, though the pedicels are more or less yellow.

Actinopyga is found usually on flats covered with eel-grass, where *Holothuria mexicana* and Stichopus live, but it occurs also under the shelter of rock and coral fragments on the reef-flats. In Jamaica, most individuals are inhabited by the commensal fish, Fierasfer. The range of *Actinopyga agassizii* seems to be rather restricted. There are records from Bermuda and Barbados but otherwise it is known only from Florida (including the Tortugas), Jamaica (where it is common) and Hayti. It has yet to be taken in Porto Rico or the Virgin Islands.

### **Stichopus badionotus** Selenka

*Stichopus badionotus* Selenka, 1867, Zeit. f. w. Zool., xvii, p. 316; Pl. 18, fig. 26. H. L. Clark, 1922, Bull. M. C. Z., lxv, pp. 55-60; Pl. 2, figs. 11-18. Deichmann, 1930, Bull. M. C. Z., lxxi, p. 80; Pl. 5, figs. 30-36.

Of all the holothurians of the West Indies, this is the most protean in appearance and it is not strange that at least seven different names have been given to it in one or another of its various forms. But the internal characters and the calcareous deposits are very constant, and once we reconcile ourselves to the fact that color and form have no significance in this particular case, we cannot doubt that we have here only a single but variable species.

The largest specimens seen were about 450 mm. long and 75-90 mm. wide in life but the great majority of individuals are 250-350 mm. long and 50-60 mm. wide. The body is somewhat quadrangular, the ventral side wider than the dorsal and the four lateral angles more or less rounded. The lower surface has 3 broad longitudinal bands of pedicels, but the development of dorsal appendages is surprisingly varied. In some individuals, aside from a few large tubercles along the lateral angles, the upper surface is quite smooth, while at the other extreme are individuals in which tubercles and papillæ of large and small sizes are so numerous that those of the lateral angles do not stand out notably. Between the two extremes all intermediate stages occur. Of course, preserved specimens show much less diversity than the living individuals. Color is extraordinarily varied. Unicolor individuals ranging from almost cream color to almost black, including buff, brown, deep red-brown and purple, are seen, but it is even more common to find spotted, blotched and variegated individuals, whose ground color may be any of the shades mentioned, while the dots, spots and blotches are of one of the other shades. A beautiful deep crimson form (var. *phœnius* H. L. C.) occurs in Tobago.

The habitat of Stichopus when adult is the eel-grass flats covered with from 1-6 feet of water. Here they are often present in considerable numbers, and usually (in Jamaica) in company with Actinopyga and *Holothuria mexicana*. Young individuals never appear out in the open but are occasionally encountered in the shelter of some rock or coral fragment. The range of this Stichopus is extensive, from Panama on the west, to Bermuda (where it is very common) and Tobago, on the east, and even to the west coast of Africa. But there is need for further information about the southeastern and eastern limits of its distribution.

There are no specimens of Stichopus in the Academy collections, though several large *Holothuria mexicana* are so labelled. But the "Fish Hawk" found this species common in Porto Rico and brought back 8 specimens from Boqueron Bay, San Juan, and Mayagüez.

### Stichopus macraparentheses H. L. Clark

*Stichopus macraparentheses* H. L. Clark, 1922, Bull. M. C. Z., lxv, p. 61; Pl. 1, figs. 1-7. Deichmann, 1930, Bull. M. C. Z., lxxi, p. 82; Pl. 5, figs. 37-43.

It is not strange that this species was for so long unrecognized, for it is not nearly so unlike a typical *badionotus* as are some of the extreme forms of that common species. Moreover, it can only be positively identified when the spicules are examined. So far as we at present know, it is a small form, the largest specimens yet examined being only 120 mm. long. The color seems to show little diversity; in life, a rather bright brown with very dark rings around the bases of the papillæ which have yellow tips; in preserved specimens, these colors are paler and duller. The texture of the body-wall is thinner and more translucent (in life) than in *badionotus*. Few specimens of *macroparentheses* have been taken and these are chiefly from under or among rock fragments; but Fisher collected specimens in Antigua, on sand among eel-grass. Aside from this Antigua material, the species has been found only in Jamaica and at the Tortugas, Florida. Hence there are no specimens in the Academy collections.

### Astichopus multifidus (Sluiter)

*Stichopus multifidus* Sluiter, 1910, Zool. Jahrb. Suppl. 11, p. 334, figs. A*a*, *b*.
*Astichopus multifidus* H. L. Clark, 1922, Bull. M. C. Z., lxv, p. 48. Deichmann, 1930, Bull. M. C. Z., lxx, p. 84; Pl. 5, figs. 44-47.

This remarkable holothurian was first described from a single specimen taken in the Southwest Channel at the Tortugas, by Dr. Hartmeyer in 1907. Unfortunately no depth is given so it is not known whether the type was dredged or not. The only other known specimens are those I have taken in Jamaica. I failed to find a specimen at the Tortugas in 1917, nor did I find one in Tobago, the previous year. The University of Iowa parties have failed to collect specimens, nor have the various collectors who have visited Porto Rico been any more successful. The specimens seen by me in Jamaica were all at Port Antonio and even there the species seems to be rare and of uncertain appearance. In 1897, a number of specimens were seen but they were of such large size it was not feasible to preserve them. Not realizing at the time that the species was new or remarkable, no measurements were made and only the anterior and posterior ends, and three intermediate pieces, of a single individual were preserved. In life these Port Antonio specimens were at least 450 mm. long, 80-90 mm. wide and 60-70 mm. high. The upper side was variegated with several shades of brown and some black; the lower side, densely crowded with large pedicels, was very white. The animals were living on an eel-grass bottom in shallow water (2-5 ft.) and moved about more obviously than any other large holothurian I have ever watched. On my later visit to Port Antonio in 1909 I found but a single specimen of Astichopus and that was much smaller than those observed in 1897. Its color was different also, for while the lower surface was white, the upper side was "variegated with black and white"; in the preserved specimen it is dark brown and fawn color. During my visits to Jamaica in 1896, 1902 and 1912, no individuals of this species were noted, but practically no collecting was done at Port Antonio. Yet very similar eel-grass bottoms were worked over at Port Maria, Montego Bay, and Port Royal without seeing this big holothurian. It may perhaps live ordinarily in water two or more fathoms deep and only occasionally, perhaps accidentally, come into the more shallow water close to shore.

## Order *DENDROCHIROTA*

### Family Cucumariidæ

#### **Phyllophorus seguroensis** Deichmann

*Phyllophorus seguroensis* Deichmann, 1930, Bull. M. C. Z., lxxi, p. 141; Pl. 17, figs. 10-13.

All species of Phyllophorus, when contracted, are so much like Thyone that they are easily mistaken for members of that genus. If very fully contracted, it is difficult and sometimes impossible to count the number of tentacles accurately, but it is possible, unless the whole head end is missing, to determine whether or not there are more than 10. If that is found to be the case, it is safe to consider the specimen, if from West Indian shores, a Phyllophorus. There is still, however, some doubt as to the number of species in this region and how they are to be distinguished from each other. Dr. Deichmann's work has, however, cleared up much of the difficulty and if care is used in the examination of the calcareous particles, the forms at present known may be correctly identified.

The present species lives near low water mark under or among rock fragments more or less buried in the sand, or actually buried in the mud of eel-grass flats. It is 75-100 mm. long in life, even more when fully extended, but when preserved it is hardly more than half as much. The somewhat mottled brownish color, with light pedicels, is little changed by preservation.

As yet *seguroensis* is known only from the type locality, Porto Seguro, Brazil; from Port Antonio, Jamaica; and from the Tortugas, Florida. There are no records from Porto Rico or the Virgin Islands.

### **Phyllophorus occidentalis** (Ludwig)

*Thyonidium occidentale* Ludwig, 1875, Arb. Zool.-Zoot. Inst. Würzburg, ii, p. 119.

*Phyllophorus occidentalis* Deichmann, 1930, Bull. M. C. Z., lxxi, p. 148; Pl. 18, figs. 1, 2.

Although the calcareous tables of this holothurian are so markedly different from those of *seguroensis* as amply to justify its recognition as a distinct species, the distribution and even the habitat are identical. It is apparently somewhat smaller than *seguroensis* but does not differ noticeably in form or color. It lives buried in sandy mud, among eel-grass roots, at the Tortugas, but nothing has been noted as to its habitat elsewhere. It has been reported from the Tortugas, Antigua, Barbados, Surinam and Porto Seguro, Brazil, but there are no records from Porto Rico or the Virgin Islands.

### **Phyllophorus destichadus** Deichmann

*Phyllophorus destichadus* Deichmann, 1930, Bull. M. C. Z., lxxi, p. 146; Pl. 18, fig. 3.

It is hard to believe that four species of Phyllophorus should occur in so limited an area as the shallow water surrounding the Tortugas and I think it very probable that an abundance of material will show that these supposedly different forms intergrade with each other to such an extent that their real relationship is better expressed by the recognition of two species. For the present, however, I follow Dr. Deichmann's judgment in the matter. The present species is based on two specimens which I collected at the Tortugas, where they were living among eel-grass roots in firm mud. They were about 100 mm. long in life (now 40-60 mm.) and the color was dull violet brown. No other specimens are as yet known.

**Phyllophorus parvus** (Ludwig)

*Thyonidium parvum* Ludwig, 1881, Arch. Biol., ii, p. 54; Pl. 3, figs. 16-18.
*Phyllophorus parvus* Deichmann, 1930, Bull. M. C. Z., lxxi, p. 149.

This small species is said to be "common along the coast of Brazil down to Rio Janeiro" but the only West Indian record is that from English Harbor, Antigua, where the Iowa University party of 1918 collected a single specimen. Dr. Deichmann does not mention the size of this individual but says the color was pale reddish brown with deep violet tentacles. Ludwig says merely that the color was pale reddish, but he gives the size of his type specimen as 28 mm. in length and 8 mm. in greatest diameter. It seems quite possible that these little specimens are merely the young of one of the large but still very imperfectly known species.

**Phyllophorus tritus** (Sluiter)

*Thyone trita* Sluiter, 1910, Zool. Jahrb. Suppl. 11, p. 339, figs. E, *a-c*.
*Phyllophorus tritus* Deichmann, 1930, Bull. M. C. Z., lxxi, p. 147; Pl. 18, figs. 4-8.

Here again we have a species based on scanty material; a single specimen, almost certainly immature, served as the type, and only two other specimens are known. Sluiter's specimen was taken on Bird Key Reef, Tortugas, and was gray violet in color, darker above than below; it was only 25 mm. long by 7 in diameter. Dr. Deichmann thinks Sluiter's reference, in his description, to "ten" tentacles is an error. Her specimens from English Harbor, Antigua, were only a little larger and were at first considered Thyones, but a more critical examination revealed 18 tentacles.

**Thyone briareus** (Lesueur)

*Holothuria briareus* Lesueur, 1824, Jour. Acad. Nat. Sci. Phila., iv, p. 161.
*Thyone briareus* Selenka, 1867, Zeit. f. w. Zool., xvii, p. 353. Deichmann, 1930, Bull. M. C. Z., lxxi, p. 165; Pl. 13, figs. 5-7.

This is one of the commonest of American holothurians, and because of its distribution along the eastern coast of the United States from Texas to southern Massachusetts it has been known to science for more than a century and has become the most familiar holothurian to students of zoölogy in the United States. But it is open to debate whether it should be included in the present report for it is not actually known from a single West Indian island.[5] It seems to be wholly confined to the United States coast and has not crossed the Gulf Stream.

When fully grown this Thyone reaches a length in life of 125-150 mm. but of course preserved specimens are mostly under 100 mm. unless

[5] Dr. Deichmann's statement that the type locality is St. Bartholomew is an unfortunate slip as Lesueur distinctly says his specimens were from Florida.

they have been carefully prepared with tentacles expanded. It is a curious fact that specimens less than half grown have been taken so rarely that we know nothing either of the development or of the growth stages. The color in life is always dark, the tentacles darker than the body, which is a greenish or blackish brown. The normal habitat in the Woods Hole region is on soft, muddy bottoms in shallow water (but below low-tide level) where the Thyones lie buried, with both tentacles and anal opening above the level of the mud. Even a slight disturbance, however, causes a contraction which may bury the whole animal below the surface. Owing to this ability to get out of the way by prompt depression of its two ends, this holothurian is rarely dredged but it lives, no doubt, wherever the bottom is suitable, down to a depth of several fathoms. Records of the occurrence of *briareus* on sandy bottom are probably attributable to a mistake or misunderstanding; a small mud-filled depression on a generally sandy bottom might easily explain such reports. There are no records of this holothurian from Porto Rico or the Virgin Islands.

**Thyone pseudofusus** Deichmann

*Thyone pseudofusus* Deichmann, 1930, Bull. M. C. Z., lxxi, p. 168; Pl. 14, figs. 6-9.

This very small species is based on specimens dredged in 25 fms. off the coast of Yucatan, but what is apparently the same thing was found by me in the coralline algæ of Buccoo Bay, Tobago, and in similar marine vegetation at the Tortugas. It has not yet been recorded from other localities but this is probably due in part, if not wholly, to its small size and secretive habits. When extended in life it is only a little more than 25 mm. long, and preserved specimens are of course much less. The color is dirty whitish or very pale brown.

**Thyone micropunctata** Sluiter

*Thyone micropunctata* Sluiter, 1910, Zool. Jahrb. Suppl. 11, p. 338; figs. D*a-c*. Deichmann, 1930, Bull. M. C. Z., lxxi, p. 171; Pl. 14, figs. 14-18.

This is another very small species, less than 25 mm. in length, of a grayish color, lighter below than above. It has been taken off Florida and at the Tortugas, as well as at Tobago. The type material was from a depth of 12 fms. at the Tortugas but the individuals which I collected at Tobago were in coralline algæ in very shallow water. Like *pseudofusus*, this species may prove to be the young of some larger form, as the secretive habits and the peculiar habitat may be considered indications of immaturity.

**Thyone cognata** (Lampert)

*Semperia cognata* Lampert, 1885, Holothurien, p. 251; fig. 51 (as *Cucumaria cognata*).
*Thyone cognita* Deichmann, 1930, Bull. M. C. Z., lxxi, p. 169; Pl. 15, figs. 1-4.

Unfortunately a typographical error (or a slip of the pen) makes Théel in his "Challenger" Report speak of this species as "*cognita*" and Dr. Deichmann has followed him in the error. Moreover, a typographical error in Dr. Deichmann's paper indicates that the type locality, Fernando di Noronha, is in Cuba; Lampert gave both Cuba and the Brazilian Island as type localities. Miss Deichmann has found additional specimens in the National Museum, from Yucatan, and in the Museum of Comparative Zoölogy, from Porto Seguro, Brazil, and from the Tortugas, where I collected a number of specimens in 1917. They were living buried in mud among eel-grass roots and are apparently fairly common on that particular "flat" on the southwest side of Loggerhead Key. The largest specimens were about 150 mm. long, rather slender, tapering toward each end; the body is strongly curved, and the middle portion well buried in the mud while each end is at the surface. The color in life is nearly white with gray-brown tentacles and yellowish feet; in preserved specimens the colors are darker.

The species is not known from Porto Rico or the Virgin Islands, but in view of the wide distribution from Yucatan to Brazil, it is probable that intensive collecting will bring it to light at many West Indian islands.

**Thyone suspecta** Ludwig

*Thyone suspecta* Ludwig, 1875, Arb. Zool.-Zoot. Inst. Würzburg, ii. p. 92; Pl. 6, fig. 19. Deichmann, 1930, Bull. M. C. Z., lxxi, p. 175; Pl. 16, figs. 3, 4.

The general appearance as well as the calcareous spicules seem to separate this species from the following (*surinamensis*) but they are closely allied. In *suspecta* the body-wall is thin and not rigid as there are relatively few deposits. This is in decided contrast to the firm body-wall with crowded deposits of *surinamensis*. In size the two species are alike (about 75-90 mm. long in life) but in color *suspecta* is brownish of a "dirty" shade and may show, rather faintly, 5 longitudinal streaks of brown of a different tint, quite in contrast to the gray of *surinamensis*. The type of *suspecta* was from Barbados and it has subsequently been taken there as well as on the coasts of Brazil and Colombia. A single specimen, now 50 mm. long by 20 in diameter, was taken by me in August, 1897, in a crevice of the reef rock at Folly Point, Port Antonio, Jamaica; the color was and still is decidedly brown. I know of no other records.

**Thyone surinamensis** Semper

*Thyone surinamensis* Semper, 1868, Holothurien, p. 65; Pl. 15, fig. 15. Deichmann, 1930, Bull. M. C. Z., lxxi, p. 173; Pl. 16, figs. 5-8.

Next to *briareus*, this is the commonest and best known Thyone of the West Indian region but until 1926, when Miss Deichmann discovered the truth, it was generally called *Cucumaria punctata* Ludwig. The identity of Ludwig's and Semper's species had not been previously suspected since one had been placed by its describer in Thyone and the other in Cucumaria, a fact which illustrates well how the two genera merge into each other and how badly in need of revision on modern lines they are.

Fully grown individuals of *surinamensis* may be 100 mm. long, but 75-80 mm. in length, by 20-25 mm. in diameter, is a more common size. The color is given by Dr. Deichmann as "brownish; tentacles dark, feet usually whitish, sprinkled with brown and provided with brown or yellowish disks". Presumably this description is of preserved material. My impression of the living animal is that of a distinctly gray holothurian, more or less variegated, but closely resembling the rocks among which it lives, and a specimen collected by me in Jamaica in 1912 is light gray, not at all brown.

At Bermuda, *surinamensis* is very common, near low water mark, under and among rocks to which it clings tightly by its numerous feet. It has been recorded also from Surinam, Barbados and St. Thomas, and I found one specimen at Montego Bay, Jamaica, in 1912, as already mentioned. The Academy collection contains two specimens from opposite Fort San Geronimo, San Juan, taken July 16, 1914, by R. W. Miner, the first record for Porto Rico. One is 35 mm. long, the other 52 mm.; both are much contracted.

**Pentacta pygmæa** (Théel)

*Colochirus pygmæus* Théel, 1886, "Challenger" Holos., p. 83; Pl. 4, fig. 9.
*Pentacta pygmæa* Deichmann, 1930, Bull. M. C. Z., lxxi, p. 180; Pl. 21, figs. 10-16.

The holotype of this little holothurian was from Bahia, Brazil, but all other known specimens are from "Florida, at low tide level or a few (1-3) fathoms depth". It seems a little strange that it has not been found at any intermediate point or even at the Tortugas. Dr. Deichmann gives the length as 30-70 mm. and the color brown; "the animal greatly resembles a piece of not too fresh chocolate candy". The occurrence of a Pentacta, a genus particularly characteristic of northwestern Australia, in the West Indian region seems to me well-nigh incredible and I await the discovery of further material with great interest. The genus is sadly in need of revision and when this is completed the West Indian form may be found to be *sui generis* literally!

### Family Psolidæ

**Thyonepsolus braziliensis** (Théel)

*Psolus braziliensis* Théel, 1886, Bull. M. C. Z., xiii, p. 15; fig. 7.
*Thyonepsolus braziliensis* Deichmann, 1930, Bull. M. C. Z., lxxi, p. 192; Pl. 21, figs. 1-6.

As Dr. Deichmann says "it is very extraordinary to find a species of Thyonepsolus in the West Indian seas", for the genus was established for a curious, little, brood-protecting holothurian from the coast of California. Théel's species from Brazil is still so imperfectly known we may justly be skeptical as to whether it is really a Thyonepsolus. The holotype from Porto Seguro is only 32 mm. long and the only other known specimens are very much smaller than that. They were taken in Buccoo Bay, Tobago, in 1916, by me, and were a very fine, deep, rose-red color in life. None was ever found actually by collecting in the Bay, even careful hunting by the hour under and around stones or among the coralline algæ, proving fruitless. But it was our custom to take to the laboratory from the shallow flat in the bay, buckets full of coralline algæ and this was distributed in glass aquaria and covered with sea-water. The next morning large numbers of small brittle stars and holothurians (not to mention myriads of crustaceans, worms, etc.) would be found on the sides or bottoms of the aquaria or on the surface of the masses of algæ. Many secretive and supposedly rare species were got in this way and it was the only way in which several were secured, among these being *Thyonepsolus braziliensis.* Where the adult Thyonepsolus lives remains a mystery to this day.

### Family Molpadiidæ

**Caudina obesacauda** H. L. Clark

*Caudina obesacauda* H. L. Clark, 1907 (1908), Apod. Holos., p. 38; Pl. 9, figs. 1-5. Deichmann, 1930, Bull. M. C. Z., lxxi, p. 201; Pl. 24, figs. 6-8.

Very imperfectly known from scanty material (one specimen from Marco, Florida, and one from Galveston, Texas), this is a most interesting holothurian, whose nearest relative is found in the Far East (Japan, North Australia, New Zealand). Another species, *arenata,* is found on the New England Coast. Until more material is secured, the actual status of *obesacauda* must remain doubtful. It reaches a length of 150 mm. (probably 200 mm. in life) and is of a dirty whitish color. Judging from the habits of its Australian relative, it will be found living somewhat gregariously in rather firm sandy mud near low water mark, along the Gulf coast of the United States and possibly Mexico. It is more doubtful whether it occurs in any of the West Indian islands.

## Family SYNAPTIDÆ

### **Euapta lappa** (Müller)

*Synapta lappa* Müller, 1850, Arch. f. Anat., Phys., etc., p. 134.
*Euapta lappa* Östergren, 1898, Öfv. K. Vet. Ak. Förh., lv, p. 113. H. L. Clark, 1924, Bull. M. C. Z., lxv, p. 464; Pl. 1, figs. 5-7.
*Euapta tobagoensis* Heding, 1928, Vid. Mad., lxxxv, p. 134.

This long worm-like holothurian is one of the most characteristic animals of the West Indian reef-flats. Living as it ordinarily does, under slabs of rock, it is not generally noted by the casual observer, but it is quite possible that it is nocturnal in its habits and only hides beneath coral slabs during the day. For it is quite an active and very graceful animal when disturbed and makes a most attractive occupant for an aquarium. Dr. Deichmann (1926) has published some excellent notes by Professor Nutting and Dr. Fisher on the appearance and habits of Euapta, to which there is little I can add. It is difficult to say what the length of an adult specimen is, so very extensile is the creature. Nutting says "two feet" and Deichmann "one meter"; no doubt both are right, for a specimen two feet long in repose would easily extend without injury to a meter if necessary. Preserved specimens are seldom over 400-500 mm. A specimen 600 mm. long in life would be about 25-30 mm. in diameter. The color is more or less variable, ranging from a very light gray to light brown, variegated with the small patches of white formed by the numerous miliary granules. Longitudinal stripes of a darker shade are sometimes evident; the color is little affected by alcohol.

According to Dr. Deichmann the range of this big synaptid is from the coast of tropical America to the Canary Islands. It is not known from Bermuda and apparently does not occur there, nor is it yet recorded from the Bahamas or Cuba. It is known from Florida and the Tortugas however. It is common in Jamaica and is known also from Porto Rico, Antigua, and Barbados. In Tobago, it is common in Buccoo Bay. Heding (1928, Vid. Med., lxxxv, p. 134) would make a distinct species of these Tobago specimens, but their appearance in life, their habitat, and their habits, are identical with those from Jamaica and the differences which he points out in the anchor-plates of the two forms are too slight and inconstant to trust. I feel sure they fall within the limits of diversity which even a well-defined and very constant species may show.

The Academy collection contains three specimens of this holothurian. One is a very good specimen of average size, and variegated brownish color, taken on the reef outside Cayo Maria Langa, entrance of Guayanilla Harbor, Ensenada, while the others are merely bleached head ends, in poor condition, of two individuals taken on the inner side of the outer reef, south of the entrance to Guanica Harbor, Ensenada.

### **Synaptula hydriformis** (Lesueur)

*Holothuria hydriformis* Lesueur, 1824, Jour. Acad. Nat. Sci. Phila., iv, p. 162.
*Synaptula hydriformis* H. L. Clark, 1907 (1908), Apod. Holos., p. 23. 1924, Bull. M. C. Z., lxv, p. 473; Pl. 3, figs. 5, 6; Pl. 4, fig. 4.

As I have published a complete account of the structure, habits and development of this interesting viviparous synaptid (H. L. Clark, 1898, Synapta vivipara, Mem. Boston Soc. Nat. Hist., v. pp. 53-88), it is unnecessary to go into details here. The fully grown animal, under favorable conditions, may be in life 100 mm. long and 6 or 7 mm. in diameter, but the great majority are less than this, and when preserved in alcohol most adult specimens are 20-40 mm. in length and only about 2 or 3 mm. in diameter. In color, we find two distinct forms; one distinctly red-brown, the other more or less deep green; both are much variegated with the whitish patches caused by the miliary granules. The brown form lives in red and brown algæ while the green form lives in green algæ. I have never seen any intergrading specimens, but brown specimens often, if not always, show green pigment in the skin when examined under the compound microscope. This synaptid is free-living and fairly active for a holothurian, creeping about among the branches or over the fronds of the algæ on which it is living. It is quite gregarious and scores are often found living in the same cluster of sea-weed.

In Bermuda, *hydriformis* is common, living chiefly in the bright green ulva; so far as I can recall, only the green form is present. In Jamaica, on the other hand, nearly all are of the brown form, but the green form also occurs in green algæ. The range of the species extends to the Brazilian coast, but it has not yet been taken in either Porto Rico or the Virgin Islands. It is common at the Tortugas and along the southern Florida coast. There are records from Antigua and Guadeloupe and the green form is fairly common at Tobago.

### **Leptosynapta multigranula** H. L. Clark

*Leptosynapta multigranula* H. L. Clark, 1924, Bull. M. C. Z., lxv, p. 486; Pl. 8, figs. 3-7.

This synaptid is known only from the Tortugas where it was common in June, 1917, in sandy mud among eel-grass roots on the southwest side of Loggerhead Key. In life it is upwards of 100 mm. in length and 5-8 mm. in diameter. The color is delicate flesh pink; preserved material has the ground color yellowish, but this is covered with low ill-defined, minute, dull red verrucæ.

**Leptosynapta circopatina H. L. Clark**

*Leptosynapta circopatina* H. L. Clark, 1924, Bull. M. C. Z., lxv, p. 478; Pl. 4, figs. 6, 7; Pl. 6, figs. 9-11.

This species is based on a single specimen taken by me in December, 1902, under a brick in the shallow boat canal which connects the "pond" back of Port Royal with Kingston Harbor, Jamaica. In life it was about 25-30 mm. long and 2 or 3 mm. in diameter. The color was pale dull reddish which has changed in alcohol to yellowish-brown. The unique holotype is probably quite young but until further material is collected, this cannot be demonstrated.

**Leptosynapta crassipatina H. L. Clark**

*Leptosynapta crassipatina* H. L. Clark, 1924, Bull. M. C. Z., lxv, p. 479; Pl. 6, figs. 1-4.

Here again is a species known as yet only from a single spot. I collected two specimens in sandy mud beside a mangrove key near Key West, Florida, June 17, 1917. No other specimens have been taken so far as I know. In life, they were a translucent white, and as preserved specimens they are a more opaque whitish. They were about 40 mm. long in life but are now, in alcohol, only about 25 x 3 mm.

**Leptosynapta parvipatina H. L. Clark**

*Leptosynapta parvipatina* H. L. Clark, 1924, Bull. M. C. Z., lxv, p. 490; Pl. 4, figs. 8, 9; Pl. 6, figs. 5-8.
*Leptosynapta micropatina* Heding, 1928, Vid. Med., lxxxv, p. 213, fig. 30.

This is also a species known from only a single spot, namely a sandy point in Buccoo Bay, Tobago, where we collected 15 specimens or more in March, 1916. It lived below low-water mark but in very shallow water. The largest individual extended to 150 mm. in length but was very slender, perhaps 3 mm. in diameter; most of the specimens were much smaller, and in alcohol are only 40-50 mm. long and 2-3 mm. in diameter. The color in life was translucent, pinkish-white; preserved material is pale brown, pale yellow or dirty-whitish.

Although Heding had access to my paper, he has redescribed this species under a different name without offering a word of explanation. As his material is from the very same locality as mine and collected at the same time, it does not seem possible to me that we are dealing with different species. It is true that our published figures are not exactly alike, but the differences are due in part to the artists and in part to individual diversity in the specimens examined.

**Eupatinapta acanthia** (H. L. Clark)

*Synapta acanthia* H. L. Clark, 1899, Ann. N. Y. Acad. Sci., xii, p. 126; Pl. 4.

*Leptosynapta acanthia* H. L. Clark, 1907 (1908), Apod. Holos., p. 92. 1924, Bull. M. C. Z., lxv, p. 477; Pl. 6, figs. 12-16.

*Eupatinapta acanthia* Heding, 1928, Vid. Med., lxxxv, p. 244, figs. 43, 44.

It is an interesting fact that this species, although common at Bermuda, has not been collected elsewhere, and appears to be a truly endemic form. It reaches a considerable size, up to 350 mm. in length and 8-10 mm. in diameter in life, but the great majority of those that have been taken were less than half that size. The color when living is a somewhat translucent pinkish-white, sometimes with a yellowish tinge. The pinkish tinge is caused by numerous elevated dots of a rosy-reddish pigment. On preservation, this pigment becomes darker and the dots more sharply defined, so that a specimen examined with a lens is pale yellowish-white with numerous elevated dots (Heding calls them "warts") of brownish red; these dots are most numerous anteriorly, where they may be quite crowded in a strongly contracted specimen.

This synaptid lives, like most Leptosynaptas, buried in sand, and hence would rarely be seen were it not for the thorough-going collector who, searching for whatever may turn up, occasionally digs out an individual. The local distribution in Bermuda has not been worked out at all but I found *acanthia* fairly common in a small cove on the west side of Coney Island in April, 1899.

**Eupatinapta multipora** (H. L. Clark)

*Leptosynapta multipora* H. L. Clark, 1924, Bull. M. C. Z., lxv, p. 488; Pl. 9, figs. 1-5.

*Eupatinapta multipora* Heding, 1928, Vid. Med., lxxxv, p. 244.

A single specimen of this species is all that has as yet been recorded. It was dug out of the sand at Drunkenman Cay, off the entrance to Kingston Harbor, Jamaica, June 3, 1896. When living it was about 90 mm. long, and 4 mm. in diameter, and the color was a fine rose-color. The preserved specimen is pale gray. Later visits to Jamaica, and even a special trip to Drunkenman Cay, have failed to discover additional specimens.

**Epitomapta roseola** (Verrill)

*Leptosynapta roseola* Verrill, 1874, Invert. Anim. Vineyard Sound, p. 362. H. L. Clark, 1924, Bull. M. C. Z., lxv, p. 491; Pl. 7, figs. 25-28.

*Epitomapta roseola* Heding, 1928, Vid. Med., lxxxv, p. 234, figs. 40 (12-22).

It is perhaps questionable whether this species ought to be included in this report, as it is a characteristic member of the Woods Hole fauna. But it is abundant at Bermuda and has been recorded somewhat dubiously from Jamaica by me, so it seems best to treat it as a West Indian species. The Jamaican specimen was taken at Titchfield Point reef at Port Antonio, Jamaica, in 1897; it was only 12-15 mm. long even in life and was flesh color thickly covered with dark reddish brown, elevated spots. Further material is needed to determine whether this Jamaican specimen is really *roseola*. No other specimen of this species is recorded from south of Bermuda.

At Woods Hole, *roseola* is fairly common on the Buzzards Bay shore, where it lives under rocks in fine gravel and coarse sand. It reaches a length of 100 mm. when fully extended but such a specimen so extended will be only 3-4 mm. in diameter. At Bermuda, *roseola* is very abundant under stones on sand. It may exceed 100 mm. in length (Heding refers to a specimen 120 mm. long when preserved) but most individuals are about 50-60 mm. long, and 6-8 mm. in diameter when living.

All of the *roseolas* I have myself collected both at Woods Hole and at Bermuda were rosy reddish or deep flesh color when alive, and the red color is deepened and strengthened by preservation in alcohol. Heding discusses a white form which he calls "variety *alba*" found in Mortensen's material from Bermuda. As I took scores of *roseola* at Bermuda during two weeks collecting in 1899, and never saw a single specimen that lacked the red pigment, I am puzzled by the presence and abundance (27 out of 79) of these white specimens in Dr. Mortensen's collection. I cannot avoid the feeling that the lack of pigment is artificial, but I am at a loss to explain how this can be so. Further study of *roseola* at Bermuda is greatly to be desired.

### **Chiridota rotifera** (Pourtalès)

*Synapta rotifera* Pourtalès, 1851, Proc. Am. Assoc. Adv. Sci., 5th meet., p. 15.
*Chirodota rotifera* Stimpson, 1860, Amer. Jour. Sci., xxix, p. 134. Ludwig, 1881, Arch. Biol., ii, p. 41; Pl. 3, figs. 1-15.
*Chiridota rotifera* Ludwig, 1892, Die Seewalzen, p. 359.

This is a common and wide-ranging species easily recognized among West Indian holothurians but not so easy to separate from some of its Indo-Pacific congeners. It rarely reaches a length of 100 mm., most individuals being about 40-60 mm. long and 4-5 mm. in diameter. The color in life is flesh-red with pure white wheel-papillæ. Alcoholic material is often more or less bleached, so that it may be pinkish, yellowish or even white, but the wheel-papillæ are always pure white. A dull dusky or purplish color is sometimes found in preserved specimens but this is probably due to something in the method of preservation or to staining by other accompanying material.

The range of *rotifera* is very extended. It is common at Bermuda, on the coast of southern Florida and at the Tortugas. I have also found it common in Jamaica and at Tobago. It is recorded from Antigua, Barbados and Brazil, and Heding lists 4 specimens from "Loango", presumably on the West Coast of Africa. He also lists specimens from St. John and St. Thomas, in the Virgin Islands.

The Academy collection contains a single specimen in poor condition but over 40 mm. long, of a dirty dull purplish color. It was taken at Mangrove Island, Parquera, June 27, 1915, and constitutes the first record for Chiridota from Porto Rico.

### **Chiridota peloria** Deichmann

*Chiridota peloria*, Deichmann, 1930, Bull. M. C. Z., lxxi, p. 212.

Based on two fragmentary specimens, this species is something of a mystery. The types were collected by Professor E. A. Andrews of Johns Hopkins University at Montego Bay, Jamaica, Sept. 1, 1910. They were living in "lined holes in sand on the beach" and were about 250 mm. long in life. When at Montego Bay in 1912, I made every effort to secure additional material, but in vain. We frequently found "lined holes" such as seemed to agree with Dr. Andrews' description, but they were always covered with water several feet deep and we never succeeded in getting any animal of any sort from them. The manner of life and the very large size satisfy me that this Chiridota is quite distinct from *rotifera* but until more material is collected its real status must remain uncertain.

## APPENDIX

### Local Lists

For the convenience of collectors, it seems desirable to give lists of species from the islands where most collecting of echinoderms has been done. There are eight such localities and they are here arranged geographically beginning at the north. Excepting Antigua, Bermuda has the smallest number of species and that fauna may be considered very completely known, but at Antigua and at Barbados there has been so little shore collecting done, it is probable that scarcely half their fauna is yet disclosed.

At the Tortugas more collecting has been done than at any other one place and in spite of their very small area, the largest number of species is known from there. Jamaica, with an enormously greater shore line, has not yet yielded as many species but I am confident the echinoderm fauna is fully as rich as at the Tortugas. Collecting at the Virgin Islands (U. S.) has extended over a very long period but no very intensive work has yet been done there. The fauna is probably equal to that of Porto Rico or Jamaica.

**Bermuda**

Asteroids—4

*Luidia clathrata*
*Linckia guildingii*
*Asterina folium*
*Stolasterias tenuispina*

Ophiuroids—18

*Ophiomyxa flaccida*
*Amphipholis gracillima*
*Amphipholis squamata*
*Ophiostigma isacanthum*
*Amphiodia repens*
*Ophiactis algicola*
*Ophiactis savignyi*
*Ophiothrix angulata*
*Ophiothrix suensonii*
*Ophionereis reticulata*
*Ophiocoma echinata*
*Ophiocoma pumila*
*Ophiocoma riisei*
*Ophioderma appressum*
*Ophioderma brevicaudum*
*Ophioderma cinereum*
*Ophiozona imbricata*
*Ophiolepis paucispina*

Echinoids—8

*Eucidaris tribuloides*
*Centrechinus antillarum*
*Lytechinus variegatus atlanticus*
*Tripneustes esculentus*
*Echinometra lucunter*
*Mellita sexiesperforatus*
*Echinoneus cyclostomus*
*Brissus brissus*

Holothurians—11

*Holothuria cubana*
*Holothuria arenicola*
*Holothuria parvula*
*Holothuria surinamensis*
*Actinopyga agassizii*
*Stichopus badionotus*
*Thyone surinamensis*
*Synaptula hydriformis*
*Eupatinapta acanthia*
*Epitomapta roscola*
*Chiridota rotifera*

41 species

## Tortugas

### Crinoids—1

*Nemaster iowensis*

### Asteroids—8

*Astropecten articulatus*
*Astropecten duplicatus*
*Luidia alternata*
*Oreaster reticulatus*
*Ophidiaster guildingii*
*Linckia guildingii*
*Asterina folium*
*Echinaster sentus*

### Ophiuroids—38

*Ophiomyxa flaccida*
*Astrophyton muricatum*
*Ophiacantha oligacantha*
*Amphiura palmeri*
*Amphiura stimpsonii*
*Ophiophragmus pulcher*
*Ophionephthys limicola*
*Amphipholis squamata*
*Ophiostigma isacanthum*
*Amphiodia planispina*
*Amphiodia pulchella*
*Amphiodia repens*
*Amphiodia rhabdota*
*Ophiocnida scabriuscula*
*Amphioplus abditus*
*Ophiactis algicola*
*Ophiactis mülleri*
*Ophiactis savignyi*
*Ophiothrix angulata*
*Ophiothrix brachyactis*
*Ophiothrix lineata*
*Ophiothrix örstedii*
*Ophiothrix suensonii*
*Ophionereis reticulata*
*Ophionereis squamulosa*
*Ophiocoma echinata*
*Ophiocoma pumila*
*Ophiocoma riisei*
*Ophiopsila riisei*
*Ophiopsila vittata*
*Ophioderma appressum*
*Ophioderma brevicaudum*
*Ophioderma brevispinum*
*Ophioderma cinereum*
*Ophioderma rubicundum*
*Ophiozona impressa*
*Ophiolepis elegans*
*Ophiolepis paucispina*

### Echinoids—15

*Eucidaris tribuloides*
*Centrechinus antillarum*
*Arbacia punctulata*
*Lytechinus variegatus carolinus*
*Tripneustes esculentus*
*Echinometra lucunter*
*Echinometra viridis*
*Clypeaster rosaceus*
*Clypeaster subdepressus*
*Encope michelini*
*Mellita sexiesperforata*
*Echinoneus cyclostomus*
*Plagiobrissus grandis*
*Meoma ventricosa*
*Brissus brissus*

### Holothurians—20

*Holothuria impatiens*
*Holothuria arenicola*
*Holothuria parvula*
*Holothuria grisea*
*Holothuria floridana*
*Actinopyga agassizii*
*Stichopus badionotus*
*Stichopus macroparentheses*
*Astichopus multifidus*
*Phyllophorus seguroensis*
*Phyllophorus occidentalis*
*Phyllophorus destichadus*

*Phyllophorus tritus*
*Thyone pseudofossor*
*Thyone micropunctata*
*Thyone cognata*
*Euapta lappa*
*Synaptula hydriformis*
*Leptosynapta multigranula*
*Chiridota rotifera*

82 species

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## Jamaica

Asteroids—12

*Astropecten articulatus*
*Astropecten duplicatus*
*Luidia clathrata*
*Luidia alternata*
*Luidia senegalensis*
*Oreaster reticulatus*
*Ophidiaster guildingii*
*Linckia guildingii*
*Asterina folium*
*Asterina hartmeyeri*
*Stegnaster wesseli*
*Echinaster echinophorus*

Ophiuroids—23

*Ophiomyxa flaccida*
*Astrophyton muricatum*
*Amphipholis squamata*
*Ophiostigma isacanthum*
*Amphiodia repens*
*Ophiocnida scabriuscula*
*Ophiactis savignyi*
*Ophiothrix angulata*
*Ophiothrix örstedii*
*Ophiothrix suensonii*
*Ophioncreis reticulata*
*Ophiocoma echinata*
*Ophiocoma pumila*
*Ophiocoma riisei*
*Ophioderma appressum*
*Ophioderma brevicaudum*
*Ophioderma brevispinum*
*Ophioderma cinereum*
*Ophioderma guttatum*
*Ophioderma rubicundum*
*Ophiozona impressa*
*Ophiolepis elegans*
*Ophiolepis paucispina*

Echinoids—14

*Eucidaris tribuloides*
*Centrechinus antillarum*
*Lytechinus variegatus*
*Tripneustes esculentus*
*Echinometra lucunter*
*Echinometra viridis*
*Clypeaster rosaceus*
*Clypeaster subdepressus*
*Mellita quinquiesperforata*
*Mellita sexiesperforata*
*Echinoneus cyclostomus*
*Moira atropos*
*Meoma ventricosa*
*Brissus brissus*

Holothurians—23

*Holothuria pseudofossor*
*Holothuria impatiens*
*Holothuria arenicola*
*Holothuria parvula*
*Holothuria glaberrima*
*Holothuria surinamensis*
*Holothuria grisea*
*Holothuria floridana*
*Holothuria mexicana*
*Actinopyga agassizii*
*Stichopus badionotus*
*Stichopus macroparentheses*
*Astichopus multifidus*
*Phyllophorus seguroensis*
*Thyone suspecta*
*Thyone surinamensis*

*Euapta lappa*
*Synaptula hydriformis*
*Leptosynapta circopatina*
*Eupatinapta multipora*
*Epitomapta roscola*
*Chiridota rotifera*
*Chiridota peloria*

72 species

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**Porto Rico**

Asteroids—11

*Astropecten articulatus*
*Astropecten duplicatus*
*Luidia clathrata*
*Luidia alternata*
*Luidia senegalensis*
*Oreaster reticulatus*
*Ophidiaster guildingii*
*Linckia guildingii*
*Asterina folium*
*Asterina hartmeyeri*
*Echinaster sentus*

Ophiuroids—33

*Ophiomyxa flaccida*
*Ophiacantha ophiactoides*
*Ophiomitrella glabra*
*Hemipholis elongata*
*Amphipholis squamata*
*Ophiostigma isacanthum*
*Amphiodia gyraspis*
*Amphiodia limbata*
*Amphiodia planispina*
*Amphiodia pulchella*
*Amphiodia repens*
*Ophiactis algicola*
*Ophiactis mülleri*
*Ophiactis savignyi*
*Ophiothrix angulata*
*Ophiothrix brachyactis*
*Ophiothrix örstedii*
*Ophiothrix suensonii*
*Ophionereis olivacea*
*Ophionereis reticulata*
*Ophionereis squamulosa*
*Ophiocoma echinata*
*Ophiocoma pumila*
*Ophiocoma riisei*
*Ophiopsila riisei*
*Ophioderma appressum*
*Ophioderma brevicaudum*
*Ophioderma brevispinum*
*Ophioderma cinereum*
*Ophioderma rubicundum*
*Ophiozona impressa*
*Ophiolepis elegans*
*Ophiolepis paucispina*

Echinoids—10

*Eucidaris tribuloides*
*Centrechinus antillarum*
*Lytechinus variegatus*
*Tripneustes esculentus*
*Echinometra lucunter*
*Echinometra viridis*
*Clypeaster rosaceus*
*Mellita sexiesperforata*
*Echinoneus cyclostomus*
*Moira atropos*

Holothurians—13

*Holothuria cubana*
*Holothuria impatiens*
*Holothuria arenicola*
*Holothuria densipedes*
*Holothuria parvula*
*Holothuria glaberrima*
*Holothuria surinamensis*
*Holothuria grisea*

*Holothuria mexicana*
*Stichopus badionotus*
*Thyone surinamensis*
*Euapta lappa*
*Chiridota rotifera*

67 species

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**United States Virgin Islands**
(St. Thomas et al.)

Asteroids—10

*Astropecten antillensis*
*Astropecten articulatus*
*Astropecten duplicatus*
*Luidia clathrata*
*Luidia alternata*
*Oreaster reticulatus*
*Ophidiaster guildingii*
*Linckia guildingii*
*Asterina folium*
*Echinaster sentus*

Ophiuroids—29

*Ophiomyxa flaccida*
*Ophiotreta littoralis*
*Ophioblenna antillensis*
*Amphiura palmeri*
*Ophiophragmus septus*
*Ophionephthys limicola*
*Ophionema intricata*
*Amphipholis gracillima*
*Ophiostigma isacanthum*
*Ophiocnida scabriuscula*
*Ophiactis savignyi*
*Ophiothrix angulata*
*Ophiothrix örstedii*
*Ophiothrix suensonii*
*Ophionereis reticulata*
*Ophionereis squamulosa*
*Ophiocoma echinata*
*Ophiocoma pumila*
*Ophiocoma riisei*
*Ophiopsila riisei*
*Ophioderma appressum*
*Ophioderma brevicaudum*
*Ophioderma brevispinum*
*Ophioderma cinereum*
*Ophioderma rubicundum*
*Ophioderma guttatum*
*Ophiozona impressa*
*Ophiolepis elegans*
*Ophiolepis paucispina*

Echinoids—11

*Eucidaris tribuloides*
*Centrechinus antillarum*
*Lytechinus variegatus*
*Tripneustes esculentus*
*Echinometra lucunter*
*Echinometra viridis*
*Clypeaster rosaceus*
*Clypeaster subdepressus*
*Echinoneus cyclostomus*
*Moira atropos*
*Meoma ventricosa*

Holothurians—10

*Holothuria impatiens*
*Holothuria arenicola*
*Holothuria parvula*
*Holothuria glaberrima*
*Holothuria surinamensis*
*Holothuria grisea*
*Holothuria mexicana*
*Stichopus badionotus*
*Thyone surinamensis*
*Chiridota rotifera*

60 species

## Antigua

Asteroids—3

*Oreaster reticulatus*
*Asterina folium*
*Ophidiaster guildingii*

Ophiuroids—12

*Ophiothrix angulata*
*Ophiothrix örstedii*
*Ophiothrix suensonii*
*Ophionereis reticulata*
*Ophiocoma echinata*
*Ophiocoma pumila*
*Ophiocoma riisei*
*Ophioderma appressum*
*Ophioderma brevicaudum*
*Ophioderma cinereum*
*Ophiolepis elegans*
*Ophiolepis paucispina*

Echinoids—8

*Eucidaris tribuloides*
*Centrechinus antillarum*
*Lytechinus variegatus*
*Tripneustes esculentus*
*Echinometra lucunter*
*Clypeaster rosaceus*
*Echinoneus cyclostomus*
*Brissus brissus*

Holothurians—15

*Holothuria impatiens*
*Holothuria arenicola*
*Holothuria parvula*
*Holothuria glaberrima*
*Holothuria surinamensis*
*Holothuria grisea*
*Holothuria mexicana*
*Stichopus badionotus*
*Stichopus macroparentheses*
*Phyllophorus occidentalis*
*Phyllophorus parvula*
*Phyllophorus tritus*
*Euapta lappa*
*Synaptula hydriformis*
*Chiridota rotifera*

38 species

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## Barbados

Asteroids—5

*Ophidiaster guildingii*
*Linckia guildingii*
*Asterina folium*
*Asterina hartmeyeri*
*Stegnaster wesseli*

Ophiuroids—17

*Amphiodia limbata*
*Amphiodia planispina*
*Ophiactis savignyi*
*Ophiothrix angulata*
*Ophiothrix örstedii*
*Ophiothrix suensonii*
*Ophionereis reticulata*
*Ophiocoma echinata*
*Ophiocoma pumila*
*Ophiocoma riisei*
*Ophioderma appressum*
*Ophioderma brevicaudum*
*Ophioderma cinereum*
*Ophioderma rubicundum*
*Ophiozona impressa*
*Ophiolepis elegans*
*Ophiolepis paucispina*

Echinoids—8

*Eucidaris tribuloides*
*Centrechinus antillarum*
*Lytechinus variegatus*
*Tripneustes esculentus*
*Echinometra lucunter*
*Mellita sexiesperforata*
*Echinoneus cyclostomus*
*Brissus brissus*

Holothurians—13

*Holothuria cubana*
*Holothuria impatiens*
*Holothuria arenicola*
*Holothuria parvula*
*Holothuria glaberrima*
*Holothuria surinamensis*
*Holothuria mexicana*
*Actinopyga agassizii*
*Phyllophorus occidentalis*
*Thyone suspecta*
*Thyone surinamensis*
*Euapta lappa*
*Chiridota rotifera*

43 species

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## Tobago

Crinoids—1

*Tropiometra carinata*

Asteroids—6

*Astropecten duplicatus*
*Ophidiaster guildingii*
*Linckia guildingii*
*Asterina folium*
*Asterina hartmeyeri*
*Stegnaster wesseli*

Ophiuroids—36

*Ophiomyxa flaccida*
*Amphiura stimpsonii*
*Ophiophragmus lütkeni*
*Ophiophragmus septus*
*Ophionema intricata*
*Amphipholis gracillima*
*Amphipholis pachybactra*
*Amphipholis squamata*
*Ophiostigma isacanthum*
*Amphiodia repens*
*Amphiodia trychna*
*Amphiodia tymbara*
*Ophiocnida scabriuscula*
*Ophiactis cyanosticta*
*Ophiactis algicola*
*Ophiactis savignyi*
*Ophiothrix angulata*
*Ophiothrix brachyactis*
*Ophiothrix örstedii*
*Ophiothrix suensonii*
*Ophionereis reticulata*
*Ophionereis squamulosa*
*Ophiocoma echinata*
*Ophiocoma pumila*
*Ophiocoma riisei*
*Ophioderma appressum*
*Ophioderma brevicaudum*
*Ophioderma januarii*
*Ophioderma cinereum*
*Ophioderma phœnium*
*Ophioderma rubicundum*
*Ophioderma guttatum*
*Ophioderma squamosissimum*
*Ophiocryptus dubius*
*Ophiozona impressa*
*Ophiolepis paucispina*

Echinoids—9

*Eucidaris tribuloides*
*Centrechinus antillarum*
*Arbacia punctulata*
*Lytechinus variegatus*
*Tripneustes esculentus*
*Echinometra lucunter*
*Mellita sexiesperforata*
*Echinoneus cyclostomus*
*Brissus brissus*

Holothurians—13

*Holothuria impatiens*
*Holothuria arenicola*
*Holothuria parvula*
*Holothuria surinamensis*
*Holothuria grisea*
*Stichopus badionotus* var. *phœnius*
*Thyone pseudofossor*
*Thyone micropunctata*
*Thyonepsolus braziliensis*
*Euapta lappa*
*Synaptula hydriformis*
*Leptosynapta parvipatina*
*Chiridota rotifera*

65 species

Abactinal system—the group of plates at or near the apical pole of a sea-urchin, including the oculars, and genitals, with or without (Exocycloida) the periproctal plates.

Actinal intermediate plates—the plates on the lower surface of a sea-star, distal to the jaws and between the adambulacral plates of the adjoining rays.

Ambitus—the imaginary line marking the largest circumference of a sea-urchin.

Ambulacrum—that part of the radial area of an echinoderm which includes the radial water-vessel and its tube-feet, with the accompanying skeletal plates: often used for the skeletal parts alone.

Antero-posterior axis—the imaginary straight line connecting the most anterior with the most posterior part of an animal; in sea-stars it is assumed to pass through the madreporite; in sea-urchins it passes through ambulacrum III and interambulacrum 5; in holothurians it ordinarily connects mouth and anus.

Anal papillæ—small, finger-like outgrowths either single or several together at the posterior end of the radial water-vessel in holothurians, adjoining the cloacal opening: they are often, perhaps generally, reduced or wanting altogether but they may be conspicuous, particularly when they are loaded with calcareous deposits; when completely calcified they become the so-called anal teeth.

Apical pole—the upper end of the imaginary straight line connecting the uppermost point of an echinoderm with the lower surface; the term is most frequently used in connection with regular sea-urchins in which this vertical line connects periproct and mouth.

Arm—in crinoids, most asteroids and practically all ophiurans, the projecting radial areas are called arms or rays: in asteroids they may be very short, wide and blunt; in ophiurans they may be excessively long and slender; in crinoids they are usually divided, often many times, and of course the "ray" then consists of many "arms".

Arm-plate—a plate forming the outer protective covering of the arm in ophiurans; there are three kinds, upper, under and side arm plates; of the latter there are two series, one on each side of the arm and they carry the arm-spines.

Arm-segment—one of the pieces ("vertebræ" plus arm-plates) that are jointed together to make up the arm of an ophiuran.

Arm-spine—a small spine jointed to the side arm-plate of an ophiuran; they are arranged in a single vertical series on each plate, but their number, length, form and degree of projection from the arm show the greatest diversity in different species, and form important taxonomic characters.

br—the abbreviation used to express the breadth of the arm, at its base, in sea-stars.

Brachial—a segment of the arm in a crinoid.

Buccal membrane—the membrane covering the peristomal opening in a sea-urchin.

Calcareous particles—minute bits of lime, commonly microscopic, found in the walls of various organs of echinoderms. In holothurians they are greatly developed in the body wall and furnish most important taxonomic characters. See page 93 ff.

Calcareous ring—a ring of calcareous plates, usually ten in number (often more, sometimes only five) surrounding the œsophagus in holothurians and furnishing a point of attachment for longitudinal muscles.

Calyx—the cup-like dorsal wall of the body of a crinoid made up of strong, regularly arranged plates and containing the digestive and other organs.

Cirri—Jointed, unbranched appendages, made up of solid calcareous segments, borne in a circular cluster at the center of the dorsal surface of a comatulid, or in whorls on the stem of most stalked crinoids.

Comb—a series of tooth-like, but usually rounded, projections borne at the tip of the oral pinnules of many comatulids; ordinarily there is one tooth to each segment and 6-30 segments make up a comb.

Cuvierian (or Cuvier's) organs—a cluster of peculiar, very elastic tubules, attached to the cloacal wall of some holothurians and capable of sudden, rapid extrusion whereupon they become extremely and tenaciously mucilaginous; they are ordinarily pure white in color and are supposed to be organs of defense.

Dental papillæ—a group of small calcareous projections at the tip of the jaw in some ophiurans, below the teeth, but within the mouth.

Digits—the divisions of the terminal part of the tentacles in apodous holothurians; the number ranges from 2 to 80 and the arrangement makes the tentacle pinnate, digitate or peltato-digitate.

Disk—the body of a sea-star or brittle star; the oral surface of the body of a crinoid.

Dorsal—in echinoderms, the dorsal side is usually that which is aboral, but in holothurians the dorsal surface is parallel to the antero-posterior axis and is indicated by the position of the dorsal mesentery.

Dorsal mesentery—a delicate membrance in holothurians supporting the anterior part of the alimentary canal, and attached to the body wall in the dorsal mid-line.

Fasciole—a narrow band of extremely minute and crowded spinelets, or of the tubercles which bore them. Fascioles occur only in spatangoids and have great taxonomic value; the most important are the peripetalous, which surrounds the area occupied by the petals; the subanal which surrounds (more or less completely) the subanal plastron; the anal which runs up from the subanal on each side of the periproct.

Genital pores—the more or less circular openings, often localized in special plates, through which ova and spermatozoa escape into the surrounding water.

Genital slits—the narrow longitudinal openings in ophiurans, close beside the arms, in the interbrachial areas of the lower surface of the disk.

Gonads—the reproductive cells, either male or female, aggregated in masses in the lower pinnules of crinoids, or in clusters of tubules in one or more of the interambulacra of other echinoderms.

h. d.—horizontal diameter.

Inferomarginals—the lower series of marginal plates along the sides of the arms in sea-stars.

Interambulacrum—the interradial area between two ambulacra.

Interbrachial area—that portion of the disk of an ophiuran lying between two arms; more particularly the oral surface of such an area.

Jaw—the skeletal parts, more or less closely united, at the oral end of the interambulacral areas in sea-stars and brittle stars; in sea-urchins the two half pyramids of the lantern which give support to a tooth. Also used of pedicellariæ (q. v.)

Lunule—a slit-like opening (rarely quite wide) passing entirely through the test from the dorsal to the ventral surface in many very flattened Clypeastroids.

Madreporite—a plate, microscopically like a sieve, forming the distal end of the stone-canal; in crinoids and holothurians it is internal, as a rule, but in the other classes it is a more or less conspicuous external character.

Marginals—two series of plates lying on each side of each arm of a sea-star; they may be very conspicuous but are often indistinguishable; an important taxonomic feature.

Miliaries—the minute spines, or the tubercles which bear them, covering more or less extensively the test of sea-urchins; for *miliary granules*, see page 95.

Oral papillæ—calcareous papillæ borne on the sides of the jaws in brittle stars; they show great diversity in number, size and form; an important taxonomic feature.

Oral shield—a large plate lying on the distal portion of the jaw in brittle stars; generally the most conspicuous plates of the oral surface are the five oral shields.

Papillæ—small outgrowths, projections or elevations on the surface; they may be soft and even contractile as in holothurians, but in other echinoderms, they are very often completely calcified and resemble spinelets or small plates.

Paxillæ—peculiarly modified projections on the upper surface of the dorsal plates in certain sea-stars, consisting of a stalk bearing a flat expanse covered with minute (rarely, elongated) spinelets; the close apposition of these expanded tops forms a roofing over the plates themselves.

Pedicellariæ—curious pincer-like organs, usually of very small size, found all over the body surface of most sea-urchins and sea-stars; in sea-urchins they are usually stalked and have 3 jaws; in sea-stars they are usually sessile and have 2 jaws; the number of jaws however ranges from 2 to 6 in both classes, and there is very great diversity in details of structure.

Pedicels—the tube-feet of the water-vascular system, each usually provided with a terminal sucker; pedicels without terminal sucker characterize certain groups of sea-stars.

Periproct—the area surrounding the anus in sea-urchins; it is sharply defined by limiting plates of the test and in life is covered by a membrane which usually bears calcareous plates or granules.

Periproctal plates—the calcareous plates borne on the membrane covering the periproct.

Peristome—in echini a sharply defined area extending from the mouth to the basicoronal series of plates of the test; in life it is covered by a membrane which may be fully covered with plates or only partially so, or may be almost wholly naked.

Petaloid—resembling a petal; used of those parts of the ambulacra in echini, which tend to be expanded into so-called "petals"; often used of the *adoral* end of the ambulacra.

Petals—expanded portions of the *aboral* end of the ambulacra in most exocycloid echini suggesting more or less the petals of a flower.

Pinnule—one of the lateral branches or outgrowths on the more or less feather-like arms of crinoids; they furnish many important taxonomic characters.

Polian vesicle or vessel—a small sac-like outgrowth from the circumoral water-vascular ring of echinoderms; the size and form, as well as the number, show great diversity.

Pore-pair—the pair of openings in an ambulacral plate (or plate element) of echini, through which the pedicels are connected with the radial water-vessel and ampullæ; they are a striking feature especially of dead and bare tests.

Poriferous areas—the areas on each side of the ambulacrum of a sea-urchin occupied by the pore-pairs; they show great diversity in relative width and composition.

Primaries—the largest spines (or the tubercles which carry them) in a sea-urchin; they may be sharply set off from secondaries or they may intergrade with them.

R—the abbreviation used to express the distance from the center of the disk in a sea-star to the tip of the arm (ray).

r—the abbreviation used to express the distance from the center of the disk in a sea-star to the interradial margin between two rays.

Radial shields—the pair of shields or bare plates on the disk of a brittle star lying radially, close to the base of an arm.

Ray—the arm of a sea-star or brittle star; one of the five primary, radial, projecting processes from the calyx of a crinoid, which ordinarily forks near the base and divides into 2 or more arms.

Respiratory-tree—a much branched organ with very thin walls, lying in the body-cavity but opening into the cloaca of most holothurians and believed to have a respiratory function.

Secondaries—the spines (or the tubercles bearing them) in a sea-urchin intermediate between primaries and miliaries and frequently intergrading with them.

Shoe—an enamel-like covering to the tip of certain primary spines (usually adoral in position) in some sea-urchins; it is harder and more highly polished than the spine itself.

Sole—the flattened ventral surface of certain holothurians; when fully developed it has a sharply defined margin and is covered by a much thinner body-wall than is the dorsal surface.

Stone-canal—a tube with strongly calcified walls connecting the water-vascular ring with the madreporite; in holothurians stone-canals usually hang free in the body cavity, their number ranging from one to many.

Subanal plastron—a somewhat flattened area, of diverse form, generally bounded by a fasciole, lying below the periproct in many spatangoids.

Superomarginals—the upper series of marginal plates on the sides of the arms of sea-stars.

Supplementary upper arm-plates—in certain brittle stars, at each side of the upper arm-plates, there is one (or more) additional, smaller plate; such supplementary plates are not always conspicuous and the specimen must be dried to make them stand out.

Syzygy—a non-muscular articulation of two brachials in the arm of a crinoid, recognizable externally as a very fine line, much finer than that of a normal joint.

Tentacle-scale—a small plate or spinelet lying at the base of a tentacle in brittle stars, and capable of closing, at least partially, the tentacle-pore when the tentacle is retracted; there may be one or several at the base of each tentacle but in many brittle stars they are wholly wanting.

Test—the so-called "shell" of a sea-urchin; in all Recent echini it is normally made up of twenty columns of more or less close fitting calcareous plates, two columns in each of five ambulacra and five interambulacra.

Tube-feet—the pedicels of asteroids, echini and holothurians, and the homologous tentacles of crinoids and ophiurans; more exactly the distal part of lateral branches from the radial water vessel, when supplied with a terminal sucker and used for locomotion.

Verrucæ—papilliform projections of skin on body-wall, more particularly in holothurians, frequently of a temporary nature; they vary much in size and character, but are usually numerous when present at all.

v. d.—vertical diameter.

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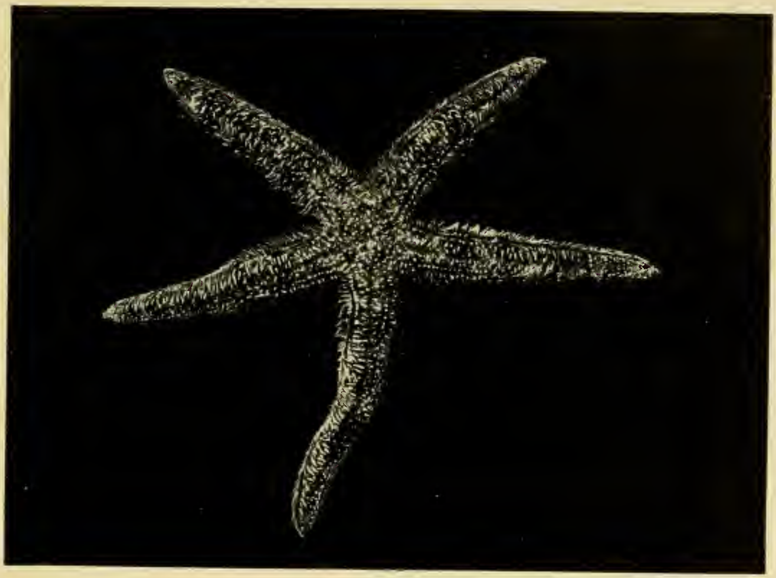

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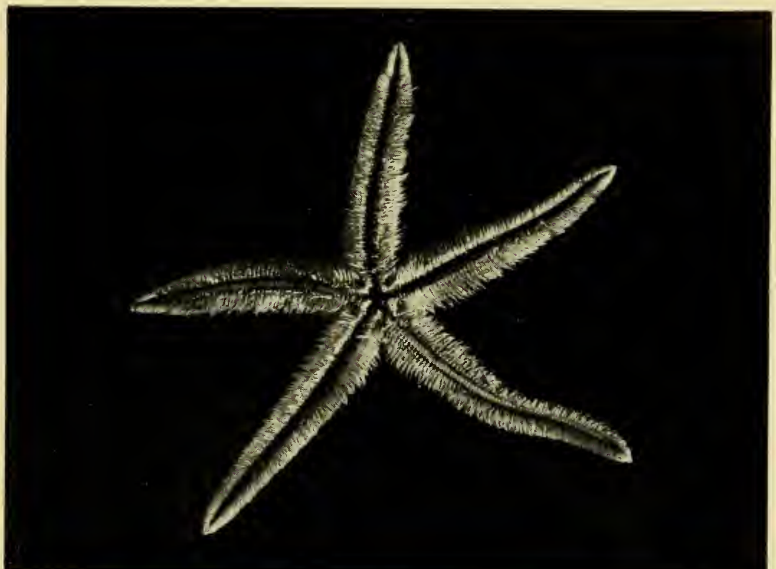
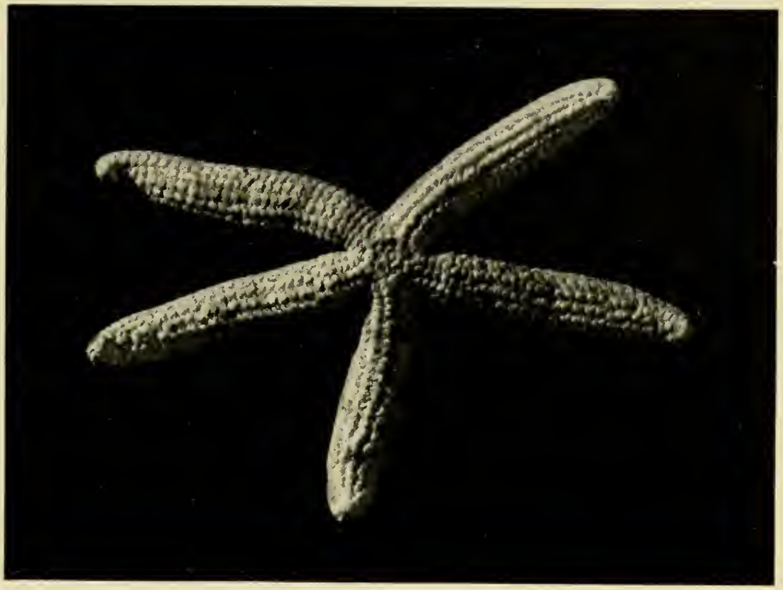


*b*

*Luidia alternata* (Say), one-half natural size. A small specimen from Montego Bay, Jamaica. *a*. Upper side. *b*. Lower side. Page 20.



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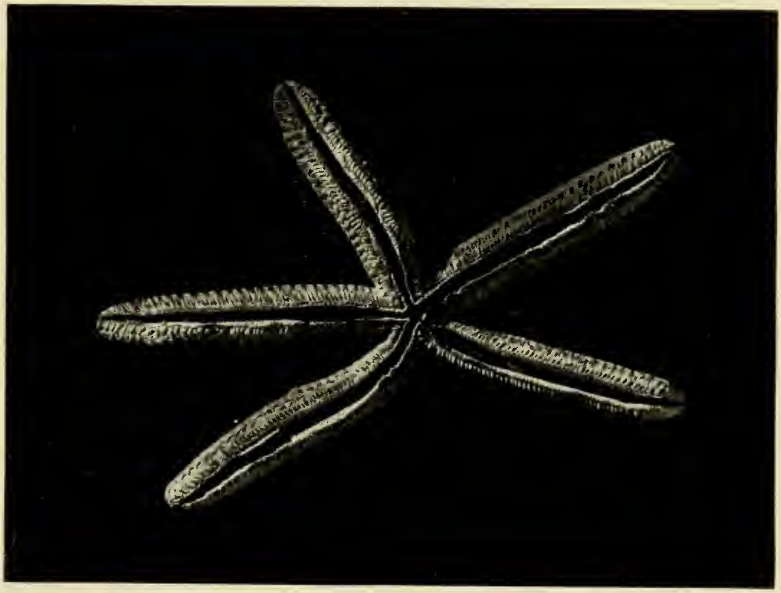

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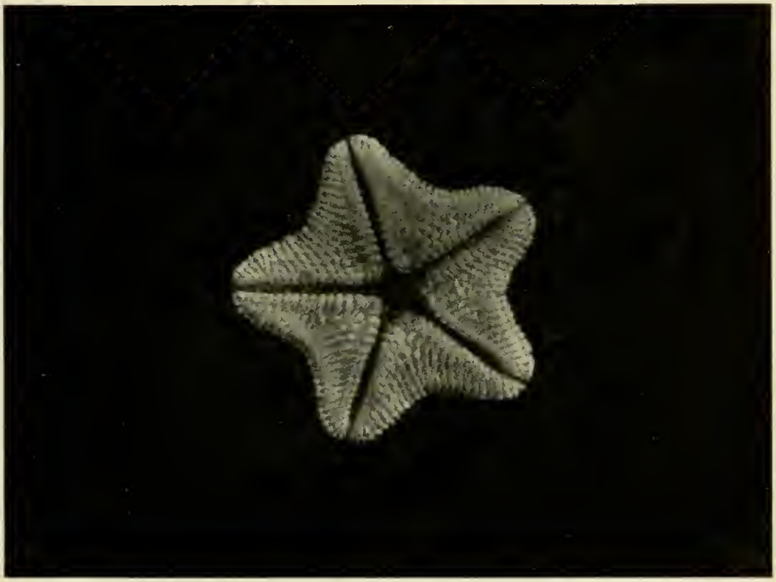
*Ophidiaster guildingii* Gray, natural size. Specimen from Buccoo Bay, Tobago.
*a.* Upper side. *b.* Lower side. Page 23.

*a*



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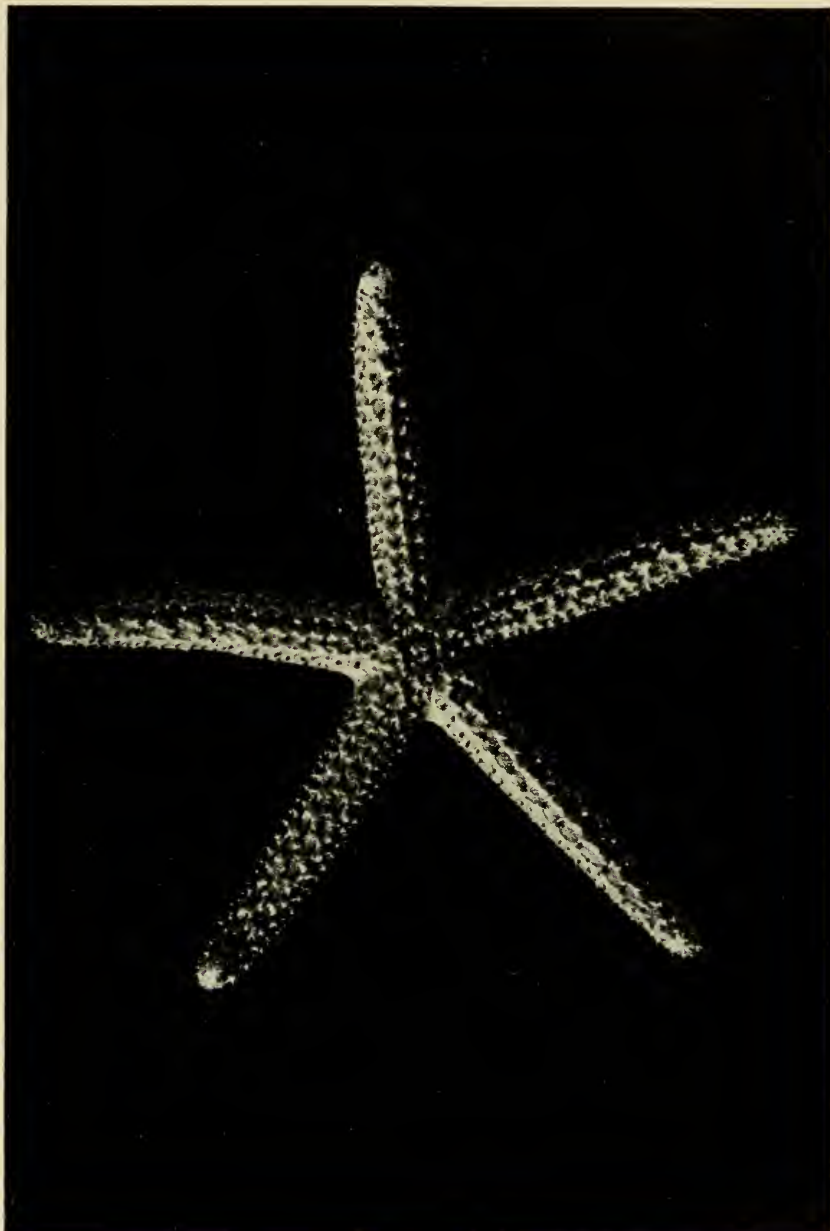
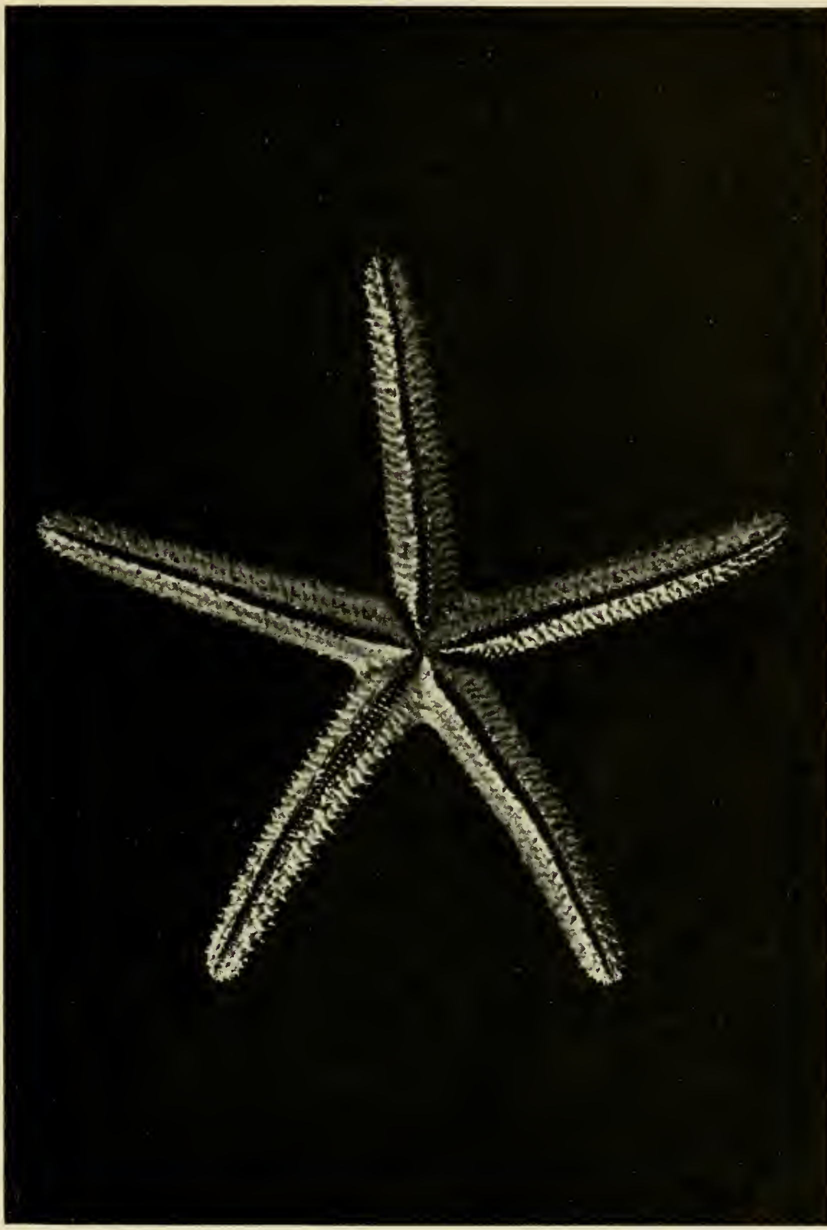
*Asterina hartmeyeri* Döderlein, x3. Specimen from Buccoo Bay, Tobago. *a*. Upper side. *b*. Lower side. Page 27.



*Echinaster echinophorus* (Lamarck), natural size. Upper side of specimen from Port Royal, Jamaica. Page 29.



*Echinaster echinophorus* (Lamarck), lower side of specimen shown on Plate IV.
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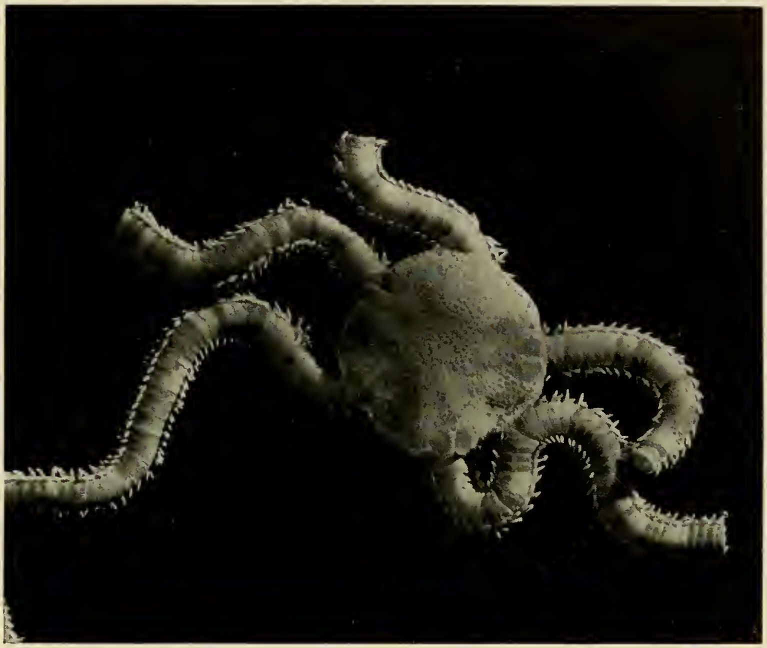

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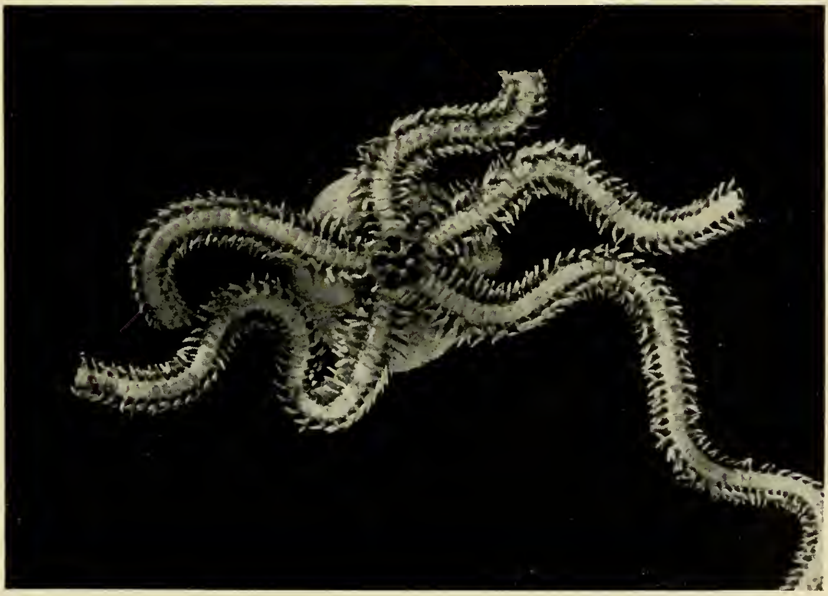

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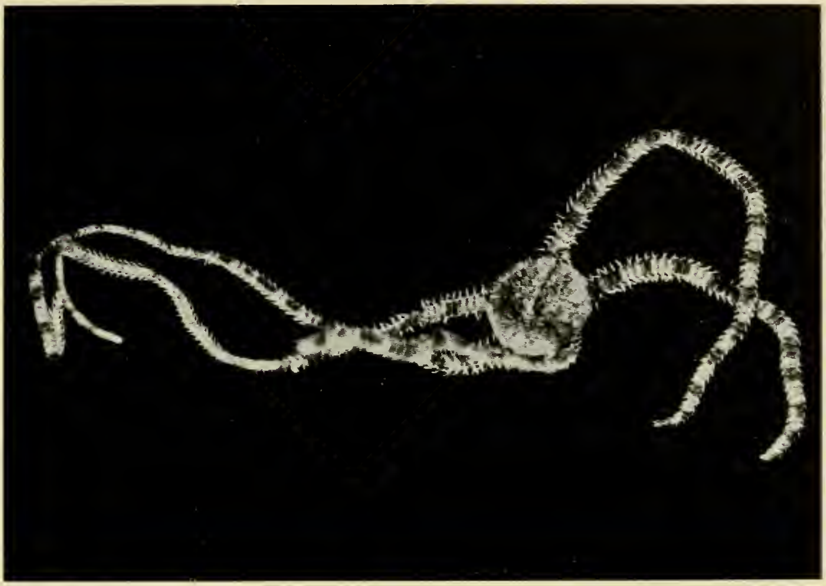
*Ophiophragmus wurdemanii* (Lyman), x3. Specimen, showing only basal part of arms, from Beaufort, N. C. *a*. Upper side. *b*. Lower side. Page 47.



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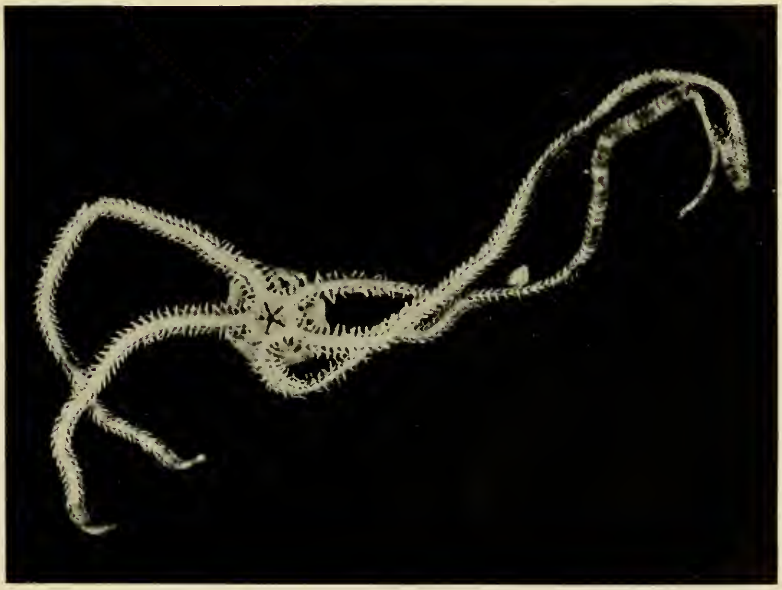

*b*

*Ophiocnida cubana* A. H. Clark, type, x3. Specimen from Ensenada de Sta. Rosa, Cuba. *a*. Upper side. *b*. Lower side. Page 55.

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OF

# PORTO RICO and the VIRGIN ISLANDS

## VOLUME XVI—Part 2

Polychaetous Annelids of Porto Rico and Vicinity

*Aaron Louis Treadwell*

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# POLYCHAETOUS ANNELIDS OF PORTO RICO AND VICINITY*

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* Publication made possible through contributions from the Department of Agriculture and Commerce of Porto Rico, and the University of Porto Rico.

## TAXONOMY OF ANNELIDS

The phylum Annelida contains those worm-like animals whose bodies are divided externally by a series of constrictions into joints known as somites or metameres. This somitic structure is indicated both by constrictions which delimit somite boundaries and by organs which are regularly repeated in all or many somites. These, to be described more in detail later, may be protrusions from the body surface or openings through its wall, serving as excretory or reproductive outlets from the body cavity to the outside. Internally, somitic structure is indicated by the arrangement of the excretory organs and by ganglia of the ventral nervous system.

The phylum is divided into five classes of which one in turn contains two subclasses. While the purpose of this report is to describe the members of only one of these subclasses which occur in Porto Rico and vicinity, it seems best to begin with an account of the phylum as a whole, stating the relation of this subclass to the other divisions. This will be limited to structures of taxonomic importance, ignoring much that is of morphological interest but which does not bear directly on the classification of the subclass.

Figure 1 is a diagram of the anterior end of an annelid. In this diagram intersomitic constrictions are distinct and somite boundaries sharply defined. While this is true for many annelids, in others superficial wrinklings may simulate constrictions and give a false appearance of metamerism. In other cases the constrictions are hard to see because of contractions of the body-wall which obscure them so that in counting somites it is sometimes safer to rely on other metamerically arranged structures than to depend on intersomitic constrictions. These structures (see below) are setae, cirri, parapodia, and nephridial openings.

While most somites are duplicates of those adjoining them, differing only in absolute size, some are especially to be noted. The first, or most anterior somite, is often either larger than the ones immediately following it or is marked in some peculiar fashion, and it always more or less surrounds the mouth. For the latter reason it is called the peristomium (FIGURE 1, *pr*). In the majority of cases it actually surrounds the mouth, but in a few genera some of the following somites cooperate with it on the ventral surface in making up the mouth-boundaries.

On the anterior dorsal face of the peristomium is a fleshy lobe extending anteriorly dorsal to the mouth. This is the prostomium (FIGURE 1, *ps*). It is marked off from the peristomium by a definite articulation but is not regarded as a true somite. It sometimes has eyes on the dorsal surface and sensory organs in the form of tentacles, the latter usually slender cylindric structures protruding from its anterior margin. In taxonomic literature the prostomium is often called the head. Since it might be expected that the head would surround the mouth, and since the prostomium has no relation whatever to the mouth, this usage is inaccurate. The prostomium and peristomium cooperate to form a specialised anterior region which might properly be called the head, and where the term is used in the following pages it will be in this sense. Whenever either prostomium or peristomium alone is under discussion its appropriate name will be used. The only other somite to which especial attention should be called is the most posterior one, the anal somite or pygidium.

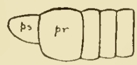


Figure 1. Diagram of the anterior end of an annelid.

Characteristic of one class of annelids is the presence of chitinous rods or setae, in nearly all somites. A seta is the product of the secretion of a special gland lying in the body-wall. Its basal portion is imbedded in the gland, which sometimes has a muscular supply, its apex extends a certain distance outside the body-surface. Setae may occur singly or in bundles and may barely reach to the body-surface or they may extend to a considerable distance beyond it. Some of these variations seem to be of an adaptive nature. In species living in tubes only slightly larger than the diameter of the body or in burrows (as in the earthworm), the setae barely reach beyond the body-surface. In the earthworm the setae aid in locomotion, in tube-dwellers they seem to act as holdfasts attaching the body to the tube. In some free-living species the setae are very long and sharp and are erected if the animal is irritated. It is possible that they have a protective function, but since some which have such setae are an easy prey to fishes the protection is evidently a limited one.

Some annelids breathe through the general body-surface by means of a capillary network in the body-wall. In other cases, outgrowths from the surface function as breathing organs and are known as gills. These may appear at practically any place on the body and are not homologous in all cases. Gills may take the form of flat plates; cylindric outgrowths which may be simple or branched; or very complexly branched structures supported on stalks. In the case of some tube-dwellers the gills may be protruded from the mouths of the tubes. In this case they function as food-catching as well as respiratory organs and often are provided with pigment-spots which presumably are light-perceiving organs, though the animals are sensitive to light-stimulation even when there are no pigment-spots. Even when gills are present a considerable amount of respiration must take place through the body-surface because blood-vessels lie very close to the surface, and the color of the animal is often in large measure due to the tint of the blood seen through the translucent skin. The commonest blood-pigments are green and red, both of which are affected by preservatives so that the color of preserved animals often is entirely different from that of these same animals when alive.

If the prostomium is prolonged anteriorly into a long flexible process, it is called a proboscis, a structure found most frequently in some fresh-water species. In other cases the prostomium carries from one to a very large number of structures varying in form from short and thick to long and thread-like. These are not prolongations of the prostomial margin as is the proboscis, but are definitely articulated with the prostomial surface and are known as tentacles. They function as sense-organs.

Attached to the under face of the prostomium are cylindric structures called palps. They may be entire, or composed of several joints. They may be thick and fleshy, or as in some tube-dwelling species expanded into large feathery structures which protrude from the mouth of the tube and are referred to above as gills.

Cylindric processes attached in various regions to the surface of the body receive the general name of cirri. They may be short and thick, or long and slender; entire or jointed. They generally occur on or near parapodia (see below), but may be attached to the most posterior somite in which case they are called anal cirri. When attached to the base of the peristomium they are often long and are known as tentacular cirri.

In the largest subclass, the Polychaeta, somitically arranged lateral prolongations of the body-wall typically occur in all somites except the first and the last. These are parapodia. The parapodium of *Nereis* (FIGURE 2) may be taken as typical. It is a vertically arranged thin plate, one lying on either side of the somite. By a deep cleft it is divided into a dorsal and a ventral portion known respectively as the notopodium (FIGURE 2, *no*), and the neuropodium (FIGURE 2, *ne*). In each of these portions lie one or more rods, the aciculae, which are formed from a glandular secretion in much the same fashion as the setae. They rarely protrude to any distance from the surface, but because of their size and rigidity must make an efficient skeleton for the parapodium.

In each of the halves of the parapodium is a setal lobe containing tufts of setae which protrude to a greater or less distance from the surface, and in *Nereis* there are various other lobes to which special names have been given. Attached to the dorsal face of the notopodium and to the ventral face of the neuropodium are cirri, known respectively as dorsal and ventral cirri (FIGURE 2, *dc* and *vc*). In *Nereis*, the part to which the dorsal cirrus is attached is much flattened and much thinner than any other part of the parapodium and is the gill (FIGURE 2, *g*). In some genera, the parapodium is uniramous, due to the disappearance of the notopodium, but dorsal cirri persist, in

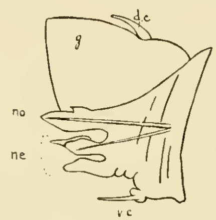


Figure 2. *Nereis* parapodium. After Verrill.



this case attached to what is left of the parapodium or to the body-wall dorsal to it. Sometimes the cirri may be attached to the body-wall instead of to the parapodium. Parapodia are sometimes rudimentary or absent. Since complete absence of parapodia occurs in some annelids whose body-diameter is almost equal to that of the tube in which they live, it would be easy to infer an adaptation, in that protruding structures might be a detriment under these conditions and have hence been lost. In a general way, this correlation holds, for free-swimming annelids have as a rule better-developed parapodia than tube-living ones, but the rule is by no means universal, some free-living species having practically no parapodia at all. Where the parapodium is absent, the setal glands lie in the body-wall, and setae come thence directly to the surface.

The alimentary canal of annelids runs straight through the body from mouth to anus without any foldings, though there may be lateral lobes, containing prolongations of the central cavity. In connection with the anterior end of the canal are various structures of taxonomic importance. Just following the mouth is the pharynx having a muscular wall and in some cases provided with teeth. Where, as in the earthworm, there are no teeth, the mouth acts as a sucking organ drawing food into the pharynx-cavity. In some leeches there are teeth which by a rasping action make a hole through the skin of the prey, through which blood is sucked by the action of the pharynx. In some marine polychaetes teeth occur. These may be few in number and simple in structure, or in other cases may make up a complicated apparatus. They are attached to the pharynx in such a fashion as to be protrusible with it to a considerable distance from the mouth and are used for seizing food. Other marine species resemble the earthworm in that there are no teeth and feeding is by suction. The gills of some tube-dwelling species are ciliated on their upper margins, and food currents set up by these cilia carry microscopic organisms down the branches of the gills and into the mouth.

The excretory organs of annelids are nephridia, coiled tubes which open at one end into the body-cavity and at the other to the surface. They occur in all but the most anterior and posterior somites, and hence their external openings have a somitic arrangement. In some tube-dwellers the nephridia are very largely suppressed, being represented only by a single gland at the anterior end of the body.

The Oligochaeta and Hirudinea (see below) are hermaphroditic, and both male and female organs are permanent structures persisting throughout the year. In the Oligochaeta the precise location of the sex-organs in the body and the position of their openings to the surface are constant for each species, but differ in different species and are of importance in species-determination. In both of these groups there is a copulation process ensuring cross-fertilization of the eggs and the eggs are laid in cocoons, small sacs filled with an albuminous material and eggs. The entire development is undergone in the cocoon and the young when they emerge are essentially of the adult form.

In the Polychaeta (see below) sex-organs appear as thickenings of the lining of the body-cavity, and may occur in almost any somite except the most anterior ones. As compared with the Oligochaeta and Hirudinea the sex-organs are not permanent structures but at the breeding season, which may be for but a few days in the year, the cells lining the body-cavity begin to proliferate. This may go on to such an extent that the entire body-cavity becomes filled with sex-products, an accumulation which may cause considerable distention of the body-wall. This occurs not only for a limited time, but at a definite season of the year. The sex-products reach the outside through the nephridial openings; or through special ducts; or in some cases are set free by a breaking down of the body-wall. In a few tube-dwellers the eggs are held between the body-wall and the inside of the tube, in other cases they are either laid in a jelly-mass or are set free into the water where they float for a time. In most cases the eggs are fertilized after laying, by the sperms which are set free at the same time, but in at least one case fertilization is internal, the sperms being swallowed by the female and reaching the eggs through the alimentary canal.

The phylum Annelida is divided into five classes:* Archiannelida, Chaetopoda, Hirudinea, Myzostomida, and Gephyrea.

CLASS 1. ARCHIANNELIDA. Several genera of very small animals whose structure is definitely annelid but so simplified in many details that they have been regarded as primitive and representative of ancestral forms. There is at present, however, a tendency to interpret this condition as due to secondary simplification rather than as ancestral. Hempelmann (1931: 155) thinks that the characteristics of the Archiannelida are of three kinds, 1, persistent larval, 2, changes due to simplification of structure, and 3, adaptive modifications of no morphological significance. They have no setae and metamerism is only faintly shown by external constrictions. Internally somitic structure is shown by septa, nephridia, and sex-organs. The larva resembles that of the flatworm and the mollusc and hence has been supposed to have an ancestral significance. This larva or trochophore (FIGURE 3) is biconvex in outline, the line of junction between the

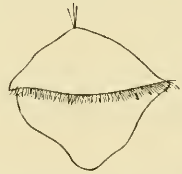

Figure 3. Annelid trochophore. After Hatschek.

two convex surfaces being provided with a ring of cilia known as the prototroch and constituting the locomotor organ. When the larva is swimming the prototroch lies in a horizontal plane, that portion above it being the anterior, the opposite the posterior region. At the apex of the anterior region is a tuft of stout sensory cilia and just inside this is a nerve-ganglion which eventually becomes the cerebral ganglion of the adult. A mouth opens just posterior to the prototroch

* A different classification of the annelids will be found in Zoölogical Names. A list of phyla, classes, and orders. A. S. Pearse, editor. Published by the A. A. A. S. 1936, which appeared after the manuscript of this paper was sent to the New York Academy of Sciences.

and leads into an alimentary canal which opens through the anus at the extreme posterior part of the body.

The Archiannelida are all of very small size and limited distribution.

Class 2. Chaetopoda. Characterized by the possession of setae. Clean-cut differences justify its division into two subclasses.

*Subclass 1. Oligochaeta.* The somitic structure is well defined by intersomitic constrictions, but there are no prominent outgrowths from the body-surface. In a few species gills occur as slender processes either at the anterior or posterior ends but in the vast majority the body is devoid of external appendages. They inhabit land and fresh water and a few are found in brackish water but none are truly marine. In land species living in burrows the setae are short, protrude only slightly from the body-surface, and are used for locomotion. Some aquatic species have more complicated setal arrangements in that setae may have lengths as great as the diameter of the animal's body. The longer of these setae are slender and needle-like, others may be hooked at the ends. One genus, *Discodrilus,* a parasite on crayfish, has no setae.

The Oligochaeta are always hermaphroditic, though in some aquatic species sexual reproduction is subordinate in importance to reproduction by fission and in some genera sexual reproduction has not been seen.

Land-living oligochaetes construct burrows in which they live and from which they protrude the anterior ends for feeding or mating purposes. It is not probable that they ever voluntarily leave these burrows or that, once out, they ever return to the original burrow. Some aquatic species live in mud at the bottom of pools, others are attached to vegetable matter of any sort. Land-living and mud-living forms may be collected by digging, the others by rinsing in clear water leaves of water-plants or even dead leaves which have blown into the water. For satisfactory preservation it is necessary to narcotize, and chloretone is the best reagent for this purpose; it is used by adding a few drops of a saturated solution to the water in which the annelids are lying. When completely narcotized they are transferred to a 5% solution of formalin in which they may be kept indefinitely. Unless narcotized they will contract under the influence of the preserving fluid and be badly distorted.

*Subclass 2. Polychaeta.* While a few of these are superficially as simple in structure as are the Oligochaeta, the great majority are characterized by the possession of parapodia, gills, and cirri. Even those which most closely resemble the Oligochaeta (see below: *Lum-*

*brinereis* page 249) have small parapodia; and in the Capitellidae (see page 288), which have no parapodia, the setal structure and arrangement are distinctly unlike the oligochaetes. As a rule the sexes are distinct, though a few are hermaphroditic. The trochophore larva (see page 157) is characteristic of the subclass, though it rarely is as simple as in *Polygordius*. Where the egg contains but little yolk this "typical" form occurs. In proportion as there is an accumulation of yolk the larva departs from this typical structure. There are often also, other ciliated bands beside the prototroch lying in definite parts of the posterior hemisphere, and these give the larva a very different appearance from that of *Polygordius*.

The polychaetes are almost exclusively marine, although a few have been found in brackish or fresh water. Some are pelagic, but the majority live either in tubes of their own construction, which are attached to stones or shells, or buried in the mud or sand. Others live in more or less permanent burrows in the mud or, especially in the tropics, in rock-crevices. They are abundant in dead coral-rocks and there is reason to believe that they may bore through living corals by the aid of some secretion which dissolves the limestone.

Class 3. Hirudinea. Recognizably different from either of the other classes by the possession of two suckers, one at the anterior end surrounding the mouth and one at the posterior end. The body is somitic but the true somite structure is obscured by the presence of superficial constrictions dividing each somite into a number of rings. The number varies in different species and in different parts of the same body, the variation being from 2 to 6. In land and freshwater leeches the body is flattened from above downward, while in marine forms it is often cylindric, frequently having surface ornamentations in the form of bosses.

Hirudinea are divided into two subclasses, depending upon the presence or absence of jaws. Those of the former class fasten themselves by the anterior sucker to the body of a vertebrate, cut through the skin by means of the jaws and suck blood. In most cases this attachment to the prey is temporary, the leech dropping off as soon as its crop is filled and crawling under a stone or other protected place to complete the digestive process. A few live permanently attached to their prey. Leeches without jaws live on the flesh of invertebrates.

Leeches are hermaphroditic and eggs are laid in cocoons which in some cases are protected by the parent. In one North American genus, *Glossiphonia*, the newly hatched young attach themselves to the body of the parent, who carries them about for a time, though since the animal is very sluggish in its movements the amount of travelling that is done is very limited.

Leeches are abundant in both fresh and salt water and even in temperate climates may be found on land. In some tropical regions land-leeches are abundant and voracious and are serious pests to both man and beast.

The narcotizing agent for Hirudinea is carbon dioxide which can be obtained in the ordinary seltzer bottle. The animals should be put in a dish of convenient size without any water and covered with carbonated water. It is necessary that the dish have a cover and that the solution completely fill the receptacle. If there is an air space above the solution the animal will crawl up into that and cling to the side of the dish above the narcotizing solution. Final preservation should be in formalin of 5% to 10%.

Class 4. Myzostomida. Small disc-shaped animals living on crinoids. They are not easily seen and would not appear in ordinary collections.

Class 5. Gephyrea. Fairly common in crevices in old coral-rock and in sand. The body is cylindric and shows no external traces of somitic structure. In one order, Echiuroidea, the prostomium is elongate and spoon-shaped, while posteriorly the body is pointed and carries one pair of stout setae. The echiurids are most apt to be found in rock-crevices. In the other order, the Sipunculoidea, the body is much longer and has no setae. On the anterior end are short tentacles, but since the whole anterior end may be retracted into the body, the tentacles are not always visible. They are usually found in sand. The gephyreans are obscurely annelidan in adult characters but have typical trochophore larvae. The preservation methods used for polychaetes answer very well for them.

## THE POLYCHAETA

The subclass Polychaeta is sometimes divided into orders Errantia and Sedentaria, the distinction being that one group is free-living, the other lives in tubes. This arrangement is adopted by Hempelmann (1931: 162), but most writers prefer to divide the subclass directly into families, on the ground that there are no morphological reasons for the other method. It should be noted, however, that J. Percy Moore, who is our leading student of the annelids, discards the term Chaetopoda and divides the class Annelida directly into orders, two of which are the Oligochaeta and the Polychaeta.

## METHODS OF COLLECTION AND PRESERVATION

The animals occur in practically all muddy or sandy bottoms from high-water mark down to an indefinite number of fathoms. On the exposed beach at low tide and in shallow water an ordinary spade is the only tool needed but for a greater depth it is necessary to dredge. Some will always be found attached to shells and stones brought up by a dredge, and these materials should be examined carefully for the smaller species, which will be found hidden in crevices. Burrowing species and those building tubes in the mud or sand are not so easily dredged, because the tubes and burrows often go straight down and the animals when stimulated by the approach of the dredge retreat rapidly downward. As a result the dredge often brings up only the tops of the tubes. For collecting on coral reefs a heavy hammer and ordinary cold-chisels of various sizes are the most useful tools. With these the rocks can be broken into bits and the annelids lying in the crevices uncovered. Since the rock-crevices often make entirely unexpected turnings this breaking must be done with great caution. Forceps for picking up the animals are a necessity and stout needles are often convenient for the final breaking of the rock. For species which bore into solid coral the procedure is the same but the extraction of complete specimens is more difficult. Loose stones lying in tide-pools often have annelids clinging to their under surfaces and should be examined. Sponges frequently harbor annelids, one large leodicid (see page 237) living only in the sponge-cavities. To secure these it is necessary to tear the sponge in pieces, but for smaller ones, keeping the sponge in stagnant water will often cause the annelids to crawl out in considerable numbers. This latter method should be used with caution, since by the time the water is foul enough to drive the annelids out of the sponge, it may have had a deleterious action upon the annelids themselves.

To secure satisfactory results it is essential that the animals be narcotized, and for polychaetes a solution of Epsom salts ($MgSO_4$, 154 grams to the litre in fresh water) is the most satisfactory reagent. They should be left in this until they are thoroughly narcotized, which is shown by complete relaxation, and then transferred to a 5% solution of formalin for fixation. If the narcotizing is satisfactory, there should be no contraction when put in formalin. The most convenient dish to use for this fixation is a shallow rectangular tray as long as the animal, which is held out in the formalin until fully dead and left for a few hours, the precise time not being of great importance. It should then be transferred to 95% alcohol for hardening. When this is completed, it is again transferred to alcohol of 80% for final preservation. The use of lower grades of alcohol in these processes does not give good results and final preservation in formalin is always very unsatisfactory, in that it often leaves the specimens soft, flabby, and slimy, while the alcohol technique leaves them firm and hard.

## SPECIFIC DETERMINATION

For the determination of species of polychaetous annelids the following details are important.

SIZE.—While there is considerable variability in this respect and while small size may merely indicate a juvenile condition, the absolute length and width of the body are often important diagnostic features; *e. g.*, a sexually mature leodicid six inches long could not possibly be *Leodice fucata*.

COLOR.—The color of the living animal may be due to blood in the fine vessels just under the skin, and a reddish tint due to this cause has little significance. Pigment-colors are often present and in the living animals are of great value in species determination. Most of this color is usually lost in preservation, but often the action of the preserving fluid merely changes the color and this may be diagnostic.

FORM OF PROSTOMIUM.—The general outline, and whether or not provided with tentacles and eyes. If present, the size and position of these organs.

FORM OF PERISTOMIUM.—Its size relative to the prostomium and to the somites which follow it. Whether tentacular cirri are present and if so, their form and number.

FIRST FEW SOMITES BEHIND THE PERISTOMIUM.—Whether they carry cirri or not, and if present, on which somites. Do any of them enter into the mouth-boundaries? Is there a caruncle or elevated ridge running backward over them from the dorsal surface of the peristomium?

MOUTH.—Is this entirely bounded by the peristomium, or do other somites play a part?

PHARYNX.—Is an evertible pharynx present and if so, is it provided with teeth? If teeth are present, what are their numbers and forms?

PARAPODIA.—Are they once or twice branched? What is the form and relative size of setal lobes, lips, and cirri? Are they similar in form throughout the body, or do they vary in different regions?

CIRRI.—Form and size of tentacular, parapodial, and anal cirri. Are cirri present in other portions of the body?

GILLS.—Character and places of attachment.

Setae.—Important in taxonomy because, while they appear in infinite variety, those of any one species show great constancy of structure. For the purpose of this paper they may be classified as simple, compound, and uncini.

(a) *Simple setae* are composed of a single chitinous rod, which in different species varies from the form of a slender needle to a heavy spike. Some are expanded toward the end to form thin plates, which may have marginal teeth; others have teeth along their stalks, the appearance of teeth in some cases being due to marginal rows of denticulated plates (figure 4c). Specially designated forms of simple setae are—limbate (figure 4b) which have a marginal fin along one side of the stalk, being bilimbate if this fin occurs on both sides; pectinate which have the end flattened and bent up at the sides to form a "scoop," the free margin being finely denticulate (figure 4f); camerate, which have toward their outer ends rectangular spaces in the interior of the stalk (figure 4g); pennoned, always extremely small and characteristically associated in tori with uncini in the Sabellidae (see page 291). They have slender stalks which are expanded into asymmetric rounded heads from which a slender process is given off (figure 4h).

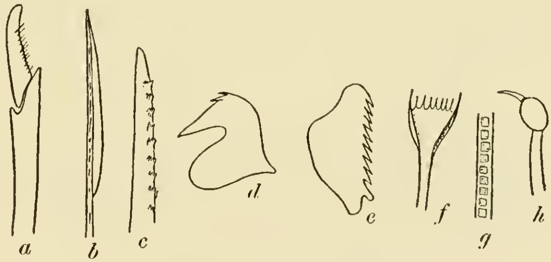


Figure 4. Different forms of polychaete setae.

(b) *Compound setae* are composed of two pieces, a terminal one articulated with the end of a ventral one (figure 4a). The terminal joint may have marginal spikes as in the figure, its margins may be smooth, or it may carry teeth. The length of the terminal joint as well as its breadth varies greatly in different species.

(c) *Uncini* are small flattened plates characteristically occurring in tube-dwelling species, situated in rows on an elevation called the torus. They may be rostrate, having a prominent tooth with smaller teeth distal to this (figure 4d), or pectinate, having a row of fine teeth along one margin (figure 4e). They are sometimes incorrectly called crotchets, that term being properly used for very heavy spikes which are usually bent or hooked at the ends. Aciculae (see page 154) are always associated with setae in the parapodium but are generally larger and heavier. They may be rounded at the outer ends, or bent and hooked.

## METHODS OF STUDY

For this study both dissecting and compound microscopes are needed, the former for general observations and the latter for finer details. Few surface-structures can be seen without the use of a low-power lens, and for setae a magnification up to 500 diameters is often necessary. Parapodia and setae that are to be studied under the compound microscope may be mounted in 50% glycerine under a cover-glass, in which solution they will keep indefinitely, especially if the margin of the cover is ringed. In some small species (see Syllidae) the entire animal may be mounted in this fashion. The glycerine makes the tissues transparent and details of internal structure which are taxonomically important can be seen much more clearly than if not so mounted. Parapodia should be dissected away from the body and mounted flat. As a rule setae must be teased out and mounted by themselves, as most parapodia are so thick that if the whole parapodium is present the cover-glass will be held too high to allow of focusing on the setae under high powers.

## STATIONS

In the reports of the Fish Hawk and the Johnson-Smithsonian expeditions some localities are indicated only by their station-numbers. The precise positions of these stations are as follows:

### Fish Hawk Stations

6055. Off Aguadilla, Point de Bourinquen lighthouse NE. by N. ¾ N., 3¼ miles.
6057. Mayaguez Harbor, custom-house E. ½ N., ⅜ mile.
6059. Mayaguez Harbor, custom-house E. by S., 2 miles.
6061. Mayaguez Harbor, black buoy, entrance harbor, N. by W. ½ W., ½ mile.
6062. Mayaguez Harbor, red buoy, entrance harbor NE. ½ E., ½ mile.
6063. Mayaguez Harbor, Punta del Algarobbo E., 2¾ miles.
6064. Mayaguez Harbor, custom-house E. ¼ N., 4⅜ miles.
6066. Mayaguez Harbor, Punta del Algarobbo E., 4⅝ miles.
6067. Mayaguez Harbor, Punta del Algarobbo E. by N. ½ N., 5¾ miles.
6069. Mayaguez Harbor, custom-house ESE. ½ E., 7⅞ miles.
6070. Mayaguez Harbor, E. ⅝ S., 9 miles.
6073. Off Punta de Melones, Punta Guaniquilla S. by E., 1⅛ miles.

6075. Off Boca Prieta, Punta Guaniquilla SSE., 3¼ miles.
6079. Off St. Thomas, Sail Rock W. by N. ½ N., 6 miles.
6080. Off St. Thomas, Sail Rock NW. ½ W., 4 miles.
6084. Off Vieques Island, San Juan lighthouse NW. ⅛ N., 14¾ miles.
6085. Off Vieques Island, Point Mula lighthouse SSW. ⅜ W., 5¾ miles.
6086. Off Culebra Island, Point Mula lighthouse SW. ½ S., 8½ miles.
6089. Off Vieques Island, Culebritas lighthouse N. ¼ E., 7¼ miles.
6091. Off Vieques Island, Culebritas lighthouse NE. ½ N., 10 miles.
6092. Off Vieques Island, Culebritas lighthouse NE. ⅜ E., 7¼ miles.
6093. Off Culebra Island, Culebritas lighthouse NE., 5¼ miles.
6096. Off Vieques Island, Point Mula lighthouse E. ½ N., 11¼ miles.
6098. Off Humacao, village of Hucares N. ½ W., 3 miles.

## Johnson-Smithsonian Expedition Stations

| | | | | |
|---|---|---|---|---|
| 21. | Lat. | 18° 30′ 20″ N. | Long. | 66° 10′ 30″ W. |
| | | 18° 31′ 15″ N. | | 66° 12′ 20″ W. |
| 23. | Lat. | 18° 32′ 15″ N. | Long. | 66° 17′ 45″ W. |
| | | 18° 32′ 00″ N. | | 66° 21′ 15″ W. |
| 26. | Lat. | 18° 30′ 20″ N. | Long. | 66° 22′ 05″ W. |
| | | 18° 30′ 30″ N. | | 66° 23′ 95″ W. |
| 35. | Lat. | 18° 23′ 40″ N. | Long. | 67° 16′ 45″ W. |
| | | 18° 24′ 45″ N. | | 67° 14′ 15″ W. |
| 38. | Lat. | 18° 11′ 55″ N. | Long. | 67° 42′ 50″ W. |
| | | 18° 10′ 00″ N. | | 67° 46′ 00″ W. |
| 67. | Lat. | 18° 30′ 12″ N. | Long. | 65° 45′ 48″ W. |
| | | 18° 32′ 18″ N. | | 65° 46′ 12″ W. |
| 69. | Lat. | 18° 23′ 55″ N. | Long. | 65° 37′ 00″ W. |
| | | 18° 24′ 30″ N. | | 65° 38′ 30″ W. |
| 94. | Lat. | 18° 37′ 45″ N. | Long. | 65° 05′ 00″ W. |
| | | 18° 39′ 00″ N. | | 65° 03′ 30″ W. |
| 100. | Lat. | 18° 38′ 45″ N. | Long. | 64° 52′ 45″ W. |
| | | 18° 40′ 15″ N. | | 64° 50′ 15″ W. |

## PREVIOUS WORK

The only annelid paper dealing exclusively with the Porto Rican region is by Treadwell (1901), and is an account of the polychaetous annelids collected by the U. S. Fish Commission Steamer Fish Hawk in the expedition of 1899. The Johnson-Smithsonian expedition of 1933 collected in the vicinity of Porto Rico and the new species obtained by that expedition have been described (Treadwell 1934), while lists of the old species are as yet unpublished. A few annelids have been taken on the island by members of the staff of the American Museum of Natural History. The character of other expeditions to this general region is sufficiently indicated in the bibliographic references.

## SYSTEMATIC ACCOUNT

The following key is intended to cover only those polychaetous families which have been recorded from the vicinity of Porto Rico and is based in part on the key given in Chamberlin's monograph (Chamberlin 1919: 19–23). In that monograph will be found a more elaborate key covering all polychaete families as well as some generic diagnoses.

### Key to polychaete Families recorded from Porto Rico

A. Prostomium fully exposed.
  B. Scale-like plates or elytra on dorsal surface of body.
    C. Elytra not arranged as in *Sigalionidae* (below).
      D. Elytra on somites 2, 4, 5, or 2, 3, 4, 6, and on alternate somites in anterior part of body.
        E. Jaws 4, strong. Tentacles 2 or 3. . . . Polynoidae, page 180.
        EE. Jaws none or weak. Tentacle 1. Facial tubercle in front of tentacle. Felt of fine hairs often covering elytra. . . Aphroditidae, page 188.
      DD. Elytra usually on alternate somites. Eyes stalked. Tentacles 2 or 3 . . . . . . . . . . . . . . . . . . . . . . . . . Acoetidae, page 191.
    CC. Elytra in anterior region borne on alternate somites, in posterior region on all somites . . . . . . . . . . . . . . . . . . Sigalionidae, page 193.
  BB. Scale-like plates or elytra none.
    C. Uncini of anterior somites (except possibly 1–4) in rows on tori at right angles to longitudinal body-axis.
      D. Branching or arborescent gills absent from anterior body-somites. Capillary setae present. Tori elongate. Uncini numerous . . . . . . . . . . . . . . . . . . . . . . . . Maldanidae, page 275.
      DD. Branching or filiform gills present on anterior body-somites.
        E. Tentacular cirri none.
          F. Prostomium and peristomium more or less fused to form an upper lip carrying numerous tentacles. Paired gills varying in number in different species, on somites 2–5. . . . . Terebellidae, page 281.
          FF. Prostomium distinct from peristomium. Tentacles retractile within pharynx. Gills generally 4 pairs, simple, pointed. Sometimes 2 rows of conspicuous paleae on somite 3. . . . . . . . . . . . . . . Ampharetidae, page 285.
        EE. Tentacular cirri 2 pairs. Caudal 5 or 6 body-somites much smaller than the others. . Amphictenidae, page 287.
    CC. Uncini absent from first 9 somites, or if present mingled with capillary setae.
      D. Buccal armature a complex arrangement of plates. . . . . . . . Leodicidae, page 233.
      DD. Buccal armature simple or absent.

E. Setae on first 9–14 somites capillary only. Uncini and usually capillary setae on other somites. Anterior parapodia rudimentary, posterior ones absent. Gills, if present, at ends of row of uncini, often retractile. CAPITELLIDAE, page 288.

EE. Setae not thus arranged.

F. Prostomium long and annulate, with 4 short tentacles at the tip.

G. Parapodia similar throughout the body. 4 similar jaws in proboscis. GLYCERIDAE, page 260.

GG. Parapodia of 2 types, the anterior uniramous, the posterior biramous. Numerous small plates on side of proboscis. GONIADIDAE, page 266.

FF. Prostomium not annulate.

G. Palps elongate-tentaculiform. SPIONIDAE, page 270.

GG. Palps not so.

H. Body composed of 3 distinct regions: anterior of 9 to 14 somites, middle of 2 to 5, posterior indefinite in number. Parapodia uniramous in anterior, biramous in posterior region. On median region often a long tentacle-like notopodium. Peristomium funnel-shaped. CHAETOPTERIDAE, page 266.

HH. Body not so divided. Integument smooth. Gills numerous.

I. Body with parapodia.

J. Gills dorsal. Body elongate, of many short somites. Setae annulate or cross-striate. Uncini in posterior part of body none ........ ARICIIDAE, page 262.

JJ. Gills on anterior somites only. Setae not striate nor camerate. A sensory papilla at the end of the prostomium............ PARAONIDAE, page 265.

JJJ. Gills and tufts of setae lateral. Body of few somites, usually annulate . . . OPHELIIDAE, page 274.

II. Body without parapodia. Gills long and filiform, on the sides of many somites. Larger cirri or branchiae in a transverse row on the dorsum of some anterior somites CIRRATULIDAE, page 271.

FFF. Prostomium bearing palps or tentacles or both.

G. Notopodial setae blade-like, largely or entirely covering the dorsal surface............... PALMYRIDAE, page 199.

GG. Notopodial setae not blade-like.

H. Notopodia and neuropodia with conspicuous lamellae, the notopodium with a cirriform gill on the ventral face...... NEPHTHYDIDAE, page 200.

HH. Mouth bordered by several somites. A ridge or caruncle usually extending over the dorsal midlines of several somites.

I. Setae and gills limited to margins of the somites..AMPHINOMIDAE, page 169.

II. Setae and arborescent gills covering a large part of the dorsal surface. EUPHROSYNIDAE, page 178.

HHH. Mouth not bordered by several somites.

I. Integument not roughened.

J. Cirri flattened.

K. Tentacles in 2 pairs, a fifth sometimes present. Tentacular cirri 1–5 pairs... PHYLLODOCIDAE, page 202.

KK. Tentacles 5. Tentacular cirri 3 or 5. Eyes very large. Small pelagic forms..ALCIOPIDAE, page 208.

JJ. Cirri not flattened.

K. Palps absent or, when present, more or less fused. Cirri and tentacles usually articulate.

L. Body usually small and colorless. Palps never biarticulate. Tentacular cirri 1 or 2 pairs. SYLLIDAE, page 209.

LL. Body usually short and plump. Palps biarticulate. Tentacular cirri 6–8 pairs....... HESIONIDAE, page 213.

K. Palps heavy and biarticulate, the terminal joint small. Pharynx protrusible, usually with terminal jaws and with paragnaths on one or both joints. Tentacles and tentacular cirri present.......... NEREIDAE, page 218.

II. Integument roughened. Gills on peristomium numerous. Sometimes long setae extending forward in front of peristomium............ CHLORHAEMIDAE, page 279.

AA. Prostomium more or less hidden by the peristomium. Palps subdivided to form gills. Body composed of thorax and abdomen.

B. Tentacles small. Peristomium with no cirri nor setae.

C. Thoracic membrane and operculum absent. A collar more or less developed around the bases of the gills. Tube of mucin impregnated with foreign matter or not....SABELLIDAE, page 291.

CC. Thoracic membrane and operculum usually well developed. Tube of mucin impregnated with calcareous matter........ SERPULIDAE, page 300.

BB. Tentacles well developed. Peristomium in the form of a bilobed hood, each lobe with 2 or 3 semicircles of stout paleae. Thorax of 5 or 6 somites.................................SABELLARIIDAE, page 306.

## Family **AMPHINOMIDAE**

In this family the body is usually elongate and more or less tetragonal in cross-section, the two parts of the parapodium being well separated. The prostomium is usually relatively small, this condition being emphasized by the fact that the first somites crowd forward against its lateral margins and have to be drawn away before the prostomium can be clearly seen. There are one pair of palps, 1, 3 or 5 tentacles, and usually 4 eyes, though in some cases the number may be 2, or sometimes eyes are absent. In most genera of the family there is a caruncle, a longitudinal ridge, often more or less pleated and sometimes having lateral branches, attached to the dorsal surface of the prostomium, its posterior, free end often extending for some distance over the anterior somites.

The parapodia carry dorsal and ventral cirri, and in some genera there are two dorsal ones. Gills, in the form of pinnatifid or arborescent tufts, are attached to the dorsal faces of the parapodia but never extend across the body. The setae are, as a rule, simple and capillary, but in some cases there may be stouter hooked spines.

This family is especially well represented in the tropical and subtropical waters, generally found in rock-crevices where they cling with considerable tenacity. Some characteristically attach themselves to floating logs, a single log often carrying a large number of individuals. Many erect the setae when disturbed, so that when picked up in the bare hand setae will stick in the skin and pull away from the animal; these rarely penetrate far enough to cause any discomfort.

### Key to Genera recorded from Porto Rico

A. Branchiae arborescent. Caruncle present.
  B. Caruncle small.
    C. Neuropodial setae bifurcate. Caruncle a flexuous crest with lateral folds. Eyes present . . . . . . . . . . . . . . . . . . . . . . . . . . *Eurythoe.*
    CC. Neuropodial setae not bifurcate. Caruncle tongue-shaped or cordiform . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Amphinome.*
  BB. Caruncle large.
    C. Caruncle with lateral branches diverging toward the head. Cirrus one, dorsal . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Hermodice.*
    CC. Caruncle a median and two lateral longitudinal lobes, all much plicated. Eyes 4. Cirri dorsal and intermediate. Anal opening on dorsal face of body several somites in front of the pygidium . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Notopygos.*
AA. Branchiae pinnatifid.
  B. Caruncle relatively broad and short, composed of 3 not very distinctly separated lobes all much plicated. Cirrus one, dorsal. Eyes 4, those of the same side sometimes nearly fused . . . . . . . . . . *Chloeia.*
  BB. Caruncle none . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Hipponoe.*

## **EURYTHOE** Kinberg

### **Eurythoe complanata** (Pallas)

Figure 5

*Amphinome complanata* Pallas (1766) 109. *pl. 8, fig. 19–26.*
? *Eurythoe pacifica* Kinberg (1857) 14.—McIntosh (1885) 27–29. *pl. 2, fig. 3, 4; pl. 3, fig. 2; pl. 2a, fig. 13; pl. 3a, fig. 5–9.*
*Eurythoe complanata* Ehlers (1887) 29–31.

It seems probable that *E. complanata* and *pacifica* are synonyms, though the matter has not been thoroughly investigated. McIntosh recorded *E. pacifica* from Bermuda, and Ehlers' material came from Florida. The name *complanata* has precedence. The following description is mainly taken from McIntosh.

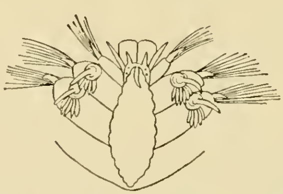

Figure 5. *Eurythoe complanata* (Pallas). After McIntosh.

The prostomium (figure 5) has one unpaired and two paired tentacles, and four eyes, two on either side of the unpaired tentacle. The lateral boundaries of the mouth form prominent lips, and the first three somites enter into the mouth-boundaries, the posterior border of the mouth being on the fourth somite. The caruncle has a pointed-oval outline and there is no very distinct division between central and lateral regions. The margin has 8–10 slight indentations.

Gills begin as bifid tufts on the second somite. In later somites they take on the form of dichotomously branched, rather short processes which are never as prominent as they are in some other members of this family. They extend to the last, or next to the last, somite.

The dorsal setae are of three kinds. Some are large, smooth, and slightly curved to a blunt apex. Others are much more slender and carry a distinct tooth at some distance from the end, the portion beyond this tooth being more slender than the main portion; this terminal portion has a series of marginal notches. The third form is about the same size as the first but carries along one edge a series of strong teeth whose points are directed toward the base of the seta. In the ventral tuft are slender setae resembling the second form of the dorsal ones, but the tooth is larger and the serrations on the terminal portions smaller. A second form of ventral seta is stouter than any of the others, unequally bifid near the end and carries a few small teeth on the inner margin of the larger branch.

*Eurythoe complanata* is much the commonest member of this family in the West Indies and will probably be found in any collection. It may reach a considerable size, one described by Ehlers being 145 mm. long and 10 mm. wide, not counting the setae. This individual had 114 somites.

Ehlers' specimens were taken at the Dry Tortugas, Florida, off Carysfort Reef and Cape Florida, and Silver Key Bank (Ehlers 1887: 31); from Porto Rico they have been listed by Treadwell (1901: 194), at Arroyo, Hucares, Puerto Real, and Ensenada Honda (Culebra), and by Hoagland (1919: 576) from rocks off Guanica Harbor. Among the Barbados-Antigua material they appear from Pillars of Hercules, Pelican Island, "old coral heads" and "off the Crane" (Treadwell 1924: 4). The Arcturus expedition collected them on Saba Bank, 17° 39′ N. Lat. 63° 16′ W. Long.; at Tower Island, Galapagos, 0° 19′ N. Lat. 89° 57′ W. Long.; at 0° 16′ S. Lat. 91° 23′ W. Long.; and at Hood Island, 1° 22′ S. Lat. 89° 39′ W. Long. (Treadwell 1928: 450). I have found it in Bermuda. Ehlers (1887: 30) suggested that *Amphinome macrotricha* of Schmarda (1861: 144) is really *E. complanata*.

**AMPHINOME** Brugière

**Amphinome microcarunculata** Treadwell

FIGURE 6

*Amphinome microcarunculata* Treadwell (1901) 194, 195. *fig. 32.*

Described by Treadwell from an incomplete specimen in which only the anterior 36 somites were preserved. The specimen differs from the generic diagnosis of *Amphinome* as given by Kinberg (1857: 12), in that it lacks a median tentacle and the gills begin on the eighth instead of the third somite. It was located in *Amphinome* however, on the assumption that these differences were due to the incompleteness of the specimen.

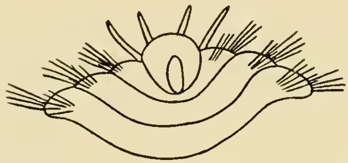

Figure 6. *Amphinome microcarunculata* Treadwell. × 8.

The prostomium (FIGURE 6) is nearly circular as seen from above and carries the very small caruncle near its posterior end. The caruncle is peculiar in that it does not extend beyond the border of the prostomium. No eyes could be seen. Dorsal and ventral paired tentacles are present, the former slightly the smaller.

The body widens very rapidly from the first to the twentieth somite and behind this point it again narrows. Gills appear first on the eighth somite as single filaments and in later somites develop into tufts of thick short filaments. The dorsal cirrus lies a little behind and ventral to the seta-tuft and is about three-quarters as long as the setae. The ventral cirrus is small, and is shorter than the setal lobe. No record was made of the character of the setae.

Recorded as from Station 6070 in Porto Rico.

**Amphinome jamaicensis** Schmarda

FIGURES 7a, b, c

*Amphinome jamaicensis* Schmarda (1861) 143. *3 text-figs.*—Hoagland (1919) 575.

The body is rectangular in cross-section, is 60 mm. long and 6 mm. wide and is composed of 70 somites. In the alcoholic specimen the color is reddish. The oval caruncle reaches to the third somite. The gills occur in small bundles and have a reddish color. The anal opening is situated dorsally on the last somite. Dorsal cirri extend beyond the ends of the dorsal setae, while the ventral ones are very short. Dorsal setae are shorter than the ventral and there are two kinds in the dorsal bundle. One is very long and slender and carries near the end a strong lateral tooth (FIGURE 7a); beyond this tooth the shaft of the seta is much narrowed. The other forms are straight and carry a row of saw teeth along one margin (FIGURE 7b). The ventral setae are much heavier, and have a large terminal and a much smaller stout subterminal tooth (FIGURE 7c).



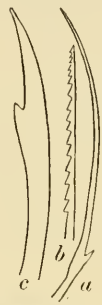


Figure 7. Setae of *Amphinome jamaicensis* Schmarda.

Schmarda described this species from specimens collected on coral reefs south of Port Royal, Jamaica. His description is very brief and he figures only the setae. Hoagland (1919: 575) identified it among specimens collected near Guanica Harbor by R. W. Miner.

**HERMODICE** Kinberg

**Hermodice carunculata** Kinberg

FIGURE 8

*Hermodice carunculata* Kinberg (1857) 13.—Webster (1884) 307.—McIntosh (1885) 24–27. *pl. 5; pl. 3a, fig. 1–4.*

If in the various descriptions and listings of this species there has been no confusion of identities, it has been grouped in an astonishing number of genera (for bibliography see Webster 1884). According to Kinberg's original description the body is long and depressed, rectangular in cross-section and five somites cooperate to form the mouth-boundaries. The gills are large and branching and arise from a short stalk. Throughout the greater part of the body they are more prominent than would appear from the first pairs (FIGURE 8). McIntosh's description is the most complete of any. The prostomium (FIGURE 8)

Figure 8. *Hermodice carunculata* Kinberg. × 8.

carries a large caruncle which extends to the posterior border of the fourth somite and is composed of a central axis from which lateral branches are given off. The lateral branches carry side-lobings on both sides. The specimen drawn in FIGURE 8 had been so bent that only one set of these side-lobings appeared. A median tentacle lies immediately in front of the caruncle and two smaller tentacles lie on either side outside and in front of the median. Two small eyes are on either side of the median tentacle.

Beginning with the first setigerous somite a tuft of gills (FIGURE 8) is attached to the somite on its posterior border near its outer end. The dorsal cirrus lies just ventral to this and a seta-tuft just in front of the gills. Each gill consists of an outer smaller and an inner larger tuft, the larger one dividing into three or more branches.

The halves of the parapodium are widely separated, the notopodium and the neuropodium lying at the upper and lower lateral angles of the body respectively. The notopodia are cylindric in form and squarely truncate at their ends, the latter having a lip-like rim surrounding a dense tuft of setae. These notopodia are arranged alternately in two rows, one nearer the dorsal body-surface. The neuropodium has an outline oval in section, the longer axis being arranged vertically. The setae protrude through a narrow slit-like opening at the end of the neuropodium. Some notopodial setae are long and slender and finely tapered and toward the ends have minute roughenings. Others are stouter and are distinctly serrated towards the ends. Each neuropodial seta has a distinct tooth at a considerable distance back from the curved apex and a series of denticulations between the tooth and the apex. The dorsal cirrus lies posterior to the setal tuft and has a slender tip. The ventral cirrus occupies a similar position behind the neuropodium and is smaller than the dorsal.

This species is often found on floating logs and also occurs among stones. It reaches a very considerable size, one in the possession of the writer being 230 mm. long, 9 mm. high on the lateral surface and 18 mm. wide in the widest portion. Even in preserved material the greenish tint of the living animal is preserved. The body-surface especially dorsally is decidedly rugose, being divided into more or less rectangular areas by interlacing lines.

McIntosh (1885) described specimens from the surface of the sea near Bermuda; from the littoral regions of the same islands; from St. Vincent, Cape Verde Islands; and from St. Thomas in the "West Indies" (Virgin Islands ?). Webster (1884: 307) found it in Bermuda. Treadwell (1901: 194) listed Porto Rico specimens, collected by R. W. Miner, H. Mueller and A. L. Treadwell, from Guanica Bay, Fajardo, Arroyo, Ponce, San Antonio Bridge, San Juan, Bouqueron Bay, Mayaguez, Playa de Ponce reef, Ensenada Honda (Culebra), Stations 6092, 6088. Treadwell (1924b: 4) listed it among the collections of the Barbados-Antigua expedition at Needham's Point, D. S. 79, D. S. 81, Pelican Island, "off the Crane" and in "old coral heads." Treadwell (1928: 450) from 17° 39′ N. Lat., 63° 16′ W. Long. It appeared in the Johnson-Smithsonian collections at Station 35.

### **NOTOPYGOS** Kinberg

#### **Notopygos crinita** Grube

FIGURE 9

*Notopygos crinita* Grube (1855) 93; (1878) 7, 8.—Ehlers (1887) 24–26. *pl. 1, fig. 3; pl. 3, fig 5, 6, 7.*

Members of the genus *Notopygos* can easily be recognized by the oval body, which is decidedly tapered toward the posterior end, by the duplication of dorsal cirri in each somite, and by the position of the anus, which lies on the dorsal body-surface at some distance in front of the pygidium. The following description of *N. crinita* is taken from Ehlers (1887) and Grube (1878).

Figure 9. Caruncle of *Notopygos crinita* Grube. × 3.

The prostomium carries a median unpaired and four paired tentacles, all approximately of the same length (FIGURE 9). On either side of the unpaired tentacle are two eyes, of which the anterior is slightly the larger. The caruncle is attached to four somites and is composed of a median ridge, which is more or less plicated along the margins, and on either side a lateral ridge as long as the median, and like it thrown into folds. The posterior end of the caruncle overlaps the sixth setigerous somite.

Gills begin on the fifth setigerous somite and extend to the extreme posterior end of the body. Each gill consists of a tuft of slender finger-shaped processes arising from a broad common base.

The dorsal cirri are filiform, one lying on the median side of the gill-tuft, slenderly cylindric, about as long as the gill-filaments; the other lies posterior to the gill, has a stout basal and slender terminal portion, and is scarcely as long as the setae. The anal opening lies on the dorsal surface of the twenty-first somite. The setal structure is not recorded with any clearness in the literature.

Ehlers (1887) lists this species from the Dry Tortugas. Treadwell (1901: 194) recorded it among the Fish Hawk specimens from Station 6079 and it appeared in the Barbados-Antigua material from "sea beach at low tide" and at Pillars of Hercules (Treadwell 1924a: 4).

### CHLOEIA Savigny

### Chloeia euglochis Ehlers

FIGURE 10

*Chloeia euglochis* Ehlers (1887) 18–24. *pl. 1, fig. 1, 2; pl. 2, fig. 1–8; pl. 3, fig. 1–4.*

The prostomium carries five tentacles, of which the median lies directly in front of the caruncle and the dorsal paired ones lie directly ventral to this, with their bases almost in contact. These three tentacles are about of the same size, while the ventrally situated paired ones are smaller and lie one on either side lateral to the upper lip, which bounds the dorsal margin of the mouth. The caruncle is attached to the dorsal surface of the first two somites and extends to the fifth. On either side of the unpaired tentacle is a pair of eyes which have nearly fused into one. On the ventral surface the first setigerous somite forms a prominent upper lip to the mouth, the second and third somites bound it laterally and the fourth forms a posterior lip.

Figure 10. Caruncle of *Chloeia euglochis* Ehlers. × 2.5.

The caruncle (FIGURE 10) is divided longitudinally into a larger median and two smaller lateral portions, the median portion being again divided by a median groove into halves each of which is complexly plicate. A similar plication occurs on the lateral portions and all three fuse at the posterior end. The left lateral portion does not show in the figure.

Gills begin on the fourth somite. When seen from the dorsal surface the gill appears as a stout tapering central axis, carrying on either side a row of ten or more branches, which decrease in length toward the apex of the gill as the central axis becomes narrower. Ventrally each branch carries dense rows of filaments so that when seen from the ventral surface the gills appear as more or less tangled masses. They extend to the extreme posterior end of the body.

The large seta-bundles are separated from one another on the lateral face of the animal by a considerable space. All setae are more or less encrusted with limestone, which gives them a whitish appearance.

Those of the dorsal bundle are stout and carry heavy recurved teeth; the ventral ones are larger and more numerous than the dorsal and are not toothed. Ehlers describes them as bifid one branch being very short.

Ehlers figures this species as brilliantly colored, the body in blotches of purple and brown, the general effect of the large seta-bundles being gray, but each bundle is represented as having a red patch near its end. It is probable that this is the attempt of the artist to indicate the iridescence which is a characteristic feature of the setae of this family.

Ehlers's material came from Tortugas, Cape Florida, and "Florida." Treadwell (1901: 194) recorded it from Porto Rico, but did not give any precise locality.

### **HIPPONOE** Audouin & Milne-Edwards

#### **Hipponoe elongata** Treadwell

FIGURE 11

*Hipponoe elongata* Treadwell (1931) 3, 4. *fig. 10–12.*

An uncommon genus, only one other species having been thus far recorded from the eastern American coast.

The anterior end of the prostomium is rounded (FIGURE 11), while its posterior end terminates in a point. The eyes on either side lie behind the mid-line of the prostomium. Those of the same side are close together, the anterior pair being the larger. In front of either anterior eye is a short blunt tentacle, and another lies on either side just below the anterior prostomial margin, its tip being visible from above. A very short elevation near the posterior margin of the prostomium represents the unpaired posterior tentacle. There is no caruncle.

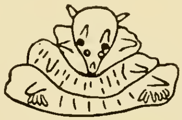

Figure 11. *Hipponoe elongata* Treadwell × 10.

On either side the first somite extends around the prostomium almost to its anterior border. This leaves the mid-dorsal line of the first somite very short, so that it really seems to be composed of triangular halves, the bases of the triangles being lateral to the apices. The second somite is also longest on its margins and shortest in the mid-dorsal line. Neither of these first two somites carries gills. The third somite is wider than the second and has gills on either side posterior to the dorsal cirrus. On the ventral surface the first three somites bound the mouth.

The gills occur on all somites posterior to the second except the one in front of the anus. In the most anterior somites the gill has the appearance of a "hand" of bananas and there are two of these "hands" on either side. Farther back, the number of the "hands" increases and their arrangement may become more complicated.

In the middle of the body the neuropodia and notopodia are quite widely separated and are prominent, while the portion between them is hardly elevated above the general body-surface. The prominent dorsal cirrus and the seta-tuft protrude from an oval depression at the end of a cylindric elevation. The neuropodial setae protrude from a similar depression on the neuropodium. A small ventral cirrus lies just below this.

The notopodial setae are all very long, slender, and sharp-pointed. The neuropodial ones have near the end a blunt marginal tooth beyond which the seta tapers to a point. The ends are darker than any other part of the setae.

The type and only known specimen was collected in Porto Rico by R. W. Miner. Type in American Museum of Natural History, Cat. No. A. M. N. H. 2067.

## Family **EUPHROSYNIDAE**

A family whose members resemble the Amphinomidae in many respects, and *Euphrosyne triloba* was included in that family by Ehlers (1887: 31–33). The body is oblong or elliptic in outline and generally has few somites, sixty being approximately the largest number in any member of the family. There is a caruncle. In one genus (*Lophonia*) there are no tentacles, but in most there are three, a median prominent one and two small lateral ones. There are two pairs of eyes, one pair on the dorsal and the other on the ventral surface of the prostomium. In each somite a continuous ridge starts at the ventral cirrus and extends to and beyond the dorsal cirrus, those from the two sides leaving uncovered only a narrow portion of the mid-dorsal line of the body. On this ridge are carried setae, a row of branched gills, and the cirri. In *Euphrosyne*, the only genus thus far described from the West Indian region there are three cirri, a ventral and two dorsal.

## EUPHROSYNE Savigny

### Euphrosyne triloba Ehlers

FIGURE 12

*Euphrosyne triloba* Ehlers (1887) 31–33. *pl. 4, fig. 1–7.*

The body is decidedly oval in outline and has 28 somites. Ehlers records one specimen as measuring 17 mm. in length and 6 mm. in breadth, in another these measurements were respectively 23 and 7.5.

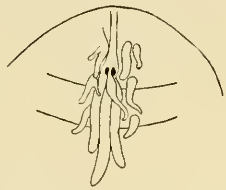

Figure 12. *Euphrosyne triloba* Ehlers. × 11.

The prostomium (FIGURE 12) carries a caruncle composed of 3 cylindric cirrus-like processes, of which the longest reaches to somite 6 the others to somite 5. The tentacle is attached directly in front of the caruncle and is about as long as the lateral portions of the caruncle. Two very large dark eyes lie at the base of the tentacle and two others are on the ventral surface and thus not visible from the dorsum. Ehlers does not describe any paired tentacles. On either side of the caruncle is a row of cirrus-like processes which Ehlers suggests may be undeveloped gills or cirri.

On the lateral surface of fully equipped somites is a vertical row of eight gills, of which the second to the fourth are the most complexly branched. One dorsal cirrus lies dorsal to the gill-row, a second is in the region of the sixth gill, and the ventral cirrus lies near the ventral side of the seta-tuft, which is itself ventral to the first gill. The ventral setae form a dense tuft, but dorsal to these a single row of setae continues as far as the dorsalmost gill. Ehlers distinguishes two seta groups, a dorsal row which extends to the sixth gill and a ventral tuft. His figure 5, however, shows only a very small gap between the two. Setae are of two kinds, both unequally bifid. In one the two branches diverge only slightly from one another and both are cylindric and rounded at the apices. In the other, one of the terminal branches is flattened, one side is straight while the other forms a quarter of a circle, this latter being notched along its margin; the other branch curves around this first branch and directly in line with the main axis of the seta bends outward to end in a short cylindric tip. Its curved portion is notched to correspond with that of the other branch.

Collected in Porto Rico at Station 6098 Treadwell (1901: 194). Ehlers (1887) recorded it south of East Key, off Carysfort Reef, and 14 miles south of Sand Key.

## Family POLYNOIDAE

The most prominent family characteristic is the possession of elytra, flattened plates covering more or less of the dorsal body-surface and lying in a single row on either side of the body. Morphologically they are modified dorsal cirri. Their size determines the extent to which they cover the dorsal surface, but usually those of one side overlap one another from in front backward and frequently those on opposite sides overlap in the mid-dorsal line. Usually the head is completely covered by the first pair, even if some somites through the median body-region are exposed. These elytra appear on definite somites, usually on 2, 4, 5, 7, 9, counting from the anterior end, and on alternate somites behind 9, though through the median body-region it is a rule that every third somite carries an elytron. In genera having short bodies, the number of elytra is constant, varying in different genera from 12 to 18 pairs, but where the body is elongate the number is greater and varies with the absolute length of the body. In a few genera the elytra are small and inconspicuous.

In a few genera there are only two tentacles, but in most there are three, a median and a lateral on either side. The lateral ones may be carried on short cirrophores which are continuations of the lateral margins of the prostomium, or the cirrophores are ventral to these margins, in which case the margins themselves are prolonged to form "peaks" dorsal to the cirrophores.

The parapodia may be either uniramous or biramous and in the former case it is the notopodium which has failed to develop. In many truly biramous species, the notopodium is very small or rudimentary and may easily be overlooked. The setae are never compound, but generally are heavy and well supplied with toothed marginal plates or with terminal teeth. On the prostomium are two pairs of eyes. The pharynx has dorsal and ventral rows of teeth on its distal margin, visible only when protruded. The palps are always prominent, as are the tentacular cirri, the latter consisting of two pairs on either side of the first somite. The tentacular, dorsal, and anal cirri are always quite similar in structure, the dorsal ones being located on somites which do not carry elytra.

Key to Genera recorded from Porto Rico

A. Lateral tentacles inserted ventrally.
  B. Body long and vermiform. Elytra 15 pairs. Prostomium with anterior peaks. Neuropodial setae bifid. . . . . . . . . . . . . . . . . . . . . . *Polynoe.*
  BB. Body short and depressed. Median tentacle at margin. Notopodial setae smooth and stouter than neuropodial. . . . . . . . . . . . . . . . *Melaenis.*
AA. Lateral tentacles inserted on margin of prostomium.
  B. Elytra 18 pairs. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Halosydna.*
  BB. Elytra 12 pairs, all of normal size. . . . . . . . . . . . . . . . . . . . . . . *Lepidonotus.*
  BBB. Elytra 12 pairs, the first normal, all others very small. . . . . . . . *Hermenia.*

**POLYNOE** Savigny

**Polynoe polytricha** Schmarda

Figure 13

*Polynoe polytricha* Schmarda (1861) 156. *4-text figs.*—Ehlers (1887) 49–50. *pl. 10, fig. 9, 10; pl. 11, fig. 1.*
*Harmothoe polytricha* Treadwell (1901) 186.

The single specimen described by Ehlers was 10 mm. long and carried thirty-eight elytra* on somites 2, 4, 5, 7,—23, 26. He stated that it had only two eyes but Treadwell found four eyes on a mutilated specimen which he identified as this species. Ehlers' specimen. (figure 13) had lost the median tentacle, but the short lateral ones,

Figure 13. *Polynoe polytricha* Schmarda. × 10. After Ehlers.

the palps, and the tentacular and dorsal cirri, were all thickly studded with slender papillae. The setae are all heavy, those of the notopodium carrying rows of toothed plates almost to their apices while those of the neuropodium have similar plates but are bifid at the ends. Exposed parts of the elytra have a few large horny teeth with a number of smaller ones elsewhere, but the unexposed portion (*i. e.*, that which in life is covered by the overlapping one in front), is smooth. The exposed margin also has a fringe of long processes which are shorter on the sides and do not occur on the covered part.

Ehlers' specimen was taken off French Reef in 34 fathoms (1887); Schmarda's at a key on the southern coast of Jamaica (1861); Treadwell's from Stations 6079, 6091, 6070, and Mayaguez Harbor

* Ehlers gave the elytral number as thirty-eight although the *Polynoe* number is fifteen. If this species is found it should be reexamined to determine where the error lay, and the correct generic name.

(1901); Hoagland (1919: 572) recorded one as collected between Ensenada and Guanica.

### MELAENIS Malmgren

#### Melaenis tropicus Treadwell

Figure 14

*Melaenis tropicus* Treadwell (1934) 1, 2. *pl. 1, fig. 1–6.*

The body is completely covered by twelve pairs of elytra. The prostomium is rounded in outline (figure 14), and carries three cirrophores, of which the median is the largest and overlaps the others on the sides. No eyes are visible.

The first parapodia are very small and are partly concealed by the bases of the palps. The main axis of the parapodium widens considerably toward the end and carries two large cirrophores. On its anterior border are numerous papillae. The second parapodium has a

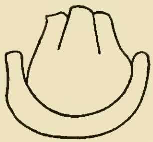

Figure 14. *Melaenis tropicus* Treadwell. × 5.

broad notopodium which narrows to a sharp point. The neuropodium is ringed at the base and narrows regularly to the apex. These two parapodia are quite small but the third is much larger and its setae extend as far as to the tips of the palps. Following parapodia are also large.

The elytra are broadly oval in outline with their points of attachment nearer one end and their long axes at right angles to that of the body. Some notopodial setae are stout and carry a row of barbs on either side toward the end. The neuropodial ones are few and heavy, bent at the apices to an acute tip and have two or three stout teeth on the outer surface. Some neuropodial setae have teeth along the margin. In both parts of the parapodium are long and slender, sharp-pointed ones.

Not reported from Porto Rico, but collected in the Virgin Islands by Johnson-Smithsonian expedition.

### HALOSYDNA Kinberg

#### Halosydna brevisetosa Kinberg

Figure 15

*Halosydna brevisetosa* Kinberg (1856) 385.
*Polynoe brevisetosa* Treadwell (1901) 186.—Johnson (1897) 167–170. *pl. 6, fig. 24; pl. 7, fig. 31, 40, 40a; pl. 8, fig. 46, 46a.*

Kinberg's specimens were taken near San Francisco, California, and in the above mentioned paper Johnson described it under the generic name *Polynoe* as the commonest polynoid of the Pacific coast. It is very variable as to form, size, and coloration, the long and slender individuals being commensal in tubes of other annelids. The following description is taken from Johnson.

The prostomium (FIGURE 15) has a breadth equal to its length, and is broadest a little posterior to the anterior pair of eyes. There are four black eyes, the anterior pair slightly farther apart than the posterior. The tentacles and the tentacular and all other cirri, are smooth, cylindric, slightly bulbous near the apex, and have long filamentous tips. Just below the bulbous portion is a dark pigment-band.

Figure 15. *Halosydna brevisetosa* Kinberg. × 20. After Johnson.

There are eighteen pairs of elytra, which seldom cover the entire dorsum. The parapodia are stout, short, scarcely biramous. The notopodium is very small and carries some short, small, toothed setae which do not reach beyond the end of the neuropodium. The neuropodium is much larger and carries about sixteen setae arranged in two groups, six dorsal to the acicula and ten below. These setae are short and stout, have a large terminal and small subterminal tooth and carry, proximally to the subterminal tooth, a number of rows of transversely arranged toothed plates.

The elytra are very varied in form, the first pair nearly round, others reniform or elliptic. The most anterior ones have rounded tubercles on the surface, others have only small ones.

While the coloration is extremely variable, the ground-color is always white overlaid by pigmented areas of iron-gray, tawny, yellow, brown, or orange. On the dorsal surface of each somite is a transverse dark bar, a lighter bar of the same color lying in front of it.

Treadwell's (1901) records for this species show that it was collected at Puerto Real, Caballo Blanco Reef, and Guanica Bay. One other specimen was marked simply from "Porto Rico."

### LEPIDONOTUS Leach

**Lepidonotus branchiatus** (Treadwell)

FIGURE 16

*Polynoe branchiata* Treadwell (1901) 186. *fig.* 5–7.

The prostomium is roughly hexagonal carrying the anterior eyes at the outer angles. The tentacular cirrophores are extensions of the anterior prostomial margin and the median is longer than either lateral one. The tentacles are brownish for about half their length, this is followed by a white region, then a second brown portion immediately under the swollen end, which terminates in a slender point. The tentacular cirri have the form of and are colored like the tentacles, while the dorsal and anal cirri have the same form but only one white band.

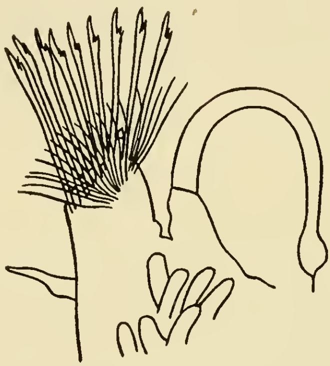

Figure 16. *Lepidonotus branchiatus* (Treadwell). × 9.

There are twelve pairs of elytra, which completely cover the dorsal body surface. They are covered with minute tubercles, with a few longer and softer ones near the outer margin, and the lateral and posterior margins are densely fringed. The tubercles and fringes give the dorsal surface the appearance of being covered with a fine gray sand.

The most characteristic feature of the parapodium is the presence on its posterior surface of a tuft of finger-shaped processes which are interpreted as gills (FIGURE 16). The parapodium has a small notopodium which carries a tuft of slender setae toothed on both margins, and a much larger neuropodium provided with a bunch of heavy setae which end bluntly, but each carries a transverse row of sharp teeth a short distance proximal to its end.

Of the three specimens recorded by Treadwell (1901: 186) from Boqueron Bay, Ponce, and Station 6065, one had a total length of 25 mm., the other 20 mm.

### Lepidonotus variabilis Webster

FIGURE 17

*Lepidonotus variabilis* Webster (1879) 5–8. *pl. 1, fig. 6–11; pl. 2, fig. 12–14.*—Hoagland (1919) 572.

The body is narrow and of nearly uniform width throughout. The prostomium (FIGURE 17) is, except for the cirrophores of the lateral tentacles, a trifle wider than long. The eyes are small, the anterior pair being a trifle larger than the posterior. The styles of the tentacles are all slender, decidedly swollen toward the ends and terminating in acute points. At the base of each swelling is a prominent dark band. The tentacular cirri have long cirrophores and slender styles, and are similar to the tentacles in size and form. The palps are a little shorter than the median antenna and taper uniformly from base to apex.

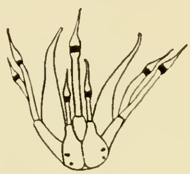

Figure 17. *Lepidonotus variabilis* Webster. × 12.5.

Twelve pairs of elytra completely cover the back. Those of the first pair are nearly circular in outline, those farther back being more nearly oval. They are coarsely fringed on the posterior and outer margins, with a small patch on the surface of the elytron near its inner margin. Where there is no fringe the margin carries a series of short papillae. The surface is covered with minute spines.

The parapodia are about equal in length to the body-width and are truncated externally. The dorsal cirri are about half as long as the median antenna and have the same form. The dorsal setae are numerous and delicate, and usually covered with a series of rather coarse denticulations. Ventral setae are stout and bidentate, the upper tooth projecting some distance beyond the lower. There are two very long anal cirri.

The color is variable, antennae and all dorsal cirri being clear white except for dark bands at the swollen regions. The prostomium is sometimes pure white, but sometimes it has dark-brown specks on the white background. The general body-color is some shade of brown, but the elytra vary in that the brown may become almost black or there may be a large white spot on the surface. The anal somite is brown or black. The anal cirri are dark-colored.

Description from Webster (1879). The species was recorded by Hoagland (1919: 572) from outer reef south of Guanica Harbor, near the mouth of Guayanilla Harbor, off Guanica Harbor near bell-buoy in 10 fathoms, and one lot was labeled simply Porto Rico. Collections were made by R. W. Miner and R. C. Osburn.

### **Lepidonotus notatus** Hoagland

FIGURE 18

*Lepidonotus notata* Hoagland (1919) 572–573. *pl. 29, fig. 5–10.*

The body of the type specimen is sixteen mm. long and four mm. wide, carries twelve pairs of light-brown smooth elytra, and has a row of light-brown pigment-spots on alternate somites in the mid-dorsal line. The prostomium (FIGURE 18) is longer than broad and is prolonged into the bases of the tentacles. Near the lateral border is a

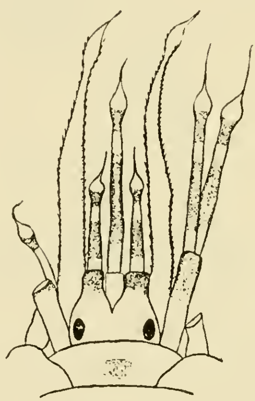

Figure 18. *Lepidonotus notatus* Hoagland. × 25.

pair of eyes and a second pair lies near the posterior margin, overlapped by the anterior margin of the first somite and not visible from a dorsal view. All tentacles and tentacular cirri are similar in form, having subterminal swellings and very acute tips. The median tentacle is about twice as long as the lateral ones, while the tentacular cirri are a little shorter than the median tentacle.

Neuropodial setae are stout, ending in a sharp point. Below the terminal point is a single row of six stout teeth of which the distalmost is the largest. Notopodial setae are of two kinds, one long and slender, abruptly swollen below the sharp apex and have smooth margins, the others much shorter and stouter and carrying transverse rows of toothed plates for a considerable part of their length.

Described by Hoagland from specimens collected near Guanica Harbor in 1915, by R. W. Miner.

Type in American Museum of Natural History Cat. No. A. M. N. H. 1213.

### **HERMENIA** Grube

#### **Hermenia verruculosa** Grube

FIGURE 19

*Hermenia verruculosa* Grube (1857a) 44, 45.—Treadwell (1911) 9–11. *fig.* 23–26.
*Polynoe nodosa* Treadwell (1901) 187. *fig.* 8, 9.

In his report on the annelids of Porto Rico, Treadwell (1901: 187) noted that the body of this animal is more or less coiled in the preserved material and looks much like a beetle larva. He found only one pair of elytra and concluded that all others had been lost. From the granular character of the surface of the body the specific name *nodosa* was given to it, though afterward it was discovered that this name was preoccupied. Later collections in the Dry Tortugas gave Treadwell material by which to correct his earlier description (1911: 9–11) and it was discovered that Grube had identified it in a few lines of Latin diagnosis without figures (1857a: 44, 45).

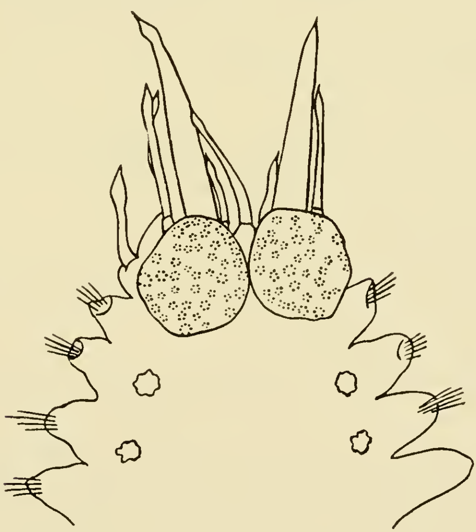

Figure 19. *Hermenia verruculosa* Grube. × 6.5. After Treadwell.

The prostomium is rounded and the tentacles arise from its anterior margin (FIGURE 19). The prostomial length is slightly greater than its breadth. The eyes are placed laterally and are scarcely visible from the dorsal surface. The ceratophore of the median tentacle is about one-third as long as the prostomium, the tentacle itself longer than the prostomium. The lateral tentacles are rather more than half as long as the median, while the tentacular cirri are about equal to it. All cirri are similar in form, having subterminal swellings and acute tips. The palps are long and taper very gently at first, later ending in acute points. The protruded pharynx shows a smooth surface with seven to eleven papillae around the terminal margin, and in the mouth are two large brown horny teeth.

The first elytra (FIGURE 19) cover the peristomium. They are irregularly rounded in outline, have many small tubercles on their surfaces and a marginal fringe of small processes. All subsequent elytra are very small and are easily overlooked. Treadwell (1901: 187) thought that they had been lost in the preservation process and it was only when living specimens were later collected in the Dry Tortugas that the error was recognized. The relative sizes of the first and later ones are shown in FIGURE 19. The small elytra have relatively larger tubercles than do later ones and their marginal lobes are more marked.

The parapodia are uniramous and carry short dorsal and ventral cirri, the dorsal ones having subterminal swellings like those of the other cirri, the ventral ones are without this swelling. The setae are stout and irregularly bifid at the ends.

The general ground-color of the body is white or cream but the color-effect of the body as a whole is determined by the small brown tubercles scattered over its surface. These tubercles are more numerous on somites bearing elytra, giving the dorsal surface the appearance of alternate dark and light somites.

In the Dry Tortugas Treadwell (1911: 11) records this species as not uncommon, living in holes in the coral rocks and retreating to deeper crevices when disturbed. They cling with considerable tenacity to the rocks and are not easily dislodged.

The Fish Hawk material had specimens from Station 6079 and Fajardo (Treadwell 1901). Grube's specimen came from "San Jan" (1857a). The American Museum of Natural History has one from Andros in the Bahamas, and it appeared in the Arcturus collections from 17° 39′ N. Lat. 63° 17′ W. Lat. (Treadwell 1928). In material from the Barbados-Antigua expedition it was found from Station 101 (Treadwell 1924). It is common in Bermuda (Treadwell 1928: 452).

## Family APHRODITIDAE

In this family the body is broad and short, the dorsal surface rounded, the ventral flattened. The dorsal surface is usually covered with a thick felting of fine capillary hairs which are often iridescent, among the hairs may be seen setae of various sizes, and underneath them are elytra. The prostomium is distinct from peristomium and carries a single median tentacle. There are two pairs of eyes. The peristomium generally carries setae and has two pairs of long tentacular cirri. The setae are all simple and some may be very stout.

KEY TO GENERA RECORDED FROM PORTO RICO

A. Median but no lateral tentacles. Eye not on base of antenna. Dorsal hair felted. Eyes on peduncles.
  B. Some notopodial setae arrow-shaped........................*Laetmonice.*
  BB. No notopodial setae arrow shaped........................*Pontogenia.*

## LAETMONICE Kinberg

### Laetmonice kinbergii Baird

FIGURE 20

*Laetmonice kinbergii* Baird (1865) 180.—Ehlers (1887) 44, 45. *pl. 7, fig. 6; pl. 8, fig. 1–5.*

The body is elongate-oval in outline, the anterior end being a trifle more rounded than the posterior. Dorsally it is covered by two series of smooth whitish elytra, which are more or less overlaid by a feltwork of capillary setae. Protruding from the sides are much heavier setae. The prostomium (FIGURE 20) is composed of a median and two lateral

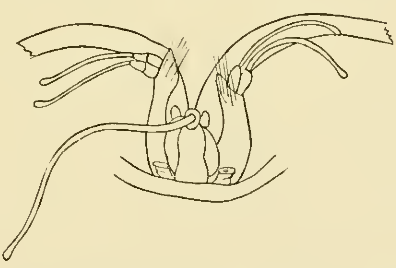

Figure 20. *Laetmonice kinbergii* Baird. × 5. After Ehlers.

portions, the single elongated tentacle arising from the apex of the median lobe. The lateral portions appear as a bulging of the median one on either side and each has a terminal knob. The first pair of parapodia extend around and considerably in front of the prostomium, and each is provided with a median tuft of setae and two slender tentacular cirri, which are considerably smaller than the median tentacle. The palps are very large, only their bases being shown in the figure. The elytrophores for the first pair of elytra are shown near the bases of the parapodia.

The elytra are smooth and broadly oval in outline. Alternating somites carry dorsal cirri, which are very long, five or six times as long as the parapodium. Notopodial setae are stiff and sharp-pointed, and carry several barbs on either side below the apex. Neuropodial setae have elongate stalks, and at the ends carry on one side a row of bristles forming a structure like a brush. Below the basal bristle are one or two heavier teeth.

Collected by the Johnson-Smithsonian expedition at stations 35, 38, and 100.

### PONTOGENIA Claparède

#### Pontogenia sericoma Ehlers

FIGURE 21

*Pontogenia sericoma* Ehlers (1887) 46–48. *pl. 7, fig. 1–5.*

The body is short, one specimen containing thirty-three somites being 17.5 mm. long. Its breadth varies very slightly in different body-regions but the posterior end is a little narrower than elsewhere. Seen from the dorsal surface the large brown setae extend up on either side and almost meet in the dorsal mid-line leaving only a narrow uncovered strip. This strip is covered by felt.

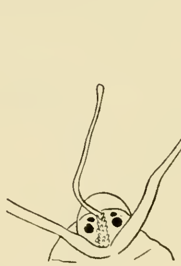

Figure 21. *Pontogenia sericoma* Ehlers. × 1.5. Adapted from Ehlers.

The prostomium is completely covered by the first elytron. It is arched in the mid-line and its length is little more than the breadth of its anterior border. The single tentacle, whose base is covered by papillae, arises near its anterior border (FIGURE 21), and on either side of the tentacle-base is a rounded portion carrying a pair of very large, black, and nearly confluent eyes. The tentacle is slender but slightly swollen at the end and reaches as far as somite 5. The palps are long and smooth and reach as far as somite 8. The figure is adapted from Ehlers and omits the setae, which extend forward from the first parapodium to form a dense mass on either side of the mouth and outward almost as far as the ends of the palps.

In each parapodium there is a tuft of golden-brown notopodial setae, which extend upward and backward and may cover as many as 3 somites. There are 2 groups of these setae, the larger dorsal ones, whose bases are arranged in an oval thus enclosing a free center, and the smaller ones which arise in a bundle. These setae are slightly bent and carry a row of saw-teeth on their convex margin. Just in front of the point of origin of the setae arises a bunch of fine hair-setae which combine with those from other somites to form a dense felt-mass over the dorsal surface. Setae of the neuropodium are straight and bifid at the ends, the two teeth being unequal in size.

Collected by the Johnson-Smithsonian expedition at Station 26.

## Family ACOETIDAE

Annelids having flattened elongate bodies composed of numerous somites. In some genera the eyes are carried on the ends of stalks. There are 3, 2, 1, or no tentacles, and the palps are long and subulate. Elytra are carried on somites 2, 4, 5, 7, and thereafter alternate with dorsal cirri throughout the remainder of the body. They generally live in tubes and according to Chamberlin (1919: 85), are the most voracious of any members of the group.

The only genera of this family recorded from the West Indian region are the three mentioned below, and *Panthalis* is the only one of these which has been found in Porto Rico. Ehlers (1887: 54–55. *pl. 12, fig. 1–7; pl. 13, fig. 1*) described *Euarche tubifex* collected at 28° 51′ N., 89° 01′ W., but Chamberlin (1919: 86) showed that *Euarche* is synonymous with *Eupanthalis* McIntosh. Treadwell (1924b: 7–9. *pl. 1, fig. 10–15*) described a new species *Panthalis pustulata,* collected by the Barbados-Antiqua expedition at English Harbor, Barbados. *Acoetes magnifica* Treadwell (1929a: 1–4. *fig. 1–7*) was collected in Montego Bay, Jamaica. Apparently only two species of *Acoetes* have been described, and the family is of rare occurrence.

### Key to Genera recorded from the West Indian Region

A. No composite setae. Three tentacles.
  B. Eyes on stalks.
    C. Gills bladder-like . . . . . . . . . . [*Acoetes.*]*
    CC. Gills none . . . . . . . . . . *Panthalis.*
  BB. Eyes sessile . . . . . . . . . . [*Eupanthalis.*]

* Names in brackets not treated in this paper.

### PANTHALIS Kinberg

### Panthalis oculea Treadwell

FIGURE 22

*Panthalis oculea* Treadwell (1901) 188, 189. *fig. 14–18.*

The prostomium (FIGURE 22) is broader than long and its anterior margins are prolonged to form two stout stalks on the ends of which are the large eyes. The median tentacle arises on a short cirrophore, its style extending only a trifle in front of the eyes and jointed near the end, the terminal joint being very small. The paired tentacles are longer than the unpaired and have longer terminal joints, but otherwise are quite similar to them in form. The palps are very long and tapering, and their surfaces are covered with minute filiform processes. The first parapodium has two long cirri whose ends are like those of

Figure 22. *Panthalis oculea* Treadwell. × 14.

the tentacles, and they are nearly as long as the palps. Later parapodia have recognizable notopodial and neuropodial lobes, but the distinctions in form are very few, both being rounded lobes. The ventral cirrus is short, not reaching to the neuropodial end.

The elytra are located on somites 2, 4, 5, 7, etc., and are all very small, leaving a large part of the dorsal body-surface uncovered. The elytron surface is divided by fine lines into "cells," many of which contain a brownish pigment.

Notopodial setae are slender. Toward the distal ends they have globular enlargements and immediately beyond this they narrow to acute points. Rows of spines occur on the margins of this narrowed portion. Neuropodial setae are of two kinds. The first are heavy, truncated at the distal end to a blunt point, and along the truncated surface bear minute spines, with larger ones at the apex. The second type are much more slender, curved toward the apices, and carry rows of toothed plates along the curved region.

A characteristic feature of this species is a pair of chitinous rods, which are attached at one end to the parapodium while the remainder of the rod lies in the coelom as a more or less tightly coiled mass. In front of the twenty-first somite, septa are absent, and the coelom is a continuous cavity, which is nearly filled by these rods. In somites behind the twenty-first, the rods are more tightly coiled than in front of this point.

None of the specimens were entire. One, 17 mm. long, contained 55 somites.

Collected in Porto Rico at Stations 6059, 6063, and "Porto Rico" (Treadwell 1901).

## Family **SIGALIONIDAE**

The body is usually long and narrow but sometimes short and flattened. The prostomium is rounded, and there may be 4, 2, or no eyes. The tentacle-number ranges from one to three. The palps are long and attenuated; the tentacular cirri are fused with the first parapodia and carried well forward of the prostomium. Elytra are located on somites 2, 4, 5, and 7, on alternate ones behind this to the twenty-third somite (twenty-seventh in some), and on all somites behind this. The parapodia are biramous, carrying simple setae in the notopodium, and either compound alone, or compound mingled with simple in the neuropodium. The animals occur from the littoral zone down to several hundred fathoms and frequently live in mud or sand.

#### Key to Genera recorded from Porto Rico

A. Setae simple, body short. Elytra on somites 2, 4, 5, 7, etc. . . . . . . . . *Eulepethus.*
AA. Setae partly compound. Median tentacle present.
  B. Tentacle 1; branchiae rudimentary. . . . . . . . . . . . . . . . . . . . . . . . . . *Eupholoe.*
  BB. Tentacles 3.
    C. Median tentacle with prominent lateral lobes. . . . . . . . . . . *Sthenelais.*
    CC. Median tentacle without lobes. . . . . . . . . . . . . . . . . . . . . . . *Psammolyce.*

### **STHENELAIS** Kinberg

#### **Sthenelais simplex** Ehlers

Figure 23

*Sthenelais simplex* Ehlers (1887) 60–63. *pl. 13, fig. 2, 3; pl. 14, fig. 1–6.*

Ehlers' description was based on several specimens, none of which was entire. The longest was 92 mm., composed of 123 setigerous somites. Another 90 mm. long had 128 setigerous somites. The greatest width, counting the parapodia, was 4.5 mm.

The prostomium is transversely oval and has no eyes (figure 23). The tentacle is about as long as the prostomium and carries a rounded lamella on either side near its base. Lateral tentacles are rather smaller than the median. The palps are very long and slender, reaching as far as the fourteenth parapodium, and between their bases is a pair of buccal lamellae. The tentacular cirri, of which the dorsal is the larger, are carried on the first parapodia, which also have tufts of capillary setae.

Figure 23. *Sthenelais simplex* Ehlers. × 7.5.

The two lobes of the parapodium are quite distinct from one another, the neuropodium being the larger. Both lobes have numbers of papillae attached to their distal ends, these varying somewhat in size and transparency. The setae are of three kinds, capillary with smooth walls, capillary with a row of fine teeth on either side, and a stouter variety with a distinct camerated condition at the outer end.

The elytra do not cover the dorsal surface but leave the median line bare. They are smooth but very irregular in outline.

Description taken from Ehlers (1887), whose specimens were collected at 28° 42′ N., 88° 40′ W. in 321 fathoms. Treadwell recorded it (1901) from Porto Rico at Station 6066. It was taken by the Johnson-Smithsonian expedition at Stations 23, 21, and 94.

### PSAMMOLYCE Kinberg

### Psammolyce rigida Grube (?)

*Psammolyce rigida* Grube (1878) 55.

Treadwell (1901: 188) identified a fragment of a *Psammolyce* collected by the Fish Hawk at Station 6022 as *P. rigida* Grube. Grube stated that in all respects except the eyes his material from the Philippines agreed with the original description of the species from the Red Sea. Since it seemed odd that a species should have such a wide distribution, I have through the courtesy of Dr. W. L. Schmitt of the United States National Museum made a reexamination of the Porto Rico specimen. This does not definitely disagree with Grube's description, but the latter is too brief for accurate comparison. The prostomium has a swollen base and the single tentacle is long and slender. There are two pairs of large eyes located near the base of the prostomium, the posterior ones covered by the anterior margin of the following somite.

Augener (1906: 109–113. *pl. 2, fig. 24–30*) described *P. floccifera* from Barbados, and McIntosh (1885: 146–148. *pl. 22, fig. 5; pl. 23, fig. 2, 3; pl. 27, fig. 6; pl. 13a, fig. 14, 15*) *P. occidentalis* from "Sombrero Island" West Indies. *P. floccifera* has four small crescent-shaped eyes and *P. occidentalis* has none, while both have bifid terminal joints to their ventral compound setae. In the Porto Rico specimen the terminal joints of these setae are entire. It is evidently not the same as other West Indian species of *Psammolyce*, but its identification remains uncertain. If more material could be obtained the matter could easily be determined.

### **EULEPETHUS** Chamberlin

#### **Eulepethus splendidus** (Treadwell)

Figure 24

*Eulepis splendida* Treadwell (1901) 189–190. *fig. 19–22b.*

The prostomium (figure 24) is rounded and no eyes are visible. The unpaired tentacle is smaller than the paired, the latter arising from the lateral borders of the prostomium. All tentacles are conic in outline, their distal two-thirds brown, but the extreme tips are white. The palps are about one and a half times as long as the prostomium and white.

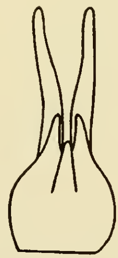

Figure 24. *Eulepethus splendidus* (Treadwell). × 17.

The first parapodium has two relatively large cirri and two tufts of delicate setae, these latter long and thread-like, some showing delicate serrations along one border. In later parapodia there is a definite distinction between notopodia and neuropodia, the latter being much the larger. In these the dorsal cirrus on cirrus-bearing somites is heavy, the ventral one quite small. The notopodial setae are of two kinds, one stout, brown, curved at the apex, with pointed recurved ends. The others are fine and thread-like, some with serrations on one border. The neuropodial setae are similar in form to the larger of the notopodial, but are smaller. The elytra are carried on somites 2, 4, 5, 7....21, 24. The last elytron, that covering somite 24, is much the largest of any, extending so as to cover the greater part of somite 31. All elytra are white, and under the microscope show a fine granular texture.

The body of the single entire specimen is 37 mm. long and contains 37 somites. One anal cirrus remains.

Collected by the Fish Hawk at Stations 6062, and 6065 (Treadwell 1901).

**Eulepethus fimbriatus** (Treadwell)

FIGURE 25

*Eulepis fimbriata* Treadwell (1901) 190–191, *fig. 23, 24*.

The prostomium is nearly round in outline, shaped very like a sphere supported on a broad stalk (FIGURE 25). No definite eyes are visible, but there are two pigmented spots near the base on either side and one anteriorly in the mid-dorsal line which might be interpreted as eyes. The median tentacle rises from under the anterior margin of the prostomium and is distinctly globular at the apex. The lateral tentacles are conic in outline and lie close together under the median.

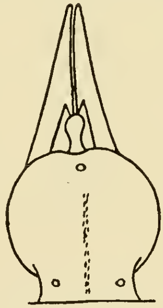

Figure 25. *Eulepethus fimbriatus* (Treadwell). × 18.

The palps are also elongated-conic in outline and are only a trifle longer than the prostomium. On the dorsal median region of the prostomium is a line representing the point of attachment of a process from the base of the first elytrophores which meet in the mid-line.

The parapodia and setae are quite similar to those of *E. splendidus*, but the setae of the dorsal ramus are not quite so numerous as in that species. As in *E. splendidus*, the last elytron is much the largest of any; it is located on somite 24 and covers nearly the entire body posterior to this. The elytra are similar in color and texture to those of *E.*

*splendidus*, but have leaf-like processes along one border. The body is 24 mm. long and has thirty-seven somites.

Collected by the Fish Hawk at Station 6061 (Treadwell 1901).

### EUPHOLOE McIntosh

#### **Eupholoe grubei** (Treadwell)

FIGURE 26a, b

*Sthenelais grubei* Treadwell (1901) 187, 188. *fig. 10–13.*

The prostomium is rounded, and carries two pairs of eyes, the anterior pair being situated so far forward as scarcely to be visible from the dorsal surface (FIGURE 26a). The single slender tentacle arises from a rather large cirrophore, which carries a broad lamella on either side. The palps extend as far as the ninth somite. The parapodium (FIGURE 26b) is biramous, the lobes being nearly of equal size.

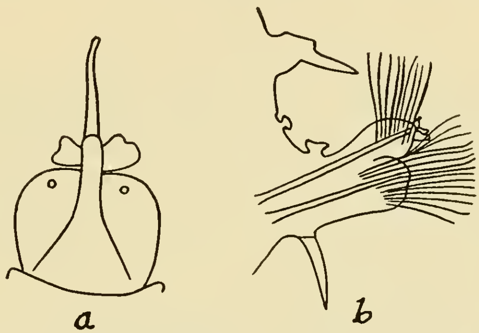


Figure 26. *Eupholoe grubei* (Treadwell). a. Head. × 21. b. Parapodium.

On somites carrying elytra there is a small cirrus ventral to the elytra; on others the dorsal cirrus is broad. The setae of the notopodium are arranged in a row and are long, capillary, with serrations along both margins. The neuropodial setae are of two kinds: compound, having smooth terminal joints, and simple, carrying two rows of toothed plates.

The elytra are white and semitransparent, the first pair kidney-shaped, the others approximately oval, having the posterior border fringed with a few delicate papillae. As far back as somite 27 they do not completely cover the dorsal body-surface.

The specimens from Porto Rico were more or less broken, but one piece containing 28 somites was 14 mm. long. Collected at Stations 6057, 6059, 6061, 6062, 6063, 6073, Boqueron Bay, and San Antonio Bridge, San Juan (Treadwell 1901).

**Eupholoe acuminata** Treadwell

Figure 27

*Eupholoe acuminata* Treadwell (1934) 3, 4. *pl. 1, fig. 7, 8.*

A single incomplete specimen was in the Johnson-Smithsonian collection. The prostomium is small and carries a single median tentacle (FIGURE 27). As seen from a dorsal view the first parapodia are conic, and they with their cirri, lying on either side of the tentacle, give a pointed effect to the anterior end of the body. The anterior

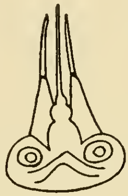

Figure 27. *Eupholoe acuminata* Treadwell. × 15.

elytra overlap so as to cover entirely the dorsal body-surface and are covered with sand-grains. In the middle of the body the mid-dorsal region is uncovered by elytra, but farther back they completely cover it. The body-surface and the elytra carry many sand-grains. Beginning at somite 25 and extending posteriorly each somite has three transversely arranged minute sand-piles which from somite to somite make up longitudinal rows.

The most characteristic features of this species are the pointed anterior end and the covering of sand-grains.

Collected at Station 100 by the Johnson-Smithsonian expedition (Treadwell 1884).

**Eupholoe cirrata** Treadwell

Figure 28

*Eupholoe cirrata* Treadwell (1934) 5, 6. *pl. 1, fig. 9–12; pl. 2, fig. 13–16.*

Described from an incomplete specimen containing only the anterior 60 somites. The prostomium (FIGURE 28) is oval, and carries only a single slender tentacle inserted somewhat back from the anterior prostomial border in the median line. The first parapodia extend forward by the sides of the prostomium, and together with the bases of the palps and a buccal membrane bound a space lying between them and the prostomium. The second parapodium is thick and heavy and bends around outside the first. On the dorsal surfaces of both parapodia are numerous finger-shaped cirri. The second parapodium carries an elytron which is circular in outline and small. Later parapodia carry either elytra or cirri, the latter fleshy lobes looking much like the cirrophore without any style. A relatively heavy finger-shaped gill hangs ventrally from the end of the notopodium.

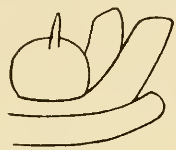

Figure 28. *Eupholoe cirrata* Treadwell. × 7.5.

Some compound as well as simple setae have camerated regions toward their outer ends, so that the middle of the seta looks as if it were divided into rectangular cavities.

Collected at Station 14 by the Johnson-Smithsonian expedition (Treadwell 1934).

## Family **PALMYRIDAE**

The most characteristic feature of this family is the structure of some of the notopodial setae, which are in the form of "paleae," broad, flattened for the greater portion of their length, and supported on slender stalks. They are arranged on either side of the body so as to cover the dorsal surface more or less completely and they extend over and beyond the head region in such a fashion as to make a study of the prostomium with its appendages difficult. The family is closely related to the Chrysopetalidae, but differs in that in the latter all notopodial setae are paleae and they occur on all somites, while in the former simple setae are also present in the notopodium and somites are alternately with and without paleae.

### **PALMYRA** Savigny

#### **Palmyra goodei** (Webster)

Figure 29

*Bhawania goodei* Webster (1884) 308–309. *pl. 7, fig. 10–15.*—Treadwell (1901) 195.

This species is included under *Palmyra* rather than *Bhawania* because the latter genus is a member of the Chrysopetalidae and the simple notopodial setae described by Webster puts his material in the family Palmyridae. Webster, using alcoholic material, was unable to free the head region from the overhanging paleae and gives no details of the prostomium or appendages. The expanded portion of the palea (figure 29) is toothed along the margin and carries on its face two longitudinal raised lines which are so marked as to resemble strings of beads. These paleae diverge from the middle half of the lateral body-region so that the dorsal ones bend over the dorsal surface of the body; the ventral ones bend laterally.

The notopodium is separated by a considerable interval from the neuropodium and has the form of a truncated cone, carrying a small cirrus in the center of the truncated surface. The neuropodium is described by Webster as a little longer than the notopodium, its terminal portion slender and conic. Treadwell found that the terminal portion is expanded at the base, and then narrows rapidly to the end.

Figure 29 Palea of *Palmyra goodei* (Webster).

In the notopodium are 10–15 thin flattened simple setae, which according to Webster's figure have broad bases. Treadwell found that they had constricting bases and showed some resemblances to the paleae in surface markings. In the neuropodium are two forms of compound setae, the one slender, with a long terminal joint, the other stouter than the first and the terminal joint very short, hardly longer than the transverse diameter of the basal joint at its end, its outer margin curved and having no subterminal teeth. Description mainly from Webster. The length of the largest specimen was 50 mm. its width 3 mm.

Webster's specimen was collected in Bermuda and it has since been collected there by Treadwell (1936: 54). The record from Porto Rico is of a number of fragments lacking both head and tail, from Arroyo (Treadwell 1901).

## Family NEPHTHYDIDAE

Characterized especially by the rectangular cross-section of the body, the slightly curved dorsal and the flat ventral surfaces being wider than the vertical lateral ones. The neuropodium and the notopodium are situated at the upper and lower angles of the sides of the body and each is provided with a stiff bunch of setae and usually with lobes. On the ventral surface of the notopodium is attached a cylindric, more or less curved gill, which hangs down into the space between the two parts of the parapodium and does not project beyond the setal lobes. The prostomium is broader at the anterior than at the posterior end and is more or less rhomboidal in outline. On its anterior margin are two dorsal and two ventral tentacles, situated toward the lateral margins and never very large. Two small eyes have been described in some species, while none have been found in others. This may have been due to the fact that only preserved material was studied, and eyes are often obscured by preserving fluids. There are no tentacular cirri. The anal cirri have been described as one or two; probably two is the correct number. The setae are generally simple, compound ones being very rare.

The family is unusual in that it is generally recognized that only one genus is represented in it. This is *Nephthys*, which has the general characters of the family.

**NEPHTHYS** Cuvier

**Nephthys squamosa** Ehlers

FIGURE 30

*Nephthys squamosa* Ehlers (1887) 128–131. *pl. 37, fig. 7–10.*

The prostomium (FIGURE 30) is longer than broad and its posterior margin is drawn out into a point whose apex reaches somite 2. The dorsal tentacles are small and are situated at the antero-lateral angles of the prostomium, the ventral ones much larger and attached nearer the middle of the lower prostomial surface. The palps are short and inconspicuous. No pharyngeal structures have been described.

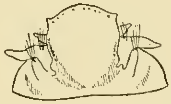

Figure 30. *Nephthys squamosa* Ehlers. × 8.

The parapodia have the form characteristic of the family, the halves being widely separated. Attached to the notopodium is a rounded, and to the neuropodium a more lanceolate lobe, three much smaller lobes being attached to the terminal portion of each setal lobe. A cylindric, gently tapered gill, coiled so that its ends are in contact, is carried on the ventral face of the notopodium near its apex. The setae are of two kinds. The first are very long and relatively stout, and very finely toothed along the convex margin. The others are smaller and carry a series of notches along one face, giving them in profile the appearance of being notched with teeth like those in a cog-wheel.

Ehlers' specimens were taken off American Shoal; off the Sambos; off French Reef and off Alligator reef in depths from 50–118 fathoms

(1887). The Fish Hawk collected them in Porto Rico at Stations 6084, 6085, 6091, 6092, and 6093 (Treadwell 1901).

### Family PHYLLODOCIDAE

A large family, whose members are recognizable in all but one aberrant genus by the possession of leaf-like dorsal and ventral cirri, those on the dorsal surface being generally the larger. They often overlap along the sides and cover more or less of the dorsal surface. They are not easily confounded with preceding families in which dorsal cirri have been modified into overlapping scales, because the leaf-like dorsal cirri are always much softer than are the elytra, do not pack down over one another nearly so closely as do these, and occur on every somite. In most genera the body is very long and composed of a large number of somites. Glands in its body-wall secrete large quantities of mucous, which will cover the animal completely if left in a small quantity of water in a collecting dish.

The prostomium is usually rounded, and carries two pairs of more or less foliaceous tentacles near its anterior end. Two of these are dorsal and two more ventrally located, the latter often not easily visible from the dorsal surface. In some genera a fifth tentacle arises on the dorsal prostomial surface a little back of the middle. There are two or four eyes, which may be very large. There are no palps.

Except in one genus there are from one to five pairs of tentacular cirri situated on somites 1 to 3, their arrangement on these somites being a matter of taxonomic importance. Parapodia may be uniramous or biramous, depending on the genus. In the majority of cases only compound setae are present, but sometimes simple ones occur as well. There are two anal cirri, subulate or foliaceous in form.

As a rule the phyllodocids are littoral, living at or near the tidal zone and down to 8–12 fathoms, but some have been taken in deeper water. They occur in rock crevices and are easily collected, though because of the slime they secrete it is not well to keep them in dishes with other annelids. They are active and if stimulated will free themselves from the slime by the simple process of crawling out of it. A few genera are normally pelagic, one of which, *Lopadorhynchus*, is described below. Two species of this genus were in the Arcturus collections (Treadwell 1928: 467, 468), and the same two species were collected in Bermuda in 1931 (Treadwell 1936: 60). They swim at night and may be caught in the plankton under electric lights. *L. uncinatus* was taken by the Johnson-Smithsonian expedition and is described below; the other common species, *L. nans* Chamberlin, differs from *L. uncinatus* most noticeably in that there are 3 instead of 2 anterior parapodia enlarged and provided with heavy hooked setae.

KEY TO GENERA RECORDED FROM PORTO RICO

A. Tentacular cirri 2 pairs. Both simple and compound setae present. Prostomium fused with first somite. Anterior somites enlarged and provided with strong setae. Pelagic. . . . . . . . . . . . . . . . . . . . *Lopadorhynchus.*

AA. Tentacular cirri 4 pairs.

B. Median tentacle present . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Eulalia.*

BB. Median tentacle none . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Phyllodoce.*

## PHYLLODOCE Savigny

### Phyllodoce oculata Ehlers

FIGURE 31

*Phyllodoce oculata* Ehlers (1887) 135–140. *pl. 40, fig. 4–6.*

The body is long and noticeably tapered toward the posterior end. Dorsally it is brown, each somite having a transverse narrow darker band near its posterior margin. The dorsal cirri cover a large part of the dorsal surface and are white, in marked contrast to the body-tint. The prostomial width is about twice its length, its posterior margin being indented so that the lateral posterior corners have a slightly

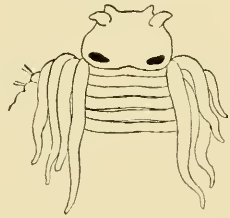

Figure 31. *Phyllodoce oculata* Ehlers. × 18. After Ehlers.

lobed effect. The anterior prostomial margin carries the four small tentacles, and two large oval, brown eyes lie near the postero-lateral margins (FIGURE 31). The protruded pharynx has on either side several rows of papillae.

There are four tentacular cirri on either side, of which three are located on the first somite, the fourth on the second somite. The longest extends as far as somite 14, the others are much shorter. The parapodia are short and obtuse, each having a bifid anterior and a rounded posterior lip. The ventral cirrus is heavy and is as long as the setal portion, the dorsal cirrus has the usual leaf-like outline and is wider than the vertical diameter of the parapodium. The notopodium is absent. There are two long filiform anal cirri.

The setae are compound, the basal joint widened at the apex, where it carries a number of stout spines. The terminal joint is long and slender, toothed along one margin.

Description and figures from Ehlers (1887). His specimens were taken at 24° 43′ N., 83° 25′ W.; and at 24° 15′ N., 82° 13′ W. The Fish Hawk collected it at Station 6065 (Treadwell 1901).

It was also collected by the Barbados-Antigua expedition (Treadwell 1924: 9), and at 17° 39′ N., 63° 17′ W. by the Arcturus expedition (Treadwell 1928: 466, 467).

### **Phyllodoce papillosa** Ehlers

FIGURE 32

*Phyllodoce papillosa* Ehlers (1887) 140–142. *pl. 40, fig. 7, 8, 9.*—Hoagland (1919) 573.

The body is long and narrowed toward the posterior end. The prostomium has a breadth nearly twice its length and has 2 very prominent eyes (FIGURE 32). Of the anterior tentacles the dorsal pair are much the smaller and the tentacular cirri are proportionately large and heavy. The parapodium has a single seta-tuft and a broad

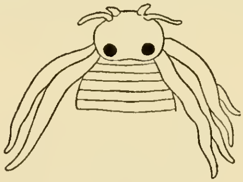

Figure 32. *Phyllodoce papillosa* Ehlers. × 11.

lanceolate ventral cirrus. The dorsal cirrus is situated on the body-wall at a noticeable distance from the parapodium and is broadly ovate in outline but abruptly terminates in an acute tip. The setae are compound, the end of the basal joint carrying a number of sharp spines. The terminal joint is long and flattened, and has smooth margins.

Identified by Hoagland in collections made at Guanica Harbor by R. W. Miner, in 1915.

### **Phyllodoce magna-oculata** Treadwell

FIGURE 33

*Phyllodoce magna-oculata* Treadwell (1901) 191. *fig. 25, 26.*

The prostomium is broadly rounded, the breadth being nearly twice the length, and carries 2 very large eyes (FIGURE 33). The anterior tentacles are longer than the prostomium and are lanceolate in outline, all four being approximately of the same size. There are four pairs of tentacular cirri, of which the largest is 3.5 times as long as the anterior tentacle; the others are much smaller and are about equal in size.

The dorsal cirri were nearly all lost from the single specimen available for study, but the few which remained were reniform in outline, the point of attachment being near the hilus. At the point of attachment they were light-brown, and small brown pigment-granules were scattered over their surfaces. They showed numerous anastomosing blood-vessels.

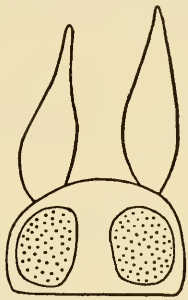

Figure 33. *Phyllodoce magna-oculata* Treadwell. × 7.

The parapodium is uniramous and slightly bifid at the end. Treadwell's original description did not differentiate between the two lips. The setae are very much like those of *P. oculata* (see above), the apex of the basal joint being enlarged and marked by longitudinal lines. The terminal joint at its base is as wide as the basal but it narrows to a sharp point.

Collected by the Fish Hawk at Station 6067 (Treadwell 1901).

### EULALIA (Savigny) Malmgren

#### Eulalia quinquelineata Treadwell

FIGURE 34

*Eulalia quinquelineata* Treadwell (1901) 192. *fig. 27–29.*

The prostomium is oval, broadest just in front of the eyes, and is constricted at the base of the anterior tentacles. The anterior tentacles are stout and sharp-pointed, about three-fourths as long as the prostomium, the median unpaired one arising about half way from the eyes to the anterior prostomial margin, slender, and extending beyond the ends of the anterior ones (FIGURE 34). There are four pairs of tentacular cirri, one on somite 1, two (dorsal and ventral) on somite 2, one on somite 3, which also carries a thick, flat, ventral cirrus similar in form to the ventral cirri of later somites. The dorsal cirrus of somite 2 and that of somite 3 are about equal in size and larger than the others.

The body is 450 mm. long, and, not counting the parapodia, 2 mm. wide at the anterior end. This width is maintained until near the posterior end, where it narrows. Because of the great amount of coiling it was not found possible to determine the exact number of somites in the body, but an estimate was made that at least 1300 are present.

The parapodium is uniramous, the anterior lip bifid, the posterior one rounded. The dorsal cirri are large and ovate in outline and in

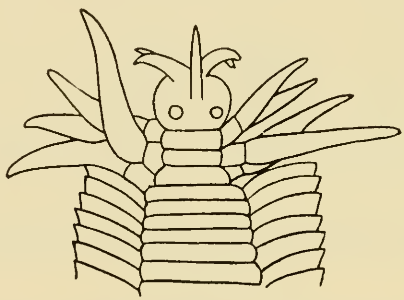

Figure 34. *Eulalia quinquelineata* Treadwell. × 10.

the entire animal they overlap the somites in front rather than behind. This position was probably a result of the action of the preserving fluids causing a distortion, but because of the softness of these dorsal cirri it might easily happen during life. The ventral cirri are in general ovate in outline and extend beyond the setal lobe. The setae are all compound, their terminal joints long, gently tapered to an acute point and toothed along one slightly concave margin.

The body-color is yellowish-brown with a faint greenish tinge. On the dorsal surface are 5 longitudinal black bands one median, two admedian and two lateral, the last just at the base of the parapodium. They begin on the posterior edge of the fourth somite as small spots which are repeated on the fifth and sixth and become continuous lines on the seventh. On the ventral surface are three bands, a median and two lateral, similar to those of the dorsal surface, but there are no admedian.

Collected at Hucares, in Porto Rico (Treadwell 1901). It appeared in the collections of the Barbados-Antigua expedition (Treadwell 1924: 9).

### LOPADORHYNCHUS Grube

#### Lopadorhynchus uncinatus Fauvel

Figure 35

*Lopadorhynchus uncinatus* Fauvel (1916) 57–61. *pl. 1, fig. 2, 3; pl. 4, fig. 4–14.*

A pelagic species of small size, the body varying in length from 9 to 20 mm. There may be from 25 to 32 somites. The most striking peculiarity of the genus is the tremendous development of certain anterior setigerous somites, which carry enlarged parapodia and heavy spines and are separated from the later somites by a deep fissure. The anterior border of the prostomium (figure 35) is flattened and somewhat rounded, and slopes downward to the ventrally

Figure 35. *Lopadorhynchus uncinatus* Fauvel × 2.5.

located mouth. The dorsal anterior tentacles are conic and sharp-pointed and are longer than the transverse prostomial border. They usually are carried bent toward the ventral surface. The ventral pair of the anterior tentacles are considerably smaller than the dorsal and lie one on either side of the mouth. The first two pairs of tentacular cirri are approximately equal in size and are two or three times as long as the dorsal anterior tentacles. If bent backward, they would reach the border of the sixth setigerous somite. The third pair of tentacular cirri are very small and are attached on the ventral surface at the base of the second pair. On either side of the prostomium is a large eye located at the base of the first tentacular cirrus. The eyes have whitish opaque centers and are surrounded by brown pigment. Specimens which have lain in formalin may become completely depigmented.

The first two parapodia are very heavy, the second a little larger than the first, and are round or oval on cross-section. The dorsal cirrus (figure 35) is small and foliaceous, lanceolate in outline. The second is a trifle smaller than the first. Both are inserted toward the ends of the parapodia. The ends of the parapodia are rounded and have a thin membrane which extends up over the bases of the setae. In each parapodium are six or seven heavy setae having slender stalks but widening toward the ends; beyond this widening they assume the form of an elongate S, terminating in a sharp point. The third and following somites are very different from the first two, and except that the third is a trifle smaller than the fourth they are alike in structure. Each has a sharp-pointed setal lobe into which the acicula extends, and a broad rounded lobe anterior to this. The dorsal and ventral cirri are heavy and blunt-pointed, the former the larger of the two. In the third setigerous somite are a few ventrally placed simple setae, but most of the setae in this somite and all of them in other somites are compound, the terminal joint being in the form of a broad elongate oval blade or paddle carrying a few denticulations along one margin. These are characteristic swimming setae and their structure is correlated with the pelagic mode of life of the animal.

Diagnosis from Fauvel. Collected by the Johnson-Smithsonian expedition at Station 62.

## Family **ALCIOPIDAE**

The members of this family are all pelagic and generally are of small size. The eyes are very large and the body is usually unpigmented but may have brown or violet tints. There are 4 paired tentacles and 1 unpaired one.

### **ALCIOPA** Audouin & Milne-Edwards

#### **Alciopa mutilata** Treadwell

FIGURE 36

*Alciopa mutilata* Treadwell (1934) 8. *pl. 2, fig. 20, 21.*

All members of this genus have very large eyes, which make up the greater part of the prostomium. In *A. mutilata* the eyes are in contact dorsally but separated ventrally (FIGURE 36). There are a single

Figure 36. *Alciopa mutilata* Treadwell. × 10.

median and two pairs of frontal tentacles, the median being very much smaller than the others. The parapodia have only the neuropodial lobes, the notopodial having been lost, but the dorsal cirri persist as rather large lobes. Only fragments of this species have as yet been found.

Collected by the Johnson-Smithsonian expedition at Station 6 (Treadwell 1934).

## Family SYLLIDAE

Generally of small size and more or less transparent. As a rule, cirri and tentacles are relatively long and often are strongly articulated. The palps are generally prominent and may be separate or more or less fused with one another. The pharynx is composed of an anterior muscular and a posterior chitinous portion, and at its anterior end there may or may not be a tooth; the presence or absence of this tooth is a detail of importance in taxonomy. A row of soft papillae surrounds the anterior end of the pharynx. Most syllids are small enough to be mounted on a slide in glycerine in which they become sufficiently transparent to allow details of pharynx-structure to be seen. Classification into genera is based on the presence or absence of ventral cirri, whether the palps are separate or more or less fused with one another along the mid-line, and the presence or absence of a median pharyngeal tooth. Syllids live in association with sponges and ascidians, or attached to the under sides of stones and among seaweed. If sponges are allowed to stand in stagnant water, considerable numbers of syllids will be certain to crawl out (see page 212). The Syllidae of Bermuda have been described by Verrill who gives a key to genera and species (1900: 632). Bermudian species may occur in Porto Rico, so that this key would be useful there.

### Key to Genera recorded from Porto Rico

A. Antennae and cirri articulated.
- B. Median tooth in pharynx none . . . . . . . . . . *Xenosyllis.*
- BB. Median tooth in pharynx present . . . . . . . . . . *Syllis.*
  - C. Setae all compound and similar but differing in relative length of blades . . . . . . . . . . *Syllis* (*Typosyllis*).

### XENOSYLLIS Marion & Bobretsky

#### Xenosyllis complanata (Treadwell)

Figure 37

*Syllis complanata* Treadwell (1901) 183. *fig. 1.*

Described by Treadwell as *Syllis*, but since it is stated to lack the pharyngeal tooth it should be listed as *Xenosyllis*. The body is much flattened and has dark-brown spots around the posterior margin of the prostomium, across the posterior portion of each somite, and around the annuli of the tentacles and cirri. The median tentacle is longer than either lateral (figure 37). An incomplete specimen 44 mm. long. Collected at Ponce (Treadwell 1901).

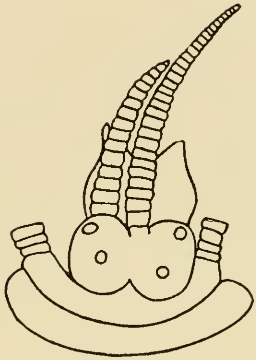

Figure 37. *Xenosyllis complanata* (Treadwell). × 36.

**SYLLIS** Savigny

**Syllis prolifera** (Krohn) (McIntosh)

FIGURE 38

*Pionosyllis prolifera* McIntosh (1908) 161–164. *pl. 46, fig. 1; pl. 59, fig. 10; pl. 70, fig. 4–6; pl. 79, fig. 14–14c, 15, 16.*

Identification by Hoagland. The articulated cirri would separate it from *Pionosyllis*. The prostomium is hexagonal in outline, with four distinct reddish eyes (FIGURE 38, from McIntosh). The palps are

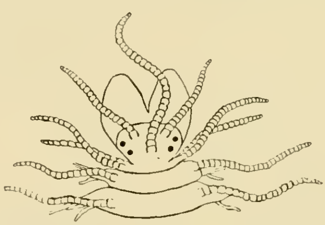

Figure 38. *Syllis prolifera* (McIntosh). After McIntosh.

large and long, the median tentacle has twenty-five to thirty joints the lateral ones sixteen to eighteen. Tentacular cirri are long and moniliform. Body three-quarters of an inch in length, banded with brown. On either side of the somitic constrictions is a lateral brown bar with a spot in front and a shorter bar in the mid-line of the body. There are two moniliform anal cirri. The dorsal cirrus has 27–28 articulations. The terminal joint of the seta is long, with a nearly straight spinous edge and a minutely bidentate tip. Description from McIntosh.

Recorded by Hoagland (1919) as collected at Montalva Bay by R. W. Miner.

### Syllis gracilis Grube

FIGURE 39a, b

*Syllis gracilis* Grube (1840) 77.—McIntosh (1908) 203–206. *pl. 51, fig. 3; pl. 70, fig. 25, 25a;* (1910) *pl. 80, fig. 17–17c.*

The prostomial length is greater than its breadth and there are four small black eyes. The median tentacle has 18 articulations, the lateral ones 12, the tentacular cirri 18. The anal cirri are of moderate length and have 13 articulations. The ventral cirri are long and lanceolate. Setae of the anterior parapodia have basal joints with

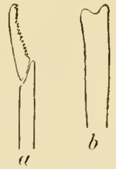


Figure 39. *Syllis gracilis* Grube. a, and b. Types of setae.

dilated ends, the terminal joints carry apical and subapical teeth and a row of slender spines (FIGURE 39a). Toward the ventral end of the setal row these terminal joints progressively diminish in length. In the posterior somites are strong bristles, looking like dilated basal joints of the other kind which have lost their terminal portions (FIGURE 39b). Description from McIntosh. Recorded by Hoagland (1919) as collected in Guanica Harbor by R. W. Miner.

### Syllis spongiphila Verrill

FIGURE 40

*Syllis spongiphila* Verrill (1885a) *pl. 42, fig. 183;* (1885b) 435, 436.

A large species, the somites separated by well marked constrictions. The prostomium (FIGURE 40) has a rounded anterior margin, its length being about half its breadth. There are four eyes, the anterior pair much the larger and situated near the lateral margin of the prostomium, the posterior pair located just posterior to the lateral tentacles. The palps are separate to their bases and are longer than the prostomium, projecting forward as obtuse rounded lobes. The unpaired tentacle is about eight times as long as the prostomium, is regularly beaded into about thirty joints and narrows from base to apex. The lateral tentacles are shaped like the unpaired, but are only about two-thirds as long and have about twenty joints. The tentacular cirri resemble the unpaired in form and size. On the body the dorsal cirri of the first somites are also similar in form to the unpaired but are about twice as large. In later somites there is more or less irregularity in the form of the dorsal cirri, which show something of a tendency to an alternation of long and short in successive somites but in this respect there is not the regularity of alternation which appears in some other species. The ventral cirri are short, in length scarcely exceeding the setigerous lobe of the parapodium. The setae are numerous, all compound, the terminal joint triangular in outline and minutely bidentate at the apex. The pharynx is large and extends

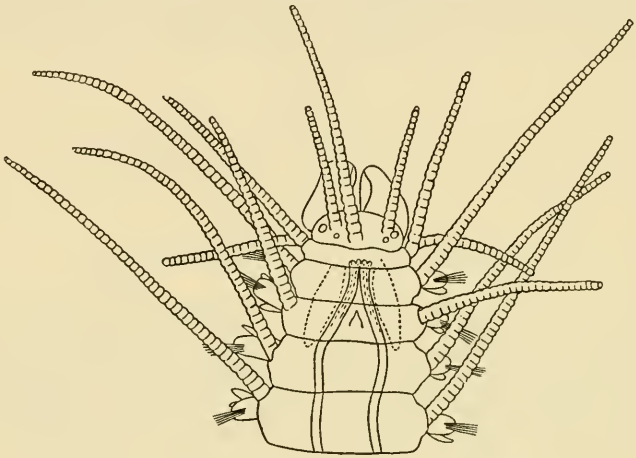

Figure 40. *Syllis spongiphila* Verrill. After Verrill.

through about seven somites. Near its anterior end is a single stout tooth. The color is yellowish-white and the length about 25 mm.

Verrill states that this species is common from Martha's Vineyard to Cape Hatteras and is often very abundant among hydroids and sponges in 65 to 125 fathoms. Collected by the Fish Hawk at Boqueron Bay, Station 6065, Arroyo, Puerto Real, and on corals at Mayaguez (Treadwell 1901: 183).

Description from Verrill (1885b), figure from Verrill (1885a).

### Syllis (Typosyllis) corallicola (Verrill)

*Typosyllis corallicola* Verrill (1900) 603.

Described by Verrill from Bermuda. No figures were given. It is a large species having long and strongly beaded cirri and tentacles. The prostomium is about one-third broader than long and its frontal margin is slightly three-lobed. The eyes are conspicuous but not very large, the anterior ones the larger and situated farther apart while those of the same side are close together. The palps are large and separate to the bases. The median tentacle is about five times as long as the prostomium, the lateral ones being one-third shorter than this. Tentacular cirri and dorsal anterior cirri are similar to tentacles in form. The setae are slender and the notopodial ones have narrow lanceolate blades with minutely bidentate tips. Neuropodial ones have much wider blades. The oesophagus is as long as the first ten to twelve somites, is dark-brown, the median tooth dark and a little back from the margin. The stomach occupies fourteen to seventeen somites.

Collected by the Johnson-Smithsonian expedition at Station 80.

## Family **HESIONIDAE**

Usually rather small animals, the somite-number ranging from twenty to forty. There may be three, two, or no tentacles on the anterior margin of the prostomium and these when present may be very small and hard to find. There are two pairs of eyes and biarticulate palps. One genus, *Talpa*, has been described as without tentacular cirri, but these are present in most genera. The notopodia usually are reduced and carry simple setae. The neuropodium is always present and usually its setae are compound. The dorsal and ventral cirri are long and there are two anal cirri. The animals occur at moderate depths, attached to stones or seaweed, but are capable of free swimming. Most are dark-colored but some (*Psammate*) are more brilliant.

### Key to Genera recorded from Porto Rico

A. Pairs of tentacular cirri 6.
  B. Parapodium uniramous . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Irma.*
  BB. Parapodium biramous . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Podarke.*
AA. Pairs of tentacular cirri 8. Tentacles widely separated. Blade of compound seta has a subdental process . . . . . . . . . . . . . . . . . . . . . . . . . . *Hesione.*

### **IRMA** Grube

#### **Irma mutilata** (Treadwell)

Figure 41

*Castalia mutilata* Treadwell (1901) 185. *fig. 4.*

Originally identified as *Castalia*, it should be classed with *Irma* on account of the uniramous character of the parapodium. Moreover Chamberlin (1919: 185) has shown that *Castalia* should be replaced by *Psammate.* The prostomium (figure 41) is much broader than long, and on its anterior border has a median tongue marked off by very indistinct lines. A very minute tentacle lies on either side of the midline. The palps are two-jointed, and there are four eyes of which the anterior pair are the larger. There are fifty-three somites in the body, which is broadest at the anterior end and 17 mm. long. The parapodium is uniramous; it has a long conic anterior lip and a more rounded posterior one. There are two bundles of compound setae, the terminal joint of the ventrally placed ones being shorter than those of

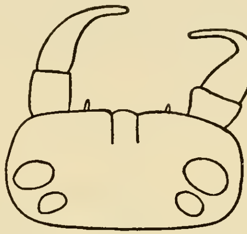

Figure 41. *Irma mutilata* (Treadwell). × 26.

the dorsalmost ones. The ventral cirrus is slender, located about one quarter of the length of the parapodium from its apex and reaches as far as the end of the posterior lip. The much stouter dorsal cirrus is located nearer the body. All terminal joints of dorsal and anal cirri had been lost.

Collected at San Antonio Bridge, Porto Rico (Treadwell 1901).

### PODARKE Ehlers

#### Podarke agilis Ehlers

Figure 42

*Podarke agilis* Ehlers (1864) 197–199. *pl. 8, fig. 9–11.*

According to Ehlers' description the body is short and is marked with reddish-gray transverse lines. The prostomium (figure 42

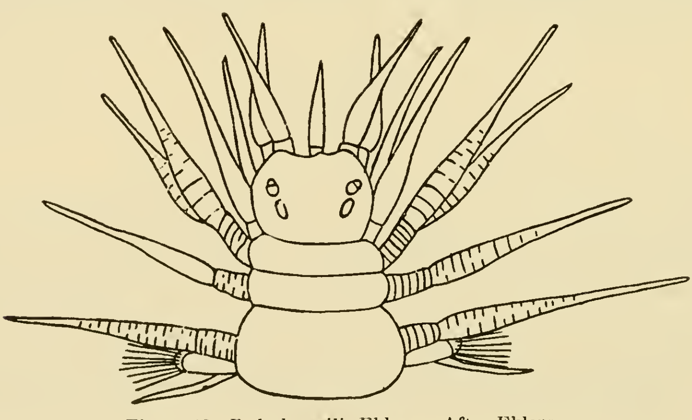

Figure 42. *Podarke agilis* Ehlers. After Ehlers.

from Ehlers) is a little broader than long and has three tentacles of which the median is the smallest. The palps (called lateral antennae by Ehlers) are no longer than the tentacles but are much thicker. There are six pairs of tentacular cirri. Ehlers described the parapodia as uniramous, carrying very long ventral and dorsal cirri. All setae are compound. The specimen was collected at "Quarnero," presumably the gulf of that name on the Adriatic Sea. Treadwell (1901: 185) doubtfully referred to this species one specimen collected at Puerto Real, but because of the mutilated condition of the specimen, especially in the head-region, accurate identification was difficult. In this the number of body-somites was greater and the median tentacle longer than in Ehlers' material. Considering the nature of the habitat of this genus, it would be surprising to find identical species in such widely separated localities.

### **Podarke guanica** Hoagland

FIGURE 43

*Podarke guanica* Hoagland (1919) 571–572. *pl. 29, fig. 1–4.*

The body is about 12 mm. long and 1 mm. wide. The prostomium (FIGURE 43) is broader than long, its angles decidedly rounded. There are two pairs of large eyes, the anterior ones being nearly twice as large as the posterior. The median antenna is very short and has a small terminal joint, the inner lateral ones are entire and more than

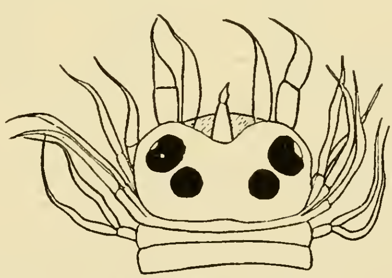

Figure 43. *Podarke guanica* Hoagland. × 60.

twice as long as the median, the outer lateral about as long as the inner but stouter and two-jointed. There are six pairs of tentacular cirri. The ventral lobe of the parapodium has a conic anterior and rounded posterior lip and carries a bundle of long compound setae having smooth, slender terminal joints. The setae nearer the center of the bundle are longer than are those on either the upper or lower side. The dorsal cirrus is long, extending nearly as far as the seta-tips.

Collected on rocks off Guanica Harbor by A. L. Treadwell (Hoagland 1919). Type in American Museum of Natural History, Cat. No. A. M. N. H. 1279.

### HESIONE Savigny

#### Hesione longicirrata (Treadwell)

FIGURE 44

*Castalia longicirrata* Treadwell (1901) 185. *fig. 2, 3.*

As stated above, *Castalia* is not a valid genus. Moreover, Treadwell's original description and figure were not clear concerning the number of tentacular cirri and the form of the protruded pharynx. Through the courtesy of Miss McCain and Dr. Schmitt of the United States National Museum these points were verified on the type specimen and it was found to have eight tentacular cirri and a smooth margin to the pharynx. *Psammate* (the generic name replacing *Castalia*) has six cirri. It is therefore listed here as *Hesione*.

Figure 44. *Hesione longicirrata* (Treadwell). × 14.

The prostomium (FIGURE 44) is roughly shield-shaped and has two diverging processes running from its posterior border to the posterior border of the peristomium. The protruded pharynx carries a distinct process just under the median anterior margin of the prostomium. There are two tentacles, eight tentacular cirri, and four eyes, of which the anterior pair are much the larger. There are nineteen body-somites. The notopodium is much smaller than the neuropodium, this difference becoming more marked toward the posterior end of the body. The setae of the ventral bundle are compound, having a slender terminal joint carrying at the apex a terminal and a subterminal small tooth, and a subdental process extending as far as the subterminal tooth. The dorsal cirri are four times as long as the body-diameter and the ventral cirrus extends to beyond the parapodial apex. Dorsal setae are acicular, minutely serrate near the apices. There are two anal cirri.

In the preserved material the body-color is pale-yellow with a marked iridescence and an indication of transverse markings in most of the somites.

Collected by the Fish Hawk at Station 6079 (Treadwell 1901).

**Hesione proctochona** Schmarda

Figure 45a, b

*Hesione proctochona* Schmarda (1861) 79–80. *pl. 28, fig. 226.*—Treadwell (1901) 184.
*Fallacia proctochona* Webster (1884) 311. *pl. 8, fig. 21.*
*Hesione vittigera* Ehlers (1887) 143–147. *pl. 41, fig. 1–4.*
*Hesione praetexta* Ehlers (1887) 147. *pl. 41, fig. 5, 6.*

The body is composed of sixteen setigerous somites, has eight pairs of tentacular cirri, two very small antennae, four eyes, and two anal cirri. The antennae are very small and easily overlooked and were not seen by Ehlers. In some specimens the margins of the anal funnel are drawn out into a series of conic lobes, but these often do not show in preserved material. The dorsal surface of the body is marked by transverse brown lines in each somite, a broader white line occupying the anterior somite-margin. Ehlers distinguished his species *H. praetexta* from the others by the fact that the brown lines are

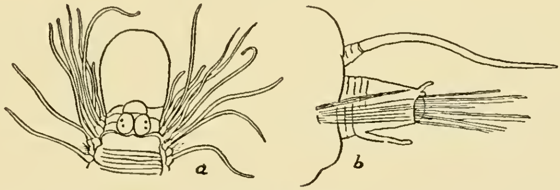


Figure 45. *Hesione proctochona* Schmarda. a. Head. × 2.5. b. Parapodium. After Ehlers.

longitudinal instead of transverse, but since in the Fish Hawk material this character is combined with parapodial features of other species as described by Ehlers, Treadwell concluded that the differences are merely sexual (a suggestion made by Ehlers).

Figure 45a is Ehlers' drawing of the head, on which he did not show tentacles. Figure 45b, also taken from Ehlers, represents a parapodium. The lip-like projections on the dorsal border of the parapodium were not mentioned in Schmarda's original description, but this seems to have been an oversight.

The two lobes on the parapodium may vary in relative size, one of them sometimes being very small. The dorsal cirrus is long. The setae are all compound, having apical and subapical teeth on the terminal joint.

Treadwell's material from Porto Rico contained a large number of individuals from many localities, and a comparison of these showed in single individuals such combination of characters mentioned in the above literature as characterizing distinct species that he decided they all are synonymous, *proctochona* having precedence.

*H. proctochona* was collected by the Fish Hawk at Arroyo, Mayaguez, Hucares, Boqueron Bay, Playa de Ponce reef, Ensenada Honda (Culebra), Stations 6072, 6080, 6092, 6096, and 6098 (Treadwell 1901) and by R. W. Miner, H. Mueller and R. C. Osburn at Guanica Harbor, Paraguera, and Salinas Cove. Schmarda's specimen was taken at Jamaica (1861); Ehlers' came from Key West and from 24° 43′ N. Lat. 83° 25′ W. Long. (1887). Webster's came from Bermuda with no precise locality recorded but he stated (1884) that he had collected them in "large numbers" on the west coast of Florida from Sarasota to Key West. Treadwell (1928: 473), found it in Beebe's Arcturus material from 17° 39′ N. Lat. 63° 17′ W. Long. Hoagland (1919: 571) recorded one from Bermuda.

## Family NEREIDAE

Of the Nereidae a greater number of species have been described than in any other annelid family. This, together with the fact that there is little variation in the external features (number of tentacles etc.), makes the family a puzzling one for the taxonomist who wishes to be certain that he has a new species, and at the same time avoid dangers of synonymy in giving it a name. The general character of the parapodia has been indicated above (see page 154).

Identification difficulties are intensified by the fact that many species become pelagic when discharging their sex-products and at that time undergo profound structural modifications, assuming what is known as the "heteronereis" or "epitokous" stage, in contrast to the vegetative or "atokous" condition. In this phase the eyes are very much enlarged, the appearance of the whole head-region is much altered and noticeable changes appear in the body. In both sexes the body is definitely marked off into two regions, of which the anterior is the shorter, noticeably more so in the male than in the female. In the male, in this anterior region, usually a certain number of the dorsal cirri acquire a longer, cylindric form and are frequently sharply curved and pointed at the end (FIGURE 56). In both sexes, in the posterior body-region, the small lobes which lie at the ends of the setal portion of the parapodium are much enlarged and broadened, and the dorsal cirrus lengthens and is lobed along one border. All setae have the terminal joint becoming very broad and paddle-shaped and faintly toothed along one margin. These changes are obviously correlated with the assumption of the free-swimming habit. This swimming usually takes place at night, and heteronereids will quite certainly appear in any tow taken at that time especially under lights.

The pharynx of *Nereis* may be protruded to a considerable distance from the mouth and is divided by surface marking and a constriction into two regions, a proximal and a distal. At the end it carries a pair of stout jaws, each having a strong terminal tooth and in most species a row of smaller teeth along its concave margin. In addition, the pharynx in most species has a basal and a distal band of small structures known as paragnaths, which generally are sharp-pointed chitinous teeth or small plates but in a few are soft papillae. When fully equipped with paragnaths their arrangement would be that in each of the two pharynx-divisions there are four groups forming a broken band around the pharynx. The number in each group varies from one to a large number and in some cases they are fused to form a plate. Conventionally they are designated as I, lying on the dorsal median surface at the base of the jaws; II, a group on either side of I on the dorso-lateral surface of the pharynx; III, on the median ventral surface; IV, two groups on either side of III; V, lying on the dorso-median line of the proximal section of the pharynx; VI, VII, and VIII, occupying positions corresponding to those of II, III, and VI. The most constant feature of nereids is this paragnath arrangement, since it persists through the epitokous phase when practically every other structure has been modified. In some nereids the paragnaths are entirely absent, in others one or more of the groups is not present, these differences forming the basis for a division of the genus *Nereis* into a number of subgenera, as indicated in Chamberlin's key (1919: 194, 195). Although this subdivision was adopted by some of the older taxonomists, it has not been uniformly followed by their successors, one possible reason being that unless the pharynx is protruded the paragnaths can be studied only after dissection, which is difficult in small species. It is however, the only certain way to identify nereids when in the epitokous condition.

The large *Nereis* of the New England coast, *N. virens* or "clam worm," lives in burrows in the muddy or sandy beach, and West Indian species may be found in similar localities, but the best place to look for them is in the crevices of the dead coral rocks. None of the West Indian species thus far described is as large as *N. virens*.

### NEREIS Cuvier

Since in some cases the original description of species of *Nereis* recorded from Porto Rico either omitted mention of the paragnaths or the description is imperfect, the species are all here grouped under *Nereis*, but where it is possible to carry the classification farther that is indicated under each species.

#### Nereis bairdii Webster

FIGURE 46

*Nereis bairdii* Webster (1884) 312, 313. *pl. 8, fig. 22–28.*

The prostomium (FIGURE 46) is long, the four small eyes located near the postero-lateral border. The tentacles are separated at their bases by a little less than half their diameters. The basal joint of the palp is cylindric and longer than the prostomium, the terminal joint

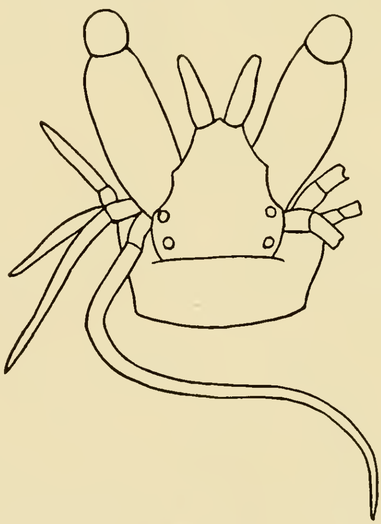

Figure 46. *Nereis bairdii* Webster. After Webster.

nearly spheric. The tentacular cirri are slender, the longest being the dorso-posterior one which extends to somite 8, the others being much shorter. All groups of paragnaths are present on the pharynx and have the following arrangement. I, irregularly V-shaped group; II, an irregular double series; III, two transverse linear series; IV, numerous and irregular; V, sometimes absent, or number sometimes varying from one to three; VI, a small rectangular plate; VII and VIII in two continuous series.

The parapodia are short and stout. Anteriorly all lobes are rounded and short and nearly equal in length. Toward the posterior end the dorsal gill becomes much more prominent and the cirrus is carried nearer the tip of the gill. There are two slender anal cirri as long as the last ten somites.

There are two kinds of setae, both compound, those of the upper bundle and the dorsalmost of the lower one having long slender, smooth terminal joints while the remainder of the ventral bunch are much stouter and their terminal joints are stout, sharp-pointed, about four times as long as they are wide, and carry a row of fine teeth on the concave margin.

The body-length is 35–50 mm. and the width 3–4 mm., the body having 50–80 somites.

Description from Webster (1884). The paragnath arrangement would locate it in *Cirronereis*.

Treadwell (1901) concluded that there are 3 well marked varieties of this species, differing in color and form of parapodia. One has the outer portion of the prostomium and dorsal surface of anterior somites brown, each somite and the prostomium carrying a row of transverse white dots. In the second variety there is a band of brown across the prostomium but without the white spots, and a transverse narrow pigmented band on each somite. In this variety also, the posterior dorsal parapodial lobes are not as enlarged as occurs in the first variety and as described by Webster. He found also, that the margin of the terminal joint of the slender setae is finely toothed.

Collected by the Fish Hawk at Puerto Real, Arroyo, Boqueron Bay, Mayaguez, "Porto Rico," Stations 6065, 6091, 6092, 6062, 6063, and Ensenada Honda (Culebra) (Treadwell 1901). Hoagland (1919) from Guanica Harbor, Guayanilla Bay, and Condado Bay, by R. W. Miner, H. Mueller, and R. C. Osburn.

### **Nereis mirabilis** Kinberg

Figure 47

*Nereis mirabilis* Kinberg (1865) 170.—Ehlers (1887) 117–120. *pl. 37, fig. 1–6.*
*Nereis gracilis* Webster (1884) 313, 314. *pl. 9, fig. 29–35.* Name preoccupied; see Kinberg (1865) 170.

Characterized especially by the form of the prostomium, which is broader than long, and carries large eyes. In Ehlers' figure the prostomium is represented as deeply incised, divided into two lobes; the tentacles are prolongations of its anterior margins and are not jointed at their bases, while the palps are ventral to the prostomium. Webster represents the palps as continued forward from the lateral prostomial regions, and the tentacles attached to a cirrophore which is an extension forward of the prostomial border just median to the palps FIGURE 47. Webster records the dorso-posterior cirrus as reaching to somite 34, while the others are much shorter. The palps have short terminal joints.

Kinberg described this species as lacking paragnaths on the proximal section, and classed it therefore as *Ceratonereis*. Webster did not see any jaw-structures; Ehlers' description agrees with Kinberg.

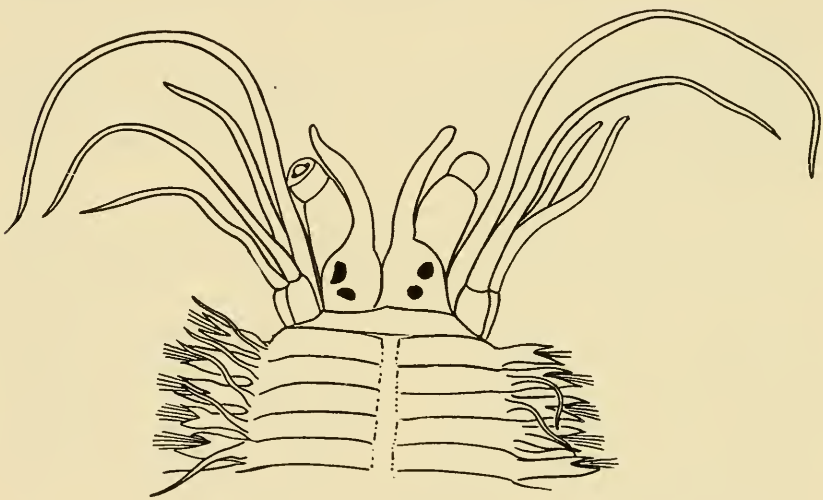

Figure 47. *Nereis mirabilis* Kinberg. After Ehlers.

The parapodia all have slender lobes and long slender dorsal cirri. The anal cirri are similar in all respects to the dorsal ones.

The setae are of two kinds, a slender form whose terminal joint is very long and sharp-pointed, and toothed along the margin; the other stouter, the terminal joint relatively short and blunt, toothed at the apex, and carrying a row of fine teeth along one margin. Webster classifies them into two groups: the homogomph, in which the apex of the basal joint is divided into two branches of equal length, and the heterogomph, in which one of these branches is longer than the other.

Kinberg's type specimen (1865) was taken off the Brazil coast, Ehlers' (1887) at Key West and at 24° 43′ N. Lat. 83° 25′ W. Long., Treadwell (1901) listed a single specimen in the Fish Hawk material, collected at Bouqueron Bay, and from Pelican Island and Station 99 in the Barbados-Antigua collections (1924b: 13).

**Nereis arroyensis** Treadwell

Figure 48

*Nereis arroyensis* Treadwell (1901) 193. *fig. 30, 31.*

The prostomium is broader than it is long and the dorsal surface shades off into the palps, there being no sharp boundary between the two (FIGURE 48). The anterior margin is broadly rounded and carries two stout tentacles. Of the four eyes, the anterior pair are crescent-shaped. The tentacular cirri are short in the specimens available for examination, but these had lost the posterior dorsal one which is usually longer than the others. There are two long anal cirri.

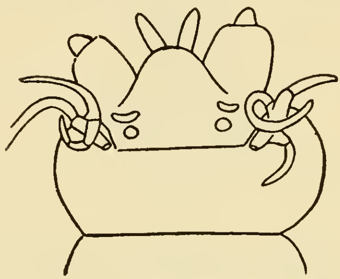

Figure 48. *Nereis arroyensis* Treadwell. × 17.

The parapodial lobes are rather short and blunt, and the dorsal cirrus is longer than the corresponding lobe. There are two types of setae: one has a long, nearly straight terminal joint, which is finely toothed along one border; the other has a much shorter terminal portion, which is hooked at the end and toothed along one border.

Description taken from Treadwell (1901) but the paragnaths were not mentioned. The body is 45 mm. long and 2.5 mm. wide.

The Fish Hawk collected it at Arroyo, and at Station 6052 (Treadwell 1901). Hoagland (1919: 574), recorded one from the reef outside Cayo Maria Langa, Porto Rico, collected by R. W. Miner.

**Nereis antillensis** McIntosh

Figure 49

*Nereis antillensis* McIntosh (1885) 224, 225. *pl. 35, fig. 7, 8, 9; pl. 16a, fig. 14, 15, 16.*

The prostomium is rather slender, deeply incised in the anterior mid-line, and the slender tentacles are as long as the prostomium. The eyes are large (FIGURE 49). The tentacular cirri are very long, the longest reaching to somite 14. The jaws are pale straw-colored at the base and brownish along the dentary margin and tip. Each has 8 teeth below the terminal one. Of the paragnaths, I, II, and III are absent; IV is a series of rows forming an angle on each side; V is absent; VI has two parallel rows on either side; VII and VIII are series of parallel rows, two in each. This jaw arrangement would probably put this species in the genus *Cirronereis*, though in Kinberg's diagnosis of that genus (1865: 169) he mentions only that I, II, and V are missing.

The parapodia have bluntly rounded lobes and slender dorsal cirri, which extend beyond the ends of the lobes. In the dorsal seta-

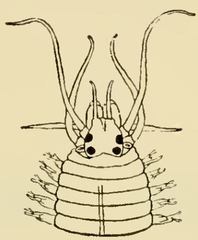

Figure 49. *Nereis antillensis* McIntosh.

bundles are slender homogomph (see page 163) setae, the terminal joint very long and slender and feebly toothed along one border. With these are stouter ones, in which the terminal joint is short, deeply inserted in the end of the proximal one, and bent at the end. In the ventral bundles of posterior somites are much larger heterogomph setae; the terminal joint is roughly triangular in outline, having a curved apex.

Description from McIntosh, whose material was fragmentary so that a complete diagnosis was not possible. It was collected at St. Thomas in the "West Indies," presumably in the Virgin Islands. Hoagland (1919) recorded it as collected in red algae, at the entrance to Guanica Harbor, Porto Rico, by R. W. Miner.

### Nereis diversicolor Müller

FIGURE 50

*Nereis diversicolor* Müller (1776) 217.—McIntosh (1910) 312–324. *pl. 52, fig. 4, 4a; pl. 60, fig. 11, 11a; pl. 72, fig. 5, 5a, 5b; pl. 81, fig. 5, 5a, 5b.*

The prostomium (FIGURE 50) is somewhat triangular and is mottled with dark pigment. The tentacles are small and not widely separated on the prostomial margin. The basal joints of the palps are more than half as broad as the prostomium but are comparatively short, and their terminal joints are very small. The eyes are small and situated near the posterior margin (McIntosh's figure 11 shows an abnormal condition in that there are 3 on one side and only 1 on the other). The tentacular cirri are slender and only of moderate length. The jaws are brownish in color and have 5–7 teeth. The paragnaths are all very small and all groups except V are represented. This would put this species in Kinberg's genus *Nereilepas* (1865). I is figured by McIntosh as three small teeth; II a somewhat diffuse bunch on either side; III and IV also diffuse bundles; VI a small group on either side; VII and VIII a continuous band.

The first parapodium has a single conic dorsal lobe and two somewhat similarly shaped ventral ones. The dorsal and ventral cirri are shorter than the lobes, and the setal portion is small. In later somites the parapodia acquire large triangular dorsal and ventral lobes, the

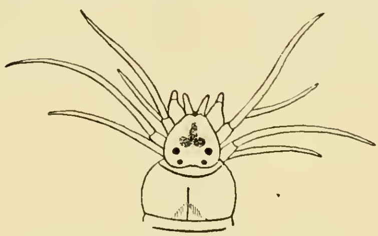

Figure 50. *Nereis diversicolor* Müller.

setal portion being trilobed, and there is a very small lobe between it and the dorsal one. The cirri are all small.

The setae of the dorsal bundle are slender, and the basal joint is homogomph. The terminal joint is very long and sharp pointed, and very faintly toothed along one margin. McIntosh (*pl. 81, figs. 5a* and *5b*) figures two types of setae in the lower bundle, but except in size they differ in no essential characters. The basal joint is heterogomph, the terminal joint short and stout, terminating in a blunt and slightly curved point. On one margin is a row of relatively heavy teeth.

The body is three to four inches in length and contains about 120 setigerous somites. The general color is yellowish-brown, duskier anteriorly and "greenish at the sides from the feet" (McIntosh). I assume that this means that the green color is located on the parapodia.

Description from McIntosh, who gives a long bibliography of the species. He states that is very generally distributed on the shores of the North Sea, the Baltic, the Channel, and other European coasts including the Mediterranean. It has also been described from Japan.

Described from Porto Rico by Hoagland (1919) who identified it from the structure of the paragnaths. It was collected on rocks south of Ensenada, Porto Rico in 1915 by R. W. Miner and R. C. Osburn.

### **Nereis dumerilii** Audouin & Milne-Edwards

FIGURE 51

*Nereis dumerilii* Audouin & Milne-Edwards (1834) 196–199. *pl. 4a, fig. 10–12.*—Ehlers (1868) 535–542. *pl. 20, fig. 21–37.*—McIntosh (1910) 302–312. *pl. 52, fig. 5; pl. 60, fig. 10–10c; pl. 72, fig. 4–4f; pl. 81, fig. 4–4c.*

In the two latter of the above references are given complete descriptions of this species and in McIntosh's paper a very full bibliography. Ehlers (*pl. 20, fig. 21*) figures the prostomium very much as McIntosh describes it. McIntosh's figures of the prostomium are all of the epitokous form, and his plate 60, figure 10b of an epitokous form represents it as having articulated tentacles and tentacular cirri. This feature is not mentioned in his description, nor is it shown in any other figures. According to Ehlers' figure (FIGURE 51) the prostomium is

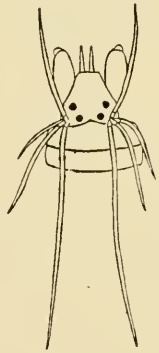

Figure 51. *Nereis dumerilii* Audouin & Milne-Edwards. After Ehlers.

roughly hexagonal in outline, with the two lateral margins composed of equal planes, the anterior margin narrower than the posterior. The tentacles are sharp-pointed, more than half as long as the prostomium, and not in contact at their bases. The palps are large, extending well beyond the apices of the tentacles. The eyes are large. The tentacular cirri are unusually long, ranging according to McIntosh from one-fifth to one-third the length of the body, having a greater relative length in the smaller specimens.

The pharynx has two amber-colored jaws which have five teeth in addition to the terminal one. Of the paragnaths, I and II are lacking;

III, transverse rows of small denticles; IV, triangular patches of similar denticles; V, is lacking; VI a small two-rowed patch; VII and VIII a row of sharply separated denticles running transversely. (Description from Ehlers.) From the arrangement of the paragnaths it would be listed as *Platynereis*.

In the anterior parapodia the lobes are slender and well separated from one another, the dorsal cirrus extends well beyond the setal lobe, and the ventral cirrus equals the setal lobe in length. Farther back the dorsal and ventral cirri become much more slender and, while the ventral one becomes relatively shorter, the dorsal one increases in length relative to the setal portion. At the region of the thirty-seventh parapodium glandular bodies appear at the base of the dorsal cirrus and in later somites these become very much larger. The setae of the dorsal tuft are homogomph as to the basal joint, the terminal joint very long, sharp-pointed, and toothed along one margin. It is quite similar in outline to that of *N. diversicolor*, but heavier. In the ventral bundle the basal joint is heterogomph and the terminal joint very short. Along one margin it carries a row of fine teeth.

McIntosh states that the body is 2½ inches long and made up of from 70 to 80 somites. On the dorsal surface the color is reddish-brown, the surface of the anterior region being dotted with brown spots. Minute white dots occur at each somitic boundary. Some small specimens from deep water are greenish-yellow, the dorsum being spotted with rather large yellowish grains. In preserved material the glandular structures in the parapodia are prominent features.

The epitokous forms are most abundant in the warmer months and are characterized by rounded prostomiums and large eyes. The very long tentacular cirri are also characteristic. The parapodial modifications are in general those of the typical heteronereis phase. A detailed description of the epitokous changes is given by McIntosh.

*N. dumerilii* is a very wide-ranging species, having been identified from both coasts of the Atlantic Ocean. It is found in shallow and deeper waters living in tough tubes. If deprived of its own tubes (*e. g.*, in collecting dishes), it will crawl into tubes of other annelids.

Description from McIntosh and Ehlers.

Webster (1879: 34) listed this species from the coast of Virginia; Hoagland (1919: 574) from Guanica Harbor and rocks opposite Fort Geronimo in Porto Rico. Collected by R. W. Miner, H. Mueller, and R. C. Osburn. McIntosh gives numerous European localities where it has been found.

**Nereis limbata Ehlers**

FIGURE 52

*Nereis limbata* Ehlers (1868) 567–570.—Verrill (1874) 590. *pl. 11, fig. 51.*—Webster (1879) 35, 36. *pl. 6, fig. 70–75.*

The prostomium is longer than broad, its tentacles being less than half as long as the prostomium and in contact at their bases, and the palps extending beyond the apices of the tentacles (FIGURE 52). The tentacular cirri are mostly short, the longest being the dorsal posterior one, which extends as far as somite 5. The pharynx is rather long and has heavy jaws. Of the paragnaths, I has three in a longitudinal row; II, a bent double row; III, transverse bands; IV, bundles; V, diffuse; VI, bundles; VII and VIII, transverse bands containing many teeth; or, V to VIII, continuous bands (FIGURE 52).

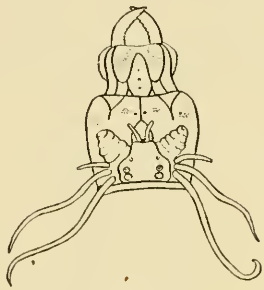

Figure 52. *Nereis limbata* Ehlers. × 1.

In anterior somites the parapodia have narrow and pointed dorsal lobes with the dorsal cirrus arising near their bases. Of the ventral lobes the dorsalmost is the larger, being larger than any dorsal lobe. Posteriorly the setal portion becomes much smaller, while the dorsal lobe is very large, extending beyond the setal portion and carrying the small dorsal cirrus near its apex. The ventral cirrus is small in all cases. The setae have not been described.

According to Webster, the condition of sexual maturity is not always definitely correlated with structural changes, for he found well developed sex-products in animals in which no changes had appeared.

Ehlers states that the coloration is very characteristic, the head region being more or less brown; from this a reddish-brown band runs posteriorly, covering about one-third of the dorsal surface, and being prominent because of the contrast between it and the white lateral region of the body and the parapodia. The brown band becomes much narrower posteriorly.

Ehlers records the species as from the east coast of North America. Verrill states that it is found from Massachusetts Bay to Charleston, South Carolina, Webster found it in collections from the coast of Virginia. Hoagland (1919: 574) recorded it as collected on mangroves between Ensenada and Guanica, Porto Rico by R. W. Miner.

The description mainly from Ehlers, who gives no figures. Verrill figures the anterior end of an epitokous male and Webster a number of parapodia of both atokous and epitokous phases.

### **Nereis versipedata** Ehlers

Figure 53

*Nereis versipedata* Ehlers (1887) 116, 117. *pl. 36, fig. 5–10.*

The prostomium (figure 53) is peculiarly shaped in that the basal portion bearing the eyes is very short, the lateral beveling beginning much nearer the base than is usual. The lateral beveled areas are really slightly concave and make definite angles where they meet the

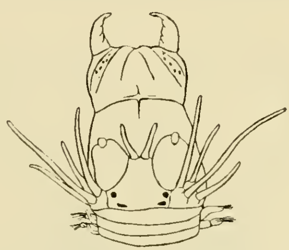

Figure 53. *Nereis versipedata* Ehlers. × 8.



anterior margin. The tentacles are rather long, though shorter than the prostomium and are in contact at their bases. The palps have stout basal portions and very small terminal ones. The tentacular cirri are slender and short as compared with other species, and are carried on stout cirrophores. The jaws are concave, stout, and have obscure denticulations on the inner faces. Of the paragnaths, I, V, VI, VII and VIII are lacking, III is composed of three very small teeth, II an oblique row on either side, IV a small group. This arrangement of paragnaths leads Ehlers to list this as a sub-genus *Ceratonereis*, characterized by having no paragnaths on the proximal ring of the pharynx.

The parapodia differ only slightly in different portions of the body. The lobes are all decidedly conic in outline and in posterior somites these cones are sharper than in anterior ones. The cirri are slender, the dorsal one extending as far as the ends of the setae, the ventral one shorter than the ventral lobe of the neuropodium. According to Ehlers' figure 8, the dorsal lobe of the notopodium and the ventral one of the neuropodium contain pigmented granules. The setae are of two kinds: slender homogomph, having the terminal joint very long and slender and very faintly toothed, and stout heterogomph, the terminal joint heavy, ending in a stout tooth which carries a recurved fang, and a row of about ten strong teeth along the margin.

There are two long anal cirri.

Description from Ehlers. The species was recorded by Hoagland (1919: 574) from the mouth of Guanica Harbor, Porto Rico, collected by R. W. Miner.

### **Nereis glandulata** Hoagland

FIGURE 54

*Nereis glandulata* Hoagland (1919) 575. *pl. 30, fig. 1–6.*

The prostomium (FIGURE 54) is six-sided, the posterior lateral borders diverging very slightly from their bases to just in front of the

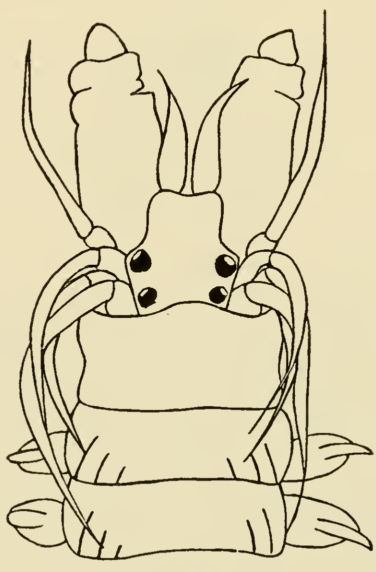

Figure 54. *Nereis glandulata* Hoagland. × 15.

anterior eyes, where they bend inward for a distance about equal to the diameter of these eyes and then run straight forward, making rounded angles with the anterior margin. The tentacles are almost as long as the prostomium, but taper to very acute apices. The palps are long and stout, but their terminal joints are small. The tentacular cirri are nearly equal in length, subulate in form and very sharp-pointed. The longest extends to about somite 3.

The jaws are rather small and have four small teeth below the terminal fang. Of the paragnaths, I is two small teeth one behind the other; II, diagonal patches on either side, each consisting of three rows, the rows unequal in length; III, three transverse rows of which the most posterior is composed of much the largest teeth; IV, quite similar to II in form; V, missing; VI, a circular patch on either side; VII, two large teeth on either side; VIII, a single large tooth similar in form to those in VII. Lacking only group V this species belongs in *Nereis*.

The parapodia have very bluntly rounded lobes, those of the notopodium being the longest and somewhat similar in form to the ventralmost one of the neuropodium. The presetal and postsetal lips of the neuropodium are very small. All setae are heterogomph, the dorsal ones having a moderately long and uniformly tapered terminal joint with very minute teeth along one margin. The terminal joint of the ventral setae is of more uniform diameter throughout and ends in a recurved hook-like tooth. Along the margin is a row of slender teeth. Reported by Hoagland from rocks off Guanica Harbor, in Guanica Harbor, at entrance to Guayanilla Harbor, Salinas Cove, and Paraguera, all Porto Rican localities, collected by A. L. Treadwell and R. W. Miner. It was in the Barbados-Antigua material (Treadwell 1924: 13) at Pelican Island, Pillars of Hercules, and "old coral heads." The Arcturus expedition found it at 17° 39′ N. Lat. 63° 17′ W. Long. and at 32° 65′ N. Lat. 65° W. Long. (Treadwell 1928: 469).

Type in American Museum of Natural History, Cat. No. A. M. N. H. 1211.

**Nereis (Uncinereis) lutea** (Treadwell)

FIGURE 55

*Uncinereis lutea* Treadwell (1928) 469–471. *fig. 40–49.*

A small species measuring about 35 mm. in length and 0.75 mm. in prostomial breadth. A characteristic on which the subgeneric name was based by Chamberlin (1919: 215, 216), is that in all setigerous somites except the anterior ones there are stout hooked setae. In this species the most noticeable feature is the great length of the postero-dorsal tentacular cirrus and of all dorsal parapodial cirri. The prostomium (FIGURE 55) is irregularly oval in general outline, indented posteriorly by a lobe from the first somite, and bulging slightly in the region of the eyes. The eyes are very large. The tentacles are longer than the prostomium, separated at the bases, and slender. The palps are also slender and extend about as far as the ends of the tentacles, the terminal lobe being short. As mentioned above, the postero-dorsal tentacular cirrus is long, reaching to the fourteenth somite, the antero-dorsal is about two-thirds as long, the postero-ventral a little shorter than the antero-, while the antero-ventral is hardly longer than the prostomium.

In general the parapodia are characterized by their very long dorsal cirri and rounded terminal lobes. The neuropodial setae are compound and have very short terminal joints, which are strongly hooked at the ends and carry fine bristles along the concave margin. A

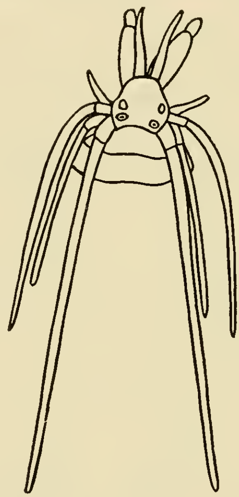

Figure 55. *Nereis* (*Uncinereis*) *lutea* (Treadwell). × 16.

second seta occurs in the neuropodium. This is compound, but the terminal joint is long and slender and finely toothed along one margin. A third type is the hooked seta, also compound, but the terminal joint set rather deeply into the end of the basal joint. This terminal joint is shaped somewhat like those of the first mentioned type but is usually heavier and has no marginal bristles. As far back as the general region of somite 16 these do not appear but are found in later parapodia.

In the original collection was one male in the epitokous condition. The prostomium was nearly round in outline and had large eyes. The palps were like those described above but the tentacles were heavier. In anterior parapodia the dorsal cirrus was much swollen, but on the tenth parapodium these abruptly became slender and in later somites assumed the marginal lobing characteristic of the epitokous condition.

Collected by the Johnson-Smithsonian expedition at Stations 63, and 90.

**Nereis egregicirrata** (Treadwell)

FIGURE 56

*Leptonereis egregicirrata* Treadwell (1924b) 13, 14. *fig. 24.*

A heteronereis described by Treadwell as *Leptonereis* because of the apparent absence of paragnaths. The species appeared in the collections of the Johnson-Smithsonian expedition and here a few obscure paragnaths were found, leading to the change in the generic

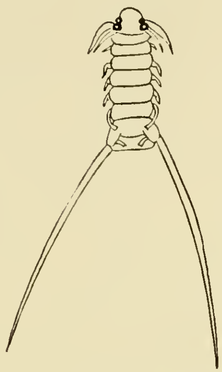

Figure 56. *Nereis egregicirrata* (Treadwell). × 8.

assignment. The most characteristic feature of the animal is that in some males the dorsal cirri of the sixth setigerous somite are enormously elongate (FIGURE 56). Apparently there are two forms of males, one having cirri like the usual heteronereis and the other the elongate form. In all other respects they agree. The eyes are very large and have prominent lenses. The tentacular cirri are short, the longest reaching to somite 6, the shortest barely longer than a somite. The jaws are light-brown and relatively very heavy. Each has about ten denticulations.

Collected at Santa Barbara, Porto Rico.

## Family LEODICIDAE

In 1817 Cuvier divided the family Nereidae into Nereidae proper and Eunicidae, basing the family name of the latter on its principal genus *Eunice*. This terminology was generally used until Verrill

(1900: 638 and in earlier papers) showed that *Eunice* had been preoccupied and that Savigny's name *Leodice* should be used instead. Some taxonomists have accepted this view, while others have declined to do so on the ground that *Eunice* had been too long in use to warrant the change. Both names will therefore be found in the literature and are to be understood as synonyms. *Leodice* and Leodicidae will be used in this paper.

There is great variation in the external appearance of the members of this family and the only common feature is the jaw-structure which is very characteristic. The jaw is composed of a dorsal or maxillary portion and a ventral or mandibular, the latter being only very exceptionally absent. In *Dorvillea* (*Stauronereis*, which has not been reported from Porto Rico), the maxillary is composed of a large number of plates lying in a V-shape and united at the apex of the V by a larger plate. In others the maxillary portion consists of a "forceps" whose jaws are united by a basal "carrier" (FIGURE 75a). Close to the forceps lies a pair of plates, the "proximal paired"; just in front of the left proximal is an "unpaired" and distal to this another set of paired. All plates have teeth on one margin, the number and size of these teeth being of taxonomic importance. In some genera the unpaired plate does not appear. The mandible (FIGURE 75c) is composed of two distinct halves joined together at their anterior ends but diverging posteriorly. Considerable variation exists among different genera in the form and size of the plates. In the majority of genera no palps are in evidence. It is generally held that two ventro-lateral portions of the prostomium, which sometimes are completely fused with the prostomium and sometimes are sufficiently distinct to give it a 4-lobed appearance, really represent the palps. In *Dorvillea* the palps are long tentacle-like structures which are larger than the true tentacles.

Some Leodicidae have no head-appendages, but in most genera there are tentacles attached near the base of the prostomium. The latter may also carry eyes. Tentacles, 1, 3, or 5. Nuchal cirri attached to the dorsal surface of the second somite occur in many genera. Two other features which are not always present, but which are absolutely diagnostic when they are, are the gills and the pectinate setae. The gills are attached to the dorsal surfaces of the dorsal cirri on the parapodia or to the body wall close to this. Sometimes a gill has only one filament, but usually they carry a lateral row of branches, which sometimes reach a considerable length. They do not generally appear on all somites, but their distribution is constant and regular in any given species. The pectinate setae (FIGURE 4f) are very characteristic.

They are often small and difficult to see and only a few appear in any one parapodium.

KEY TO GENERA RECORDED FROM THE WEST INDIAN REGION

A. Tentacles 5; parapodial gills.
  B. Nuchal cirri present . . . . . . . . *Leodice.*
  BB. Nuchal cirri none . . . . . . . . *Marphysa.*
AA. Tentacles 3–5 or none; gills none.
  B. Tentacles present.
    C. Tentacles 5; nuchal cirri . . . . . . . . *Nicidion.*
    CC. Tentacles 3; nuchal cirri none . . . . . . . . *Lysidice.*
    CCC. Tentacles 3, covered by anterior border of peristomium; dorsal cirrus foliaceous . . . . . . . . [*Oenone*].
  BB. Tentacles none; dorsal cirrus rudimentary, ventral cirrus none.
    C. Posterior border of mouth formed in part by a prolongation from first somite . . . . . . . . *Lumbrinereis.*
    CC. Posterior border not so formed.
      D. Maxillary plates small . . . . . . . . [*Drilonereis.*]
      DD. Maxillary plates large . . . . . . . . *Arabella.*
AAA. Tentacles 7 (or tentacles 5 and frontal palps 2).
  B. Nuchal cirri present. First three pairs of parapodia extending forward beside prostomium . . . . . . . . *Rhamphobrachium.*
  BB. Nuchal cirri absent . . . . . . . . *Hyalinoecia.*

## LEODICE Savigny

### Leodice rubra (Grube)

FIGURE 57

*Eunice rubra* Grube (1857a) 59.—Ehlers (1887) 87–88. *pl. 26, fig. 1–11.*—Treadwell (1901) 197.
*Eunice ornata* Andrews (1891) 284, 285. *pl. 13, fig. 6–13.*—Treadwell (1901) 195.
*Leodice rubra* Treadwell (1921) 15–17. *pl. 2, fig. 1–4; text-fig. 13–20.*

The prostomium is noticeably bilobed (FIGURE 57), and in life is mostly colorless though there is some green pigment in front of the tentacles. The median tentacle reaches to the anterior border of

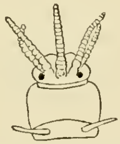

Figure 57. *Leodice rubra* (Grube). × 1.5.

somite 4, the inner paired ones are about the same length and the outer paired ones are much shorter. All are articulated, the basal joint being small, the next the longest of any, and from this a decrease toward the end, the last being moniliform. The nuchal cirri extend to about the middle of the peristomium. The eyes are small, one on either side near the bases of the inner paired tentacles.

The gills begin on somite 7, 8, or 9, at first as small structures with only two branches. The second gill has eight, the third has thirteen branches. From the tenth to the twentieth they are very prominent, and meet over the dorsal surface of the body. They continue on all but the last four somites, the later ones having fewer branches. The gills are attached to the dorsal cirri, which are large. The ventral cirrus is small in anterior somites but larger farther back.

There are three kinds of setae, a condition characteristic of this division of the family which includes *Leodice* and *Marphysa*. Setae of the first type are slender, simple, more or less notched along one margin; those of the second type are compound, the basal joint denticulate along one margin at the very end. The terminal joint heavy, carrying a terminal and subterminal tooth, the whole covered by a hood which also is denticulate along the margin. The setae of the third type are pectinate. In anterior parapodia are two straight aciculae which protrude for a short distance from the surface of the setal lobe. In later somites a second type of acicula appears. These are strongly hooked at the outer ends, the hooks covered by hoods. There are two pairs of anal cirri.

The jaw-apparatus is brown, this color being denser along the margins of the plates. The proximal paired plates have 5 teeth on the right and 4 on the left; the distal paired have 8 on the right and 5 on the left, and the unpaired has 6. The mandibles have heavy brown shafts marked with concentric lines, their beveled portions being covered by a dense white deposit.

The animals are small, a mature female being 105 mm. long and 3 mm. wide at the anterior end; it had 130 somites. In life the general body-color is dark-olive-green, shading into purplish-brown toward the posterior end, though this latter color may be affected by the color of the sex-products in mature animals.

This species is common throughout the West Indies. Ehlers (1887: 87) listed it from Key West, Florida; Grube (1857a) from "St. Thomas" (Virgin Islands ?); Treadwell (1924) in the Barbados-Antigua collections at Bathsheba, and in the Fish Hawk material (1901) from Porto Rico at Stations 6080, 6079, 6073, 6092, 6086, 6091, Mayaguez, Ponce, Arroyo; R. C. Osburn from off Guanica Harbor; Treadwell (1921) also reported it from Porto Rico, Dry Tortugas (Florida), Tobago, Bermuda, Beaufort, North Carolina, and Pernambuco, Brazil; Andrews (1891) from Beaufort, North Carolina.

### **Leodice denticulata** (Webster)

FIGURE 58

*Eunice denticulata* Webster (1884) 316–317. *pl. 10, fig. 41, 41a, 41b, 42–45.*
*Eunice conglomerans* Ehlers (1887) 93–95. *pl. 23, fig. 1–9; pl. 24, fig. 1–4.*
*Leodice denticulata* Treadwell (1921) 22–25. *pl. 3, fig. 1–4; text-fig.* 41–53.

A large species, reaching a length of 500–600 mm. It lives in parchment-like branching tubes some of whose branches end blindly. In the Dry Tortugas these tubes follow the windings of sponge-cavities and on account of the complexity of the branching of the tubes their removal from the sponge is often a difficult process. In Bermuda they are common, but there the tubes are most often found on the lower sides of stones. In life the anterior somites have a bright vermilion-carmine color, with the tentacles and the anterior margin of the prostomium a lighter tint. Posteriorly this color weakens and by

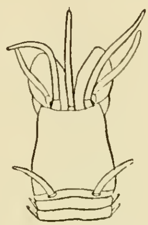

Figure 58. *Leodice denticulata* (Webster). × 2.

the fiftieth somite it disappears entirely, the remaining portion of the body being practically colorless.

The prostomium (FIGURE 58) is two-lobed and the tentacles are relatively short, not reaching for more than one-third their length beyond the prostomial border. The peristomium is as long as the following five somites and the slender nuchal cirri are not more than three-quarters of its length. Gills first appear as single filaments on somite 27, on somite 50 there are two branches, in the region of somite 90 there are three, and they continue to the extreme posterior end of the body, though the last ones have only one branch. Through the middle of the body, where the number of branches is greatest, they are very long and slender and form a dense fringe along either side of the body. At the extremities they are shorter than the dorsal cirri.

The simple setae are slender and very slightly curved toward the apices, which are winged along both margins, this wing being broader on the concave than on the convex side. The compound setae of the first parapodium are much smaller than those in posterior somites, their terminal joints being only faintly two-toothed and covered by a hood.

Posteriorly these compound setae have much larger basal joints much striated at the ends. The terminal joints inside the hood have small subterminal and much larger terminal teeth and rounded thickenings at the bases. The pectinate setae have about ten teeth, the terminal ones about equal in length. The dorsal aciculae are bifid at the ends, the ventral ones which do not appear in anterior somites, carry each a large subterminal and smaller terminal tooth.

The jaw is dark-brown with a whitish incrustation. The right proximal plate has 4, the left 5 teeth; the unpaired has 6; the right paired has 6, the left 2. The mandible is short and thick, the basal halves well separated and dark in color.

Verrill (1900: 639) lists this species as synonymous with McIntosh's *Eunice cirrobranchiata* (1885: 277). It does not, however, agree with that in tooth-structure.

This species is abundant in the West Indies, and in Bermuda. Ehlers' specimens were collected at Key West, and at 24° 44′ N., 83° 26′ W. (1887). The U. S. National Museum has specimens from Key West and Rodregas Creek, Florida; Curacao; Old Providence; St. Thomas, Virgin Islands; off Cape San Antonio, Cuba; and Dominica. The American Museum of Natural History has one taken at Guayanilla Harbor, Porto Rico; and I have collected it in the Dry Tortugas; Bermuda; Tobago; and at Guanica Harbor (Treadwell 1921). It was collected by the Fish Hawk at Stations 6065; 6079; Mayaguez; and Ensenada Honda (Culebra) (Treadwell 1901).

**Leodice longisetis** (Webster)

FIGURE 59

*Eunice longisetis* Webster (1884) 317, 318. *pl. 10, fig. 46, 49.*
*Eunice violacea-maculata* Ehlers (1887) 86, 87. *pl. 24, fig. 11, 12; pl. 25, fig. 1–7.*
*Leodice longisetis* Treadwell (1921) 27–30. *pl. 2, fig. 5–8; text-fig. 54–65.*

A large species, reaching a length of 400 mm. The general color of the body in life is dark-green with longitudinally arranged irregular dark lines, the surface having a marked iridescence. In the middle of the body the dark lines cover more of the surface than anteriorly. At the very posterior end there is a tendency toward dark-brown, which may pass into purple, the extent of this colored region varying in different individuals. One specimen collected in the Dry Tortugas was uniformly purple over its entire body. The sixth somite is colorless and the tentacles and cirri are all banded, the tentacles and anterior cirri with white bands on greenish-brown while on the posterior cirri this brown changes to full brown or purple. The longitudinal markings and bands on the cirri persist after preservation.

The prostomium (FIGURE 59) is small and obscurely four-lobed. The median tentacle is as long as the first six somites, the ones of the lateral pairs successively smaller. The peristomium is long as compared with later somites but these relative lengths vary with the preservation methods. The nuchal cirri reach to the anterior peristomial border.

The gills first appear on somite 9 and except for a very few somites at the posterior end, occur throughout the body. At their fullest development they have as many as fifteen branches. This number decreases toward the posterior end, the last ones having only one branch.

In the first two setigerous somites the ventral cirri are prominent, but in those immediately following they are small and attached to the end of a pad-like swelling. In still later somites this pad disappears

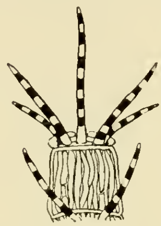

Figure 59. *Leodice longsetis* (Webster). × 3.

and the ventral cirrus again becomes prominent. The simple setae are very long and slender, and with a wing along only one margin. The compound ones are heavy, their terminal joints carrying subequal terminal and subterminal teeth covered with a hood whose edge is denticulate. The pectinate setae have about ten teeth, the terminal ones not symmetric. The dorsal aciculae are sharp-pointed at the apices and very dark in color, the ventral ones hooded, each with a smaller terminal and a larger subterminal tooth.

The jaw is very dark in color, the carrier of the forceps being short, its terminal halves relatively long. The proximal paired plates have 4 teeth on the right and 6 on the left; the distal paired have 9 on the right and 6 on the left; the unpaired has 6. The mandible has very dark shafts.

In the Dry Tortugas this species is never common, though some appeared in each season's collections. Ehlers' specimens came from the Tortugas; Verrill (1900) records it as very abundant in Bermuda but in a season's collection there I found only one specimen. In the U. S. National Museum are specimens from Curacao, Cuba, and vicinity of Key West (Treadwell 1921). In the Fish Hawk material it occurred from Ensenada Honda (Culebra), and from Station 6079 (Treadwell 1901, listed as *Eunice violacea-maculata*); R. W. Miner and H. Mueller collected a large number of specimens from Parguera, Porto Rico.

**Leodice longicirrata** (Webster)

FIGURE 60

*Eunice longicirrata* Webster (1884) 318, 319. *pl. 12, fig. 75–80.*
*Eunice articulata* Ehlers (1887) 83. *pl. 24, fig. 8–10.*
*Leodice longicirrata* Treadwell (1921) 11–14. *pl. 1, fig. 1–4; text-fig. 3–12.*

Apparently this species has been described under several names. For synonymy see Treadwell's paper.

A medium-sized species, reaching a length of 237 mm. Its coloring is very striking, consisting of various arrangements of brownish pigment on a white background. Anteriorly each somite except the

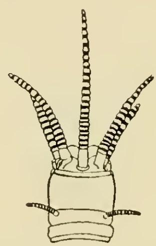

Figure 60. *Leodice longicirrata* (Webster). × 2.

second, fifth, and ninth has its anterior region brown, its posterior border uncolored. The second, fifth, and ninth are generally entirely colorless. There is a brown band at the base of each parapodium. The tentacles are long and articulated, their ground-color being pure white but they have brown or purple bands in all constrictions. The dorsal cirri are also banded with pigment but are not articulated. There are two pairs of unequal sized anal cirri, the larger pair being colored.

The prostomium is small and four-lobed. A narrow collar-effect is formed by the anterior border of the peristomium which partly covers the base of the prostomium (FIGURE 60). The nuchal cirri extend as far as the bases of the tentacles, being foreshortened in the figure.

Gills begin on somite 5 as a one-branched structure which becomes two-branched on somite 6, six-branched on 7, seven-branched on 10, nine-branched on 15 and fifteen- or more branched in later ones. The number of branches diminishes from somite 35 to 40 and gills disappear entirely at about somite 58. When fully developed they are very prominent, meeting over the dorsal surface of the body. A noticeable feature of the parapodia is a large pigment-spot near the base of each dorsal cirrus.

The simple setae are slender and sharp-pointed but have no marginal wings. The compound ones have very small apical and subapical teeth and the whole terminal joint is relatively much smaller than in other species. The pectinate setae have about fourteen very small teeth. Anteriorly there are only bluntly rounded aciculae, but in later somites a ventral hooded form is added. The latter have small apical and much larger subapical teeth.

The jaw is rather light-colored, only the tips of the forceps and the margins of the toothed plates being colored. The right proximal plate has 7, the left 6 teeth; the right distal has 10, the left 8; the unpaired 6. The mandible is lighter-colored than the maxilla, each half having a dark-brown patch along its inner margin.

In the Dry Tortugas this species occurs sparingly, living in tubes covered with small stones and bits of shells on the under side of rocks in tide pools. Ehlers' specimens (1887) were taken "off French Reef in 15 Fathoms"; Augener (1906: 130, 131) listed it from 41° 34′ 30″N., 65° 54′ 30″ W., and 33° 42′ 15″ N., 76° 00′ 50″ W.; the American Museum of Natural History has a specimen from the Bahamas; the U. S. National Museum collection contains some from Pernambuco, Brazil; St. Thomas, Virgin Islands; Cuba; Key West; 27° 04′ N., 83° 21′ 15″ W.; 28° 45′ N., 85° 02′ W.; 29° 9′ N., 82° 50′ W.; 29° 11′ 30″ N., 85° 29′ W., at depths varying from 12½ to 30 fathoms (Treadwell 1921). It appeared in the Barbados-Antigua material (Treadwell 1924), and I have collected it in the Dry Tortugas, Tobago, and Bermuda. The Fish Hawk material contained specimens from 6065, 6098, 6096, and Playa de Ponce Reef (Treadwell 1901). R. C. Osburn obtained 3 specimens off Tallaboa Bay, Porto Rico, in 1915.

### **Leodice cariboea** (Grube)

Figure 61

*Eunice cariboea* Grube (1857a) 57.
*Eunice siciliensis* Treadwell (1901) 196.
*Leodice cariboea* Treadwell (1921) 47–49. *pl. 4, fig. 1–4; text-fig. 136–143.*

A species characterized by the relatively enormous development of the mandible as compared with the maxilla, and the feeble development of the gills. In these respects it agrees with the European *E. siciliensis*, with which it was confused by Treadwell (1901: 196). The anterior region of the body has a greenish-yellow tint while posteriorly it is more of a gray. Anteriorly the ventral surface is much flattened or even concave, the dorsal surface rounded. The animals live in crevices of the coral rocks, generally winding through them in a complicated fashion and the head-region is bent sharply on itself and wedged tightly into a space in the rock. This makes it difficult to remove them without breaking. In immature animals the posterior region is transparent, but when sexually mature it is colored by the sex-products. There is a prominent black spot in the middle of the ventral surface of each somite and sometimes another one at the base of the parapodium. Sometimes the posterior portion of the body containing the sex-products is as sharply separated from the remainder as it is in *L. fucata* (see page 243), indicating a possibility that this also may swarm, but no such swarming has been recorded.

The prostomium (FIGURE 61) is usually bent ventrally so as to form an angle of 45° with the peristomium, and is large. The tentacles are

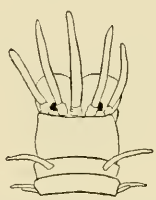

Figure 61. *Leodice cariboea* (Grube). × 2.

longer than the peristomium and the nuchal cirri do not reach to the anterior prostomial border. Anteriorly the dorsal cirri are large but posteriorly they become very small.

Gills appear first in the region of somites 80 to 90 and occur for about 110 somites, there being as many as 700 somites in the body of some individuals. The gills are filled with blood in living specimens and are then easy to see, but in preserved material they are quite obscure. Usually there is only one filament but occasionally there may be a second one. In only one case has a third filament been seen on any gill. In very young individuals the gills may not appear at all, making it easy to mistake them for *Nicidion*, but the mandible would in such cases be diagnostic.

In the jaw the carriers of the forceps are long, and the terminal plates not definitely toothed. The mandible is large and white, and when protruded looks like a starched cuff which has been stuffed into the mouth opening.

The simple setae are slender and striated along the border, but have no wings. The compound ones have very small terminal joints. No pectinate setae have been found.

The species is common in the Dry Tortugas; in Montego Bay, Jamaica; and in Tobago (Treadwell 1921); it appeared in the Arcturus material at 17° 39′ N., 63° 17′ W., and at 32° N., 65° W. (Treadwell 1928); in collections of the Barbados-Antigua expedition at "Pillars of Hercules," and at Station 99 (Treadwell 1924b). Treadwell also obtained it off Guanica Harbor, Porto Rico, in 1915.

### **Leodice fucata** (Ehlers)

FIGURE 62

*Eunice fucata* Ehlers (1887) 91–93. *pl. 25, fig. 8–20.*
*Leodice fucata* Treadwell (1921) 43–47. *pl. 4, fig. 5–10; text-fig. 127–135.* (For other literature see this paper.)

A large and rather slender species, reaching a length of 673 mm. The prostomium (FIGURE 62) is rounded and distinctly bilobed, each lobe divided into a small dorsal and a larger ventral one. The tentacles all taper to blunt apices, the median being the longest and reaching to the fourth somite. The form of the peristomium varies with the degree of expansion of the animal, but in life it usually shows a longer

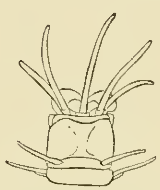

Figure 62. *Leodice fucata* (Ehlers). × 1.

longitudinal than transverse diameter. In life the anterior face of the prostomium is pale-green and very iridescent and has a pearly lustre between the bases of the tentacles. The cirrophores of the tentacles are reddish-brown, while the greater part of the tentacle is lighter brown washed with green, but the apices are colorless. The peristomium is very iridescent, but has more or less green and brown, this latter color being continued on to the later somites, and the general effect is that of a green animal. As far back as about somite 40 there is a faint transverse white band in each somite. At this point a white spot appears in the mid-dorsal line, at first of only an occasional somite, but later it occurs in each somite to the extreme posterior end, the white band disappearing.

Gills begin on the fifth setigerous somite. In some cases the number of the branches of this first gill may be as low as one or two but there are usually more. Between the fifth and eighteenth somites the number of gill-branches may be as high as eighteen and behind this they are much fewer though they extend as far as somite 200. Because of the small size of these later gills the general effect is that of gills confined to the anterior somites of the body.

The simple setae are very long and slender and carry fine teeth along one margin. The compound setae are relatively heavy, and the terminal joint is short and without teeth or hood. Pectinate setae have about 18 terminal teeth. No aciculae are toothed or hooded, but all are rounded at the apices and straight.

The maxilla is almost black, with heavy forceps. Each proximal plate has a small apical and 4 other larger teeth; the distal paired ones have 7 on the right and 4 on the left; the unpaired has 7. The mandible is dark and has very dark, rather heavy shafts.

*Leodice fucata* is known as the "Atlantic Palolo" because like a related species *L. viridis* Gray of the Pacific, known there as the Palolo, it regularly swarms at the breeding season. The animals live in crevices in the coral rocks from which the anterior ends of the bodies are protruded for feeding purposes, but the remainder of the body never leaves the crevice until the breeding season. At this time the posterior end which has become much distended with sex-products is thrust out and twists in an anti-clockwise direction until it breaks at a clearly defined point between the anterior portion and the much distended part of the body. This detached portion swims to the surface of the water, continuing its anti-clockwise movement and so numerous are the animals that at this time hardly a square foot of the surface lacks at least one specimen. This process takes place before daylight and just as the sun rises these fragments, whose body-walls have been under considerable tension, burst, setting free the eggs and sperm, and fertilization follows. The eggs are rather large and may be seen floating at the surface for several days, but later sink to the bottom. The peculiar feature of this swarming is that wherever it has been described it occurs in definite relation to the phases of the moon.

The Pacific Palolo swarms in October and November at the times of the moon's first quarter. In the Dry Tortugas, *L. fucata* swarms within three days of the last quarter of the June–July moon. If, however, this last quarter comes late in July, there may be a swarm in connection with the first as well as with the last quarter. In the Bahamas, it was collected in 1914 on June 11th, the date of the corresponding collection in the Dry Tortugas being July 11th, indicating that this particular rhythm varies in different localities. Data collected in the Dry Tortugas from 1898 to 1914 (mostly by the late Dr. A. G. Mayor) showed that in those years the correlation between the phases of the moon and the swarming followed with great regularity the schedule as given above (Treadwell 1921: 45).

This species has been recorded from the Bahamas; the Dry Tortugas; Tobago; Montego Bay, Jamaica; Cape Florida; and 9° 32′ N., 79° 54′ 30″ W. (Treadwell 1921). Ehlers' specimens were taken at the Tortugas, and in the Tortugas channel (1887). The Fish Hawk collected it at Caballo Blanco Reef, Boqueron Bay, and Arroyo (Treadwell 1901).

**Leodice auriculata** (Treadwell)

Figure 63

*Eunice auriculata* Treadwell (1901) 196–197. *fig. 33–36b.*

The prostomium is bilobed (figure 63), each lobe having a median triangular portion, the apices directed anteriorly. The peristomium is about twice as broad as it is long, the prostomium fitting into its anterior border in such a fashion that the length at the margins is

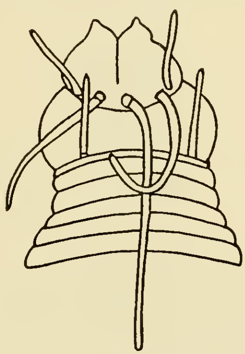

Figure 63. *Leodice auriculata* (Treadwell). × 6.

greater than in the center. The tentacles are slender and the median one, which is the longest, reaches as far as somite 18. The inner paired tentacles are about half as long as the median, the outer paired about half as long as the inner. The nuchal cirri extend beyond the anterior peristomial border.

The gills begin on somite 19 as single filaments, and by somite 27 there may be three branches, but the number never becomes very large. Posterior somites had been lost in the specimens from which the description was written and the extent of the gills was not recorded.

In anterior somites there are simple setae and compound ones with long and acute terminal joints. The simple setae also occur in posterior somites, but there the compound ones have terminal joints which are toothed at the ends. Pectinate setae also occur in posterior somites.

The dorsal setae are longer than the gills. Noticeable features of the dorsal cirri are the rounded swellings on their ventral surfaces, which are evidently sense-organs, but no very definite study has been made of their functions.

This species has been collected only in Porto Rico, where it was taken at Stations 6066, and 6067 (Treadwell 1901).

**Leodice culebra** (Treadwell)

Figure 64

*Eunice culebra* Treadwell (1901) 197. *fig. 37.*
*Leodice culebra* Treadwell (1921) 49–51. *pl. 2, fig. 13–16; text-fig. 144–153.*

A small species, not more than 150 mm. long. The anterior portion of the body is colorless, except for the tint given it by the blood, and is very iridescent. The posterior region has a green color which turns to brown in alcohol. The prostomium (figure 64) is noticeably four-

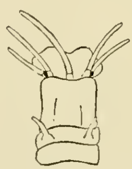

Figure 64. *Leodice culebra* (Treadwell). × 3.

lobed and is wider than the peristomium. The tentacles are slender, the median one reaching to the third somite. The peristomium is nearly rectangular in outline and is as long as the three following somites. The nuchal cirri are short.

The gills are in the form of single filaments and have very irregular distribution, but in general they are more regularly distributed and larger in posterior somites than in anterior. One individual had gills on somites 25–32 and no more until about somite 100 and from here they continued for about fifty somites.

The simple setae are long and slender, the compound ones have short terminal joints which have sharp-pointed, subequal terminal and subterminal teeth. The pectinate setae are relatively broad at the ends and carry about sixteen teeth.

The maxilla is light-brown with darker margins. The proximal paired plates have 5 teeth on the right and 4 on the left; the distals have 6 on the right and 4 on the left; the unpaired has 7.

This species lives in crevices of the coral rocks in association with *Nicidion kinbergii* (see page 254). Most of my specimens were collected at Marshall Island, Bermuda, but a single one was collected by dredging in the Northwest Channel in the Dry Tortugas, and it was found in Tobago (Treadwell 1921). The Fish Hawk collections contain one from Ensenada Hondo (Culebra) (Treadwell 1901). One specimen was dredged off Guanica Harbor, Porto Rico, by R. C. Osburn, in 1915.

### **Leodice floridana** (Pourtalès)

FIGURE 65

*Marphysa floridana* Pourtalès (1868) 108.
*Eunice floridana* Ehlers (1887) 88–90. *pl. 22, fig. 1–7.*
*Leodice floridana* Treadwell (1921) 33, 34. *text-fig. 77–84.* (Other references in this latter paper.)

A rather large species, living in branched paper-like tubes somewhat resembling those occupied by *L. denticulata* (see page 237) but differing in that in *L. floridana* the openings are laterally placed. The prostomium (FIGURE 65) is small as compared with the peristomium and is

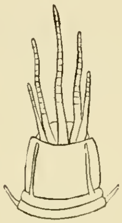

Figure 65. *Leodice floridana* (Pourtalès). × 1.5. After Ehlers.

definitely bilobed (in the figure the median fissure is obscured by the unpaired tentacle). The median tentacle is about six times as long as the prostomium and is obscurely articulated, the inner paired nearly as long as the first, the outer paired much shorter. Both are articulated like the median. The peristomium is three times as long as the prostomium and very prominent. All later somites are very short. It should be kept in mind, however, that all of these annelids have a considerable power of contraction and may in life differ decidedly from the condition of preserved material. FIGURE 65 is from Ehlers, and was originally drawn from preserved specimens; it is possible that in living material this distinction would be less marked. The nuchal cirri reach to the anterior peristomial border.

Gills extend throughout the body except for the first six and the last two somites, the largest number of branches in any one being 7–8. They are carried on the dorsal cirrus or just at its base on the body-wall. The dorsal cirrus extends to the end of the gills and is comparatively stout, the end rounded. The ventral cirri consist of a globular body carrying a very short conic lobe on the outer margin.

The maxillae are rather slender and dark-colored. The inner paired plates are colored like the maxilla and each carries 5 strong teeth. The other plates are also colored and their teeth are small. The compound setae are heavy, having long terminal joints which carry terminal and subterminal teeth. The hood is denticulated along one border.

Assuming that the identifications were accurate, the literature shows this species to be of wide range. It has been found in Porto Rico only by the Johnson-Smithsonian expedition at Station 47 and was doubtfully identified by Treadwell (1921: 33) as collected near the Dry Tortugas.

### Leodice unifrons Verrill

FIGURE 66

*Leodice unifrons* Verrill (1900) 644.—Treadwell (1921) 17–20. *pl. 1, fig. 5–9; text-fig. 21–30.*

A small species originally described from Bermuda by Verrill. An average-sized individual is 50 mm. long. When living there are greenish-brown markings in front of the eyes on the prostomium, and there is similar pigmentation on either side of the dorsal mid-line

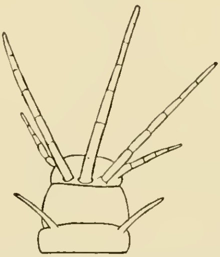

Figure 66. *Leodice unifrons* Verrill. × 10.

throughout the body. In the anterior region are prominent median dorsal areas of considerable size, which are continued posteriorly by a median row of white dots. Through the posterior half of the body there is a dark spot on the dorsal face of each parapodium. Preserved specimens are dingy-gray in color, with marked iridescence.

The name *unifrons* was given this species by Verrill because there seemed to be no median fissure in the anterior margin of the prostomium as appears in most members of this genus. At times this anterior margin does seem to be entire, but at others there is a slight depression, the latter being the more frequent condition. The median tentacle reaches to about the fourth somite, the others are progressively shorter (FIGURE 66). All are articulated, but the articulations are obscured in life by the pigmentation. The nuchal cirri are about as long as the prostomium and are not articulate.

Gills occur on somites from the third to the fiftieth. The first have only one filament, this number gradually increasing in later ones, the greatest number being six on somites 21–27.

The maxilla is light in color except along the margins and has a very short carrier. The plates are also colored only along the margins and have from eight to ten teeth on each. Setae are of the types usually found in this genus, the pectinate ones having few teeth. The simple setae are rather stout at the outer ends and carry minute denticulations.

This species has been recorded from Bermuda by Verrill (1900), by Treadwell (1921) from Bermuda, the Dry Tortugas and Montego Bay, Jamaica. The Johnson-Smithsonian expedition found it at Station 26, and north of Culebra Island.

### LUMBRINEREIS Blainville

De Blainville's original spelling of this generic name was *Lumbrinereis;* this was changed by later writers to *Lumbriconereis,* though no reason for the change was given. The genus is corrrectly named *Lumbrinereis.*

#### Lumbrinereis parva-pedata (Treadwell)

FIGURE 67

*Lumbriconereis parva-pedata* Treadwell (1901) 198. *fig. 38–40.* .

The prostomium (FIGURE 67) is acute and about as broad as it is long, the dorsal surface being marked by a median longitudinal ridge.

Figure 67. *Lumbrinereis parva-pedata* (Treadwell). × 8.

The first two somites are short and more or less fused dorsally and ventrally, their total length being only a little greater than that of the third. The first parapodium is very small, while the second is longer and carries two or three stout hooked setae and one or two slender ones with broad marginal wings. Toward the middle of the body the parapodia become larger but the general character of the setae does not change.

The jaw-structure was not recorded in the original description. The type was 200 mm. long and was light-yellow in color with yellowish-brown bands crossing the somites. These might have been remnants of color which had not been entirely extracted by the preservatives.

Collected by the Fish Hawk at Ensenada Honda (Culebra) (Treadwell 1901).

**Lumbrinereis maculata** (Treadwell)

FIGURE 68

*Lumbriconereis maculata* Treadwell (1901) 198–199. *fig. 42–44*.
*Lumbrinereis maculata* Treadwell (1921) 103–104, *pl. 8, fig. 10; text-fig. 378–385*.

The prostomium (FIGURE 68) is blunt sugar-loaf in form and carries three pigment-patches, one in the median line and one on either side, the median being smaller; this color persists in alcohol. The body-somites are marked with transverse patches which vary somewhat in

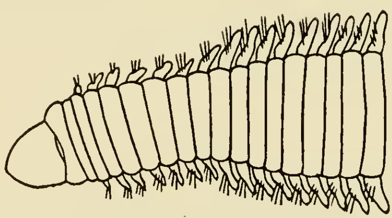

Figure 68. *Lumbrinereis maculata* (Treadwell). × 4.

color but in general are dark-brown. The parapodia are much more prominent than is usual in members of this genus, especially toward the posterior end where they are long and narrow. There are three kinds of setae, of which the hooded variety from the anterior region is the most characteristic. They have long, gently curved terminal portions ending in a toothed region beyond a narrow neck, and for about half their length they are covered by a hood.

The maxilla is short and rather heavy, especially as concerns the carrier of the forceps. The proximal plates have each 4 teeth, the first and second distal 2 and 1 each.

Collected in the Dry Tortugas at Long Key, and at Mangrove Key near Key West (Treadwell 1921). The Fish Hawk found it at Puerto

Real (Treadwell 1901). Also collected by R. C. Osburn near Guanica Harbor, Porto Rico.

### **Lumbrinereis floridana** (Ehlers)

FIGURE 69

*Lumbriconereis floridana* Ehlers (1887) 103. *pl. 30, fig. 10–15.*
*Lumbrinereis floridana* Treadwell (1921) 100–101. *text-fig. 365–370.*

The prostomium (FIGURE 69) when seen from above, is conic in outline, and carries no eyes. The first parapodium has a broad base and a conic posterior lip; later ones differ from this mainly in size. The setae of the first parapodium are all compound, the terminal joint having two large and three small teeth, all covered by a hood. A

Figure 69. *Lumbrinereis floridana* (Ehlers).

similar hood covers the apex of the basal joint. By the tenth parapodium, simple setae curved at the ends and carrying broad marginal wings have appeared. In the posterior body-region is found only one kind of setae. These are simple, rather stout, having toothed apices beyond a narrow neck and a hood covering the distal end.

The maxilla has slender forceps. The proximal plates have each 4 teeth, the distal two pairs have 2 and 1 respectively, all very dark-brown in color.

Ehlers' specimens were taken at Key West (1887). The U. S. National Museum has specimens from Key West, and from 25° 47′ N. 80° 05′ W.; and they were taken at the Dry Tortugas, and in Bermuda (Treadwell 1921). The Fish Hawk found them at Bouqueron Bay, and at Station 6065 (Treadwell 1901).

### **Lumbrinereis bilabiata** Treadwell

FIGURE 70

*Lumbrinereis bilabiata* Treadwell (1901) 199. *fig. 45, 46.*

Described from a single specimen collected at Station 6061 by the Fish Hawk expedition. The specimen was incomplete, retaining only 57 of the anterior somites. The prostomium is sugar-loaf in shape, much like that of *L. floridana* (FIGURE 70). The first somite is longer than the second, and succeeding somites are of uniform breadth, about eight times broader than long. In the anterior parapodia there is a prominent but narrow posterior lip, and in posterior ones there is

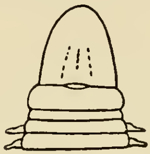

Figure 70. *Lumbrinereis bilabiata* Treadwell. × 13.

added to this a blunt anterior one. Most of the setae had been lost, but those that remained were bent toward the apices and carried marginal wings. The description of these setae as given in the original diagnosis is not complete. No jaws were described.

### ARABELLA Grube

#### Arabella opalina (Verrill)

FIGURE 71

*Lumbriconereis opalina* Verrill (1874) 594. *pl. 13, fig. 69, 70.*

Verrill's original description of this species was based on material collected along the New England coast from New Haven to Vineyard Sound. He states that its length may be up to 400 mm. with a diameter in the mid-region of the body of 3 mm. The prostomium

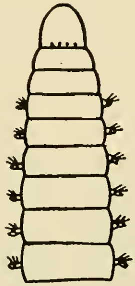

Figure 71. *Arabella opalina* (Verrill). After Verrill.

is rounded-conic and carries four eyes in a transverse row near its base, the two inner ones being slightly larger than the others and situated a very little in advance of them (FIGURE 71). The parapodia have elongate posterior lips and two kinds of setae, one of which has a long capillary tip, the others are geniculate with teeth along the angle. The color is reddish or brownish with a brilliant iridescence.

Webster (1884: 321) records this species from Bermuda, and states that it occurs from Cape Cod to Beaufort, North Carolina. Andrews (1891: 288) recorded it from Beaufort, North Carolina; and specimens from Puerto Real and Arroyo were identified as this species by Treadwell (1901: 199) from the Fish Hawk material. Specific distinctions are obscure in both *Lumbrinereis* and *Arabella* and it seems quite probable that renewed study of these genera in Porto Rico would show that they are not identical with those from the New England coast.

### LYSIDICE Savigny

### Lysidice sulcata Treadwell

FIGURE 72

*Lysidice sulcata* Treadwell (1901) 200, *fig. 47, 47a, 48;* (1921) 89, 90. *pl. 4, fig. 13–15; text-fig. 314–323.*

The prostomium (FIGURE 72) is lobed on the anterior margin and colorless or very lightly tinted with pink. The tentacles are shorter than the prostomium and are red, in life, throughout the greater part of their length, leaving the bases and apices uncolored. There is one pair of dark-brown eyes. The peristomium is about as long as the two following somites, but later somites are short. The body has a reddish coloration, which color persists in alcohol.

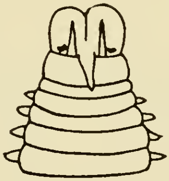

Figure 72. *Lysidice sulcata* Treadwell. × 12.

The parapodia have anterior and posterior setal lips, the dorsal cirri being rather slender. The ventral cirrus of the first parapodium is stout, but later ones are more slender, while in later somites the dorsal cirrus becomes very much reduced in size. The compound setae have small terminal joints with sharply defined apical and subapical teeth, the simple ones are straight and sharp-pointed, the pectinate have twenty or more fine teeth. The maxilla has short carriers to the forceps, which are noticeably bent at the ends. The proximal paired plates have each 3 teeth, the distal paired have 5 on the right and 3 on the left; the unpaired has 7.

In the Tortugas region this species was dredged near Loggerhead Key, and it was also dredged off Sand Key Light in Key West Harbor.

One was collected in rocks off Guanica Harbor, Porto Rico (Treadwell 1921). The Fish Hawk expedition collected it on reefs off Ponce, at Mayaguez Harbor in 22–33 fathoms, and off St. Thomas in 20–23 fathoms (Treadwell 1901). The type was described from specimens in the Fish Hawk collection.

Schmarda (1861: 121. *pl. 32, fig. 255*) describes as *L. brachycera* a species which may be synonymous with *L. sulcata* and if so, *L. brachycera* takes precedence. Schmarda's description is not sufficiently complete to make possible accurate comparisons. His specimen came from Jamaica. The Arcturus expedition found it at 17° 39′ N. 63° 17′ W. (Treadwell 1928).

### NICIDION Kinberg

#### Nicidion kinbergii Webster

FIGURE 73

*Nicidion kinbergii* Webster (1884) 320. *pl. 12, fig. 81–88.*—Treadwell (1911) 7–9. *fig. 15–22;* (1921) 91–93. *pl. 6, fig. 5–8; text-fig. 324–332.*

A small species, abundant in the coral rocks. It was first described by Webster on specimens from Bermuda, and his description has been extended and corrected by Treadwell (1921). The color is very variable, but is in general a pale-straw, with in most cases a consider-

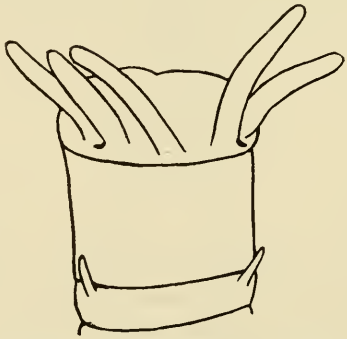

Figure 73. *Nicidion kinbergii* Webster.

able amount of reddish-brown pigment. Through the median region the body is very apt to be colored dark by the intestinal contents. The dorsal blood-vessel is very prominent. The apices of the tentacles are white, and the dorsal surface of the peristomium may be covered with blotches of brown and yellowish-white. As a rule, the dorsal surfaces of somites 4 and 5 are uncolored, but in one case it was somites 6 and 7 that were marked in this way. On the dorsal face of the peristomium are two colored bands forming an X-shaped figure, leaving an uncolored patch just behind the median tentacle.

The prostomium is bilobed, though this lobing does not show from the dorsal surface (FIGURE 73). The peristomium is as long as the following three somites, and somites immediately behind this are short. Toward the posterior end of the body there is a noticeable increase in the somite length. The tentacles are nearly of equal length and not longer than the peristomium. There is one pair of black eyes.

The first few parapodia are small and have prominent dorsal and ventral cirri. Later ones have a much larger setal portion and ventral cirrus, the latter with a much swollen base. In posterior somites the two cirri are very small. The nuchal cirri are shorter than the peristomium.

The maxilla is light-brown and has dark patches between the two portions and along their inner edges. The proximal paired plate has 4 teeth on the left and 6 on the right, the distals have 8 and 5 respectively, the unpaired has 7.

Webster gave no specific locality for his specimen. It is abundant in Bermuda, Tobago, the Dry Tortugas, and Montego Bay, Jamaica, wherever there is decaying coral rock as in the surface layer bored by sponges. Some were collected in sponges in the Tortugas. It was collected also by R. W. Miner, H. Mueller and R. C. Osburn at Guanica Harbor, Parguera, and Guayanilla Harbor in Porto Rico (Treadwell 1921). It did not appear in the Fish Hawk collections. The Arcturus expedition collected it at 100 D. 1. (Treadwell 1928). This is a dredging locality.

### Nicidion breve Ehlers

FIGURE 74

*Nicidion brevis* Ehlers (1887) 98, 99. *pl. 28, fig. 9–14; pl. 29, fig. 1, 2.*

Ehlers' description of this species is given only in his Latin diagnosis, and omits the further description in German, which he gives for most of his Florida species. His figure of the anterior region is reproduced here (FIGURE 74). According to the diagnosis the prostomium is bilobed and carries two eyes. The tentacles are short and thick, indistinctly articulated and do not extend as far as the fourth somite. The prostomium is longer than succeeding somites and the nuchal cirri do not reach the anterior peristomial border. His description of the setae would correspond with that noted for *N. kinbergii*.

The maxillae are delicate in texture, and have short carriers to the forceps. The proximal plates have 5 teeth on either side, the distals have 4 each, and the unpaired has 3. The mandible has a broad marginal wing on either side, which is drawn out into fine fringes.

Ehlers' specimens were taken at Key West (1887). The Fish Hawk expedition collected it at Station 6085, Mayaguez, Puerto Real,

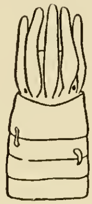

Figure 74. *Nicidion breve* Ehlers. × 6. After Ehlers.

Caballo Blanco Reefs, and Ensenada Honda (Culebra) (Treadwell 1901). A reexamination of these specimens and a comparison of them with *N. kinbergii* would be interesting, as it is not impossible that they are really of the latter species.

### MARPHYSA Savigny

#### Marphysa regalis Verrill

Figure 75a, b, c

*Marphysa regalis* Verrill (1900) 636–637.—Treadwell (1921) 66–69. *pl. 5, fig. 9–12; text-fig. 224–234.*
*Marphysa fragilis* Treadwell (1911) 2–5. *fig. 1–7.*

Characteristically found in soft coquina stone, in which it occupies a burrow just large enough to hold the animal. There is a considerable amount of variation in the body-coloration, but the general appearance is unmistakable. The anterior and ventral surfaces of the prostomium are white, while its dorsal surface as far as the bases of the tentacles is brown, with more or less white between the bases of the tentacles. There is a brown ring around each of the unpaired and inner paired tentacles at its base. The eyes are small and deep-purple. There are brownish rings on the tentacles, but they are not articulated. Treadwell (1921: 67), reported that specimens collected in Porto Rico were more pigmented than were those from the Dry Tortugas, the former having a darker-brown pigmentation on the dorsal surface, except for somites 10, 11, and 12, which were colorless. The latter are much less pigmented, the peristomium brown with pearly white spots; the next three somites are colored like the prostomium and each has a white spot in the mid-dorsal line. These median white areas continue in an irregular fashion to the posterior end of the body. Somites 10 and 11 are white, but sometimes this extends on to 12, in such cases being correspondingly withdrawn from 10. The posterior end of the body is apt to have a bluish tint. In Porto Rico specimens, but not in others, there is a transverse brown band on the ventral surface of the last 40 somites.

The length of the body may be as much as 150 mm., with a maximum width of 7 mm. They are very apt to break when handled, and since they often show regenerating posterior ends it seems probable that they are often broken under normal conditions.

The prostomium (FIGURE 75a) is bilobed with a rather broad depression between the lobes. The tentacles extend only a short distance beyond the prostomium. In a relaxed condition, the peristomium is considerably longer than broad.

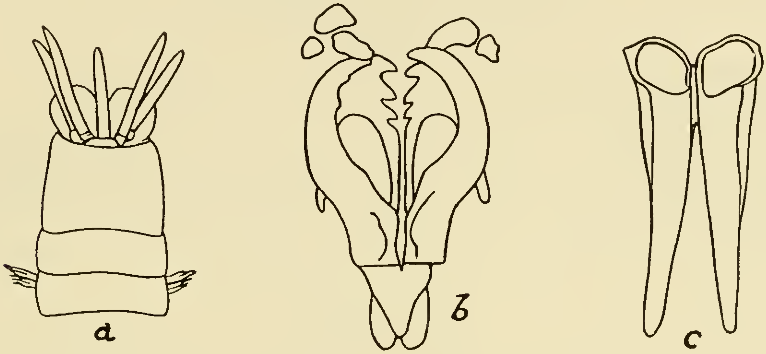


Figure 75. *Marphysa regalis* Verrill. a. Head. × 7.5. b. Maxilla. × 10. c. Mandible. × 10.

A characteristic feature of the anterior parapodia is the sagittate outline of the dorsal cirri. The parapodia from the third to the twenty-fifth somites have pad-like swellings on the ventral face of the ventral cirrus. Simple setae have long shafts which bend slightly toward the ends and then taper to sharp points. On the convex surface of each is a marginal wing. Compound setae have narrow terminal joints, each with a small terminal and sub-terminal tooth, the apex of the basal portion marginally toothed. The pectinate setae have about twenty teeth. The maxilla (FIGURE 75b) is dark-brown with the margins of the plates more or less covered by a whitish incrustation. The proximal plates have 3 teeth on each side, the distal paired have 4 on the left and 7 on the right, the unpaired has 6. The mandibles (FIGURE 75c) are long and slender, light-brown with darker edges, and the terminal plates are pearly-white.

The gills begin on somites 16–19. The anterior one has only one or two branches, but the number increases to five in later somites. They are most prominent in somites 20–50, being long enough to meet over the dorsal mid-line.

Verrill (1900) stated that his Bermuda specimens reached a length of 400 mm. This is considerably larger than any I have seen, but the difference may be due to different degrees of expansion. The species is abundant in Bermuda (Treadwell 1921), (Treadwell 1936: 57). It was also found in the Dry Tortugas, at Tobago, and in Porto Rico in Condado Bay and Guanica Harbor by R. W. Miner and the author (Treadwell 1921).

### **RHAMPHOBRACHIUM** Ehlers

#### **Rhamphobrachium agassizii** Ehlers

FIGURE 76

*Rhamphobrachium agassizii* Ehlers (1887) 70–73. *pl. 17, fig. 1–5; pl. 18, fig. 1–9.*

The extension forward by the sides of the prostomium of the first three parapodia is a distinguishing feature of this genus. Equally characteristic is the group of very long and slender setae with bent ends, which extend forward from each of these parapodia. FIGURE 76, taken from Ehlers, is a dorsal view of the head. The cirrophores of

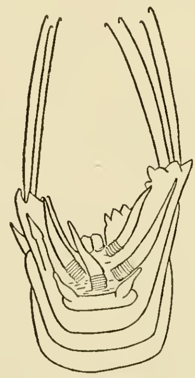

Figure 76. *Rhamphobrachium agassizii* Ehlers. × 7. After Ehlers.

the tentacles are annulated and the styles of the tentacles are relatively short, hardly reaching to the ends of the parapodia. The left paired tentacle is not represented. The frontal tentacles are two almost globular bodies on the anterior margin of the prostomium. The nuchal cirri are flask-shaped bodies posterior to the lateral paired tentacles. On the left of the figure the dorsal cirri of the first parapodia are seen as small flask-shaped bodies far out on the parapodium. The dorsal cirri are shown only on the left.

On the fourth parapodium the extension forward abruptly ceases and from here they all have normal appearance. The dorsal cirrus is flask-shaped as in the first parapodia and the ventral one of anterior somites globular. In later somites this disappears entirely (see Ehlers' *fig. 8* and *9*, *pl. 18*). On parapodia behind the sixteenth, gills appear as four or five branched bodies on the dorsal surface of the parapodium.

Aciculae in anterior somites are smoothly rounded on the ends, posterior ones have two strong hooks at the end, covered by a hood. The long setae of the first parapodia are very strongly hooked, and in later somites there are bilimbate and pectinate forms. The maxilla has a heavy base and very numerous teeth on all of the plates.

The tubes in which the animals live are composed of soft papyrus-like material which may be covered by foraminiferal or other fragments.

Description from Ehlers. It was collected by the Johnson-Smithsonian expedition at Station 67.

### **HYALINOECIA** Malmgren

#### **Hyalinoecia branchiata** Treadwell

FIGURE 77a, b

*Hyalinoecia branchiata* Treadwell (1934) 6–8. *pl. 2*, *fig. 17–19*.

The specimens were assigned to this genus because of the absence of nuchal cirri. The prostomium (FIGURE 77a) has a width about equal

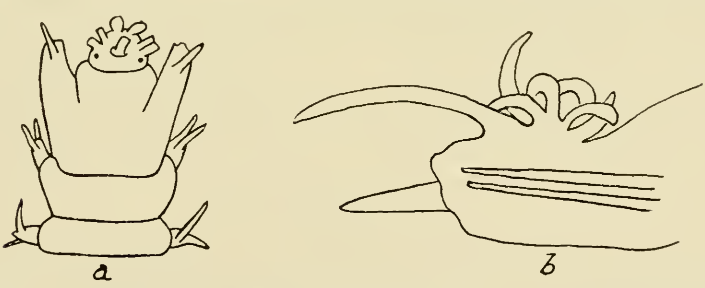


Figure 77. *Hyalinoecia branchiata* Treadwell. a. Head. × 5. b. Parapodium.

to twice its length and carries short tentacles. The style of the median tentacle was lost from the type but those of the inner paired tentacles extend to somite 10, those of the outer paired being about one-quarter as long as these. The parapodia of the first somite extend almost to the anterior prostomial border, those of the second extend forward but are shorter than in the first, while those of the third are similar to those in the remainder of the body. The gills are in the form of filaments attached to the parapodia. On the sixteenth parapodium there are six palmately arranged ones (FIGURE 77b). Of the setae, those on the first parapodium are hooked, having large terminal and much smaller sub-terminal teeth. On other somites are somewhat similar ones having the ends covered by hoods.

*Hyalinoecia* tubes are generally slender and composed of a translucent substance the whole resembling a quill. Other polychaetes, however, have somewhat similar tubes hence it is not safe to assign every such tube to *Hyalinoecia*.

Collected north of Culebra Island by the Johnson-Smithsonian expedition (Treadwell 1934).

## Family **GLYCERIDAE**

The members of this family have slender, often much elongated bodies, which are composed of many somites. In life they often have a reddish color because of blood in vessels just under the skin, but there is little pigmentation. The prostomium is an elongated cone which is divided into a number of joints and which carries four tentacles at the apex, these tentacles themselves sometimes being jointed. Eyes may, or may not, be present. The somites are generally annulated and the parapodia are either uniramous or biramous, being constant in this respect in any one genus.

A characteristic feature of the members of this family is the proboscis, a muscular organ which can be protruded from the mouth often to a considerable distance. It is provided at the end with four chitinous hooks and its surface is more or less covered with papillae. A row of papillae extends around the outer end of the proboscis. Gills are present in some species but absent in others. In some, the gills may be drawn into the body wall and thus give a false impression of absence. As a rule they live in sandy mud at moderate depths.

The only genus of the family which has been recorded from Porto Rico is *Glycera* which has a biramous parapodium and a long proboscis devoid of any hard dentate processes among the papillae.

### **GLYCERA** Savigny

#### **Glycera abranchiata** Treadwell

FIGURE 78

*Glycera abranchiata* Treadwell (1901) 200–201. *fig. 49.*

The prostomium is of the usual conic form, not noticeably segmented and is about one-third as long as the extended proboscis. There are four delicate tentacles. The proboscis is smooth at its base, but is covered for the greater part of its length by minute papillae and there is a row of larger papillae at the distal end. There are four strong, black teeth.

The somites are biannulate and increase gradually in width up to about the twenty-fifth which is five times as broad as it is long. From this point there is a decrease in width, later somites being as long as they are broad. The parapodia when fully developed protrude

Figure 78. *Glycera abranchiata* Treadwell.

noticeably from the body surface and carry two long pointed anterior, and much thicker and shorter posterior lobes. The ventral cirrus is attached to the middle of the ventral posterior lobe, the dorsal one being on the body wall above the parapodium (FIGURE 78). The dorsal setae are simple, long, smooth and curve to acute points. The ventral ones are compound, their terminal joints long and tapering and slightly curved carrying minute denticulations along their concave margins. There are no gills.

Collected by the Fish Hawk at Arroyo (Treadwell 1901) and by the Arcturus expedition at 17° 39′ N. Lat. 63° 17′ W. Long. (Treadwell 1928: 473).

### Glycera tesselata Grube

FIGURE 79

*Glycera tesselata* Grube (1863) 41. *pl. 4, fig. 4.*—Ehlers (1868) 654–656. *pl. 24, fig. 2, 9, 33, 34.*

The following description taken from Ehlers. The body is slender, colored brown with white markings and has about ninety somites. The prostomium (FIGURE 79) is divided into thirteen distinct rings and carries four short tentacles. Ehlers describes and figures a bunch of short hairs on either side of each ring which he states are visible only in the living condition. All body somites are biannulate. The parapodia are long and have long anterior and posterior lips much as has *G. abranchiata.* The dorsal cirrus is carried on the body wall at a little

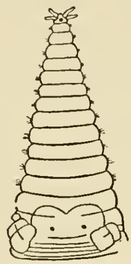

Figure 79. *Glycera tesselata* Grube.

distance from the surface of the parapodium. The proboscis is short and thick, the papillae all alike, slender and sharp-pointed.

Collected by the Fish Hawk at Stations 6065, 6066, Ensenada Honda (Culebra) and Puerto Real (Treadwell 1901).

## FAMILY ARICIIDAE

Elongated annelids the body generally flattened dorsally and convex ventrally, bluntly pointed anteriorly and more sharply pointed at the posterior end. The prostomium is cone-shaped, and neither it nor the peristomium has any appendages. Eyes may, or may not, be present. The parapodia are attached nearer to the dorsal than to the ventral surface of the somite, and in some cases the posterior ones are more nearly dorsal than are the anterior. Gills begin on one of the first twenty somites and continue throughout the body as a ligulate process on either side of the dorsal mid-line. They at first are very short but later ones reach a considerable size. The Ariciidae occur in shallow water but may be found at considerable depths.

Key to Genera recorded from Porta Rico

A. Prostomium conic. Gills never with transverse filaments ........... *Scoloplos.*
AA. Prostomium anteriorly rounded ................................ *Nainereis.*

### SCOLOPLOS Blainville

**Scoloplos cirratus** (Treadwell)

Figure 80a, b

*Aricia cirrata* Treadwell (1901) 201–202. *fig. 54–57.*

The identification of this species as *Aricia* was corrected by Treadwell (1931: 4, 5), after an examination of a specimen collected at Montego Bay, Jamaica. The ventral surfaces of the parapodia are not connected across the mid-ventral line by a lamination, as is the case in *Aricia.* The prostomium is acute (FIGURE 80a) and has no eyes. In the original description as shown in FIGURE 80a the peristomium is as long as the following two somites. It is probable (see Treadwell 1931) that what was originally figured as one somite is really two. The body is narrow anteriorly but rapidly widens so that at the posterior end its width is nearly four times that of the anterior portion. The dorsal surface is flat, the ventral rounded. On the first sixteen somites there is a wide dorsal space between the two parapodia, but behind the sixteenth this space narrows very noticeably.

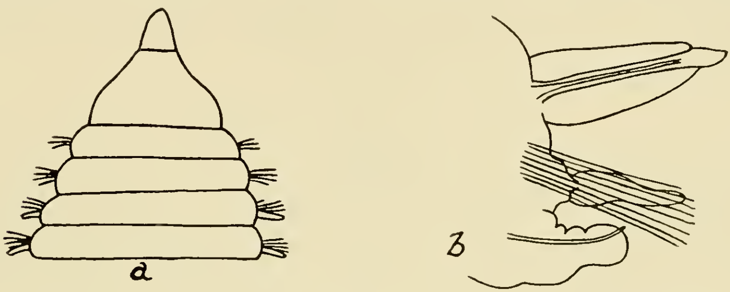


Figure 80. *Scoloplos cirratus* (Treadwell). a. Head. × 12. b. Parapodium.

The anterior parapodia are uniramous, have cylindrical dorsal cirri and two bundles of setae the dorsalmost ones being very long and capillary with finely toothed margins. In the ventral bundle are a few of these capillary setae but most of the bundle is composed of stout, slightly curved, brown-colored setae. In a somite ranging between the twelfth and the twentieth (FIGURE 80b) a cylindric ramus appears in which occur a few of the stout setae. Aside from being a trifle stouter, setae of the posterior region are similar to those of the anterior.

The gills appear on the twelfth to the sixteenth setigerous somite. They are very small at first but increase in size up to the twelfth which is full size. Posterior to this the size remains quite constant. They are very prominent, flat, and have acute tips.

The Fish Hawk expedition collected this species at Stations 6061, 6066, and 6067 (Treadwell 1901).

### NAINEREIS Blainville

#### Nainereis ramosa (Schmarda)

*Anthostoma ramosum* Schmarda (1861) 62.

Identified with some doubt by Treadwell (1901: 203) from the brief description given by Schmarda. The prostomium is rounded, almost semicircular in outline. The proboscis is in the form of three broad plates one being much larger than the other two. Each plate is much subdivided and is colorless at the base though dark-brown at the apex. As far back as somite 34, the body is much flattened and the gills are short, leaving a large part of the dorsal surface uncovered. Behind this point the body becomes narrower as if the sides had rolled upward, and the gills are longer so that they cover the greater part of the dorsal surface. The gills begin on setigerous somite 4. Anteriorly there are from 9–13 stout setae in each somite, but this number is reduced at the posterior end.

Schmarda's material came from Jamaica. Webster (1884: 321) described it from Bermuda. The Fish Hawk collected it at Arroyo and at Boqueron Bay (Treadwell 1901).

**Nainereis latacapitata** (Treadwell)

FIGURE 81

*Anthostoma latacapitata* Treadwell (1901) 203, 204. *fig. 61–65.*

The prostomium is nearly four times as broad as it is long, its anterior end being nearly straight, with rounded antero-lateral angles. The peristomium is twice as wide as the prostomium, the first setigerous somite a little wider than the peristomium and succeeding somites retain this width to about somite 25 (FIGURE 81).

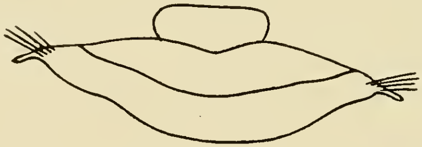

Figure 81. *Nainereis latacapitata* (Treadwell). × 18.

Behind this point the body is narrower than anteriorly but of fairly uniform width throughout. The parapodia as far back as somite 23 have dorsal and ventral post-setal lips, the former asymmetrically lanceolate on a narrowed base, the latter a vertical plate whose upper anterior angle is prolonged into a short cirrus. The gills begin on somite 6 and are linear with acute apices. In the posterior region they are much larger than anteriorly. The dorsal setae are long and slender and are marked by fine transverse lines giving them almost a jointed appearance. The ventral setae are stouter and have parallel V-shaped transverse lines. The ventral setae in posterior somites are not as numerous as anteriorly.

Collected by the Fish Hawk expedition at Hucares (Treadwell 1901).

## FAMILY PARAONIDAE

These in many respects resemble the Ariciidae but differ in lacking any camerated or cross striated setae. They may, or may not, have tentacles, and have sensory papillae on the end of the prostomium. The only genus of the family which has been recorded from Porto Rico is *Aricidea* which has a single median tentacle, biramous parapodia which carry dorsal cirri on all somites, but ventral ones only on anterior somites, and while most setae are slender, hooked ones occur in the posterior part of the body. Gills are limited to anterior somites.

### **ARICIDEA** Webster

### **Aricidea alata** Treadwell

FIGURE 82

*Aricidea alata* Treadwell (1901) 202. *fig.* 58–60.

The prostomium is rounded and carries two large irregularly shaped eyes (FIGURE 82). The first somite has parapodia with setae and a small dorsal cirrus. The cirrus is much larger on the second parapodium and this increase is continued in later somites so that they

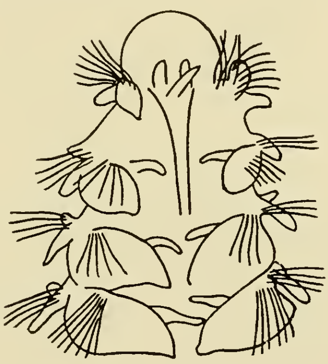

Figure 82. *Aricidea alata* Treadwell. × 28.

cover a large part of the dorsal surface. Beginning with the first and ending with the twenty-first, conic gills arise one on either side in each somite just dorsal to the margin of the cirrus. Anterior to each cirrus is a tuft of stout golden-colored setae. These are curved, taper gradually to a sharp apex and are longitudinally striated. In the posterior part of the body are large spines which have apical and subapical teeth at the outer ends both being covered by a hood.

One specimen was collected by the Fish Hawk expedition, at Arroyo (Treadwell 1901).

## Family GONIADIDAE

Elongate slender annelids superficially much resembling the Glyceridae in that the body is composed of numerous somites, there is a protrusible pharynx and the prostomium is divided into a series of annuli the terminal one bearing four tentacles. In the anterior body region the parapodia are uniramous, but throughout the median and posterior region they are biramous. In *Goniada*, the only one of the family yet recorded from Porto Rico there is on either side of the proboscis a row of V-shaped black chitinous plates located near its base.

### GONIADA Audouin & Milne-Edwards

#### Goniada oculata Treadwell

FIGURE 83

*Goniada oculata* Treadwell (1901) 201. *fig. 50–53.*

The prostomium has ten segments and there are two pairs of eyes, one in the basal segment and one in the eighth. On the tenth segment are four tentacles the basal joint of each being longer than the segment. The terminal joint of the tentacle is much smaller than the

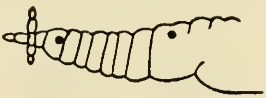

Figure 83. *Goniada oculata* Treadwell. × 26.

basal (FIGURE 83). The anterior parapodia are uniramous with rounded-flat dorsal and ventral cirri. The dorsal cirrus is shorter than the parapodium, the ventral one is somewhat longer. At about the thirty-sixth parapodium, a dorsal ramus makes its appearance. This is small and carries only a few setae. The compound setae have very long and slender terminal joints, though the length of these varies in different parts of the parapodium.

The color in alcohol is light brown with a red spot in the center of each somite on the ventral surface.

Collected by the Fish Hawk expedition at Station 6064 (Treadwell 1901).

## Family CHAETOPTERIDAE

The members of this family are all very highly specialized as to structure, the body being divided into two or three divisions, of which the anterior is the most sharply defined. This generally is composed of from nine to fourteen somites and has a small and very inconspicuous prostomium which carries no appendages but often has eyes.

On the peristomium is a collar which extends over the prostomium and often completely obscures it. The peristomium has a pair of long and usually grooved tentacles. In addition, there is sometimes a pair of second appendages, sometimes called tentacles but in reality they are modified parapodia and sometimes they carry setae.

In the anterior division of the body the somites are all alike, each carrying a uniramous parapodium, the neuropodium being absent. Its dorsal surface is marked by a longitudinal groove which also extends over the greater part of the body length. In the posterior region of the body the parapodia are biramous. Thoracic setae are generally lanceolate in form, while those in the neuropodia of the other regions are uncini with toothed margins.

Chaetopterids generally occur in shallow water living in parchment tubes which are bent in U shapes so that both ends of the tubes come to the surface of the sand or mud. By means of cilia in the dorsal groove a current of water is kept going through the tube. The tubes may be branched.

Key to Genera recorded from Porto Rico

A. Body divided into 3 regions.
  B. Peristomium with 1 pair of tentacles. Median region consists of 5 somites of which the first has separate notopodia while in the others the notopodia are united across the dorsal surface to form fins.... *Chaetopterus.*
  BB. Peristomium with a second pair of small tentaculariform processes..... *Phyllochaetopterus.*

## CHAETOPTERUS Cuvier

### Chaetopterus variopedatus (Renier)

Figure 84

*Tricoelio variopedatus* Renier (1804).
*Chaetopterus variopedatus* Claparède (1869) 78.

One of the most aberrant of the polychaetous annelids. The body is divided into three distinct regions, the anterior, median, and posterior. At the anterior end the body expands into a broad "buccal funnel" within which the mouth opens. At the dorsal ends of the lips of this funnel there is a slender tentacle on either side (figure 84). A small brown eye lies at the base of each tentacle. The nine following somites are setigerous, their parapodia being represented only by notopodia. The middle region covers somites 12 to 16 inclusive. On the twelfth, on either side, is a long prominent notopodium and on the ventral surface of this somite is a sucking disc. A dilated intestine (dark green in life) appears on the posterior margin of somite 12. Somites 14, 15, and 16 have the form of round biconvex discs which are held together by a central stalk. These are the "palettes" which by waving back and forth act as fans in keeping a current of water in motion through the tube in which the animal lives. The posterior portion of the body which may comprise as many as 500 somites in large specimens is more normal in appearance than either of the other portions. Each somite has a conic notopodium extending dorsally and may be distended with sex products.

The tubes of *Chaetopterus* are also characteristic, composed of a parchment material and bent in a U shape so that both ends open to

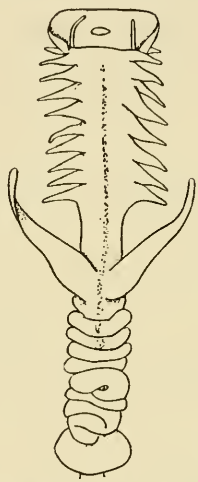

Figure 84. *Chaetopterus variopedatus* (Renier). × 1.

the surface. The "neck" at each opening is narrower than the remainder of the tube. In some unusual cases a third opening may occur at the end of a lateral tube branching off from the main one.

*C. variopedatus* occurs along the Atlantic coast from Woods Hole southward being especially abundant at Beaufort, North Carolina. It had often been listed as *C. pergamentaceus*, but Enders (1909: 481) gives reasons for thinking that is synonymous with *variopedatus*. It has never been taken in any of the expeditions to Porto Rico and the sole record of its occurrence there are specimens collected in Condado Bay by Mrs. Ana M. Diaz Collazo and Rosa N. Haydon in March 1933, and sent me by Mrs. Collazo for identification in January of 1934. Munro (1933: 1050) lists tubes from "Tabogo; Galapagos, James Is. James Bay; Onslow Is.; Albemarle, Tagus Cove; Gorgona Is." A few of these tubes contained fragments which Monro thought probably belong to this species.

### PHYLLOCHAETOPTERUS Grube

#### Phyllochaetopterus claparedii McIntosh

FIGURES 85, 86a, b, c

*Phyllochaetopterus claparedii* McIntosh (1885) 374–378. *pl. 45, fig. 9–11; pl. 46, fig. 1; pl. 24a, fig. 1–5.*—Treadwell (1901) 205, *fig. 68, a, b, c.*

The Fish Hawk expedition collected at Stations 6055 and 6075 some tubes containing fragments of animals, which Treadwell provisionally listed as of this species. His material was not, however, sufficient in either amount or preservation to allow of accurate diagnosis. The following is taken from McIntosh.

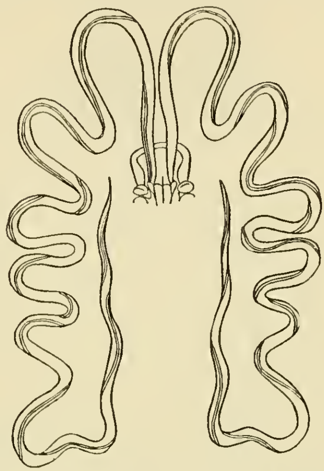

Figure 85. Head of *Phyllochaetopterus claparedii* McIntosh.

The anterior region of the body (FIGURE 85) has an enlarged truncate snout whose anterior margin is shaped like a horse's hoof with the hollow looking upward. The elongated tentacles arise behind the sides of the hoof. Just above the insertion of each of these is a short


Figure 86. *Phyllochaetopterus claparedii* McIntosh. a, b, and c. Types of setae.

clavate tentacle. There are nine somites in the first region of the body which is concave dorsally and convex ventrally. A narrow elevated ridge runs lengthwise through the centre of the dorsal groove. On either side is a row of nine pad-like tori carrying setae which are unsymmetrically spear-headed in outline. McIntosh records that the middle region of the body is similar to that of the typical form.

FIGURES 86 a, b, c are of setae from the Porto Rico specimens and do not entirely agree with McIntosh's description of *P. claperedii*. These details are recorded here for reference in case more material should become available. It is quite possible that if such material should appear, it would be found to belong to a distinct species.

## Family SPIONIDAE

Small annelids whose bodies are composed of numerous somites. The prostomium is small, in the form of a narrow band, which may extend as far caudally as the fourth somite, but generally goes only as far as the second. There are generally four eyes, but the number may vary, or eyes may be absent. There are no tentacles. The most characteristic feature of the family is the pair of elongated palps which look much like tentacles. They are easily lost, but their points of origin can generally be seen as definite scars. There are no setae or processes on the peristomium.

The setae are either fine capillary or stout hooded crotchets both on the same parapodia, which are all biramous. In some genera paleae occur on the fifth somite. Posterior to the setigerous part of the parapodium is a lamella whose dorsal free end is bluntly pointed. The gills are generally present in the form of ligulate structures dorsal to the parapodial lamellae with which they may be fused.

Almost entirely littoral in distribution.

The only genus thus far described from Porto Rico is *Aonides* in which the fifth somite is not especially modified, there are no prostomial processes and gills begin on the second somite. There are crochets in the notopodia and anal cirri.

### AONIDES Claparède

### Aonides cirrata Fauvel

FIGURE 87

*Aonides cirrata* Fauvel (1914) 220–222. *pl. 20, fig. 4–9.*

The prostomium (FIGURE 87) is rounded on the anterior face and has a slight furrow on either side. There are two groups of eyes. There is a median occipital "tentacle" and a long sinuous caruncle which extends throughout the greater part of the gilled region. In Fauvel's specimen the palps had disappeared but their scars were easily seen. The first parapodium had two small elevations carrying capillary setae but no gills. Gills begin on the second setigerous somite and extend for forty-two somites. The gills are longer than the dorsal parapodial lobes and are distinct from them throughout.

The anterior parapodia have a long gill, a large ear-shaped dorsal lamella and a much more rounded ventral one. Both branches of the

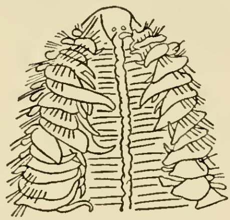

Figure 87. *Aonides cirrata* Fauvel. × 5.

parapodium have capillary setae of which those in the notopodium are longer and more numerous. In the gilled region the gills and dorsal lamellae are prominent, but leave a portion of the dorsal body surface uncovered. Behind the forty-third somite, where the gills disappear, the dorsal lamella is much smaller and its pointed apex is laterally directed. Large hooded setae appear on the forty-fifth somite and continue in addition to the capillary ones.

Listed by Hoagland (1919: 576) as from Porto Rico. No further data are given but is listed as collected by A. L. Treadwell in which case it came either from Guanica or the vicinity of San Juan.

## Family **CIRRATULIDAE**

The body is generally elongated, consisting of a large number of somites. The prostomium is usually bluntly conical in outline and carries no appendages. There may, or may not, be eyes. The first three somites have no setae but both notopodial and neuropodial setae occur in later somites. There are no parapodia hence the setae arise direct from the body surface. On the dorsal surface of some somites are large tentacles, and slender thread-like gills arise in a dorso-lateral position along more or less of the body. The only genus of the family which has been recorded from Porto Rico is *Cirratulus* in which the body color is generally some shade of green or brown. The most characteristic feature is the row of long slender gills appearing along the lateral line of the body as filaments often longer than the body diameter. While not occurring on every somite they are generally found throughout the body though more thickly grouped toward the anterior region. They are easily lost in the preservation and absence may be due to such loss. Usually on the dorsal surfaces of the fifth and sixth somites, but sometimes on others, there is a transverse row of larger cirri which sometimes are heavier than the lateral gills. Setae are of two kinds, capillary and crotchets, the latter often being heavy. The cirratulids live in mud, often in that containing putrid materials.

### CIRRATULUS Lamarck

#### Cirratulus melanacanthus Grube

*Cirratulus melanacanthus* Grube (1872) 31.—Ehlers (1887) 155, 156.

Our total information concerning this species is a very brief description by Grube, and a longer one by Ehlers. Neither gave any figures. It was listed by Treadwell (1901: 204) from a comparison of the Fish Hawk material with Ehlers' description and the following is taken from that. A characteristic feature is the presence (except in the most anterior ones), in each setigerous somite of a large very black crotchet. At first these occur in combination with capillary ones, but later the capillary disappear and a second crotchet takes their place. This double row of black crotchets on either side forms against the colorless body wall a very noticeable feature.

The prostomium is sometimes egg-shaped and sometimes more pointed, and extends forward over the broad mouth opening. The two first somites are without setae, and together are as long as the following five. The dorsal surface of the body is more or less rounded, the ventral flat. In anterior somites there is in each a dorsal and a ventral bundle of capillary setae, a ventral crotchet appearing first in somite 5. Later arrangements are as above indicated.

Gills appear on the seventh setigerous somite and extend throughout the greater part of the body. Behind somite 22 they do not appear in every somite, but Ehlers was unable to find any regularity in their distribution. The transverse row of cirri generally appears on the fifth somite but sometimes has been seen on the fourth or sixth.

Ehlers' specimens came from Key West (1887). The Fish Hawk material was collected at Guanica Bay (Treadwell 1901). The Barbados-Antigua expedition found one specimen at "Pillars of Hercules" (Treadwell 1924b: 16).

### **Cirratulus nigromaculatus** Treadwell

FIGURE 88

*Cirratulus nigromaculata* Treadwell (1901) 204. *fig. 66.*

The body is short, 10 mm. long and is less than 2 mm. in diameter. The prostomium is much narrower than somites immediately behind it, but decidedly thick. The somites are very short and their limits are hard to see in preserved material. The gills are very delicate

Figure 88. *Cirratulus nigromaculatus* Treadwell. × 5.

structures and it was not possible to give the normal number. In the type there were only five, but the last arose near the beginning of the posterior fourth of the body. The cirri lie on somites 5 or 6, or possibly on both. They are relatively heavy (FIGURE 88) and are as long as the body diameter.

The dorsal surface is brownish in color, the ventral colorless. The whole body is spotted with black marks which are especially numerous along the dorsal surface. The cirri are white with numerous black bands. The gills are covered with numerous brown spots.

Collected by the Fish Hawk at Ensenada Honda (Culebra) (Treadwell 1901). One specimen was taken by the Barbados-Antigua expedition at Station 25256 (Treadwell 1924b: 16).

### **Cirratulus elongatus** Treadwell

FIGURE 89

*Cirratulus elongatus* Treadwell (1901) 204. *fig. 67.*

The prostomium is short and conic, and the three following somites are each about twice the length of somites posterior to the third (FIGURE 89). They do not carry setae. Setae appear first on the fourth somite. This somite is abruptly wider than the third, and succeeding somites increase in width as far as the tenth, then there is a slight decrease, and then uniform width to the posterior end. There are no eyes. In the single specimen from which the species diagnosis

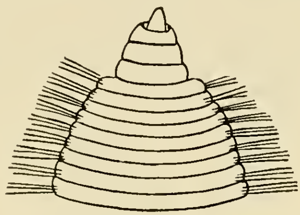

Figure 89. *Cirratulus elongatus* (Treadwell). × 12.

was written there were only a few gills, most having been broken off. Those that remained were long and slender. The setae are in two rows all delicate capillary. No mention is made of any crotchets.

Collected by the Fish Hawk expedition at Ensenada Honda (Culebra) (Treadwell 1901).

## Family **OPHELIIDAE**

Small annelids, the number of somites generally between 25 and 40. The prostomium is not very greatly differentiated and is either rounded or conical in front, often with a median tentacle-like prolongation. The peristomium is generally setigerous and may have setigerous papillae. The body often has a smooth appearance in which it is not easy to distinguish the somite boundaries, or it may be annulated between the true somite grooves. In some genera there are eye spots along the lateral margins. The parapodia are really biramous, but the two rami are often confluent. The notocirri generally appear as gills occurring over more or less of the length of the body. Neurocirri are not generally present. The setae are all capillary and may be smooth, limbate, or serrulate. The proboscis is often protrusible and then appears as a button with folded margins.

Some of the opheliids live in pure sand in association with *Amphioxus* with which they have a very great degree of purely superficial resemblance. *Ammotrypane,* the only genus reported for Porto Rico, is a very active form in both sand and water.

### **AMMOTRYPANE** Rathke

#### **Ammotrypane fimbriata** Verrill

Figure 90

*Ammotrypane fimbriata* Verrill (1874) 604. *pl. 15, fig. 79.*

The body is smooth and slender, thickest in front of the middle and tapering to both ends (FIGURE 90). The ventral surface is flattened and has rounded margins which are separated from the lateral regions by deep grooves. The prostomium is very acute and has two small black eyes. The gills are long and slender, one on either side in each somite. The anterior setae are longer than half the body diameter, but posterior ones are shorter. The caudal appendage is spoon-shaped,

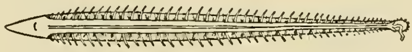

Figure 90. *Ammotrypane fimbriata* Verrill.

fringed along its outer margin by small slender papillae. From near its base arise two slender cirriform processes and a longer one is generally concealed in its cavity.

Description from Verrill, whose material was collected from Buzzards Bay, Massachusetts, to Bay of Fundy. Treadwell (1901) identified it in the Fish Hawk material, the only difference being that the Porto Rico material did not have eyes. It was taken at Ensenada Honda (Culebra), and at Stations 6093, 6092, 6096, and 6098.

## Family MALDANIDAE

The body of the maldanids is smooth, and of nearly uniform diameter throughout, the somites being long and few in number, rarely over thirty in all. There are no appendages on the prostomium which is sometimes obliquely truncated, this truncated surface surrounded by a raised margin which may be entire or broken into several parts, and there is a longitudinal median keel on the dorsal surface. On either side of this keel is a nuchal furrow. The peristomium has no setae, and is fused with the prostomium. The parapodia are biramous.

Notopodial setae are capillary and variable in form. The neuropodial ones are crotchets and are arranged in either single or double rows along the side of the body. Toward the end of the crotchet is a narrowed neck beyond which are teeth, the largest one at the end curving toward the neck. Under the large tooth is a hair or tuft of hairs.

Maldanids live in thick walled tubes usually composed of mud.

### Key to Genera recorded from Porto Rico

A. Cephalic plate present.

  B. Anal depression, from the bottom of which a cone arises, funnel-shaped.

    C. Ventral setae on somites 1–3 numerous . . . . . . . . . . . . . . . . . *Paraxiothea.*

    CC. Ventral seta on somites 1–3 single . . . . . . . . . . . . . . . . . . . . . . *Euclymene.*

  BB. Anal cirri present. Free cephalic margin well developed . . . . . . *Maldanella.*

**PARAXIOTHEA** Webster

**Paraxiothea torquata** Verrill

FIGURES 91a, b

*Clymenella torquata* Verrill (1874) 608. *pl. 14, fig. 71–73.*

A slender species, in life usually colored pale red with bright red bands around the somites. It lives in tubes made of fine white sand around the roots of eel grass. A characteristic feature is a collar on

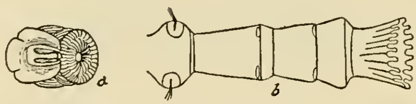

Figure 91. *Paraxiothea torquata* Verrill. a. Head. b. Anal funnel. After Verrill.

the fifth somite. FIGURE 91a is Verrill's drawing of the prostomium and protruded pharynx as seen from a front view and FIGURE 91b also taken from Verrill, represents the posterior body somites and anal funnel. The character of the setae was not recorded by Verrill.

Collected by the Fish Hawk on Playa de Ponce Reef, and an anal funnel was taken at Station 6055 (Treadwell 1901).

**EUCLYMENE** Verrill

**Euclymene cirrata** (Ehlers)

FIGURE 92

*Clymene cirrata* Ehlers (1887) 182–185. *pl. 46, fig. 10–13.*

The prostomium is truncated in the usual fashion and is surrounded by a well developed marginal lip which is divided into a posterior and two lateral portions by a depression on either side. The lateral lips when seen from above extend outward, and the posterior one partly

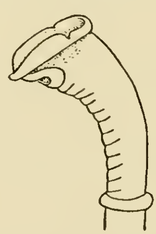

Figure 92. *Euclymene cirrata* (Ehlers). × 6.

covers over the posterior surface of the truncated portion (FIGURE 92). The dorsal ridge is prominent, its anterior end protruding slightly from the anterior margin. The peristomium is fused with the prostomium and this with the first setigerous somite. The somites are more or less elongated, all except the anal being setigerous. The anterior end of the second setigerous somite forms a collar around the posterior end of the first, and between the second and the third there is a definite depression. In later somites the separating groove is not so obvious. The anal opening is in the center of a conic elevation at the very end of the body, and an elevated rim surrounds the posterior margin of the last somite. On either side are two long, slender anal cirri.

The capillary setae are limbate, the ventral uncinate, the latter having a large tooth just beyond the "neck," and this followed in turn by four others decreasing in size toward the apex. A bunch of hairs extends from the bottom of the large tooth.

Ehlers' specimen was taken off Carysfort Reef. The Fish Hawk collected several anterior fragments at Stations 6055 (Treadwell 1901).

### **Euclymene cingulata** (Ehlers)

FIGURE 93

*Clymene cingulata* Ehlers (1887) 185–188. *pl. 47, fig. 2–5.*

The prostomium is bent antero-ventrally so as to lie like a hood over the mouth (FIGURE 93), and there is no surface distinction to be made between the prostomium, peristomium and first setigerous somite. Toward the posterior end of each of the first, second, and third somites is a seta tuft composed of a dorsal bundle of capillary setae and

Figure 93. *Eyclymene cingulata* (Ehlers). × 6.

a ventrally placed stout hook. Beginning with the fourth, the seta tuft lies toward the anterior end of the somite and each tuft contains dorsally the capillary setae and ventrally a number of uncini of the usual form each having a "neck" near the end and beyond this one large tooth followed by a succession of smaller ones. The fourth somite is different from all of the others in that on its anterior end it carries a thin collar which overlaps the posterior end of the third. This is longer on the ventral than on the dorsal surface.

Ehlers' diagnosis was based on two specimens collected at 24° 08′ N., 82° 51′ W. It was taken by the Fish Hawk in Porto Rico at Station 6069 (Treadwell 1901).

### MALDANELLA McIntosh

#### Maldanella fimbriata Treadwell

FIGURE 94

*Maldanella fimbriata* Treadwell (1934) 8, 9. *pl. 2, fig. 22–24.*

As in other genera of this family the dorsal surface of the prostomium makes an angle of about 45° with the main body axis. Around the margin of this "cephalic plate" is a raised rim. In this species this rim is divided into three parts. The anterior portion is smooth and rounded and occupies only the anterior margin. The posterior portion is thicker and heavier than the anterior and extends nearly half way

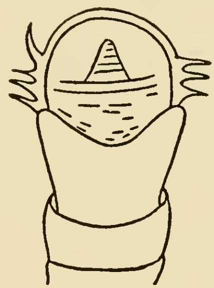

Figure 94. *Maldanella fimbriata* Treadwell. × 12.

around on either side. Connecting these two is a much thinner membrane whose margin is drawn out into sharp pointed lobes. In front of the posterior marginal wall is a rather deep depression, while farther forward the surface is only slightly depressed. A central ridge extends backward from the anterior part of the head plate, but goes only about half way to the posterior margin (FIGURE 94).

Setae begin on the second somite. This somite around its entire anterior margin, overlaps the first somite, forming a collar. At the posterior end of the body is an "anal funnel" which has a two-lobed dorsal portion and a single lobed ventral one. On the dorsal lip are a few slender cirri.

Collected at Station 35 by the Johnson-Smithsonian expedition (Treadwell 1934).

## Family CHLORHAEMIDAE

The members of this family are all small, rarely more than 70 to 80 mm. in length. The most noticeable feature is that the body is covered by a closely adherent thin layer of sand grains held in place by a mucilaginous secretion. Imbedded in this layer are papillae which remain in place, if the sand layer is removed with sufficient care. The prostomium is very inconspicuous and often is retracted into the peristomium. It bears a pair of palps. A number of short filiform gills extend forward over the prostomium and peristomium, the latter being short and setigerous. The parapodia are biramous, are without cirri and carry both capillary setae and crotchets. The stalk of the capillary seta is characteristically cross-striated throughout its length.

KEY TO GENERA RECORDED FROM PORTO RICO

A. Setae of first to third somites forming a "cage" over the anterior end of the body.
  B. Body-papillae short and few................................*Stylaroides.*
  BB. Body covered with long papillae............................*Flabelligera.*

### STYLAROIDES Della Chiaji

#### Stylaroides glabra Treadwell

FIGURE 95

*Stylaroides glabra* Treadwell (1901) 208. *fig. 73–75.*

Described from a single specimen which was somewhat mutilated. At the anterior end of the body is a central small lobe with larger ones at the sides from each of which a long tuft of simple setae extends (FIGURE 95).

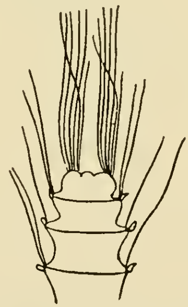

Figure 95. *Stylaroides glabra* Treadwell. × 12.

The limits of prostomium and peristomium are not shown in the original diagnosis. The three following somites are sharply marked off from one another, and each has a tuft of setae which in all cases extends beyond the prostomium. What was figured by Treadwell as a proboscis is obviously one of the palps which is folded on either margin so that the dorsal surface is deeply grooved. The only setae mentioned in the diagnosis are the simple ones, which are variable in size but all strongly marked by transverse lines. The outer incrustation covered all of the body except the extreme posterior end.

Collected by the Fish Hawk at Station 6066 (Treadwell 1901).

### **FLABELLIGERA** Sars

#### **Flabelligera cariboa** Grube

FIGURE 96

*Siphonostomum cariboum* Grube (1859) 108.—Ehlers (1887) 158–161. *pl. 42, fig. 6–9; pl. 43, fig. 1.*

The body is somewhat spindle-shaped, thickest in the middle, and tapering toward either end, but more noticeably so posteriorly. Ehlers' specimens collected at Key West were small, the larger one measured 25 mm. and contained 64 somites. The body is covered with a characteristic incrustation of sand grains which in some cases form a thicker deposit over the anterior region. Papillae are numerous and along the sides they are larger, looking much like cirri connected with the parapodia.

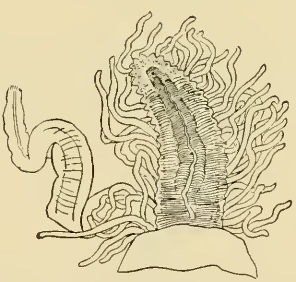

Figure 96. *Flabelligera cariboa* Grube. × 12.

The setae of the first two somites extend forward beyond the prostomium, those of the succeeding somites as far as the tenth setigerous are long but much shorter than those of the first two. Throughout the middle region the dorsal setae are short, becoming somewhat longer again at the posterior end. These setae are all of the capillary form. From the fifth somite backward, hooked setae occur in each somite, lying in a row of seldom less than five. In the anterior somites the notopodia and neuropodia are close together but they gradually separate so that posteriorly they are distant by practically the entire body diameter.

In the mouth region is a broad plate called "kopflappen" by Ehlers which extends for a considerable distance when protruded (2 mm. in an animal 25 mm. long), and carries on its margin a row of slender filaments (FIGURE 96). Ventral to this is a pair of heavy "tentacles" which evidently correspond to the palps.

Collected by the Fish Hawk at Ensenada Honda (Culebra), and from Stations 6062, and 6063 (Treadwell 1901).

## Family **TEREBELLIDAE**

A large family containing many genera and species. The body may be divided into thorax and abdomen, the distinction being that in the former the parapodia are biramous containing both capillary and uncinate setae, while in the latter only the uncini occur. In keeping with their tubicolous mode of life, the parapodia are much reduced and in the abdomen are represented only by tori. In some genera there are comparatively few thoracic somites (from 17 to 20), but in others the capillary setae occur throughout a large part of the body. The prostomium is horse-shoe shaped and may carry eye-spots along its dorsal margin. It carries the tentacles, long slender filaments which are usually quite numerous. Gills are usually present and are of various forms, cirriform, arborescent, pectinate, or subulate. The number is from one to three pairs situated on the dorsal surface of certain of the most anterior somites, their position and number being of diagnostic value.

The capillary setae are generally limbate and their borders may be denticulated. The uncini are of varying shapes, but constant in form and arrangement in any species.

The terebellids are tubicolous, living in tubes which have a membranous substratum to which are attached foreign matters such as mud, sand, shell fragments, etc. Sometimes the tubes may be imbedded in mud or attached to the under sides of stones.

### Key to Genera recorded from Porto Rico

A. Uncini pectiniform. Setae beginning on 4th somite. Seta-tufts 17. Arborescent gills 3. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Loimia.*

AA. Uncini hooked and with transverse rows of denticles on crest.

B. Setae beginning on 4th somite. Apex of seta toothed. Number of seta-tufts variable. Gill with well developed trunk and branches. . . *Terebella.*

BB. Setae beginning on 3rd somite, uncini on 5th. Apex of capillary seta entire. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Thelepus.*

### LOIMIA Malmgren

#### Loimia bermudensis Verrill

*Loimia bermudiensis* Verrill (1900) 664.

A stout species with three pairs of large, sub-equal arboresent gills, each having a long stem and numerous branches which take on a somewhat conic arrangement when expanded. The lower lip is large and projects freely and has on either side another lobe. In the first and second somites below the bases of the gills are lateral lobes. The capillary setae begin on the third branchiate somite and continue on seventeen somites. The larger of these capillary setae are only faintly limbate, and taper to sharp points which at the very tips may be faintly denticulate. The smaller ones are more definitely pinnate on one side. The uncini begin on the second setigerous somite and are very long, in some somites arranged in two rows. They have five large, sharp, incurved hooks.

The tube consists of a thin lining covered with loosely adherent fragments of shells.

*L. bermudensis* did not appear in the Fish Hawk collections, but Hoagland (1919: 576) listed three specimens taken from Cane Wharf, Guanica Harbor by R. W. Miner. It was collected by the Arcturus at 17° 39′ N., 63° 17′ W. though identified as this species with some hesitation (Treadwell 1928: 482). Verrill gave no figures.

### TEREBELLA Linnaeus

#### Terebella turgidula Ehlers

FIGURE 97

*Terebella turgidula* Ehlers (1887) 241–245. *pl. 52, fig. 1–4.*

Ehlers described this species from a single specimen collected at Key West. The body is short, composed of only fifty-three somites. The prostomium carries long, heavy, canaliculated tentacles and has on

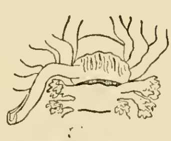

Figure 97. *Terebella turgidula* Ehlers. × 1.

either side a row of brownish spots. The peristomium is short dorsally and laterally, but has on its ventral surface a heavy, elevated lower lip. Other somites are short, 2, 3, and 4 with gills. Beginning with the third, eighteen somites have capillary setae. Uncini first appear on the fifth somite and continue throughout the body, lying in single rows in the anterior six of these somites, in double rows on the others. In the double row the apices of the uncini alternately point in opposite directions. The first gill is the largest of the three, the third the smallest. All have heavy trunks (FIGURE 97). There are fourteen ventral scutes of which the anterior ones are the widest. The capillary setae are narrowly limbate. The uncini have two small terminal teeth, and a much smaller proximal one, all very sharp and recurved.

Treadwell (1901: 205) identified as this species, specimens collected by the Fish Hawk at Playa de Ponce, and Ensenada Honda (Culebra). These agree with the generic diagnosis and disagree with Ehlers' description in having seventeen instead of eighteen thoracic somites.

### **Terebella annulifilis** Grube

FIGURE 98

*Terebella annulifilis* Grube (1878) 225–226. *pl. 13, fig. 2.*

The body has seventeen fascicles of capillary setae on either side, this thoracic region being somewhat swollen as compared with the abdominal. On either side the first somite is expanded into a lobe (FIGURE 98). The tentacles are numerous and extend as far as somite

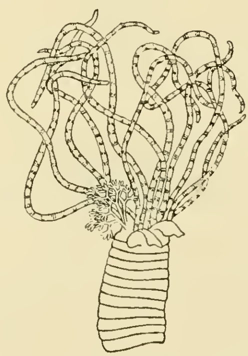

Figure 98. *Terebella annulifilis* Grube. × 3.

16. Each is marked with series of dark rings. In the thoracic region are sixteen uncinigerous tori, on the first six of which the uncini are arranged in two rows while in later ones they lie in single rows. Capillary setae are narrowly limbate. The uncini have five teeth. The gills are three in number on each side, the first being the largest, the others progressively smaller. The branches of the gills are very numerous.

Collected by the Fish Hawk at Ensenada Honda (Culebra), Arroyo, Ponce and Mayaguez (Treadwell 1901).

### **Terebella variegata** Grube

FIGURE 99

*Terebella variegata* Grube (1878) 227, 228. *pl. 13, fig. 3.*

A comparison of the specimens in the Fish Hawk material with Grube's fig. *3* and his description led me to identify the species as Grube's *variegata*. Further reading of Grube's paper makes it seem very doubtful if the identification is correct. I am publishing a copy

Figure 99. *Terebella variegata* Grube. × 1. After Grube.

of Grube's figure (FIGURE 99) and if anyone should find in Porto Rico a specimen corresponding to this figure, it should be treated as unknown and either identified with it, or described as a new species.

The Fish Hawk material was collected at Guanica Bay, and reef at Ponce (Treadwell 1901).

## **THELEPUS** Malmgren

### **Thelepus crassibranchiatus** Treadwell

FIGURE 100

*Thelepus crassibranchiata* Treadwell (1901) 206. *fig. 69–71.*

The prostomium is small and carries a row of pigment spots on its dorsal surface. The tentacles are few in number and are very thick, about as long as the first ten somites. The branchiae are in two

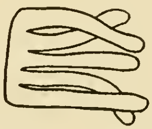

Figure 100. Gill of *Thelepus crassibranchiatus* Treadwell.

transverse rows of thick filaments on either side of the second and third somites. The anterior ones are five in number more or less fused at their bases (FIGURE 100). The second pair similar to these in general form, but the filaments are more slender and shorter and only three in number. The capillary setae begin on somite 3, the uncinate on somite 5. The uncini have two small terminal recurved teeth and one much larger sub-terminal. The form of the capillary setae is not given in the original description.

Collected by the Fish Hawk. The exact locality was not recorded (Treadwell 1901).

**Thelepus robustus** (Grube)

Figure 101

*Phenacia robusta* Grube (1878) 235, 236. *pl. 12, fig. 8.*

The body contains about 144 somites, of which the anterior are six times, the region of somite 12, seven times and posterior ones three times broader than long. The prostomium is small carrying numerous short thick tentacles whose margins are fluted (FIGURE 101). The anterior ventral scutes anteriorly are five times broader than long, begin to decrease in diameter at about somite 20, and disappear at

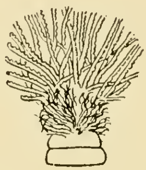

Figure 101. *Thelepus robustus* (Grube). × 1.5. After Grube.

about somite 31. The capillary setae begin on somite 3, the uncinigerous on somite 5. The capillary are narrowly limbate and slightly curved, the uncini arranged in a single row on either side. On either side are three gills each composed of numerous fine filaments and, as figured by Grube, they together make up a tangled mass on the dorsal body surface. Grube's figure from which FIGURE 101 is taken, represents only the basal portions of the tentacles and shows that these are smooth along one margin and fluted on the other.

Collected by the Fish Hawk at Puerto Real, Boqueron Bay, and Station 6065 (Treadwell 1901).

## Family AMPHARETIDAE

Small or medium sized annelids whose body is divided into "thorax" and "abdomen," the former being broad and the latter much narrower. In the thorax, except a few of the anterior ones, the parapodia are biramous carrying both capillary and uncinate setae, while generally the abdomen has only the uncinate. The prostomium together with the first one, or two, of the anterior somites are connected in such a fashion as to set off this anterior portion of the body from the remainder of the thorax.

The prostomium is distinct, sometimes prolonged into a lobe, below which are the tentacles which may be smooth or ciliated and are carried around the border of the mouth, into which they may, in most cases, be retracted. In some, the tentacles are absent. Ventral glands generally form definite cushions which extend across the ventral faces of the thoracic somites.

Thoracic parapodia have, when fully developed, a prominent notopodium which is cylindric or conic, while the neuropodium is in the form of a pad. The notopodial setae are capillary, the neuropodial are uncini somewhat similar to those of the Terebellidae. In addition, stout paleae may form two transverse series on the third somite. They correspond to the notopodial setae of that somite. There may be one or two stout spines on either side of the dorsal surface just behind the gills.

There are two, three, or four pairs of gills situated on the dorsal surface, the first on somite 3. Generally they are smooth, sharp-pointed, and unbranched, but sometimes they may be branched.

The ampharetids live in tubes composed of fine mud over a tough lining membrane. They do not leave these tubes, but feed by sweeping with the tentacles various microscope organisms into the mouth, the anterior portion of the body being protruded for that purpose.

The only genus belonging to this family which has been described from Porto Rico is *Amphicteis*, diagnosed as follows—paleae present, capillary setae confined to the anterior region of the body, seventeen pairs in all. Four pairs of gills. Cirri on the notopodia.

### AMPHICTEIS Grube

#### Amphicteis nasuta Ehlers

FIGURE 102

*Amphicteis nasuta* Ehlers (1887) 232–236. *pl. 49, fig. 1–6.*

The body is heavy anteriorly and narrowed posteriorly, distinctly articulated. The cephalic lobe is anteriorly drawn out into a wing on either side. Ehlers described the tentacles as smooth filaments carried on a plate which in his specimens had been retracted into the mouth, and do not show in his figures. The second somite carries dorsally on either side a row of about seventeen paleae and four pairs of elongated prominent gills whose bases arise close to the paleae (FIGURE 102). The first fourteen thoracic somites carry capillary setae and the last twelve of these have in addition the pectinate uncini which have six teeth. The uncini of the abdominal region have a rather large basal tooth with four transverse rows of teeth distal to it. Of these terminal teeth, the distal row is the smallest.

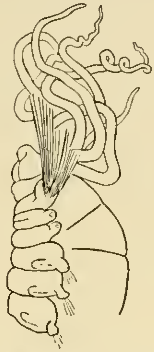

Figure 102. *Amphicteis nasuta* Ehlers. × 13.

Ehlers' specimens were taken at 25° 33′ N., 84° 35′ W. The Fish Hawk material contained a single specimen from Aguadilla (Treadwell 1901).

## Family AMPHICTENIDAE

Small annelids in which the body is divided into thorax and abdomen, but in which the abdomen is very short being composed of not more than five or six somites without setae. The abdomen is furrowed dorsally, and has a short cirrus at its caudal end. The thorax is thick and subcylindrical, and the somite boundaries are not sharply marked off. The prostomium is obliquely truncate, its truncate surface being directed dorsally. On either side of the dorsal prostomial surface is a row of very stout paleae of a bright golden yellow color. Below the paleae is a membrane, the velum, whose margin is frayed into cirriform processes which hang down over the mouth. On either side of the mouth are filiform tentacles. On either side of the prostomium are two tentacular cirri. Two pairs of gills on either side are carried on what appear to be the third and fourth somites. In some cases there are three pairs.

In addition to the paleae there are capillary notopodials and uncinate neuropodials. There are from fifteen to eighteen bundles of the capillary setae which are limbate and curved and sometimes finely serrate toward the ends. The uncini are pectinate with the base prolonged into a process.

The tubes of this family are very characteristic, being composed of sand grains, fine shells, etc. cemented together to form a conical structure which is open at both ends and may be slightly curved. The large end is normally downward in the mud with the narrower end uppermost. The paleae fit into the large end forming an operculum.

### PECTINARIA Lamarck

The only amphictenid thus far described from Porto Rico belongs to the genus *Pectinaria* which differs from *Cistenides* in that the former has thirteen pairs of uncinigerous tori while the latter has twelve. In the former the uncini have seven or eight large teeth in the latter they have three.

#### Pectinaria gouldii (Verrill)

FIGURE 103

*Cistenides gouldii* Verrill (1874) 612. *pl. 17, fig. 87, 87a.*

The body is rather stout, a trifle curved. The obliquely truncated prostomium has a smooth posterior marginal fold (FIGURE 103). The tentacles are long, tapering, and acute. On the margin of the frontal membrane are about twenty-eight long slender papillae. There are about fifteen paleae in a group on either side of the prostomium, light

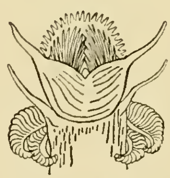

Figure 103. *Pectinaria gouldii* (Verrill).

golden in color with long, slender, and very acute tips. The paleae in the middle of the series much the longest. The tentacular cirri are stout obtuse, and folded so as to be grooved on the lower surface.

This species has been found in localities ranging from Grand Manan to North Carolina. In Porto Rico they were taken by the Fish Hawk at Ensenada Honda (Culebra), and Station 6055 (Treadwell 1901).

## Family CAPITELLIDAE

In this family the body is long, slender, composed of many somites, and since what appendages occur are small and inconspicuous, they very much resemble earthworms in their general appearance. The body is divided into thorax of from nine to fourteen somites, and a longer abdomen. The cuticle in many species has a mosaic appearance.

The parapodia are rudimentary, appearing in the thorax as retractile processes, in the abdomen as tori. The prostomium is conic, and retractile, and has neither tentacles, nor palps. Eyes are small pigment spots. Setae are either capillary, or crotchets, and may be separate or both in the same parapodium. Capillary setae always occur in the thorax, and may be present in the abdomen. Crotchets alone do not occur in the thorax.

The first true somite never has setae, but sometimes it is fused with the second in which case the apparent first somite is setigerous. Gills are located at the ends of the tori in the abdomen and in most cases they may be retracted into the body. In all genera, except *Capitella*, lateral organs occur in each somite in grooves on the thorax and freely exposed on the abdomen.

Key to Genera recorded from Porto Rico

A. Setae in thorax capillary only.
  B. Gills present. Thoracic somites 14 . . . . . . . . . . . . . . . . . . . . . . *Dasybranchus*.
  BB. Gills absent. Thoracic somites 13 . . . . . . . . . . . . . . . . . . . . . . *Scyphoproctus*.

## DASYBRANCHUS Grube

### Dasybranchus lunulatus Ehlers

*Dasybranchus lunulatus* Ehlers (1887) 174–177. *pl. 45, fig. 5–9.*

The body as a whole looks like an earthworm whose anterior end was swollen and whose prostomium had been retracted more or less into the peristomium. The anterior region of the body is quadrangular in outline, posteriorly it is more rounded. A noticeable longitudinal groove runs along the lateral line on either side between the seta tufts, and there is a decided ventral furrow. The prostomium is small as compared with the peristomium, is flattened below and rounded above, and on either side carries a horse-shoe shaped patch of pigment spots. The peristomium is two ringed, and carries no setae. The anterior of the two rings is interrupted by the mouth, the posterior one forms the lower lip. The setigerous somites behind this are anteriorly seven, posteriorly five, times as wide as they are long. While there are some foldings on the body surface, there is no indication of definite ringing in the somites. The dorsal seta bundles are carried on ridges which are not continuous with similar ridges which carry the ventral bundles, though these latter are continuous across the ventral surface. Thirteen somites behind the buccal somite carry narrowly limbate capillary setae. All setae behind these are crotchets.

The Fish Hawk collections contained this species from Puerto Real, and Arroyo (Treadwell 1901).

### **Dasybranchus umbrinus** Grube

*Dasybranchus umbrinus* Grube (1878) 189, 190.

Grube gives a brief diagnosis without figures, and from this description Treadwell identified some specimens of the Fish Hawk collection as belonging to this species. It is probable that the accuracy of the identification is questionable. According to Grube's diagnosis there are fourteen somites in the anterior region of which thirteen carry slender capillary setae which are narrowly limbate. A longitudinal groove separates the dorsal from the ventral seta tuft on either side of the body. Anteriorly the body is quadrate in outline, posteriorly it is more rounded. The crotchets lie in a single series, each crotchet having a long manubrium. No gills were observed. Since gills frequently are retracted, I have not considered that point in listing this as *Dasybranchus*.

Collected by the Fish Hawk at Stations 6061, 6062, 6066, and Boqueron Bay (Treadwell 1901).

### **SCYPHOPROCTUS** Gravier

### **Scyphoproctus rectus** (Treadwell)

FIGURE 104

*Dasybranchus rectus* Treadwell (1901) 207. *fig. 72.*

With the exception of the first, the somites are biannulated, the second only on the ventral surface, later ones both above and below. The prostomium is triangular and carries a dark pigment spot on either side (not shown in FIGURE 104). The thoracic setae are very delicately capillary and arise from the groove between the two annuli of

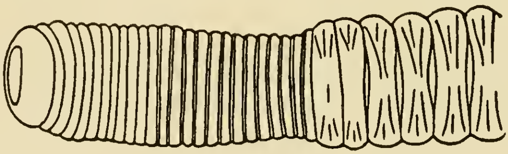

Figure 104. *Scyphoproctus rectus* (Treadwell). × 4.

the somite. The abdomen is wider than the thorax (FIGURE 104), and the tori are rather prominent, their ends meeting on the ventral surface, but widely separated dorsally. The uncini are awl-shaped, slightly curved at the ends, but not toothed. A noticeable feature is the very thin wall of the abdominal region through which the intestinal contents can be seen.

Collected by the Fish Hawk at Stations 6055, 6061, and Ensenada Honda (Culebra) (Treadwell 1901).

## Family SABELLIDAE

A family of tube-dwelling annelids in which the body is divided into thorax and abdomen, the thorax usually composed of nine somites. Both capillary and uncinate setae occur in all somites, the tuft of capillary setae lying dorsal to the uncinigerous tori in the thorax, while in the abdomen this arrangement is reversed. There are several forms of capillary setae, and the uncini may be either avicular or pectiniform. Among the bases of the uncini may be pennoned setae (FIGURE 4 h). They are often very difficult to see, but are important in classification.

The prostomium is hidden by the peristomium which forms a distinct collar. On either side is a branching gill which is a modified palp. Each gill consists of a series of central branchiae on which are arranged two rows of filaments or barbules. In some cases, smaller and fewer filaments are also carried on the outer face of each branchia. Eye-spots are often present, either as pigment spots scattered along the branchia, or they may occur as larger eyes at the ends of the branchiae.

The sabellids are generally rather small. They never leave their tubes, but protrude the anterior ends from the tube openings. The gills are then expanded and often being brilliantly colored are very attractive objects in the water. The tubes are composed of mud on a thin tough tissue-basis and generally occur in shallow water.

### Key to Genera recorded from Porto Rico

A. Setae of two kinds (uncini and pennoned) in 2 rows in thoracic neuropodial tori.
  B. Thoracic dorsal setae of 1 kind.
    C. Collar 2-lobed. Eyes on branchia terminal.......... *Branchiomma.*
    CC. Collar 4-lobed. Eyes not terminal....................... *Sabella.*
  BB. Thoracic dorsal setae of 2 kinds, abdominal of 1 kind. Collar 2-lobed. Ends separated dorsally................................ *Parasabella.*
  BBB. Thoracic setae of 2 kinds, abdominal of 2 kinds. Collar 1-lobed.... *Protulides.*
AA. Setae of 1 kind only in thoracic tori. Branchiae with dorsal appendages. Collar 2-lobed. Uncini avicular.......................... *Dasychonopsis.*

### BRANCHIOMMA Kolliker

#### Branchiomma lobiferum Ehlers

FIGURES 105a, b

*Branchiomma lobiferum* Ehlers (1887) 254–259. *pl. 53, fig. 10–15.*

The body is somewhat depressed, brown in color but reddish toward the posterior end, tori and branchiae white-spotted. There are twenty-one branchiae on a side carried on a short basal lamella. They carry long filaments and each has a subterminal eye (FIGURE 105b). The eyes on the two median dorsalmost branchiae are larger than any others.

The collar is divided into halves which are in contact on the ventral mid-line, but separated dorsally (FIGURE 105a). On the first somite is a tuft of capillary setae, and in the following seven somites there is on either side a capillary tuft which in successive somites come nearer and nearer to the ventral surface. The capillary setae are short and


Figure 105. *Branchiomma lobiferum* Ehlers. a. Collar. b. Branchia.

are expanded at the free ends. In the ventral tori are avicular uncini which have one large tooth and a cap of much smaller teeth on the apex. These make up a posterior row, while an anterior row, parallel to them, is composed of two kinds, one thick needle-formed, the other carrying a broad flat heart-shaped expansion toward the end. On the ninth somite the change in setal arrangement occurs, the now ventrally placed capillary setae, similar to those of the thorax. Dorsal to these is a bundle of uncini similar to the thoracic but smaller and lying in a single row.

Hoagland (1919: 577) records this species from Guanica Harbor, collected by R. W. Miner.

## PARASABELLA Bush

### Parasabella fonticula Hoagland

FIGURE 106

*Parasabella fonticula* Hoagland (1919) 579. *pl. 31, fig. 3–9.*

The type is 30 mm. long of which 5 mm. is represented by the gills. The body is composed of seventy-nine somites, twenty forming the thorax. Eight pairs of white gills are united at their bases by a very delicate low web, the tips of the branchiae carry no filaments, and there are no eyes. The slender tentacles are 1 mm. long. The collar is low and its dorsal ends widely separated (FIGURE 106). Ventrally the collar is higher than it is on the dorsal surface, and the recurved lobes are nearly in contact in the mid line. Thoracic setae are of two forms, one slender and regularly tapered, the other oblanceolate with median points. Uncini are avicular carrying a single tooth and a basal bar. Pennoned setae have rather long terminal points. In the abdomen the ventral setae are slender with flask-shaped terminal portions and a pointed termination, the uncini are similar to those of the thorax.

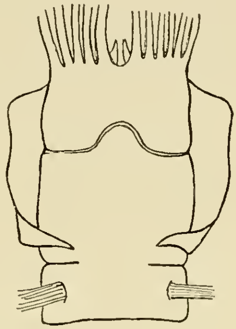



Figure 106. *Parasabella fonticula* Hoagland. × 30.

Described by Hoagland (1919) from specimens collected at the entrance to Guanica Harbor by R. W. Miner and H. Mueller. Type in American Museum of Natural History, Cat. No. A. M. N. H. 1275.

**Parasabella flecata** Hoagland
FIGURE 107

*Parasabella flecata* Hoagland (1919) 580. *pl. 32, fig. 3–8.*

The longer of two specimens is 25 mm. long, of which 5 mm. is composed of the gills. The greatest width is 2.5 mm. The entire body has sixty-seven somites of which eight are thoracic.

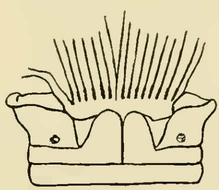

Figure 107. *Parasabella flecata* Hoagland. × 3.

The collar is moderately high, two lobed, the ends separated dorsally (FIGURE 107), but the bluntly triangular ventral ends are almost in contact.

There are sixteen pairs of branchiae which are connected at their bases on either side by a delicate membrane, which carries numerous pigment spots. On the outer surface of each branchia are small light-brown pigment spots and from three to six lie on the inner face of each branchia, these latter extending on to the bases of the filaments.

The thoracic setae are lanceolate in outline their ends tapering. The abdominal ones are similar in form but their tapering ends are longer. The uncini are alike in both thorax and abdomen, each with a very prominent tooth and a bunch of extremely fine apical dentations. In the thorax the tori also carry small sharp-pointed pennoned setae, which are not present in the abdomen.

Listed by Hoagland (1919: 580) as collected in Porto Rico by A. L. Treadwell.

### SABELLA Linnaeus

#### Sabella alba Treadwell

FIGURES 108a, b

*Sabella alba* Treadwell (1917) 266–267, *pl. 3, fig. 10–15.*

The length of the animal is 45 mm., of which the gills represent 10 mm. The greatest breadth is not more than 2 mm. There are seventeen pairs of gills which are colorless, except for a very fine dusting of pigment along some of the branchiae. The bases of the branchiae are connected by a very delicate membrane, and just beyond the end of this membrane are minute black ocelli on the surfaces of the branchiae. The antennae are slender and sharp-pointed with a white longitudinal median line. On either side of the tentacles is a patch of fine dark-brown spots.

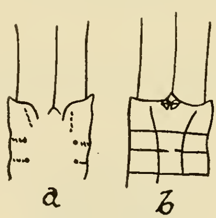


Figure 108. *Sabella alba* Treadwell. a. Dorsal view. b. Ventral view. × 5.

The collar is rather low, and its ends widely separated dorsally (FIGURE 108 b) but nearly in contact on the ventral surface (FIGURE 108 a). The ventral ends have fine recurved tips, but elsewhere the margins are not recurved. On either side is a ventro-lateral fissure, making the collar four lobed.

Except for dark brown ventral shields the body is colorless.

The thoracic setae are of two kinds, one lanceolate with an asymmetrical expansion at the end, the other stouter and symmetrically rounded at the apex when seen in full face, but in profile shows a slight curvature. The uncini have a single large tooth and very fine denticulations at the apex. The pennoned setae have heavy stalks with delicate, slender, terminal portions. The tube is composed of a tough chitin, dark brown in color and very difficult to remove from the animals without injuring them.

Collected in the Dry Tortugas, and in Guanica Bay, Porto Rico (Treadwell 1917).

Type in American Museum of Natural History, Cat. No. A. M. N. H. 977.

### **Sabella melanostigma** Schmarda

FIGURE 109

*Sabella melanostigma* Schmarda (1861) 36.—Ehlers (1887) 263–266.
*Sabella melanostigma* var. (?) Hoagland (1919) 577–578. *pl. 30, fig. 10–15; pl. 31, fig. 1, 2.*

A rather thick bodied sabellid whose most noticeable feature is a double row of black pigment spots on either side of the body, one above, the other below, the parapodium. In the anterior region the dorsal spots are the larger, but posteriorly this is reversed and the dorsal row may disappear. The gills which are uniformly colored and not banded, arise from a basal lamella which is rolled into more than half of a complete circle (FIGURE 109). On either side are nineteen branchiae

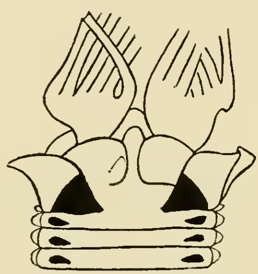

Figure 109. *Sabella melanostigma* Hoagland.

each carrying four or five pairs of eye-spots situated at considerable distances from one another. Each branchia carries a double row of filaments, but the apex of each is bare and about as thick as a filament. There are two pointed tentacles which are about one-quarter as long as the branchiae. There are fifteen thoracic somites counting the buccal.

The buccal somite has a tuft of setae corresponding to the dorsal ones of the later somites. In these latter, the dorsal bundle is composed of capillary setae, some of which are narrowly others more widely limbate. The uncini are avicular and have a number of fine teeth on their apices. On the sixteenth somite the change occurs in which the capillary become ventral in position to the uncinate and this condition persists throughout the remainder of the body, no essential change in appearance occurring in the setae themselves.

The description is taken from Ehlers who gives no figures. Hoagland described a considerable number collected in Condado Bay, Guanica Harbor and Ensenada by R. W. Miner as a variety of this species. Her material differed from the original description in that there are two pigment spots instead of one above and below the parapodium, there are 12 or 13 thoracic somites and 15 to 18 pairs of gills. The Fish Hawk specimens identified by Treadwell (1901: 208) had as few as 12 thoracic somites. The Fish Hawk material was taken from Ponce, Guanica Bay, Reef at Ponce, Boqueron Bay, Ensenada Honda (Culebra) and Station 6051. It was in the Arcturus collections from 17° 39′ N. Lat. 63° 17′ W. Long. (Treadwell 1928); and was taken at Needham's Point, Falmouth Harbor, and "in sand at low tide, Barbados" by the Barbados-Antigua expedition (Treadwell 1924b).

### **Sabella spectabilis** Grube

*Sabella spectabilis* Grube (1878) 253–255. *pl. 14, fig. 4.*

The body is short and thick, much depressed toward the posterior end, and is gray-brown in color with reddish ventral shields. The collar is of moderate height, its ventral folds in contact. The capillary setae are narrowly limbate and numerous, those of the posterior body regions much the shortest. The uncinigerous tori of the anterior regions are broadest, there being a definite decrease in length posteriorly. The uncini are avicular and lie in single rows. The branchiae are equal in length, about three-fifths as long as the body. They are united with one another by a basal membrane, and number from 39–41 on either side. Filaments extend to the ends of the branchiae. The pointed tentacles are reddish-violet, and about one-eighth as long as the branchiae.

It is not clear from Grube's description how many lobes the collar has, and it may be that this species should be listed as *Branchiomma*. Grube's material came from the Philippines. The Fish Hawk material was collected at Guanica Bay, Mayaguez, Boqueron Bay, Ponce and Hucares (Treadwell 1901).

## **DASYCHONOPSIS** Bush

### **Dasychonopsis arenosa** Treadwell

Figure 110

*Dasychonopsis arenosa* Treadwell (1924a) 1, 2. *fig. 1–4.*

The general color is yellowish brown with the ventral shields slightly darker than the remainder of the body. Dark-brown spots are sparsely scattered along the dorsal surface and on the ventral shields. The total body length is 35 mm. of which 10 mm. represents the gills.

In the thorax are eight somites with eight seta tufts and seven rows of uncini (FIGURE 110). The collar is two lobed its dorsal ends being widely separated. It is more prominent ventrally than dorsally the two ventral points, which are somewhat deeply undercut, overlapping on the mid-ventral line.

There are from fifteen to twenty branchiae on either side. Their ground color is a little lighter than the general surface of the body, but they are banded at frequent intervals by pigment patches which extend over the filaments thus giving the entire gill a banded appearance. The apex of each branchia is free of filaments, but carries a number of small dark eye spots. There is no basal membrane, and the basal

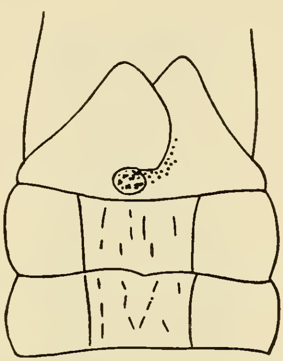

Figure 110. *Dasychonopsis arenosa* Treadwell. × 18.

portion of each gill is colored in such a fashion that colorless lines which lie between the pigment patches bifurcate, each half going into a distinct branchia.

Thoracic setae are all alike, all slightly bent toward the apex and in full face are seen to be bilimbate. From the side, only one membrane can be seen. The uncini begin on somite 2, each having a single large tooth with apical denticulations hardly large enough to be called teeth. Abdominal setae are only slightly different from the thoracic.

The tubes are smooth and are covered with very fine sand grains firmly cemented together. In this collection they were composed of dark-gray sand but had irregularly arranged light-brown bands.

Collected by R. W. Miner at Caño de Martin Pena, San Juan, and Porto Rico (Treadwell 1924a).

Type in American Museum of Natural History, Cat. No., A. M. N. H. 1616.

**Dasychonopsis ponce** (Treadwell)

FIGURE 111

*Dasychone ponce* Treadwell (1901) 209. *fig.* 76–78.

Somewhat similar to *D. arenosa* but is stouter, darker in color and has more noticeable dark spots. The eye spots on the gills are less numerous. It is also closely related to *D. conspersa* (see below) but has more branchiae, and differs in the irregular distribution of color spots and in the absence of a ventral compressed area (FIGURE 111).

The gills are very much coiled, the branchiae numbering forty-two on a side. The ventralmost are the shortest, and there is a successive increase in length up to the tenth. For 2 mm. of their length the branchiae are united by a basal membrane. This membrane is white,

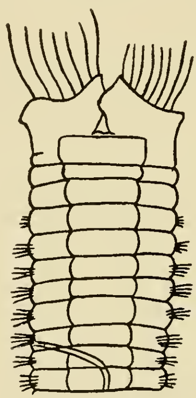

Figure 111. *Dasychonopsis ponce* (Treadwell). × 5.

but the portions of the branchiae which are united by it are brown. The free portion of the branchia is white, crossed by dark bands. On each are from 13 to 15 eye spots, and a variable number of short dorsal filaments. On the ventral surface the collar ends in a lobe on either side which overlap to a slight extent ventrally. The inner surfaces of the ventral lobes are marked by irregular patches of brown pigment and the most of the collar is brown but the margin is white. The general body color is light brown with many darker patches. The ventral surface of the abdomen is brown, the faecal groove making a distinct light area down its middle.

The capillary setae are bilimbate, almost spear-headed in form in full face. The uncini are stout, having one large tooth and a smaller apical one.

The tube is very thin and delicate, light-brown in color and covered at its upper end by fine gray mud.

The Fish Hawk collected this species at Boqueron Bay, Ponce, Arroyo, Playa de Ponce Reef, Mayaguez and reef near Ponce (Treadwell 1901). It appeared in the Johnson-Smithsonian collections at Station 69.

### Dasychonopsis conspersa (Ehlers)

FIGURE 112

*Dasychone conspersa* Ehlers (1887) 266–270. *pl. 54, fig. 1–6.*

The body is elongated, dorsally convex in anterior regions but depressed posteriorly. The coloring in general is reddish-brown irregularly dotted, especially anteriorly, by numerous dark patches. The gills have essentially the same color, but the branchiae are irregularly marked by red cross bands. The filaments are alternately red and brown.

Figure 112. *Dasychonopsis conspersa* (Ehlers). × 2.5.

The basal portion of each gill is rather low and is inrolled on the ventral end (FIGURE 112). Each has nineteen branchiae which except for the two ventralmost ones are approximately equal in length. The filaments are short, hardly three times as long as the diameter of the branchia and the terminal ones are the shortest. Small black eyespots arranged in pairs occur on the outer surface of each branchia, and here are also short filaments. The collar is two-lobed the dorsal ends separated the ventral ones overlapping.

There are eight thoracic somites which have the usual arrangement of setae. The simple setae are broadly limbate and all alike. The uncini have each a very large main tooth with a much smaller one at the apex. Pigment spots occur between the seta tufts and the tori. There are no essential differences between the setae of the thorax and those of the abdomen.

Ehlers' specimens were taken at Key West. Hoagland (1919) listed it from Guanica Harbor, where many specimens were taken by R. W. Miner, H. Mueller, R. C. Osburn, and A. L. Treadwell, and also at San Juan Harbor and Ponce.

### PROTULIDES Webster

#### Protulides elegans Webster

*Protulides elegans* Webster (1884) 325–326. *pl. 11, fig. 63–74.*

The body is convex above, flattened below. The bases of the gills, except for the white dorsalmost one on either side, are purple, which color is continued onto the branchiae as far as the outer margin of the connecting membrane. Beyond this point there is an alternation of white and purple bands. The anterior margin of somite 1 is white, its dorsal and lateral faces dark umber-brown. The remaining thoracic somites are umber-brown. Abdominal somites are light flesh color. In living material two umber-brown spots appear on the anal somite, but they are not visible in preserved specimens.

There are from nine to fourteen branchiae on either side arising from a long undivided basal portion which is one-half as long as the free portions of the branchiae. In living material may be seen two sets of eye-spots, one about two-thirds of the length of the branchia and another still farther out. These do not show after preservation.

Thoracic somites vary in number from six to eight, this not being due to age differences. In the first thoracic somite the setae are all alike, all dilated at the ends and with capillary apices. In the remaining thoracic somites are four kinds of setae. Dorsally a number of long bilimbate ones; below these, some with globular ends without capillary terminations; uncini in the ventral tori, having a heavy single tooth and minute apical denticulations; pennoned setae, which Webster figures as having very heavy stalks and rounded ends, which are unsymmetrically placed, terminating in short but sharp points.

Webster's material was taken in Bermuda. The Fish Hawk collected it at Guanica Bay, Ensenada Honda (Culebra), Mayaguez, Station 6085, Reef at Ponce, Caballo Blanco Reef (Treadwell 1901). Webster figures only setae.

## Family SERPULIDAE

A large family of tubicolous annelids resembling the Sabellidae in that the body is divided into thorax and abdomen and the palps are modified to form branching gills. In most cases one of the branchiae is without filaments and carries on its apex an enlargement which when the gills are drawn into the tube closes the mouth of the tube and is known as an operculum. The form of this operculum varies greatly being sometimes a flat plate, in other cases a series of plates on a central stalk, in others it is more or less globular. This transformed branchia is always the dorsalmost on one side, but in some species at least not always on the same side. Sometimes the corresponding branchia on the opposite side is more or less transformed, but it does not usually carry a terminal plate.

A characteristic feature is the thoracic membrane, a thin membrane extending laterally from the sides of the thorax and continued anteriorly into the collar. Posteriorly it may or may not involve the whole thorax.

The seta arrangement in thorax and abdomen is similar to that of the serpulids. The simple setae assume a variety of forms, the uncinate are always pectinate, but differ greatly in the number and relative size of the marginal teeth.

The tubes are always of limestone, and are more or less coiled or merely irregularly sinuous. They are found attached to solid objects of various sorts, such as stones and shells. The small, tightly coiled shells of the genus *Spirorbis* are often found attached to *Fucus* and other sea weeds.

### Key to Genera recorded from Porto Rico

A. Uncini tetragonal or trapezoidal, their teeth not very fine, the basal one largest and hollowed at the end.
- B. Setae in first somite of only 1 kind. Operculum infundibuliform without spines. . . . . *Spirodiscus.*
- BB. Setae in first somite of 2 kinds. Operculum a series of plates supported by a common stalk. . . . . *Pomatostegus.*

AA. Uncini with fewer teeth, the basal one not hollowed. Abdominal setae bent and toothed. Operculum cylindric, borne on an ampulla with transverse processes. . . . . *Vermilia.*

AAA. Uncini with very few teeth, the basal one shaped like the others but larger.
- B. Operculum none. . . . . *Protis.*
- BB. Operculum formed of a modified branchia. Surface of operculum with radii, and in center a crown of spines each with lateral processes. . . . . *Hydroides.*

## SPIRODISCUS Fauvel

### Spirodiscus calciferus (Treadwell)

Figures 113a, b, c

*Placostegus calciferus* Treadwell (1929b) 12, 13. *fig. 34, 35, 36.*

Described by Treadwell from a single specimen collected in 1915 by R. W. Miner at Julia Cove, Guanica Harbor. Owing to an apparent lack of collar setae, the specimen was not easily located in its proper genus, but the setae are present though imbedded in the collar tissue. The body is 20 mm. long, the gills making up 3 mm. of this measurement. On either side are about twenty-three branchiae of which the longest are the dorsalmost, the ventral ones being much shorter and inrolled into more than a complete circle. The branchiae are united for more than half their length by a membrane. In preserved material the bases of the branchial lobes are brown in color and the free portions are alternately banded with colorless and brown. In these the stalk of the operculum is considerably longer than the branchiae, and is heavily calcified and marked with longitudinal ridges. The opercular plate is 2 mm. in diameter and has about sixteen marginal denticulations. Distally the plate carries a thick deposit of limestone which is hollowed to form a cup, and from the margins of this cup irregular lamellar ridges extend toward the center, giving an imitation of a worn coral cup with septa.

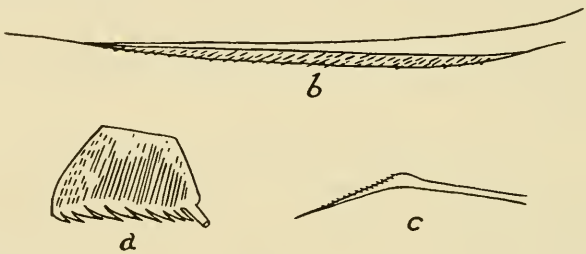


Figure 113. *Spirodiscus calciferus* (Treadwell). a. Uncinus. × 250. b. Seta. × 175 c. Geniculate seta.

The thoracic membrane is prominent, its dorsal margin extending as far as the ends of the branchiae. About half way to the ventral surface on either side it becomes abruptly shorter. Only the first setigerous somite is covered by the collar, the others being uncovered. In each of the thoracic somites the posterior margin is raised and extends over the anterior margin of the following somite. The abdomen tapers gradually to a blunt end and ventrally has a wide shallow groove which is most in evidence toward the posterior end.

Uncini are similar in form throughout the body. They are trapezoidal in outline and carry nine teeth of which the median ones are the largest. Basal to the last tooth is a cylindrical process a little longer than the tooth and hollowed at its end (FIGURE 113 a). The thoracic setae are of two kinds the larger ones having much thicker stems than the smaller. Toward the apex each larger one bends, and from the point of bending tapers to an acute tip. Along the convex surface is a marginal wing covered with minute striations (FIGURE 113 b). In the smaller setae there is a narrow marginal wing, but the bending of the whole setae is never so great as it is in the larger ones. The abdominal setae are smaller than the thoracic, their stalks being long and very slender. They are geniculate at the ends and have fine teeth along the margin (FIGURE 113 c).

Type in American Museum of Natural History, Cat. No. A. M. N. H. 1996.

### POMATOSTEGUS Schmarda

### Pomatostegus stellatus Mørch

*Terebella stellata* Abildgaard (1789) 142.
*Pomatostegus stellatus* Mørch (1863) 50.—Ehlers (1887) 296–300.

The most characteristic feature of this serpulid is the operculum consisting of a central axis on which are borne, one above the other, a series of plates. The normal maximum number of these plates is uncertain. In specimens described by Ehlers from Key West there were four. Treadwell (1901: 210) found that in Porto Rico material the number was from 1 to 3. Ehlers described a small star-shaped plate at the very end of the opercular stalk as the typical ending, but it was shown from the Porto Rico material that each plate has such a star-shaped basal attachment, and the terminal one is simply one from which the true opercular plate has been detached. The operculum has a broad stalk, laterally prolonged to form a wing on either side.

There are 7 thoracic and 140 abdominal somites. The basal portion of the gill is partially coiled, the gill itself rather small. The thoracic membrane is broad in front, and on the ventral side each half extends forward as a triangular lobe extending to the gills. Posteriorly it extends only as far as the second thoracic setae tuft.

The dorsal setae have very long points and carry a broad marginal wing which is toothed along its margin. The uncini of the thorax have few but rather large teeth the proximal one excavated at the end. Abdominal uncini are similar to thoracic in form but are smaller. Abdominal setae are capillary whose apices at first broaden and then narrow, the margin denticulated.

Description from Ehlers who gives no figures.

Collected in Porto Rico at Station 6076, Caballo Blanco Reef, Guanica Bay by R. W. Miner, H. Mueller, and R. C. Osburn, and Ensenada Honda (Culebra) (Treadwell 1901). It has been collected at the Dry Tortugas (Treadwell: unpublished).

### VERMILIA Philippi

### Vermilia annulata Schmarda

FIGURE 114

*Vermilia annulata* Schmarda (1861) 28. *pl. 21, fig. 126.*—Ehlers (1887) 308–313. *pl. 58, fig. 12–16; pl. 59, fig. 1–3.*

Only an empty shell of this species has been recorded from Porto Rico. This is of limestone, not very much bent and marked by five longitudinal ridges. The animal itself is slender, and with the exception of the operculum, colorless. The gills are relatively rather stout and are carried on a heavy base (FIGURE 114). The operculum is globular, flattened on the outer end. The thoracic membrane is widest at about its middle, extends on to the ventral surface below the bases of the gills, and posteriorly extends only part way to the posterior end of the thorax.

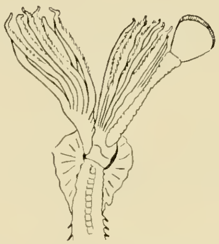

Figure 114. *Vermilia annulata* Schmarda.

Two kinds of capillary setae appear in the thorax. One is very slender and sharply pointed, the other is much heavier and towards the end widens slightly and then narrows to an acute point the narrowed portion being slightly bent. Along its concave margin it carries numerous fine teeth. Just at the bend is, according to Ehlers' figure, a division line, giving the setae almost the appearance of a compound one. The uncini are much flattened and carry a row of prominent teeth. According to Ehlers' figure there are eleven of these, followed by a single stouter blunt pointed one.

Ehlers' specimens were taken near Morro Light, Florida and at 23° 03′ N., 83° 10.5′ W. The Fish Hawk collected it at Station 6064 (Treadwell 1901).

### PROTIS Ehlers

#### Protis torquata Hoagland

FIGURE 115

*Protis torquata* Hoagland (1919) 580–581. *pl. 32, fig. 9–13.*

The total body length is 15 mm. of which 3 mm. is furnished by the gills. The width is 1 mm. In the thorax are seven somites, tori borne on the last six meeting on the ventral mid-line. The collar is one-lobed and rather high, its dorsal edges being separated and thrown into irregular folds along their median edges. The gills are spirally arranged and consist of eighteen branchiae on either side. Olive-green spots are carried on the inner face of each branchia. There is no operculum (FIGURE 115).

Thoracic setae are slightly bent and limbate toward the apices. Those of the collar tuft differ from the others in that there is a definite expansion near the apex and from this a regular tapering to the point, the whole like a very slender spear head. The symmetry of this structure is marred by a lateral outgrowth at the base which bends forward as a blunt tooth. The side of the terminal portion turned

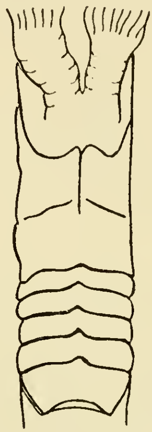

Figure 115. *Protis torquata* Hoagland. × 30.

toward this tooth is denticulated. The thoracic uncini have eight prominent sharp teeth followed by a blunt one. Abdominal setae are similar to thoracic.

Recorded by Hoagland (1919) as collected at entrance to Condado Bay opposite Fort Geronimo by R. W. Miner and H. Mueller.

Type in American Museum of Natural History, Cat. No. A. M. N. H. 1266.

### **HYDROIDES** Gunnerus

#### **Hydroides parvus** (Treadwell)

FIGURE 116a, b

*Eupomatus parvus* Treadwell (1901) 210. *fig. 79–80.*

A species name provisionally given by Treadwell to a number of small specimens found on bryozoon skeletons at Boqueron Bay, and Station 6062. They are possibly immature individuals of some already known species but do not show any familiar characteristics.

The body is 6 mm. long, the operculum with stalk 3 mm. There are eight branchiae on a side with a rudimentary pseudoperculum on the opposite side from the functional one. There are about thirty spines

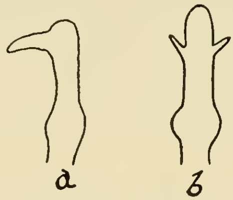


Figure 116. Opercular spine of *Hydroides parvus* (Treadwell).

around the margin of the operculum and arising from the center of its disc are eight long spines each with two lateral branches near its apex (FIGURES 116 a, b). The uncini have five well developed teeth of which the proximal is the largest.

## Family SABELLARIIDAE

Characterized by the presence of large lobes on the dorsal surface of the peristomium which extend forward and completely cover the prostomium. These lobes carry paleae on their ends and function as an operculum. In most genera they are fused to form a single structure. Gill filaments and a seta tuft lie ventral to the operculum on either side. This portion of the body is known as the head and following it is the thorax, composed of a very few somites each of which has notopodial paleae-like setae and slender neuropodial ones. Behind the thorax is the abdomen which makes up the greater part of the body. In each abdominal somite is on either side a vertically arranged torus carrying small uncini in a row on its free margin. There is also a tuft of neuropodial setae. The body ends posteriorly in a cylindrical caudal portion much narrower than any other part of the animal. The animals live in tubes composed of aggregated sand grains which often are massed in considerable numbers.

### Key to Genera recorded from Porto Rico

A. Operculum well developed, its two parts completely fused. Paleae in two rows.
  B. Dorsal hooks on the head .......................... *Idanthrysus.*
  BB. Dorsal hooks on the head none .......................... *Centrocorone.*

## IDANTHRYSUS Kinberg

### Idanthrysus varians (Treadwell)

FIGURE 117

*Hermella varians* Treadwell (1901) 210. *fig. 81.*

The anterior region has about 30 paleae on either side, and on either side are 12 lappets just behind the outer row of paleae. On the dorsal surface of the head is a pair of stout hooks. The inner paleae are only 4 on a side. The outer paleae are not toothed but are broad flat plates which under high power show longitudinal striations. The paleae on the body somites have broad flat ends, the end margin

Figure 117. Seta of *Idanthrysus varians* (Treadwell). × 600

irregular serrated, other margins entire. In the notopodial tuft are two kinds of setae, one long and delicate, the other carrying rows of toothed plates (FIGURE 117). The tentacles are not very numerous, one on either side being longer than the others.

This species was described from a single badly preserved specimen in which only the head and a few anterior somites remained. It was collected by the Fish Hawk at Station 6067.

## CENTROCORONE Grube

### Centrocorone spinifera Treadwell

FIGURE 118

*Centrocorone spinifera* Treadwell (1939) 1. *fig. 1–9.*

The body shows the usual divisions characteristic of the members of this family. Anteriorly (FIGURE 118) the opercular lobes are fused and extend beyond the remainder of the body. Ventral to the operculum on either side is a prominent bunch of gill filaments supported on a rather heavy basal plate. On the inner side of each plate is a slender tentacle whose apex almost reaches the operculum.

The operculum has two rows of paleae of which the outer have long narrow stalks imbedded in the opercular tissue and their outer ends flattened. A slender spike with fringed margins is attached to the outer end of the flattened portion and stands straight out from the opercular margin. The inner paleae are elongated-triangular in form and lie flat down on the outer opercular surface, their apices in contact.

Outside of the outer paleae is a marginal membrane with scalloped margin.

The thoracic region is composed of 3 somites each having tufts of notopodial and neuropodial setae. The notopodial are of two kinds, one much larger than the other and having flattened outer ends, the other slender, sharp pointed, and bent at the ends. Neuropodial

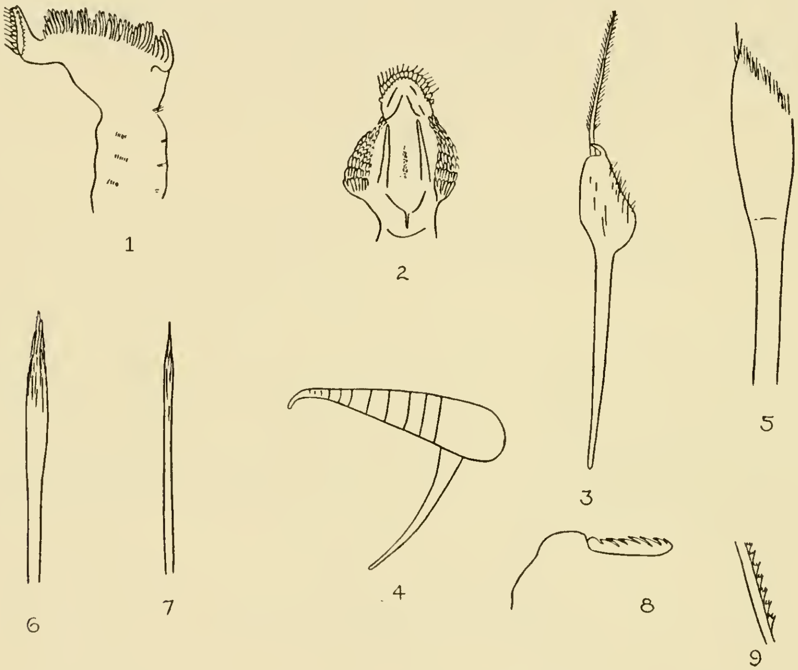


FIGURE 118. *Centrocorone spinifera* Treadwell. 1. Anterior region of body seen from right side, × 5. 2. Ventral view of head, × 5. (Figures 1 and 2 are partly diagrammatic.) 3. Outer palea, × 185. 4. Inner palea, × 185. 5. Large dorsal thoracic seta, × 185. 6. Larger ventral seta of thorax, × 185. 7. Smaller ventral seta of thorax, × 185. 8. Abdominal uncinus, × 250. 9. Detail of stalk of ventral abdominal seta, × 250.

setae are also of two kinds, the larger lanceolate at the ends, the smaller not so much expanded. The abdomen contains 30 or more somites each carrying a vertically arranged torus which carries uncini on its outer margin. The anterior tori are almost as high as the vertical body diameter, but later ones are progressively lower so that in posterior somites they are narrow elongated protrusions from the body surface. Neuropodial abdominal setae are slender and sharp pointed, and carry two rows of toothed plates along their margins.

In profile these look like a single row. Gills appear in the abdominal region as cirrus-like structures, one pair on the dorsal surface of each somite.

The caudal portion is a slender cylinder much narrower than the abdomen and about as long as the last 16 somites. At its base it has on either side a band of dark brown pigment running lengthwise. Similar pigment occurs on the ventral surface of the head, but the remainder of the body is colorless.

The tubes are composed of fine sand grains and are massed in large bunches.

The species was collected by Mrs. Ana M. Diaz Collazo at Boca de Cangrejos.

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OF

# PORTO RICO and the VIRGIN ISLANDS

VOLUME XVI—Part 3

## Bryozoa of Porto Rico with a Résumé of the West Indian Bryozoan Fauna

*Raymond C. Osburn*

NEW YORK
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*SCIENTIFIC SURVEY OF PORTO RICO AND THE VIRGIN ISLANDS*

*This natural history survey of Porto Rico and the Virgin Islands, conducted by The New York Academy of Sciences, was established in 1913. Continuous publication of the results of this survey is made possible through contributions from the Department of Agriculture and Commerce of Porto Rico, and the University of Porto Rico.*

# BRYOZOA OF PORTO RICO WITH A RÉSUMÉ OF THE WEST INDIAN BRYOZOAN FAUNA

By Raymond C. Osburn

## CONTENTS

## INTRODUCTION

In connection with the cooperative survey of Porto Rico, conducted by The New York Academy of Sciences and the Insular Government, the author spent the summer of 1915 collecting the Bryozoa. The work was all done in the shallower waters about the island down to a depth of about 30 fathoms or near the edge of the coastal shelf.

Dredgings were made at more than 50 stations, some of these being repeated. The piles of docks and the roots of mangroves in shallow water were examined, and material washed up on the beach was looked over carefully. As my whole time was given to collecting and sorting the material in this group, it seems safe to say that the list here presented is fairly representative. Care was taken to cover as many different ecological conditions as possible in the region, various types of bottom, different degrees of exposure, and varying depths.

The coastal shelf of shallow water about Porto Rico is very narrow. The broadest part is on the southern shore, but even here it extends usually only a couple of miles until the bottom plunges abruptly to the depths of the Caribbean Sea.

No previous attempt has been made to list the bryozoan species of this region and only a few have been recorded incidentally. Busk's report (1884) on the group taken by the Challenger Expedition lists only 5 species taken near Porto Rico, Levinsen (1909) mentions a few species from the nearby Virgin Islands, and Osburn (1940) has described a new species of *Cornucopina* taken by the First Johnson-Smithsonian Deep-Sea Expedition.

The region about the Florida Straits and the Tortugas Islands has been fairly well studied. Pourtales (1867) listed 7 species and his material was then turned over to Smitt (1872–73) who determined about 90 species in the Pourtales dredgings about the Straits and the Tortugas. Osburn (1914) reported on his collections in the shallow waters near the Tortugas Islands, recording 83 species and adding 40 species to Smitt's list. Canu and Bassler (1928) covered a larger territory and deeper water—Yucatan Strait, Gulf of Mexico, and the Florida coast to the Bahamas—and added about 80 more species to the list of those previously known from this area.

Of the remainder of the West Indian and Caribbean region very little is known. The largest list is that of Osburn (1927) who reported on 23 species collected in the shallow waters about Curaçao

Island by Dr. C. J. van der Horst. In 1888 Agassiz mentioned 7 species collected by the "Blake"; in 1850 Duchassaing listed 5 from the Antilles; Sonder in his "Coll. Binder" mentioned *Zoobotryon pellucidum* as an alga under the name *Ascothamnion trinitatis;* Lamouroux, in 1816, described *Amathia alternata* from "Mer des Antilles", and in 1786 Ellis and Solander described *Pasythea* (*Cellaria*) *tulipifera* from Jamaica.

My own collections in the shallower waters of Porto Rico include a total of 124 species and varieties, indicating a very rich bryozoan fauna. Seven other species are known to occur in deeper water. Careful collecting in deeper water off the coastal shelf should add very materially to the list.

Included in the keys and distribution records of the present work are the other species known to occur elsewhere in the West Indian region. The whole area from the eastern part of the Gulf of Mexico to the Lesser Antilles is so generally uniform and the currents of the gulf and the Caribbean Sea run in such a manner that there seems to be no good reason why the shallow water species, at least, should not be distributed rather uniformly where local ecological conditions will permit. This distribution will include to a lesser extent the Bahamas, the Bermudas, and the coast northward to the Carolinas where the Gulf Stream runs over or close to the coastal shelf. The fishing banks off Beaufort, North Carolina, where the reef at 13 fathoms lies in the edge of the Gulf Stream, present a very typical tropical bryozoan fauna.

The bryozoan fauna of the West Indies is very similar to that of the warmer waters of the eastern Atlantic and the Mediterranean Sea. Like that of any tropical region it contains some subtropical species and even some that are more characteristic of colder waters. The latter are usually found at some depth, for a considerable number of species appear to have a rather wide range of tolerance for both depth and temperature. As in any such neglected region, some undescribed species occur, along with numerous others not known to occur elsewhere. It would be dangerous, however, to predict that they are limited to the West Indies, for tropical species of Bryozoa have a disturbing habit of turning up almost anywhere in warm seas in true circumtropical fashion. Some of the species of the present list range northward as far as Cape Cod or even farther, and southward to Brazil, and on to Patagonia. The recent work of Marcus (1937, 1938, and 1939) shows that a large number of the present list range at least as far south as Santos Bay, Brazil.

The writer is especially indebted to Dr. R. S. Bassler of the United States National Museum for the privilege of studying numerous types and other material, and to Dr. Anna B. Hastings of the British Museum of Zoology for the comparison of a number of my specimens with the types.

## SYSTEMATIC ACCOUNT

### BRYOZOA Ehrenberg 1831

The Bryozoa form a very distinct group, distinguished by a number of characters which set them aside very distinctly from all other invertebrates. Whether the group is eventually determined as a phylum, a subphylum, or a class, need not concern us here. Also we need not discuss Cori's recent attempt, 1929, to separate the endoproctous forms as a distinct phylum, the Kamptozoa, since this has not met with much response and bryozoologists will no doubt continue to include all of them in their work.

With a few exceptions among the Endoprocta, they are highly colonial, budding occurring in a number of ways,—terminal, lateral, dorsal, frontal, or stolonate. The zoarium (colony) may be creeping, erect, or encrusting. The individuals consist of an outer wall (zooecium) into which the lophophore and tentacles are usually retractile (endoproctous species simply roll the tentacles inward). The zooecial walls may be gelatinous or chitinous, or in most species more or less heavily calcified. The individual is always small, seldom more than a millimeter, but the colonies frequently measure several centimeters and occasionally much larger, up to one-third of a meter. They are usually white or pale yellowish, but may range through the whole spectrum to occasional species so deeply violet that they appear black; a few are transparent.

The great majority of the species are marine, distributed from the polar seas to the tropics and from the shore line down to great depths.

#### Key to the Classes of Bryozoa

1. Tentacles rolled inward, not retractile into the zooecium, anal opening within the tentacle ring ........................... ENTOPROCTA, page 326.
2. Tentacles retractile, anal opening outside of the tentacle ring ............... ........................................... ECTOPROCTA, page 327.

#### Key to the Orders of Ectoprocta

1. Mostly marine, with a circular tentacle ring ..GYMNOLAEMATA, page 327.
2. Fresh-water Ectoprocta with a horse-shoe shaped tentacle ring ............. .................................... PHYLACTOLAEMATA, page 467.

Key to the Suborders of Gymnolaemata

1. Opening of zooecium circular, not closed by an operculum .................. ........................................ CYCLOSTOMATA, page 327.
2. Opening closed by a movable opercular valve like a little trap-door ......... ........................................ CHILOSTOMATA, page 344.
3. Opening closed by puckering a membrane which resembles a fringe of setae ... ........................................ CTENOSTOMATA, page 335.

The above keys and all of those which follow throughout this work are meant to refer only to species occurring within the West Indian region. They would have to be much expanded to cover all of the exceptions among species in other parts of the world.

## Class **ENTOPROCTA** Nitsche 1869

This group includes forms with stalked, naked polypides, with tentacles which are bent inward instead of being withdrawn into a zooecium, and in which the anal opening is within the ring of tentacles. In 1929 Cori separated them from the Bryozoa in a distinct phylum, the Kamptozoa, but this has not yet been generally accepted and as they are usually dealt with under the Bryozoa they are included here. The species are few in number and generally widely distributed.

### Family **PEDICELLINIDAE** Hincks 1880

#### **PEDICELLINA** Sars 1835

Colony stolonate, the individual stalks not enlarged to form a muscular, barrel-shaped base.

##### **Pedicellina cernua** (Pallas) 1771

Common off the mouth of Guanica Harbor at about 6 fathoms. The species is well known and is widely distributed in Atlantic waters and north to polar seas. On the eastern coast of the Americas it has been recorded from Nova Scotia (Cornish 1907) to Santos, Brazil (Marcus 1938). In the West Indian region it has been recorded only by Osburn at the Tortugas Islands (1914: 212).

Occasional specimens have a few spines on the stalk, but for the most part they are bare.

#### **BARENTSIA** Hincks 1880

Colony stolonate, stalks enlarged at the base into a muscular, barrel-shaped structure.

**Barentsia discreta** (Busk) 1886

Taken several times off Guanica Harbor at 5 to 10 fathoms. The species is easily recognized by the peculiar pores in the stalk. Widely distributed over the world. Osburn (1914: 185) recorded it for the Tortugas Islands, but otherwise it has not been noted for the West Indian region. Verrill (1900) recorded it from Bermuda as a new species under the name *B. timida,* and I have also seen the species from there. It ranges from Cape Cod to Santos, Brazil (Marcus 1938) on the Atlantic coast.

## Class **ECTOPROCTA** Nitsche 1869

Nearly all the Bryozoa in all parts of the world belong in this class. The zooids are housed in a zooecial wall, which may be calcareous, chitinous, or gelatinous. The tentacles are attached to a lophophore and may be withdrawn into the zooecium by retractor muscles. The anal opening is situated outside of the tentacle ring.

## Order **GYMNOLAEMATA**

### Suborder **CYCLOSTOMATA** Busk 1852

The individuals are tubular with a circular aperture which is not closed by an opercular valve. All are calcareous and form colonies which may be encrusting or erect. Reproduction is accomplished by certain individuals, gonozooecia or ovicells, which are usually much expanded and provided with a special opening the ooeciopore. Polyembryony occurs, a single embryo budding to form a large number of larvae.

Key to the Genera

1. Erect, or semi-erect branches .................................................. 2.
   Entirely encrusting .................................................. 9.
2. Flexible with horny joints .................................................. 3.
   Rigid without joints .................................................. 4.
3. Branches slender, of two series of zooecia .................. *Crisia,* page 328.
   Branches flabellate, more than two series of zooecia ... *Crisulipora,* page 332.
4. Stem and branches rounded .................................................. 5.
   Branches flattened, zooecia all on one (frontal) side ..................... 6.
5. Zooecial apertures on all sides of branch ............ *Entalophora,* page 330.
   Apertures on frontal side only, ooecia on dorsal side .... *Hornera,* page 334.
6. Zooecia irregularly arranged .................................................. 7.
   Zooecia arranged in alternating series along stem ........................ 8.
7. Ooecium on the frontal side among the tubules ..... *Diaperoecia,* page 331.
   Ooecium on the dorsal side ............................... *Tervia,* page 333.

8. Dorsal side of stem with numerous pores ..................... [*Crisina*].*
   Dorsal side without pores, ooecium a frontal inflation between the tubules ............................................. *Idmonea,* page 333.
9. Zoarium discoidal, ooecium centrally located ........ *Lichenopora,* page 334.
   Zoarium lobate or linear ................................................. 10.
10. Ooecium pyriform, in series with the tubules ......................... 11.
   Ooecium expanded transversely to the tubules ........................ 12.
11. Zoarium of linear encrusting branches ............... *Proboscina,* page 329.
   Zoarium of flabellate encrusting branches .......... *Oncousoecia,* page 329.
12. Ooecium spreads around zooecial tubules, small adventitious tubules among the functional ones .............................. *Diplosolen,* page 333.
   Ooecium lies between the tubules, disarranging them, no adventitious tubules ............................................. *Plagioecia,* page 330.

## CRISIA Lamouroux 1912

### Crisia elongata Milne Edwards 1838

*Crisia eburnea* form *denticulata* Smitt (1872) 4.
*Crisia denticulata* Osburn (1914) 185.—Canu & Bassler (1928) 156.
*Crisia elongata* Canu & Bassler (1928) 157.

This species has been given careful redescription by Harmer (1915: 96–102. pl. 8. figs. 1–8). Our material from Porto Rico seems to agree in every important detail.

The internodes are usually elongate, average about 14 to 16 tubules, but ranging from 6 to 30, slightly sinuated, and the joints of both branches and radicles are jet black, brownish in young parts of the colony. The gonozooid, or ovicell, is situated usually near the middle of an internode, short, suddenly and broadly inflated. The ooeciopore, or opening of the ovicell, is a transverse slit and there is no development of a tubular ooeciostome. The ooecial characters agree closely with the figures given by Harmer (1915).

It is my belief that the determination of *C. elongata* disposes of the questionable occurrence of *C. denticulata* in West Indian waters. Certainly my own material from the Tortugas Islands, doubtfully recorded as *denticulata,* appears to be *elongata.* It will be noted that none of the specimens recorded by Smitt, Osburn, and Canu and Bassler as *denticulata* showed the ovicells, rendering positive identification practically impossible.

*C. elongata* occurs around the world in warmer waters. It was dredged at several of our Porto Rican stations off Guanica Harbor at 6 to 11 fathoms and is evidently well distributed in the West Indian region.

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* Names in brackets not treated in this paper.

#### **Crisia ramosa** Harmer 1891

This species with colorless joints and long radicle internodes is easily distinguished by its round oceciopore situated in a flaring or trumpet-shaped ooeciostome. The ovicell is pyriform, gently inflated from its base to its widest part near the top, which is rounded. Determined for only one locality, near Caribe Island, off the mouth of Guanica Harbor. It has not been previously recorded for the West Indian region, but Marcus (1937: 17) lists it for Brazil and the writer has specimens from the Bermuda Islands, and from Beaufort, North Carolina.

It seems probable that the "*Crisia* species" with white joints listed by Canu and Bassler (1928: 157) for the Gulf of Mexico is this species.

### Family **ONCOUSOECIIDAE** Canu 1918

Linear or lobate encrusting colonies, the ovicell in line with the tubules, not greatly modified, the ooeciopore either terminal or frontal.

#### **ONCOUSOECIA** Canu 1918

#### **Oncousoecia arcuata** Canu & Bassler 1928

The branches are long, somewhat arcuate; ovicell globular, as wide as the branches, ooeciostome terminal. Recorded by Canu and Bassler (1928: 158) for the Florida Strait at 56 fathoms. Not taken at Porto Rico.

#### **PROBOSCINA** Audouin 1826

#### **Proboscina robusta** Canu & Bassler 1928

Long biserial branches which widen to 3 or 4 series of tubules before bifurcating. Tubes short and transversely striated. No ovicells observed. Canu and Bassler (1928: 157), north of Cuba at 143 fathoms. Not taken at Porto Rico.

#### **Proboscina floridana** (Canu & Bassler) 1928

Branches dichotomous, small, palmate; tubules cylindrical, transversely striate. Ovicell orbicular, with a small salient ooeciostome at the center. Canu and Bassler (1928: 158, *Peristomoecia*), Florida Strait, 56 fathoms. Not taken at Porto Rico.

### Family **ENTALOPHORIDAE** Reuss 1869

Zoarium consisting of rounded, erect, usually branching stems, with the tubules arranged on all sides.

Apparently there are two species of *Entalophora* among our material from Porto Rico, but their relationships to the species previously listed for the West Indian region appear to be problematical.

### **ENTALOPHORA** Lamouroux 1821

#### **Entalophora delicatula** (Busk) 1875

PLATE 1, FIGURE 4

*Entalophora deflexa* Smitt (1872) 11.
*Mecynoecia deflexa* Canu & Bassler (1928) 160.
*Entalophora delicatula* Marcus (1937) 24.

Zoarium erect from a rather broad base which is attached to algae, stems of hydroids, or to other bryozoans; sparingly branched, often a single erect stem not much larger than the attached base. Ovicell located between the tubules near the somewhat enlarged end of the stem, or immediately below a bifurcation. In one case a similar ovicell was present on the encrusting base. The ovicell is not perforated by the tubules lateral to it, but it sometimes partially encloses a few of them. The ooeciopore is a semilunate slit at the base of one of the tubules near the upper end of the ovicell.

Porto Rico, a number of specimens taken at Station 2377, between Ratones and Caribe Islands at 6 to 11 fathoms.

#### **Entalophora proboscideoides** Smitt 1872

A more slender species than the preceding. Not taken at Porto Rico. Smitt (1872: 11) described it from west of the Tortugas Islands at 68 fathoms.

## Family **PLAGIOECIIDAE** Canu 1918

### **PLAGIOECIA** Canu 1918

#### **Plagioecia dispar** Canu & Bassler 1928

Not taken at Porto Rico. Canu and Bassler (1928: 159), Straits of Florida at 56 fathoms. The species is distinct from the well-known *P. sarniensis* (Norman) in its very elongate ovicell which is remote from the margin.

## Family **DIAPEROECIIDAE** Canu 1918

The ooecial cavity is traversed by zooecial tubules, the ooeciostome non-terminal and not associated with a zooecial tubule, often turned forward or recurved.

Key to the Genera

1. Zoarium erect, without joints ........................ *Diaperoecia*, page 331.
2. Zoarium erect, with flexible joints ..................... *Crisulipora*, page 332.
3. Zoarium encrusting, with flabellate lobes, minute functionless tubules scattered among the normal ones ...................... *Diplosolen*, page 333.

## DIAPEROECIA Canu 1918

### Diaperoecia floridana NEW SPECIES

Plate 1, figure 3

*Idmonea milneana* Smitt (non D'Orbigny) (1872) 8. pl. 3, figs. 14–17.
*Diaperoecia radicata* Canu & Bassler (non Kirkpatrick) (1928) 160. pl. 31, figs. 3–5.

It appears that this species has never been properly named. Smitt (1872) misidentified it with *Idmonea milneana* D'Orbigny 1839. Canu and Bassler (1928) mistook it for *I. radicata* Kirkpatrick 1888, but later corrected the error (1929: 538–540) without renaming the species since their material was not satisfactory for close study.

The writer has some very fine specimens from the fishing bank off Beaufort, North Carolina, at 13 fathoms, some of them as much as 25 millimeters in height, much branched and in some cases the branches anastomosed. There is considerable variation in the width of the branches, ordinarily from 0.70 to 1.00 millimeters, often a little wider near a bifurcation and occasionally narrower branches occur. Five or six tubules, seven or eight near a bifurcation, make up the width of a branch; the free portions of the tubules have some tendency to occur in diagonal rows, and the lateral ones may be connate for a part of their length. The dorsal side of the branch is very definitely wrinkled transversely. The free portions of the tubules are about 0.40 millimeters long, somewhat wrinkled, slightly tapering, the orifice usually quite round.

The ooecium usually encloses several tubules and is irregular in outline, widest at about its middle part, measuring about 2.50 millimeters in length by about 0.90 millimeters in width. It is slightly wrinkled on the narrower basal part only and is quite smooth over most of its surface. The ooeciostome is centrally located and recurved toward the base, its width about that of a tubule (0.16 to 0.20 millimeters), the ooeciopore elliptical.

Strong unjointed radicle processes are developed from the dorsal side of the zoarium near the base for additional support.

In our Porto Rican collections this species is represented only by two small broken portions from Station 2341, off the mouth of Guanica Harbor, at a depth of 23 fathoms. Smitt recorded it from Florida (*I. milneana*) at 19 to 60 fathoms, and Canu and Bassler list it

(*D. radicata*) from the Gulf of Mexico and the Straits of Florida at 30 to 56 fathoms. The above description and the accompanying figure are taken from the fine specimens collected at Beaufort, North Carolina.

### Diaperoecia rugosa NEW SPECIES

PLATE 1, FIGURES 1, 2

Zoarium erect, small, the largest specimen not over 10 millimeters long, basal attachment wanting, but dorsal unjointed radicle processes present; branched dichotomously, the branches varying from 0.30 to 0.40 millimeters in width, one to three (usually two) tubules in a series. The whole surface, frontal and dorsal sides of the branches, the free tubules, the entire ooecial surface and the radicle processes, finely and evenly wrinkled transversely.

The free tubules are rather long, 0.30 to 0.60 millimeters, usually decreasing slightly in size toward the end, the aperture round, diameter of peristome 0.14 to 0.16 millimeters.

The ooecium is considerably inflated and is traversed by one to several tubules (seven in one case). Each of my four specimens bears a single ooecium, in two of them the ooecium is near the bifurcation and is forked as in FIGURE 1, in the other two the ooecium is situated farther down on the branch and is smaller and simpler as in FIGURE 2. In the simple ooecia the ooeciostome is centrally located, but in the forked ooecia it is situated higher up near the bifurcation. In any case the tubule is turned forward and flared out widely like the bell of a trumpet. The tube at its base measures about 0.16 millimeters, but as much as 0.25 millimeters at the transversely elliptical opening.

The species appears to resemble *Idmonea pulcherrima* Kirkpatrick in several characters, but in that species Harmer (1915: 130) indicates a bulbous enlargement of the base of the ooeciostome and does not mention nor figure the surface wrinkles so characteristic of the present species.

Four specimens from Station 2347, between Caya Caribe and Caya Parguera, off Guanica Harbor, Porto Rico, 5½ to 8 fathoms.

## CRISULIPORA Robertson 1910

### Crisulipora orientalis Canu & Bassler 1928

This erect, jointed species appears to have some of the characteristics of *Crisia* and *Tubulipora*, which the generic name suggests. The ovicell is traversed by the zooecial tubules, very definitely as in the family Plagioeciidae. The flabellate branches may reach a height of 25 millimeters.

Porto Rico, off the mouth of Guanica Harbor at 8 fathoms, two small colonies. Canu and Bassler (1928: 162) described it from Egmont Key, Florida. It occurs as far north as Beaufort, North Carolina. Marcus (1937: 21) lists the Pacific species, *C. occidentalis* Robertson, for Santos Bay, Brazil.

#### **DIPLOSOLEN** Canu 1918

##### **Diplosolen obelium** (Johnston) 1938

The species is easily distinguished by the presence of minute zooecial tubules among the normal ones. The zoarium is flat and encrusting and the ovicell is traversed by the zooecial tubes.

Porto Rico, a couple of small colonies without ovicells dredged at 30 fathoms off Guanica Harbor. Canu and Bassler (1928: 161) record it north of Cuba at 143 fathoms. It has an extraordinary range.

### Family **TUBULIPORIDAE** Johnston 1838

#### **IDMONEA** Lamouroux 1821

##### **Idmonea atlantica** var. **flexuosa** (Pourtales) 1867

Pourtales (1867: 111, *Idmonea flexuosa*), described the species from "off Havana in 270 fathoms." Smitt (1872: 6) gives a much more complete description of Pourtales material, but the species has not since been recorded from the West Indian region.

### Family **TERVIIDAE** Canu & Bassler 1920

Characterized by the erect branching zoarium and the position of the ovicell on the dorsal side.

#### **TERVIA** Jullien 1882

##### **Tervia pourtalesii** (Smitt) 1872

Described by Smitt (1872: 9, *Filisparsa*), Tortugas Islands at 60 fathoms. Not taken by any more recent collector.

### Family **HORNERIDAE** Gregory 1899

Erect, tree-like, with rounded tapering branches, zooecial tubes opening on the frontal side, the ovicell globular on the dorsal side of the zoarium.

### HORNERA Lamouroux 1921

#### Hornera galeata Smitt 1872

Not taken at Porto Rico. Smitt (1872: 10), Florida; Canu and Bassler (1928: 163), north of Cuba, 143 fathoms.

## Family LICHENOPORIDAE Smitt 1866

The zoarium is discoidal on a centrally located and usually very short stalk by which it is attached. The zooecia all open on the frontal surface, usually but not always in series, connate or free, and there is usually a basal lamina extending somewhat beyond the tubules. The ooecium is usually a single, irregularly shaped, centrally located inflation which may extend a short distance between the rows of tubules. The ooeciostome differs in size and form from the tubules and may be near the center or at the edge of the inflation.

### LICHENOPORA Defrance 1823

Key to the Species

1. Zoarium raised, dome-shaped ........................ *L. floridana,* page 335.
   Zoarium flat or only slightly raised.................................... 2.
2. Tubules closely connate in very regular uniserial series *L. radiata,* page 334.
   Tubules not so arranged................................................ 3.
3. Tubules not in series, not at all connate ................ *L. buski,* page 334.
   Tubules in more or less regular series but not closely connate............. 4.
4. Tubules in rather regular rows, central portion of zoarium reticulate .........
   ............................................... *L. clypeiformis,* page 335.
   Tubules less regularly disposed, strongly spinous at tips, center not reticulate
   ................................................... *L. hispida,* page 335.

#### Lichenopora radiata (Audouin) 1826

This well-known and widely distributed species occurred at Station 2377 between Rotones and Caribe Island, off Guanica, Porto Rico, two colonies with ooecia at 6 to 11 fathoms. Among other West Indian species it is easily recognized by the regularly radiating rows of tubules which are closely connate in single series. Its occurrence in the West Indies has already been reported by Canu and Bassler (1928: 163) north of Cuba at 67 and 143 fathoms.

#### Lichenopora buski Harmer 1915

Plate 1, figure 5

This species appears to be the commonest one in Porto Rican waters as it was taken in a number of places at 3 to 27 fathoms.

It was especially abundant at Station 2377 between Rotones and Caribe Islands, where about 50 colonies were taken, attached to algae and hydroid stems at 6 to 11 fathoms. The very irregular arrangement of the tubules which are not at all connate is characteristic. The ovicell is also more irregular than usual in this genus. In one specimen a second ovicell was acentrally placed among the lateral tubules. There is considerable difference in the size of colonies in reproduction, but my largest specimen measures only about 6 millimeters in diameter.

Canu and Bassler (1928: 163) record questionably a specimen of considerably larger size taken at 130 fathoms north of Cuba. This may represent a different species, though the isolation of the tubules and the nature of the central portion of the colony strongly suggest *buski*. Otherwise the species has not been noted for the Atlantic.

**Lichenopora hispida** (Fleming) 1829

This widely distributed species has been noted in the West Indian region only at Florida, Tortugas, and Biscayne Key, by Osburn (1914: 186). It is generally more northern in distribution though it is known from the Mediterranean Sea and the Madeira Islands.

**Lichenopora floridana** (Canu & Bassler) 1928

*Domopora floridana* Canu & Bassler (1928) 164. pl. 30, figs. 5, 6.

This species with the high, dome-shaped character of a *Domopora* is known only from the record of Canu and Bassler from the Gulf of Mexico at 30 fathoms.

**Lichenopora clypeiformis** (Smitt) 1872 (non D'Orbigny)

Smitt (1872: 12 pl. 4, fig. 31) records under the name *Discoporella clypeiformis* D'Orbigny a single specimen taken in Florida waters at 130 fathoms. Miss Jelly (Cat. Mar. Bry. 134) has removed it from D'Orbigny's species. As the specimen was young and without ovicell, it seems impossible of exact determination, but it appears to be distinct from any known West Indian species.

## Suborder **CTENOSTOMATA** Busk 1853

Gelatinous or chitinous; encrusting, stolonate or erect; aperture closed by constriction of circular muscles; no operculum, no avicularia, no ovicells.

Group A. CARNOSA Gray 1841. Encrusting. Not represented in Porto Rican collections.

Group B. PALUDICELLEA Allman 1856. Creeping or stolonate; zooecia tubular, not constricted below, in many cases the zooecium extends into the stolon. No gizzard. Page 336.

Group C. VESICULARINA Johnston 1847. Erect or recumbent branches arising from a stolon; the zooecia contracted below, usually in clusters. Gizzard present, circular. Page 338.

Group D. STOLONIFERA Ehlers 1876. A creeping stolon, often with erect branches; zooecia attenuated at the base, a flattened membranous area often present on one side. Gizzard when present consisting of four lobes. Page 342.

## Group B **PALUDICELLEA**

## Family **VICTORELLIDAE** Hincks 1880

### **VICTORELLA** Saville Kent 1870

#### **Victorella sibogae** Harmer 1915*

The members of this genus are usually in brackish water, but Harmer described the present one from the East Indies in pure ocean water and Marcus (1937: 129) records it from the Bay of Santos, Brazil. At Porto Rico it was dredged at Station 2367, in 13 fathoms, off the mouth of Guanica Harbor.

The zoarium consists of the elongated bases of the zooecia, from which arise at an angle the erect portions of the zooecia. The older zooecia are well chitinized, yellowish or horn colored. The erect part of the zooecium is circularly wrinkled in constriction. The zooecia are among the largest known among the Bryozoa; Harmer gives the total length as 1.3 to 3.1 millimeters, while Marcus found them as long as 5.0 millimeters, with the diameter ranging from 0.50 to 0.65 millimeters. The Porto Rican specimen comes within the lower range of Harmer's figures, varying from 1.50 to 2.00 millimeters in length, the breadth being about 0.40 millimeters. The number of tentacles is diagnostic, probably more than 20 according to both Harmer and Marcus. There are certainly at least that many in my specimen, but as it had become dried out before examination the exact number is impossible of determination. The size of the zooecia and the method of branching from the sides of the zooecia distinguish the species at once from any other.

* F. Braem has recently erected a new genus, *Sundanella*, for this species (1939. Zeits. Morph. Ökol. Tiere **36(2)**: 267–278).

## Family **NOLELLIDAE** Harmer 1915

### **NOLELLA** Gosse 1855

The zooecia are tubular, elongate, with little variation in size from base to tip. The outer coat is somewhat gelatinous so that argillaceous particles adhere to stiffen the tubes and render them opaque. In one species, *gigantea*, the base of the tube is sharply arrested at the stolon, in the other, *dilatata*, the tube is continued downward into an expansion of the stolon.

#### **Nolella gigantea** (Busk)

The stolon creeps over shells, algae, and the stems of hydroids and of other bryozoans. The tubular zooecia, whitened in our specimens by the attachment of minute particles of coral mud, stand erect, often closely associated along the stolon, like a row of little white posts in a miniature stockade. In diameter they vary from about 0.13 to 0.20 millimeters; in height from 1.0 to 2.0 millimeters, or even to 3.0 millimeters in zooecia that have been lengthened by regeneration.

This widely distributed species is abundant in the West Indies and northward at least as far as Beaufort, North Carolina. In our Porto Rico collections it occurred at numerous stations, from low tide to 30 fathoms. Previously recorded at the Tortugas Islands by Osburn (1914: 219, *Cylindroecium*). Marcus (1937: 131) found it common as far south as the Bay of Santos, Brazil.

#### **Nolella dilatata** (Hincks) 1860

This species is much shorter than the preceding, averaging about 0.50 millimeters in height and is slightly barrel-shaped with a diameter of about 0.20 millimeters at the middle. Unlike *N. gigantea,* the base is expanded into the stolon where a number, 2 to 6, pointed lateral projections appear to act as "hold-fasts." The ectocyst is transversely wrinkled and like that of *gigantea,* becomes covered with mud particles.

Apparently cosmopolitan and found in cold as well as in warm seas. On the eastern American coast it has previously been recorded only by Marcus (1938: 53) at Santos Bay, Brazil. At Porto Rico it was noted at two stations (2335 and 2338) at the mouth of Guanica Harbor, 6 fathoms.

### **ANGUINELLA** Van Beneden 1844

Very much like a branched *Nolella* with the zooecia budding from the sides of other zooecia instead of arising separately from the stolon.

#### Anguinella palmata Van Beneden 1844

The zoarium forms an irregularly branched colony usually about an inch in height. Hincks (1880: 539) gives the height "from 3 or 4 to 6 or 8 inches," but in the hundreds of colonies I have seen in American waters none have reached a height of more than 2 inches. Busk properly describes its appearance, "resembles a small *Fucus* covered with mud" and one would expect it to appear in the collections of the amateur algologist much oftener than those of the zoologist.

The zooecia average about 0.15 millimeters in diameter; in height varying greatly from 0.50 to 1.50 millimeters, the more elongate ones showing evidence of regeneration. The ectocyst is so thickly covered with mud as to completely obscure the internal structures.

Coasts of western Europe and the east coast of the Americas from Buzzards Bay, Massachusetts (Osburn 1912: 253) to Santos Bay, Brazil (Marcus 1937: 133). Tortugas Islands (Osburn 1914: 219) and Chesapeake Bay (1932: 444). At Porto Rico it occurred sparingly on the piles of docks in Guanica Harbor and on mangrove roots near the mouth of the harbor.

The species appears to thrive best in waters of reduced salinity. In the region about Beaufort, North Carolina, where it is excessively abundant, it reaches its best development in the enclosed harbors and sounds.

## Group C **VESICULARINA**

## Family **VESICULARIIDAE** Johnston 1838

### Key to the Genera

1. Erect or trailing branched horny stems, with the zooecia arranged closely in groups which are spirally disposed about the internodes, two series of zooecia in each group ............................ *Amathia*, page 338.
2. Trailing slightly chitinized branching stems, zooecia irregularly disposed or in loose clusters, each zooecium sharply narrowed at base before its point of attachment ................................ *Bowerbankia*, page 341.
3. Soft, scarcely chitinized, branching stems, zooecia arranged in rows along both sides of the internodes, both stems and zooecia very transparent ....... ............................................ *Zoobotryon*, page 341.

#### AMATHIA Lamouroux 1812

The members of this genus may be recognized by the rather stiffly chitinized stems and the biserial, more or less spiral arrangement of the zooecia. The latter are more or less connate.

### Amathia convoluta Lamouroux 1816

*A. alternata* Osburn (1932) 444.

A large, erect, branching, tree-like, horn-colored species, reaching a height of 100 to 150 millimeters, with the lower part of the stem strengthened by radicles. The spiral clusters of paired series of zooecia are conspicuous, occupying most of the internode, and make usually less than one complete turn about the stem. The spiral usually turns counter-clockwise, but occasionally even in the same colony some of the spirals are clockwise. There appears to be no order to this arrangement and no explanation is suggested.

The zooecia are somewhat chitinized, light brown in color in older specimens, closely connate to their tips, graduated in length from 0.55 or 0.60 millimeters at the lower part of the spiral to about 0.40 at the top. Zooecial width, 0.10 to 0.13 millimeters. Diameter of internodes varying from 0.25 to 0.40 millimeters.

Found in Australian and Malayan waters and along the eastern American coasts from Chesapeake Bay (Osburn 1932: 444) to the Bay of Santos (Marcus 1937: 136). At Porto Rico it was picked up on the beach at San Juan and dredged sparingly near the mouth of Guanica Harbor. I have found it washed ashore in great quantities on the outer beaches at Beaufort, North Carolina.

### Amathia distans Busk 1886

Zoarium spreading among stems of various kinds, the internodes slender, 0.06 to 0.12 millimeters in diameter, straw-colored and more rigid than in most species of the genus, free of zooecia for often considerably more than the proximal half.

Zooecia rather short when contracted, 0.30 to 0.40 millimeters, closely connate except at the tip, the clusters forming an elongate spiral that sometimes completely surrounds the internode.

Porto Rico, Station 2377, between Rotones and Caribe Islands at 6 to 11 fathoms, several well developed colonies. Busk described the species from Bahia, Brazil. According to my material *distans* is readily distinguished from *brasiliensis* Busk by the much smaller and more rigid internodes and by the more closely connate arrangement of the zooecia, characters which are carefully pointed out by Busk in his descriptions.

### Amathia brasiliensis Busk 1886

*A. goodei* Verrill (1901) 329.

The zoarium is an irregularly spreading, dichotomous, erect or recumbent colony, reaching a height of 25 to 50 millimeters. The internodes are rather long, varying considerably in diameter from 0.18 to 0.30 millimeters, transparent but moderately stiff. The spirals sometimes make a complete turn of the stem, but usually are much shorter. Sometimes they occupy most of an internode, but usually occupy one-half to two-thirds of the distance. The zooecia are only slightly connate and quite free from each other toward the distal end. They measure in length about 0.40 millimeters, and in width about 0.13 millimeters.

At Porto Rico it occurred near the mouth of Guanica Harbor and was at first almost unrecognizable even as a bryozoan from the deposit of coral mud. Busk (1886: 83) described the species from off Bahia, Brazil. It occurs at the Tortugas Islands (Osburn 1914: 219, ? *A. goodei* Verrill) and Dr. H. G. Richards has sent me a specimen from the Delaware Bay.

Verrill described *goodei* from Bermuda and I believe it to be the same as *brasiliensis* of which I have a specimen also from Bermuda, but I must confess that I do not understand Verrill's statement in regard to the zooids "in large dense, elongated clusters composed of several close rows." Hastings, 1927, questions the validity of *brasiliensis* Busk as a distinct species and Marcus (1937: 134) frankly places it in the synonymy of *distans*. With this I cannot agree, for while I find much variation in the diameter of the stems, they do not seem to intergrade and the zooecia are much less connate in *brasiliensis*.

### Amathia vidovici (Heller) 1867

*Vesicularia dichotoma* n. sp. Verrill (1873) 404.
*Amathia dichotoma* Osburn (1912) 254.
*Amathia vidovici* Waters (1914) 848.

Zoarium semierect but not stiff, dichotomously branching in loose spreading form to the height of one or two inches. The internodes are transparent, rather long, usually one and a half to two millimeters, free of zooecia for more than half their length (occasionally a small cluster may appear lower down on the internode). There is considerable variation in the diameter of the internodes, 0.13 to 0.20 millimeters. The joints may be dark as Verrill indicated in his description of *dichotoma*, especially in old parts of the colony, but frequently there is no indication of this. The zooecia are of moderate size, about 0.40 millimeters long, only slightly connate, and little chitinized so that in preserved specimens they seem to be in irregular clumps. There is however a very regular arrangement in a short spiral, with about 4 to 8 zooecia in each series.

A few colonies tangled among algae were taken on piles of the dock at Ensenada. The species occurs on the Atlantic coast from Cape Cod southward to the West Indies, in the Mediterranean and in the Indian Ocean.

### BOWERBANKIA Farre 1837

#### Bowerbankia gracilis Leidy 1855

Zoarium a creeping stolon spreading over algae, hydroids and other bryozoans, occasionally with free branches. The zooecia are irregularly arranged along the stolon, occasionally more or less clustered, sometimes with a bilateral arrangement on two sides of the stolon but frequently in a single row or irregularly placed. In form the zooecia are roughly elongate-elliptical, rounded at the base where the attachment is narrowed to a short stalk and usually somewhat squared at the tip. The wall is transparent so that the intestinal tract and tentacles are visible. The gizzard is rounded, with numerous teeth. A finger-like projection is often present on the outer side of the rounded base, as in the *B. caudata* Hincks.

The measurements appear to be quite variable. Zooecial length, 0.65 to 1.20 millimeters; width, at the middle, 0.16 to 0.20 or more; width of gizzard, 0.09 to 0.12.

Marcus (1938: 56) has separated *gracilis* Leidy and *caudata* Hincks, from Santos, Brazil, partially on the basis of their measurements, but I am unable to make such distinctions in North Atlantic specimens. Material from Greenland and the West Indies and various points between seem to intergrade and to show considerable variation even in the same colony. The caudate appendage, on which Hincks based his species, is apparently variable (Harmer 1915: 70, has noted them also in *B. imbricata* Adams) and not of diagnostic value.

Dredged on various occasions in Guanica Harbor and along the southern coast of Porto Rico, but never as abundant as it appears to be farther north. It is a widely distributed species and on the eastern American coasts occurs from Greenland to as far south at least as the Bay of Santos, Brazil.

### ZOOBOTRYON Ehrenberg 1831

#### Zoobotryon pellucidum Ehrenberg 1831

The zoarium branches irregularly, often trifurcate, and profusely. It is very soft and flaccid, with just enough rigidity to remain spread out in the water from the point of attachment. I have not observed the stolon to creep on other objects, but the branches are frequently so interlaced with algae and other stems, as well as among each other, that they are difficult to separate. The internodes and zooecia are very transparent, but often obscured by coral mud or tinted greenish or reddish by the attachment of minute algae.

The zooecia are elongate-oval, narrowed at the point of attachment, characteristically arranged in bilateral fashion with one row on either side of the internode, but variations from this are common and occasionally the zooecia are irregularly clustered especially near the ends of the internode. In size the zooecia and internodes vary so much that measurements have little diagnostic value.

In the same colony the author has measured what appear to be fully developed zooecia ranging in length from 0.40 to 0.90 millimeters and in width from 0.18 to 0.30 millimeters. The gizzard when fully contracted measures about 0.08 millimeters, but when expanded is about twice that diameter. The internodes range in diameter from 0.30 to 1.10 millimeters, or even larger.

Apparently the species is circumtropical. On the eastern American coasts it is distributed from Bermuda and Florida throughout the West Indies and the Gulf of Mexico southward to Santos, Brazil. In our Porto Rican collections it was taken on the piles of docks at Ensenada, Parguera, and Ponce.

## Group D **STOLONIFERA** Ehlers 1876

## Family **VALKERIIDAE** Hincks 1877

### **VALKERIA** Fleming 1823

#### **Valkeria atlantica** (Busk) 1886

The zoarium creeps over algae, shells, and stems of various kinds, with occasional branches free. The internodes are very slender (about 0.02 millimeters) and of varying length, noticeably enlarged at each end where they are separated by a definite diaphragm. Usually two branches appear at opposite sides of the end of an internode.

The zooecia are usually in pairs at the distal end of an internode, each attached to a very short joint which appears to be a vestigial internode. In form they are elliptical, narrowing rather gradually at the base into a short pedicel, the distal end usually somewhat squared. When contracted the body wall is often wrinkled transversely.

Zooecial length in various degrees of contraction, 0.30 to 0.60 millimeters or more; width, 0.07 to 0.09 millimeters; diameter of stolon, about 0.02 millimeters.

Busk (1886: 37, *Farrella atlantica*) first described the species from Bahia, Brazil. Harmer (1915: 73–76) gives an excellent discussion of material taken in the Siboga Expedition and compared with Busk's type. Taken in Porto Rico at the mouth of Guanica Harbor, 6 fathoms, trailing over a minute calcareous alga. The species is so inconspicuous as to be noted only by accident and it will probably be found to occur around the world in tropical waters.

## Family **BUSKIIDAE** Hincks 1880

### **BUSKIA** Alder 1856

The members of this genus have a creeping stolon from which free branches occasionally are given off. The zooecia have a flattened membranous area on one side, and the gizzard consists of four hemispherical lobes.

#### **Buskia setigera** Hincks 1877

The creeping stolon spreads over stems of various sorts.

The zooecia, usually attached in pairs at the distal end of an internode, are long ovate in form, transparent enough to show the four-lobed gizzard and other organs. The flattened membranous area occupies about two-thirds of the length of the ventral side. At the distal end are four small lobes from each of which projects a moderately long spine which is jointed at the base. At the proximal end are a pair of clasping processes and a caudate process. Zooecial length, 0.50 to 0.60 millimeters; width, about 0.18 millimeters; spines 0.20 to 0.30 millimeters.

Porto Rico, not common, occasional specimens on the stems of other bryozoans, hydroids, etc. Reported from Brazil at Santos Bay by Marcus (1937: 142).

This species is similar in most respects to *B.* (*Vesicularia*) *armata* Verrill (1873: 710), but lacks the yellowish color of that species. Also it possesses clasping processes near the base of the zooecia and usually a caudate process. The author has examined large numbers of *armata* without finding these structures. If they should be found to intergrade, Verrill's name will have preference.

#### **Buskia nitens** Alder 1856

This is a much smaller species than *B. setigera,* measuring only 0.35 to 0.40 millimeters in length. It has no distal spines and the proximal processes or spines for attachment are more numerous, usually three or four. The very slender stolon appears to be always attached to the stem of a hydroid, other bryozoan, or alga, and the ventral surface of the zooecium is closely appressed to the substratum for about two-thirds of its length proximally.

The colonies are so small that they are found only in looking over other material. It was noted at a couple of stations near the mouth of Guanica Harbor, Porto Rico. Marcus (1938: 59) found it in the Bay of Santos, Brazil. It is apparently distributed around the world in warmer waters.

## Suborder **CHILOSTOMATA** Busk 1852

The zooecia are usually more or less calcified and are provided with an operculum except in a very few cases. A considerable amount of polymorphism occurs in this order, and a number of different names have been applied to the various types,—autozooecia to the ordinary individuals, gonozooecia to modified reproductive ones, and kenozooecia and heterozooecia to those modified for other functions of the colony. Ooecia or ovicells are usually present, consisting of a calcified anterior chamber, as a rule externally placed on the base of the succeeding zooecium (hyperstomial ovicells), but sometimes protruding internally into the base of the succeeding zooecium (endozooecial). The calcified or chitinous lateral and distal walls between the zooecia are furnished with communication pores in various and often characteristic arrangement. Avicularia and vibracula, highly modified and reduced individuals of special function, occasionally resembling bird's heads in form, are found in most of the species and only in this order.

Levinsen (1909) distinguished two suborders, Anasca and Ascophora, on the basis of the absence or presence of a compensatorium—an internal sac which opens to the exterior for the regulation of water pressure as the polypide is protruded or withdrawn.

### Infraorder **ANASCA** Levinsen 1909

Compensation sac wanting; frontal wall at least in part membranous; or if calcareous depressed and surrounded by a raised margin; or in some cases the membranous ectocyst covered by an arched, porous frontal shield or pericyst.

Levinsen distinguished three divisions,—Malacostega, Coilostega, and Pseudostega. Harmer (1926) separated off the family Aeteidae as division Inovicellata; reestablished the group Cellularina of Smitt as a separate division, and erected a further division, the Cribrimorpha, to include the family Cribrilinidae and such species as appear to be somewhat intermediate between the Anasca and Ascophora. Canu and Bassler (1927) have erected another suborder, Hexapogona, to include a few families in which the ancestrula, or primary individual of the colony, gives rise to 6 daughter zooecia instead of 5 which is the rule. This procedure has been rather severely criticized.

## Division I **INOVICELLATA** Jullien 1888

In this division of the Anasca the zoarium is a creeping, stolon-like structure. At intervals along the stolon are swollen, spindle-shaped enlargements, from each of which rises an erect zooecial tube, with an operculum like a little trap door at the upper end. The zooecium evidently consists of both the erect tube and the basal enlargement, since the polypide extends downward into the latter. There are no avicularia, vibracula, nor permanent ovicells, though temporary membranous ovicells are present until the eggs have undergone at least the first few cell divisions. The division includes but one family and genus.

## Family **AETEIDAE** Smitt 1867

### **AETEA** Lamouroux 1812

Key to the Species

1. Zooecial tube coarsely wrinkled or corrugated.......... *A. ligulata,* page 347.
   Either very finely or not at all annulate.............................. 2.
2. Erect zooecial tube entirely without annulations....... *A. truncata,* page 346.
   With very fine annulations.............................................. 3.
3. Terminal expansion somewhat spoon-shaped and bent at an angle to the erect tube.......................................... *A. anguina,* page 345.
   Terminal expansion narrower, in line with the erect tube, basal expansion also finely annulated................................ *A. recta,* page 346.

### **Aetea anguina** (Linnaeus) 1758

Plate 1, figure 8

The stolonate portion of the zoarium is adnate to the stems of hydroids, algae, and other bryozoa, and occasionally to shells and pebbles. The erect stem is often bent or curved snake-like and the expanded terminal portion has somewhat the shape of a snake's head, and Ellis in 1755 named it the "snake coralline." The "head" appears to be finely punctate, the stalk finely annulated, and the basal swelling of the stolonate part is again more or less punctate in appearance. It should be noted that in reality there are no punctations, but instead minute protuberances which, under transmitted light give the appearance of being punctures. A flat membranous area occupies one side of the "head" and at the upper end of this area is attached the operculum, which is also thickly "punctate." The "ovicells" rarely appear, though they have been observed by several writers and on one occasion I found them rather common at Woods Hole, Massachusetts, with embryos ranging from the 4-cell stage to ciliated larve ready for extrusion (Osburn 1912: 220). Levinsen (1909: 93) considers that these are not homologous with the ovicells of other chilostomes and suggests that it is merely the egg membrane. How it should remain attached, if this is true, is a question, and it may be that there is a thin maternal membrane surrounding the egg. At any rate it seems to disappear after the larva is discharged.

The species is practically cosmopolitan and it has been noted on the eastern coast of North America from Mt. Desert Island, Maine, southward. Duerden (1896. Jour. Inst. Jamaica 270) has noted its presence in Jamaica, but otherwise it has escaped notice in the West Indian region. In our Porto Rican collections it occurred at Stations 2335 and 2367, off Guanica Harbor, in 10 fathoms, and on mangrove roots in Guanica Harbor.

### Aetea recta Hincks 1861

Plate 1, figure 7

This species resembles *A. anguina* in its annulated and punctuated areas, but the erect portion is straighter, the "head" longer and narrower and the operculum is set more transversely across the end of the zooecial tube. Furthermore the punctuations of the swollen basal tube are so distributed as to give the effect of annulation. *A. recta* has sometimes been considered only a form of *anguina,* but the writer must agree with Harmer (1926: 195) that this "seems to be improbable."

In his earlier papers (1914: 186. 1927: 124) the author listed this species as *Aetea sica* (Couch) from the Tortugas Islands, Florida, and from Curaçao. It is very widely distributed, but has been noted on the American side of the Atlantic only at the localities given above. In our Porto Rican collections it occurred at Stations 2363 and 2367, off Guanica Harbor, in 5 to 10 fathoms, on coralline algae.

### Aetea truncata (Landsborough) 1852

Plate 1, figure 6

This species is easily distinguished from the other members of the genus by its straight erect tubule, the narrow "head" which is truncated at its tip, and especially by the entire absence of any annulation. The whole surface is finely "punctate."

Like the other members of the genus mentioned it has a wide distribution, and on the American coast has been noted at Canso, Nova Scotia (Cornish 1907: 75) and at the Tortugas Islands, Florida (Osburn 1914: 186). In the Porto Rico collections it occurred at Station 2363, growing on coralline algae at 10 fathoms.

### Aetea ligulata Busk 1852

PLATE 1, FIGURES 9, 10, 11

*Aetea ligulata* Busk (1852) 30. pl. 42, fig. 2.—Marcus (1937) 30. pl. 4, fig. 10; (1938) 12.
*Aetea fuegensis* n. sp. Jullien (1888) **1**: 24. pl. 7, fig. 7.
*Aetea crosslandi* n. sp. Waters (1910) 253. pl. 24, fig. 8.

One outstanding character readily distinguishes this species from others in the genus, the stalk or erect portion below the membranous area is coarsely wrinkled or corrugated in a manner suggesting that seen in hydroid stems. It is quite a different type of "annulation" from that seen in the stalks of *anguina* and *recta*. The expansion of the stolon is also occasionally wrinkled but not so regularly as in the stalk. The whole surface is finely "punctate." The head or terminal portion containing the membranous area is about in line with the stalk and the operculum is semiterminal. In some specimens there is a slight groove or constriction at the junction of the head and stalk, but this does not seem to be a consistent character. The length of the erect stalk varies greatly, but is usually from two to three times the length of the head, extremes one to four times.

Occasionally there is a distinct distal extension of the head beyond the primary operculum, exactly as shown by Jullien (1888. pl. 7, fig. 7) for his *A. fuegensis*. This must be due to a polypide regeneration as a new aperture with an additional operculum is present at the tip of the extension. The old and new opercula are both shown in FIGURES 10 and 11. Jullien did not quite understand the nature of this structure for he states that it is prolonged beyond the operculum which then becomes lateral and not terminal, so he must have failed to observe the secondary terminal operculum. I have also a specimen of *A. recta* from the Tortugas Islands which shows a similar extension.

Described by Busk from Patagonia and Straits of Magellan; Jullien's *A. fuegensis*, Bay of Orange, Terra del Fuego; Waters' *A. crosslandi*, Khor Donogab, Red Sea; Marcus lists *A. ligulata* from the Bay of Santos, Brazil. At Porto Rico it occurred in two of our dredgings off the mouth of Guanica Harbor (Stations 2362 and 2363), at 18 and 20 fathoms, attached to sponge and calcareous algae. There is also in my collection a specimen from Magdalena Bay, Lower California, at 13 fathoms. Canu and Bassler's (1928: 51. pl. 1, fig. 2) identification of *A. sica* as *recta* from east of Georgia, U. S. A., may be at fault. The wrinkling of the basal expansion shown in the figure certainly suggests *ligulata.* Apparently the species has a very wide range in shallow water.

## Division II **MALACOSTEGA** Levinsen 1909

This group consists chiefly of the large and rather diversified series of forms which were formerly known as Membraniporas, together with some others of primitive structure. The writer must agree with Harmer (1926: 187) and Canu and Bassler (1929: 57) in excluding the family Aeteidae to constitute a separate division. The membranipores have given the taxonomist no little difficulty. Harmer (1926: 187) uses Membraniporidae as a superfamily, "which further study is likely to divide into a series of families." Canu and Bassler (1929: 26–27) have resurrected the family Electrinidae of d'Orbigny and have erected the two new families Hincksinidae and Alderinidae. Further study will no doubt result in other emendations, but the writer has found this arrangement useful and it will be followed in the present paper.

### Key to the Families

1. Ovicells wanting .................................................... 2.
   Ovicells present .................................................... 3.
2. No spines, zooecia rectangular on the dorsal side ..........................
   ........................................ MEMBRANIPORIDAE, page 348.
   No avicularia; spines or tubercles present.......ELECTRINIDAE, page 354.
3. Ovicells hyperstomial............................ALDERINIDAE, page 359.
   Ovicells endozooecial.............................................. 4.
4. Erect with flat flexible branches, little calcification.........[FLUSTRIDAE].
   Encrusting, well calcified, no dietellae...........HINCKSINIDAE, page 356.

## Family **MEMBRANIPORIDAE** Busk 1854

Membraniporae without ovicells or spines; dietellae (pore chambers) also lacking and the dorsal outlines of the zooecia are usually more or less rectangular. The family is sufficiently discussed by Canu and Bassler (1929: 62, Biflustridae).

### Key to the Genera

1. Zoarium encrusting or erect and bilaminar, without joints................ 2.
   Zoarium erect, jointed, zooecia in four series........*Quadricellaria*, page 354.
2. Zoarium free in the form of a miniature cup or saucer, long vibracula present .................................................. *Cupuladria*, page 354.
   Zoarium attached, not cupuliform.................................... 3.
3. Zooecia with denticles around the proximal border of the membranous aperture .......................................... *Acanthodesia*, page 352.
   Aperture without denticles or serrations................................ 4.
4. Zooecia elongate quadrangular, with tubercles at the distal corners .......... ............................................ *Membranipora*, page 349.
   Zooecia usually with one or two triangular or rounded small openings covered with membrane on the basal corners.................*Conopeum*, page 350.

## MEMBRANIPORA Blainville 1830

Membranipores of the *membranacea* group. Gymnocyst slightly developed, often with a pair of tubercles. The opesium or aperture occupies nearly all of the frontal surface. Avicularia, dietellae (pore chambers), and ovicells wanting.

### Membranipora membranacea (Linnaeus) 1766

Zoarium encrusting, the zooecia usually very regularly quadrate, with thin walls, occasionally with erect tubercles at the distal corners. This species appears to be almost universally distributed but seems not to be common in North American waters. It appeared only once in our Porto Rican collections, at Station 2364 in Guanica Harbor. Osburn (1914: 193) recorded it from the Tortugas Islands.

### Membranipora tuberculata (Bosc) 1802

Zoarium encrusting algae, especially the floating *Sargassum*. It is almost the only bryozoan found on the *Sargassum*, which it encrusts in large numbers with a white lace-like network. The zooecia are moderately large, elongate-quadrangular, the opesium occupying nearly the whole front, the narrow proximal cryptocyst bearing a pair of short heavy tubercles which sometimes coalesce in the midline and which appear to belong to the zooecium proximal to them.

It is a circumtropical species, and in the North Atlantic occurs northward to about the fiftieth parallel. In the West Indian region it has been recorded from the Tortugas Islands, the Strait of Florida, and the island of Curaçao. About Porto Rico it is found wherever the *Sargassum* drifts. Marcus (1937: 33) records it from Santos Bay, Brazil, and gives an excellent discussion and synonymy.

### CONOPEUM Norman 1903

The general characters of this genus are well established and mark it as one of the simplest of the membranipores. There are no ovicells, no avicularia, and no dietellae (pore chambers). Spines also are usually wanting on the mural rim, though they may occur occasionally as figured by Barroso (1923: 3–4), and short heavy tubercular processes may appear on the base of the zooecia.

"Interopesial spaces," usually triangular and with special walls are usually present, and though this character has frequently been discussed there still seems to be room for controversy. Levinsen (1909: 144 footnote) refers to "small triangular hollows (kenozooecia) between the zooecia." Canu and Bassler (1920: 86) find that "the hollows of the surface are not interzooecial, as Levinsen has described them, but are only interopesial; they are not deep and are situated between the mural rims; rarely they contain an avicularium." Harmer (1926: 211) also seems to accept the latter view, "Gymnocyst frequently with a pair of triangular depressions, which, like the gymnocyst, may be wanting."

On this basis one of two things is certain; either there is much variation in the development of these structures, or else more than one species is involved. Another interpretation is still possible, however, as there may be two different characters concerned. There can be no doubt that in my specimens from Florida and Porto Rico the "triangular spaces," sometimes abundantly developed, sometimes rare, are developed upon the gymnocyst and are therefore merely interopesial. In the same colony there may be other, usually more rounded or ovate, cavities which do go right down to the dorsal side of the zooecia and which are certainly interzooecial. Probably these are the ones to which Canu and Bassler refer as "rarely containing an avicularium." The author has examined a great many of these and has often thought that he has found an avicularium, but upon careful examination with higher power has never been able to detect a mandible. All such spaces appear to be covered by an imperforate and slightly chitinized membrane. Secondary calcification appears within these interzooecial chambers, partially closing them in older colonies, but the author has never observed them to be completely closed and raised in the form of rounded tuberosities, as may be the case with the triangular interopesial spaces.

**Conopeum reticulum** (Linnaeus) 1767

PLATE 2, FIGURES 14, 15

? *Membranipora lacroixii* (Audouin) Osburn (1914) 193, Tortugas Islands. See Harmer (1926) 211 for general synonymy of *C. reticulum* = *Membranipora lacroixii* auctt. (non Audouin).

Zoarium encrusting, yellowish-white in color, on shells, corallines, etc. Zooecia separated by a distinct groove, the walls rather high, with a narrow but heavily calcified cryptocyst which descends rapidly into the opesial area and which is thickly tuberculated all around the opesium, broader proximally. The opesium is typically rather regularly oval, the narrower end distal. Triangular spaces with separate walls often appear at the base of the zooecia, situated on the gymnocyst. Typically there are a pair of these, but the number varies and they may be so rare as to be scarcely discoverable on certain colonies. In addition to these there are usually some irregularly rounded spaces which are interzooecial in nature. These are usually scattered, but sometimes appear at the base of nearly every zooecium and occasionally they are paired. They vary much in size and appearance and sometimes resemble avicularian chambers but I have never been able to detect an avicularian mandible. They are different structures from the triangular spaces as they are continued downward to the dorsal side of the colony, while the triangular spaces are above the gymnocyst. Harmer has homologized the triangular spaces with the paired tubercles of *Nitscheina* (*Nichtina*) and this may be the correct interpretation, since they not infrequently develop into heavy rounded or triangular knobs. The interzooecial spaces, on the other hand are certainly kenozooecia.

Barroso (1923. figs. 3, 4) has figured his *Conopeum lacroixii* with occasional mural spines. I have never been able to detect any spines in American material. Neither is the cryptocyst of my specimens porous as he shows it in his FIGURE 4, and the operculum in my material is more evenly rounded. It is possible that he is dealing with another species, ? *C. lacroixii* Audouin.

There has undoubtedly been the greatest confusion about this species. The *Biflustra lacroixii* of Smitt (1872: 18. pl. 4, figs. 85–88) may in part refer to this species since he says in regard to one colony at least, "At the corners of the zooecia sometimes a triangular (through its calcification a little raised) space is left," which seems clearly to indicate *C. reticulum*. His figure 87 may possibly be of this species, but certainly figures 85, 86, and 88 are of a different species. Osburn (1914: 193) questionably recorded *Membranipora* *lacroixii* from the Tortugas Islands, Florida. This identification, with the name corrected, is now substantiated. No other authors appear to have recorded the species from the American coast, but Canu and Bassler (1920: 89) list it for Mississippi and South Carolina in the early Tertiary.

In Porto Rican waters the species appears to be well distributed but nowhere very abundant. It occurred, chiefly on dead shells, at a number of stations off Guanica Harbor.

### **Conopeum tubigerum** NEW SPECIES

PLATE 2, FIGURES 12, 13

Characterized by erect flaring tubes developed on the basal gymnocyst at the proximal corners of the zooecia. These arise from triangular areas, similar to those which appear on *C. reticulum,* but become tubular, expand as they rise to the height of 0.05 to 0.10 millimeters, and when fully developed may have a more or less stellate border. The aperture of the tube is closed by a delicate membrane.

Zoarium encrusting, or occasionally erect and bilaminate. Zooecia moderate in size, about 0.40 to 0.50 millimeters long by 0.18 to 0.20 millimeters wide; rather regular in form; moderately calcified, the opesia large and elliptical, the mural rim and the opesial border finely crenulated. In older zooecia the cryptocyst may be developed beyond the gymnocyst.

One colony dredged in Guanica Harbor at 3 fathoms. I have specimens also from Captive Island, Florida, and the erect bilaminate specimens from Port Lavaca, Texas.

## **ACANTHODESIA** Canu & Bassler 1920

### **Acanthodesia savartii** (Audouin) 1826

PLATE 2, FIGURES 16, 17

The zoarium is encrusting on pebbles, shells, and coralline algae; or erect and branching, unjointed and bilamellar. The zooecia are rather large, regularly disposed in lines and the basal part is somewhat bridged over leaving a regularly elliptical membranous area. A small serrated denticle projects forward slightly into the opening from the middle of the base of the area. There are no oecia or avicularia.

Widely distributed in all warmer oceans. Florida, 29 fathoms, (Smitt); Tortugas Islands, 10 fathoms (Osburn); Gulf of Mexico

27 and 30 fathoms (Canu & Bassler). Porto Rico, dredged by the author in 20 meters off Guanica Harbor at Station 2347.

**Acanthodesia tenuis** (Desor) 1848

Plate 3, figures 22 to 30

*Membranipora tenuis* Desor (1848) 66.—Verrill & Smith (1874) 712.—Osburn (1912) 231.
*Biflustra denticulata* Smitt (1873) 19.
*Membranipora danica* Levinsen (1894) 53.
*Membranipora denticulata* Levinsen (1909) 144.
*Hemiseptella grandicella* and *H. tuberosa* Canu & Bassler (1923) 71.
*Hemiseptella denticulata* Canu & Bassler (1928) 62.
*Hemiseptella hexagonalis* Canu & Bassler (1928) 63.
*Hemiseptella africana* Canu & Bassler (1930) 29.
*Acanthodesia tenuis* Marcus (1937) 42.

Zoarium encrusting, sometimes several layers in thickness. Zooecia irregularly quadrangular to hexagonal, closely adjacent but distinct, separated by a narrow groove in which a brown line sometimes appears; mural rim complete, tuberculated; sometimes large rounded tubercles at the anterior corners; cryptocyst depressed, finely tuberculated, extending forward along the sides of the opesia, its free border nearly up to the operculum beset with spinules projecting laterally into the opesial membrane. These spinules may be straight or curved and occasionally are branched. Smitt (1873: 19) described the cryptocyst "with white pores," though these are absent, and the writer (1912: 231 under *Membranipora tenuis*) mistook the tubercles under transmitted light for punctures. Opesia oval, asymmetrical, large, sometimes occupying most of the front, but usually only about half of it in full calcification.

Canu and Bassler (1928: 62) included this species in *Hemiseptella* "because of the presence of opesial spicules, but we have not seen the trace of opesiular muscles on the ectocyst." The writer has examined hundreds of specimens without finding any evidence of opesiular muscles or their attachments, so must agree with Marcus (1937: 42) in placing the species in *Acanthodesia*.

The size is extremely variable, zooecial length in the same colony ranging from 0.40 to 0.66 millimeters, and zooecial width 0.18 to 0.30 millimeters. The form also varies in different parts of a colony, from elongate and quadrangular to short and quadrangular or more or less hexagonal. Occasionally the zoarium may rise in bilaminar folds.

Porto Rico, off the mouth of Guanica Harbor at 20 fathoms. Smitt (1873: 19, *Biflustra denticulata*), Florida, 10 fathoms; Canu and Bassler (1928: 62, *Hemiseptella denticulata*) Punta Rosa, Florida. The species ranges northward to Cape Cod where it is very abundant, southward to the Bay of Santos, Brazil, and occurs in Denmark, and on the west coast of Africa.

### CUPULADRIA Canu & Bassler 1920

This genus was separated out of the old *Cupularia* complex of Lamouroux to include certain species which have neither cryptocyst nor opesiules and which, therefore, do not belong even in the same division with the true cupularias.

#### Cupuladria canariensis (Busk) 1859

The free, saucer or cup-shaped zoarium, 10 to 20 millimeters in diameter, consists of a single layer of zooecia. The convex side is ventral and each zooecium has a strong curved brownish vibraculum at its distal end. The concave dorsal side is usually free and clean of any attached organisms, but a small species of bryozoan, *Beania cupulariensis* Osburn, often grows attached in the concavity. Canu and Bassler (1929: 73) give an analysis of this and related species with which it has been confused.

Very widely distributed in warmer waters. Florida, 10 to 44 fathoms (Smitt); Tortugas Islands, abundant at 10 fathoms (Osburn); Gulf of Mexico, Strait of Florida, and Atlantic Ocean south of Miami, Florida, 30 to 56 fathoms (Canu and Bassler). In our Porto Rican collections the species was represented by only three colonies, dredged at 20 meters off the mouth of Guanica Harbor.

### QUADRICELLARIA D'Orbigny 1851

Zoarium erect and jointed. Zooecia membraniporoid, in four series of which two are narrower, facing four ways, placed back to back. No ovicell.

#### Quadricella caraibica Canu & Bassler 1928

Not taken at Porto Rico. Described by Canu and Bassler from the Caribbean Sea, east of Jamaica at 52 fathoms.

## Family ELECTRINIDAE D'Orbigny 1851

Primitive membranipores with an intertentacular organ and in which the larva is a Cyphonautes. No avicularia, no dietellae, no ovicell. Spines or tubercles on the opesial border or at the anterior zooecial angles.

### ELECTRA Lamouroux 1816

Proximal portion covered by a gymnocyst, distal to which is the rather large oval or elliptical opesium. The mural rim is beset with spines (at least two anterior), and a stronger spine, variously developed in the middle just proximal to the opesium. No avicularia, dietellae or ovicells.

### Electra bellula (Hincks) 1881

In its characteristic form the zoarium encrusts algae especially, thin and delicate, branching in series of several zooecia. The zooecia are thin-walled, almost transparent in younger stages, never heavily calcified. The mural rim is thin and is surrounded typically by three spines, two of which appear to be always present opposite the operculum. The characteristic large proximal spine, which is bent down over the frontal membrane, is ternately dichotomous, antler-like, with 8 points when fully developed; it varies greatly and may be reduced to a short thick spine without branches, or it may be double as in the nominal variety *bicornis* Hincks. All of these variations may occur in the same colony.

Outside of Guanica Harbor at 3 to 6 fathoms.

### Electra bellula NEW VAR. ramosa

PLATE 2, FIGURES 20, 21

A variety so different in appearance that it was at first supposed to be another species occurred abundantly on piles at Guayanilla. It grows erect and branching to a height of nearly a centimeter, with joints at the bases of the branches. Two spines are present opposite the operculum; and a large median pointed spine is directed forward over the area, occasionally this spine is bifid. The colony begins as an incrustation, extends among the branches of small algae or hydroids, and then becomes independent of support. It gives off free branches which are jointed at the base. The branches begin with two zooecia placed back to back, one extending somewhat farther than the other, and these are usually followed by four in the next series. When a rounded branch grows into contact with a flat surface it at once takes the form of the substratum and becomes encrusting; it changes character remarkably, the zooecia are shorter and broader and the spines almost disappear, while the cryptocyst becomes extended as in the normal variety. In none of the encrusting phases have I observed branching of the large spine characteristic of the typical *bellula*. Marcus (1937: 37) has given an excellent account and figured it satisfactorily. For convenience in dealing with it, I believe that it should be named and propose the varietal name *ramosa*.

The colonies taken in open water were all smaller, with smaller zooecia and showed no evidence of erect branches. All showed the cervicorn spine and were more delicate than those found on the piles of wharves.

#### **Electra tenella** (Hincks) 1880

A pair of short, blunt erect spines on the basal gymnocyst, remote from the opesial border, sometimes with three or four spines on each side of the aperture and bending over it.

Hincks described the species from Florida. Marcus (1937: 38) has recovered it at Santos Bay, Brazil, and gives an excellent discussion. It was not found at Porto Rico.

## Family **HINCKSINIDAE** Canu & Bassler 1927

Membranipores with endozooecial ovicell. Dietellae, spines, avicularia and vibracula may be present.

### Key to the Genera

1. No spines, no avicularia, no dietellae.................... *Aplousina*, page 357.
   One or more of these present ...................................... 2.
2. Mural rim beset with spines........................................ 3.
   No such spines...................................................... 4.
3. Tall pedunculate avicularia present................ *Cauloramphus*, page 359.
   No pedunculate avicularia ........................... *Hincksina*, page 356.
4. Small interzooecial avicularia present...................... *Canua*, page 357.
   A pair of pointed avicularia directed toward each other at the distal end of the aperture................................. *Antropora*, page 359.

### **HINCKSINA** Norman 1903

Zooecia encrusting, entire area membranous, mural rim surrounded by numerous spines. Ovicell endozooecial, small, short and little raised. Avicularia interzooecial, no dietellae.

#### **Hincksina periporosa** Canu & Bassler 1928

Plate 2, figures 18, 19

Zoarium encrusting. Zooecia oval, distinct, separated by deep furrows, surrounded by a line of interjunctural pores. Gymnocyst small, convex; mural rim very thin and bearing 12 to 18 spicules. Opesium has the form of the zooecium. Ovicell endozooecial, very small, a little convex, transverse. Pyriform zooeciules between the zooecia, sporadic with rounded avicularia.

Porto Rico, dredged at 20 fathoms off Guanica Harbor. Canu and Bassler (1928: 22), Gulf of Mexico, Florida Straits, and north of Cuba at 30 to 201 fathoms. I have a specimen from Bermuda taken at 2 fathoms.

### APLOUSINA Canu & Bassler 1927

Simple appearing membranipores with no spines, avicularia or dietellae (communication pores).

### ? Aplousina gigantea Canu & Bassler 1927

Plate 3, figure 31

Zoarium encrusting. Zooecia very large, not distinctly separated from each other; mural rim very thin; opercular valve removed from the distal border. Ovicell very small, transverse.

Zooecial length, 0.84 to 0.90 millimeters; width, 0.60 to 0.65 millimeters.

One small specimen near the mouth of Guanica Harbor at 5 fathoms. Canu and Bassler (1928: 20), Gulf of Mexico and Straits of Florida, 30 to 56 fathoms.

The Porto Rican specimen appears to be somewhat intermediate between this species and *A. tuberosa*. It has the thicker granulated mural rim of *tuberosa* and like that species the zooecia are distinct, but tubercles are lacking and the size equals that of *gigantea*. The ovicell appears to be larger than either of these species.

### Aplousina tuberosa Canu & Bassler 1928

Zooecium encrusting shells, serpulae, and especially *Steganoporella magnilabris*. Zooecia large, distinct, separated by a furrow, elliptical; proximal gymnocyst very small. Mural rim very thin, flat, granular, with smooth termen; opesium very large and of the form of the zooecium. Ovicell very small, transverse, little convex, always accompanied by two lateral tuberosities.

Zooecial length, 0.60 millimeters; width, 0.40 millimeters.

Not found in Porto Rican collections. Canu and Bassler list it from north of Cuba, east of Yucatan, Gulf of Mexico, and Straits of Florida, 24 to 78 fathoms.

### CANUA Davis 1934

*Membrendoecium* Canu & Bassler (1917) wrongly founded on *Amphiblestrum papillatum* Busk.

The ovicell is endozooecial; avicularia small, simple and interzooecial; dietellae present; no spines.

### Key to the Species

1. Avicularia oval, with bluntly pointed or rounded mandible....*C. compressum*
   Avicularia long, very narrow, acuminated.............................. 2.
2. Mural rim thick..........................................*C. strictirostris.*
   Mural rim thin..............................................*C. typica.*

### Canua (Membrendoecium) compressum (Osburn) 1927

Zoarium encrusting corals and shells, light yellow to brownish in color and often several layers in thickness. Zooecia well calcified, especially in older stages; distinct, separated by a deep groove, though often they are closely compressed against each other. The mural rim is raised and rather smooth, but the descending cryptocyst has progressively larger granulations toward the inner border, which appears finely crenulate. Aperture pyriform or irregularly ovoid, widening rather suddenly just posterior to the operculum. Posterior to the aperture the gymnocyst is somewhat inflated in the midline. The small oval avicularium, with a bluntly triangular or round mandible is interzooecial, though often appearing as if placed upon the proximal portion of the gymnocyst.

Zooecial length, 0.30–0.40 millimeters; width, 0.20–0.30 millimeters.

Described from the island of Curaçao (Osburn 1927: 124). In our Porto Rican collections it occurred at only one station, 2347, between Caya Caribe and Caya Parguera, at 5 to 8 fathoms, where a number of colonies were taken on shells.

### Canua (Membrendoecium) strictirostris (Canu & Bassler) 1928

Zoarium encrusting. Zooecia distinct, separated by deep furrows, a little elongated, oval, ornamented frequently by a convex gymnocyst. Opesium oval, mural rim thick, bevelled, enlarged at the base. Ovicell small, endozooecial, convex, transverse. Avicularium in the interzooecial angles, small, long, very narrow, acuminated.

Zooecial length, 0.45 to 0.60 millimeters; width, 0.30 to 0.40 millimeters.

This species differs from *C. compressum* (Osburn) especially in the form of the avicularia, and also in the larger size and the smoother opesial margins. It would seem to be a deeper water species. It has not occurred in our Porto Rican material, but Canu and Bassler described it from north of Cuba at 143 fathoms.

### Canua typica (Canu & Bassler) 1928

*Dacryonella typica* Canu & Bassler (1928) 57.

Not found at Porto Rico. Recorded by Canu and Bassler north of Cuba, 130 to 167 fathoms, and from the Pliocene of Panama.

The species shows such resemblances to *Canua* (*Membrendoecium*) that I believe it should be placed here.

### CAULORAMPHUS Norman 1903

Zoarium encrusting. Zooecia with high lateral walls which are beset with numerous spines among which are two pedicellate avicularia.

#### Cauloramphus opertus Canu & Bassler 1928

A peculiar species for this genus in that the mural spines are reflected over the membranous area, while four distal spines are elongate and jointed at the base. Not taken at Porto Rico. Canu and Bassler (1928: 35), Gulf of Mexico, 30 fathoms.

### ANTROPORA Norman 1903

This genus is characterized especially by the presence of a pair of pointed avicularia immediately distal to the aperture, set transversely with their points nearly touching. Ovicell endozooecial, but fairly well developed.

#### Antropora granulifera (Hincks) 1880

Zoarium encrusting. Zooecia distinct, mural rim rather thin, cryptocyst broad, especially proximally, descending, coarsely granulated. Opesia triangular with rounded corners. The avicularia are slightly curved to conform to the distal border and the opercular valve opens partially between them.

Rare, one colony taken near Caribe Island at 8 fathoms. I have also a specimen taken at Bermuda in shallow water. The species has not hitherto been noted for the American side of the Atlantic.

## Family ALDERINIDAE Canu & Bassler 1927

Membranipores with hyperstomial ovicell.

#### Key to the Genera

1. Zooecia in single series, separated by filiform zooeciules .................... *Marssonopora,* page 365.
   Zoarium multiserial .................... 2.
2. No avicularia, no spines .................... *Alderina,* page 362.
   Avicularia present .................... 3.
3. Cryptocyst very broad, opesial area reduced ........ *Amphiblestrum,* page 364.
   Cryptocyst narrower, opesial area much larger .................... 4.
4. One to many spines, ovicell usually with rib ............ *Callopora,* page 364.
   Spines wanting or vestigial .................... 5.

5. Avicularian mandible flagellate or acicular .............................. 6.
   Avicularian mandible broader.............................................. 7.
6. Avicularium transverse at end of zooecium..............*Cranosina,* page 363.
   Avicularia not transverse, in line with zooecia.........*Copidozoum,* page 364.
7. Avicularium independent, its walls heavy........*Crassimarginatella,* page 363.
   Avicularium always associated with a kenozooecium.....*Parellisina,* page 360.

### PARELLISINA NEW GENUS

Resembling *Ellisina* Norman 1903, but with vicarious avicularia associated with vestigial zooecia or kenozooecia, which are represented in surface view by membranous areas of varying size and shape without operculum. Spines vestigial.

Genotype.—*Membranipora curvirostris* Hincks 1862.

In addition to the genotype and the new species herein described the following species appear to belong to this group: *Membranipora falcata* MacGillivray 1869 (*M. permunita* Hincks 1881), *M. albida* Hincks 1880, *Callopora tenuissima* Canu & Bassler 1928, and *Callopora subalbida* Canu & Bassler 1929 (*M. curvirostris* var. Waters 1898).

The nature of the structure associated with the avicularium in *curvirostris* and distal to it has been in question for many years. Waters (1898: 684) suggests that "perhaps they must be considered as aborted zooecia." Harmer (1926: 228) thinks that it may be a kenozooecium or a part of the avicularium itself but favors the former view. Canu and Bassler (1928: 32–33) offer the suggestion that it may be "the unoccupied portion of an ordinary zooecium but regenerated by a falciform avicularium." Miss Hastings (1930: 711–713) appears to have cleared up the matter by a careful study in which she finds that the avicularium and distal chamber are distinct structures, separated by a wall, and interprets the chamber as a kenozooecium or aborted zooecium. With this interpretation the author finds himself in full agreement after the examination of both *curvirostris* and the new species, *latirostris.* The latter is especially convincing as the combined avicularium and chamber are occasionally as large as an ordinary zooecium and appear to take the place of it in the series, often without any disarrangement of the zooecia. There is no internal evidence of regeneration. Often the kenozooecium is much smaller than this, though always larger than the avicularian chamber, and both extend dorsally to the general level of the dorsal wall of the zoarium. In the new species the avicularium is short spatulate, instead of triangular or curved as in the other species which have the aborted zooecium. The species *falcata, curvirostris,* and *albida* have the mandible curved strongly. In *subalbida* and *tenuissima* they are straight or less curved, and in the new species, *latirostris,* they are short spatulate. There is also much variation in the size of the avicularium as well as of the kenozooecium in the various species. A delicate mural rim may be present on the kenozooecium.

I believe that the presence of the peculiar "distal chamber" or kenozooecium is of more importance than the form of the avicularium and the other characters on which the above species have been relegated to different genera. The presence of the kenozooecium appears in some way to be conditioned by the avicularium, but just what the physiological or morphological influence may be is a puzzle.

### Parellisina curvirostris (Hincks) 1862

Plate 4, figure 32

Zoarium encrusting. Zooecia separated by grooves, gymnocyst small or wanting. Mural rim thin, little raised. A small vestigial spine on either side of the aperture, not always evident, and occasionally others still smaller on the side. A narrow, finely tuberculated cryptocyst descending to the aperture. Dorsal wall little calcified, in keeping with the general nature of the species. Ovicell hyperstomial, rather small but prominent, globose, frontal surface delicately beaded and usually with a small tubercle in the middle, not closed by the operculum. Avicularium interzooecial, large and grooved, followed in series by a kenozooecium covered by a membrane and which varies considerably in size and form. Its opesium is usually more or less triangular and there is occasional evidence of a delicate mural rim.

Taken at Station 2341 off the mouth of Guanica Harbor, Porto Rico, 27 fathoms. Listed by Canu and Bassler (1928: 33) as *Callopora curvirostris* from off Havana, Cuba, 201 fathoms, and north of Cuba, 143 fathoms.

This species has been placed in the genus *Ellisina* by Harmer (1926: 28) and by Hastings (1930: 711).

### Parellisina latirostris NEW SPECIES

Plate 4, figures 33, 34

Zoarium encrusting shells and corallines; yellowish-white in color, somewhat glistening. Zooecia moderately large, rather regularly oval, the opesium occupying nearly all of the front, with a slight development of the gymnocyst occasionally. The mural rim is beaded internally, sloping downward, but is rather narrow and there is no expansion of the cryptocyst. A minute vestigial spine on either side of the aperture, often wanting. Ovicell of moderate size, hyperstomial, delicately beaded on the upper surface, and not closed by the operculum. The avicularia are vicarious with a short spatulate mandible which is without transverse bar, but has instead two small hinge teeth. The avicularium is followed directly in the series by a kenozooecium which has usually a somewhat reniform, membranous area set transversely to the long axis of the avicularium. This kenozooecium, which may be as wide as a normal zooecium, extends to the dorsal side of the zoarium and is separated from the avicularian chamber by a distinct wall with communication pores. The mural rim of this chamber presents much the same appearance as that of a zooecium but is thinner and does not slope inward. In the distal wall of the kenozooecium there are also communication pores. There is a heavily chitinized sclerite extending forward in the form of a semicircle on the avicularian mandible from the points of its attachment. Otherwise the mandible is not heavily chitinized. The operculum is slightly heavier than the frontal membrane and has a chitinized border.

Zooecial length, 0.45 to 0.55 millimeters; width, 0.30 to 0.45 millimeters. Opesial length, 0.30 to 0.40 millimeters; width, 0.25 to 0.33 millimeters.

Dredged at three stations off the mouth of Guanica Harbor, Porto Rico, at 7 to 27 fathoms.

**Parellisina tenuissima** (Canu & Bassler) 1928

Zoarium encrusting. Zooecia distinct, much elongated, elliptical or fusiform. Mural rim very thin, smooth. Opesium with the form of the zooecium; ovicell small, globular, finely granular. Avicularium falciform, unguiculated, with two small lateral denticles, and placed in the proximal portion of a zooecium with an aborted polypide (kenozooecium).

Known only from Albatross station D. 2387 Gulf of Mexico, 32 fathoms. Canu and Bassler (1928: 34, *Callopora*) state that the species differs from *curvirostris* Hincks in the great delicacy of the mural rim and the larger dimensions of the aborted zooecia.

**ALDERINA** Norman 1903

Front wall entirely membranous, side walls usually crenulated, no spines; no avicularia, but nodulous processes sometimes present. Ovicell usually bearing a rib or a depressed area. Dietellae present.

### Alderina irregularis (Smitt) 1873

Zoarium encrusting. Zooecia of simple construction without avicularia or spines; mural rim granular and enlarged at the base. Opercular valve bordered by a thick sclerite. Ovicell hyperstomial, orifice large, not closed by the operculum.

Smitt (1873: 8) records the species from Pourtales dredging, Florida, 60 fathoms; Osburn (1914: 194) listed it from Tortugas Islands 8–22 fathoms; Canu and Bassler (1928: 28) record it from north of Cuba, Gulf of Mexico, and Straits of Florida, 30 to 156 fathoms. It did not appear in our Porto Rican collections.

## CRASSIMARGINATELLA Canu 1909

Zooecia with very heavy lateral walls, no spines, avicularia interzooecial, large, oval, or rounded, replacing a zooecium in the series, with a very heavy hinge pivot. Ovicell hyperstomial.

### Crassimarginatella crassimarginata (Hincks) 1880

Zoarium encrusting. Zooecia very distinct, lateral wall thick, heavily calcified. Gymnocyst small, smooth. Cryptocyst narrow descending equally on all sides except near the operculum, coarsely granulated. Avicularia large, replacing a zooecium in series, wall granulated like that of the zooecia, mandible large, semicircular, the pivotal bar very heavy. Ovicell rather small but prominent, broader than long, heavily calcified. Abortive zooecia are not uncommon, sometimes small and nearly closed by calcification, sometimes nearly as large as the autozooecia. In the latter case the wall is granulated like that of the ordinary zooecia.

Porto Rico near the mouth of Guanica Harbor at 5 fathoms, one small, but mature colony on a shell. I have the species from Bermuda also, on shell at 20 feet. It has not been previously recorded from the American side of the Atlantic.

## CRANOSINA Canu & Bassler 1933

Characterized by the presence of an avicularium with a long vibracular mandible, set transversely across distal to the aperture.

### Cranosina coronata (Hincks) 1881

The very long transversely set vibraculum, nearly as long as the zooecium, is a very striking character. The zooecia are distinct, separated by deep grooves, the mural rim thick and granulated;

opesia large, conforming to the shape of the zooecia but narrowed and rounded in the opercular region. No spines. The dietellae are unusually large.

Porto Rico, dredged once at Station 2385 off Pt. Brea, near the mouth of Guanica Harbor at 8 fathoms. It has not been noted before on the American side of the Atlantic.

### COPIDOZOUM Harmer 1926

The genus is characterized especially by the interzooecial avicularia, in which the mandible is broad at the base and narrows at once into a long, linear point directed forward between the zooecia.

#### Copidozoum tenuirostre (Hincks) 1880

This species did not appear in our Porto Rican collections, but has been reported by Canu and Bassler (1928: 31, *Callopora*) from the Gulf of Mexico, Straits of Florida and east of Yucatan, at 24 to 56 fathoms. Marcus also reports it from the Bay of Santos, Brazil at 20 meters.

### AMPHIBLESTRUM Gray 1848

The cryptocyst is broad, encroaching on the opesial area which is reduced to an ovate or roughly triangular form; avicularia, spines and hyperstomial ovicell.

#### Amphiblestrum pustulatum (Canu & Bassler) 1928

*Antropora pustulata* Canu & Bassler (1928) 24.

The zooecia are distinct with a well-developed gymnocyst. The mural rim bears 4 to 6 spines. A pointed avicularium on either side of the operculum is directed forward and slightly inward.

Not taken at Porto Rico. Reported by Canu and Bassler from north of Cuba at 201 to 230 fathoms.

Dr. R. S. Bassler (*in litt.*) agrees that *pustulatum* should be placed under the genus *Amphiblestrum*.

### CALLOPORA Gray 1848

Front wall entirely membranous, marginal wall more or less thickened and bearing spines. Ovicell globose, commonly with a rib across the front. Avicularia and dietellae. None of the several species reported from the West Indian region appear to be typical of the genus.

**Callopora pumicosa** Canu & Bassler 1928

The zooecia are much separated, with a large gymnocyst and without a mural rim. The space between the zooecia is a calcareous pellicle perforated by numerous polygonal pores.

Not in our Porto Rican collections. Canu and Bassler (1928: 33), Straits of Florida at 56 fathoms.

**Callopora caudata** Canu & Bassler 1928

The zooecia are uniserial, with branches at right angles, tubular at the base, resembling species of *Pyripora,* but with a hyperstomial ovicell.

Not taken at Porto Rico, but reported from north of Cuba at 143 fathoms by Canu and Bassler (1928: 34).

**? Callopora sigillata** (Pourtales) 1867

The zoarium consists of erect, anastomosing branches. Smitt (1873: 8) gives an excellent account, but the species has not been seen since. Pourtales (1867: 110, *Cellepora*) and Smitt (1873, *Membranipora*), off Havana, Cuba and off Florida at 262 to 270 fathoms.

**MARSSONOPORA** Lang 1914

Zoarium uniserial, zooecia narrowed proximally into a tube.

**Marssonopora uncifera** Canu & Bassler 1928

Zoarium encrusting on shells. Zooecia in linear series, oval, elongated, united with each other by filiform zooeciules with a very small orifice and arranged in the form of stolons. Opesium oval; mural rim thin, with a dozen spines in the form of claws. Ovicell hyperstomial, globular, salient, closed by the operculum.

Known only from Canu and Bassler's records, north of Cuba, at 143 to 201 fathoms.

## Family **ARACHNOPUSIIDAE** Jullien 1888

An arched calcified frontal shield (pericyst) above the membranous ectocyst. This is perforated by large pores. It is formed by projections which originate from the lateral margins. Each of the frontal pores has a salient collar.

Levinsen (1909: 160) states that the spines are originally hollow but later become partially solid in *Arachnopusia.* In the genus

*Exechonella* Canu and Bassler, which these authors have placed in the family, there is no indication at any time of hollow spines.

In *Arachnopusia* the opercular valve is membranous. In *Exechonella* there is a true operculum attached to the ectocyst and above this is a thick walled peristome.

It is not certain that these two genera belong together or that this family is properly placed. Perhaps its relations are with the Cribrimorphs as there is a definite pericyst above the ectocyst. This structure is not formed of radial or parallel costae, but it is not certain that the arrangement of the ribs is of sufficient importance to separate them in another division.

### ARACHNOPUSIA Jullien 1888

Lateral walls provided with septulae (multiporous rosette plates), ovicell hyperstomial, the ectooecium wholly calcified and covered by the adjoining frontal shields.

#### Arachnopusia monoceros (Busk) 1854

Zoarium encrusting. Zooecia broad, ovate, primary aperture suborbicular, and the proximal sinus with sharp cardelles. Peristome very thick, bearing one or more long club-shaped spines. A strong conical process in the midline proximal to the aperture, the frontal wall with large, irregular perforations below which is the ectocyst. Moderately large avicularia with pointed mandible. Ovicell subglobose, a little longer than broad.

Recorded by Osburn (1914: 105) from the Tortugas Islands, 5 fathoms. One small specimen washed up on the beach at the Guanica Harbor lighthouse. It is a very widely distributed species.

### EXECHONELLA Canu & Bassler 1927

Pores of the pericyst large, orbicular, marginated. A peristome very much thickened, without spines, surrounds an orifice closed by a true operculum. The ectocyst is hidden under the frontal. Lateral and distal walls with a series of uniporous septulae. The salient margins of the frontal pores give a much roughened appearance to the front wall.

#### Exechonella antillea (Osburn) 1927

*Lepralia antillea* Osburn (1927) 128.
*Exechonella pumicosa* Canu & Bassler (1928) 70.

Zoarium encrusting, forming a coarse, greyish layer on shells, corals, etc. Younger zooecia more or less shining, in older stages becoming multilaminar, the later layers piling up on the primary ones with the zooecia turned in various directions. Zooecia very large, broad, gibbous, deep, coarsely and heavily calcified, well separated even in older stages by deep grooves. The whole of the frontal is coarsely punctured by funnel-shaped openings with raised borders, giving the whole surface a much-roughened appearance. A minute rounded avicularium, somewhat raised and with a heavily calcified border, is sometimes present on the lateral angle of the zooecium, occasionally on both sides but frequently wanting, and may be absent from entire colonies. Aperture very large, rounded, with a pair of small cardelles which are situated a little back of the middle. The poster is large, broad and similar in shape to the anter but is slightly smaller. The aperture averages as wide as long, but there is considerable variation in its form. A rounded, thick-walled peristome surrounds the aperture, often projecting strongly above the level of the zooecium, in some cases raised still higher on the sides in flaring projections and occasionally the whole rim flares outward into a broad, funnel-shaped structure. Usually, however, the peristome merely surrounds the aperture with a heavy border. Ooecia appear to be wanting entirely as I have dissected numerous zooecia without discovering any evidence of them.

Zooecial length, 0.80 to 1.10 millimeters, average 1.00 millimeter; width 0.60 to 0.80 millimeters, average 0.70 millimeters. Aperture length, 0.20 to 0.25 millimeters; width, 0.19 to 0.25 millimeters.

Curaçao Island (Osburn 1927: 128, *Lepralia antillea*), Tortugas Islands, Florida (Osburn 1914: 213, *Phylactella labrosa*). Fowey Light 15 miles south of Miami, Florida, 40 fathoms (Canu & Bassler 1928: 70, *Exechonella pumicosa*). Very abundant in Porto Rican collections encrusting shells, corals, etc., from 5 to 20 fathoms.

My scanty material from Tortugas Islands was incorrectly determined. At the time the species was described (1927) the description of the genus had not reached me and I listed the species under the old genus *Lepralia*. *E. pumicosa* Canu and Bassler is a synomym under this species, as I have examined numerous specimens of their material and find no differences of importance. The species appears to be widely distributed in the West Indian region.

### **Exechonella antillea** NEW VAR. **spinosa**

PLATE 4, FIGURE 35

What appears to be a variety of this species differing by the presence of tall unjointed spines to the number of 10 or 15 on the frontal. These develop between the pores and are pointed when fully formed. Similar, but shorter, spines appear on the peristome. I have a specimen from Bermuda and Dr. Bassler has kindly loaned me one from Port Antonio, Jamaica. The appearance is so different that I at first presumed them to be of a different species, but the measurements are the same and I find no other differences except in the frontal spines. If worthy of a name, the variety may be called *spinosa*.

### Family **HIANTOPORIDAE** MacGillivray 1895

The frontal is a pericyst forming an incomplete cover above the membranous ectocyst. The zooecia may be separated, with connecting tubes or closely joined to each other. There is a wide range of calcification of the frontal and the formation of a definite pericyst. In some cases the membranous ectocyst is widely exposed while in others the pericyst is complete with the exception of two to four large pores near the middle. The family may not be a natural one as nothing is known of the method of calcification in most cases. Canu and Bassler suggest that *Tremogasterina* "would perhaps be better classed next to *Figularia*."

A pericyst appears several times elsewhere, *Arachnopusia*, *Exechonella* and the cribrimorphs (Costulae) and all of these appear to show some intermediate conditions between the Anasca and Ascophora, but what little is known of the method of calcification seems to preclude any possibility of allying them very closely. Possibly they may be considered cases of parallel evolution,—sporadic attempts of nature in the direction of a compensatorium which finally arrived by way of the cribrimorphs, if our interpretation of *Figularia* is correct. A complete knowledge of the method of forming the pericyst in the various genera would probably do much to clear up the problem.

It might be better to classify all of these forms with a definite pericyst along with the cribrimorphs, intermediate between the Anasca and Ascophora, until their relationships can be more definitely determined, but for the present I prefer to leave them in the classification of Bassler (1935) rather than make any further changes in the absence of information.

#### **TREMOGASTERINA** Canu 1911

The pericyst closes above the ectocyst to give the appearance of a member of the Ascophora, but with two to four large pores, usually reniform in shape, near the center. This is the only recent representative of the family found thus far, but the genus *Tremopora,* or *Hiantopora,* will probably be found to occur. No representatives of the family were found in Porto Rico, but some of them may be looked for.

### Key to the Species

1. Avicularia truncate at tip, umbo with transverse process .................... *T. malleolus.*
   Avicularia pointed, umbo simple or wanting .................... 2.
2. A short pointed umbo present .................... *T. mucronata.*
   Umbo wanting .................... 3.
3. Avicularia very long, lanceolate, oral border with several spines .................... *T. lanceolata.*
   Avicularia long, narrowly pointed, no oral spines .................... *T. granulata.*

#### **Tremogasterina granulata** Canu & Bassler 1928

Known only from the Straits of Florida at 40 fathoms and from the Pliocene of Panama.

#### **Tremogasterina lanceolata** Canu & Bassler 1928

Known only from north of Cuba, 130 to 143 fathoms.

#### **Tremogasterina malleolus** Canu & Bassler 1928

Reported by Canu and Bassler from the Gulf of Mexico and the Caribbean Sea east of Jamaica at 52 to 60 fathoms.

#### **Tremogasterina mucronata** (Smitt) 1873

Known only from Smitt's record (1873: 24, *Escharipora* ?) west of the Tortugas at 36 fathoms.

## Division III **COILOSTEGA** Levinsen 1909

The frontal wall has within the covering membrane a depressed calcareous layer, the cryptocyst, surrounded by raised lateral walls. As a rule the cryptocyst is provided with pores and an aperture, the opesiula, sometimes confluent with the opesium anteriorly on each side, through which passes a muscle to the covering membrane. Sometimes calcified walls of the opesiules descend to the dorsal side, more or less completely enclosing the anterior part of the polypide with a polypide tube.

### Key to the Families

1. Ovicell hyperstomial.............................................................. 2.
   Ovicell endozooecial or wanting.............................................. 3.
2. No avicularia, zooecia disjunct united by short tubes ......................
   .................................... ASPIDOSTOMATIDAE, page 381.
   Avicularia large, replacing a zooecium in the series ........................
   .................................. THALAMOPORELLIDAE, page 377.
3. Zoarium cup-shaped, free; a long vibraculum distal to each zooecium .......
   ............................................ CALPENSIIDAE, page 373.
   Zoarium not cupuliform, attached................................................ 4.
4. Zooecial chamber divided into proximal and distal parts by descending wall of the cryptocyst, a distinct polypide tube present ......................
   ................................ STEGANOPORELLIDAE, page 374.
   Zooecial chamber not so divided, no calcified polypide tube ..................
   ............................................ OPESIULIDAE, page 370.

## Family **OPESIULIDAE** Jullien 1888

There is much variation in this family, but the ovicell is always endozooecial. Avicularia may be small, or absent, or highly developed with long mandibles which are winged at the base (onychocellaria). Similarly the calcification of the cryptocyst varies from a fairly large opesial area to almost closed and with small or large opesiules which may be separated from the opercular area or united with it. Two subfamilies have been erected on the basis of the presence or absence of the onychocellarium.

### Key to the Genera

1. Avicularian mandible winged at base (onychocellarium).................. 2.
   Avicularian mandible not winged.................................................. 4.
2. Opesial area oval, without opesiular notches......*Rectonychocella*, page 370.
   Opesial area with notches at the proximal corners........................ 3.
3. Opesiular notches very distinct, directed laterally.........*Floridina*, page 372.
   Opesium larger, notches shallower and directed more posteriorly ...........
   ....................................................... *Velumella*, page 371.
4. Avicularia wanting.....................................*Floridinella*, page 372.
   Avicularia present, distal to the aperture................*Micropora*, page 373.

## Subfamily **Onychocellinae** Jullien 1881

### **RECTONYCHOCELLA** Canu & Bassler 1917

Canu and Bassler (1917: 25–26) erected three new genera, *Rectonychocella, Velumella,* and *Diplopholeos* out of a complex of species allied to *Smittipora* Jullien 1881. Later (1928: 52) they suppressed *Diplopholeos* and merged its species with *Velumella*. Harmer (1926: 259) points out that "the only features which seem to separate them are certain differences in the extent and denticulation of the avicularian opesia, and in the continuity or otherwise of the mural rim with the horizontal cryptocyst," and he refuses to accept either genus, preferring *Smittipora* of Jullien. Canu and Bassler again (1929: 126) admit that *Rectonychocella* "differs from *Velumella* only in its rarely visible opesiular indentations, these corresponding to the opesiular muscles placed low and to less calcification of the frontal." Probably *Velumella* will also have to be submerged, but as the differences of calcification about the proximal part of the opesium may have some relation to the distribution of opesiular muscles it may be better to let it stand until properly prepared fresh material can be examined to settle the point.

As to the standing of Jullien's genus *Smittipora*, Canu and Bassler (1928: 52) have pointed out that, "The genus *Smittipora* is therefore not established on sufficient characters since it is the manifest result of an error of misinterpretation of Smitt's figure 60." If such is the case, *Rectonychocella* must replace *Smittipora*. My material is too scanty to decide the issue. For the present I accept both genera of Canu and Bassler.

#### **Rectonychocella abyssicola** (Smitt) 1873

Zoarium encrusting or with erect cylindrical stems with six series of zooecia. The mural rim may be raised or wanting, in which case the zooecia are separated by a furrow. Cryptocyst convex and finely granulated. Opesium often marginated, either elliptical or with only a concave proximal border. Onychocellaria much smaller than zooecia, the opesium small and without lateral denticles, the mandible winged, symmetrical, its point projecting beyond the oval wing.

Smitt (1873: 6. pl. 1, fig. 61 part), Florida, 68 fathoms; Hincks (1881: 155), off Cojima, Cuba, 628 meters; Canu and Bassler (1928: 53), Florida, 387 fathoms. Not taken at Porto Rico.

### **VELUMELLA** Canu & Bassler 1917

#### **Velumella americana** Canu & Bassler 1917

Zoarium encrusting. Zooecia distinct, separated by a furrow in which is a brown line. Mural rim thin distally, enlarged on the sides into facettes. Cryptocyst concave longitudinally, smooth, or roughly tuberculate in older zooecia, depressed. Opesium large, a little elongated, straight on the proximal border, with a deep opesiular identation proximally on either side. Onychocellaria (avicularia) as large as the zooecia, its cryptocyst with sharp spines projecting into the elongate oval opesium, the mandible large, with symmetrical wings forming an oval structure, beyond which the point of the mandible projects in a long vibraculum.

Smitt (1873: pl. 1, fig. 60, *Vincularia abyssicola,* part) Florida; Osburn (1914: 195, *Smittipora abyssicola*), Tortugas, low water to 15 fathoms, and (1927: 125), Curaçao, shallow water; Canu and Bassler (1928: 54) north of Cuba and Gulf of Mexico, 30 to 143 fathoms. In the Porto Rican collections this species appeared only once, at Station 2377, between Rotones and Caribe Islands, 6 to 11 fathoms. It appears to be well distributed in the West Indian region.

### FLORIDINA Jullien 1881

Opesiular indentations symmetrical, very large, limited above by the two very salient opesial processes and placed on each side of a much produced, semitubular polypidian convexity. Operculum attached to the ectocyst above the opesial processes. Onychocellaria straight, mandible bimembranous. (After Canu and Bassler.)

#### Floridina antiqua (Smitt) 1873

Zoarium encrusting. Zooecia moderate in size, irregularly oval, distinct, mural rim salient, complete. Cryptocyst somewhat granulated, surrounding the opesium, ventricose behind the aperture. Opesiules symmetrical and large. Onychocellarium oval, mandible winged.

Zooecial length, 0.40 to 0.50 millimeters; width, 0.40 millimeters.

Smitt (1873, *Mollia antiqua*) listed the species from Florida, 29 to 44 fathoms; Canu and Bassler (1928), Gulf of Mexico, 30 fathoms, Straits of Florida, 56 fathoms, and Fowey Light, 40 fathoms.

## Subfamily MICROPORINAE Hincks 1880

### FLORIDINELLA Canu & Bassler 1917

Ovicell endozooecial and separated from the zooecia by a fold. Polypidian convexity not prominent. Opesiular indentations large and rounded. Opesium constricted by two symmetrical lateral teeth at the level of the opercular articulation. (After Canu and Bassler.)

#### Floridinella typica Canu & Bassler 1928

Zoarium encrusting. Zooecia distinct, separated by a furrow, irregularly oval, somewhat elongated. Mural rim very thin, smooth, salient, complete. Cryptocyst shallow, flat, granulated. Opesium large, subtrifoliate, its proximal border concave or convex with very small opesiular indentations, not always present: the two lateral condyles small and deep. Small interzooecial tuberosities.

Zooecial length, 0.50 millimeters; width, 0.40 millimeters.

Recorded by Canu and Bassler (1928: 59), Straits of Florida, 56 fathoms, and Fowey Light, 15 miles south of Miami, Florida, 40 fathoms. Not present in the Porto Rican collections.

**Floridinella parvula** Canu & Bassler 1928

Zoarium encrusting. Zooecia oval, short. Mural rim thin, salient, much attenuated proximally; opesium oval, elongated, trifoliate; the two lateral condyles salient. Proximal border convex with two irregular opesiular indentations. Sometimes small tubercles between the zooecia.

Zooecial length, 0.25 millimeters; width, 0.20 millimeters.

Recorded by Canu and Bassler (1928: 59), Straits of Florida, 56 fathoms. Not taken at Porto Rico.

**MICROPORA** Gray 1848

Encrusting. Mural rim ending in a knob-like enlargement on either side of the aperture. Cryptocyst covering the entire frontal except the aperture and the small opesiules. Ooecia endozooecial, but very prominent. A small median avicularium situated just distal to the aperture.

**Micropora coriacea** (Esper) 1791

Zooecia irregularly oval, distinct, the salient mural rim enlarged opposite the aperture where it ceases. Cryptocyst complete to the level of the opercular hinge, not continued around the aperture which is entirely closed by the operculum. A pair of small opesiules, often scarcely visible and usually close to the mural rim. An avicularium with a triangular mandible pointing upwards situated in the mid-line just in front of the aperture.

Zooecial length, 0.44 to 0.50 millimeters; width, 0.26 to 0.30 millimeters.

Smitt (1873: 13), Florida, 36 to 135 fathoms; Canu and Bassler (1928: 62), Gulf of Mexico, 30 fathoms, and Straits of Florida, 56 fathoms. The writer has also a specimen from Captive Island, in the Gulf of Mexico, west of Florida, but the species did not appear in our Porto Rican collections.

## Family **CALPENSIIDAE** Canu & Bassler 1923

**DISCOPORELLA** D'Orbigny 1852

*Cupularia* of authors.

Zoarium free in the form of a more or less expanded cup, the zooecia opening on the outer surface. Opesium fringed with spinous processes of the cryptocyst which are flat and free or joined together. The two distal processes are symmetrically placed and support the opercular valve. Opesiules rounded. No ovicell. Vestibular arch present.

### **Discoporella doma** (D'Orbigny) 1852

The zoarium is cup-shaped, higher than wide. Cryptocyst more or less developed, bordered with flat spinous processes, which may be acuminate, spatulate or fimbriated and which variously modify the shape of the opesium but which never coalesce. An avicularium chamber with a long lash-like, chitinous flagellum, situated distal to every aperture.

Smitt (1873: 15), Florida, 29 fathoms; Canu and Bassler (1928: 64), Straits of Florida, 56 fathoms. Not otherwise noted in the West Indian region.

### **Discoporella umbellata** (Defrance) 1823

Zoarium flatter than in *D. doma,* wider than high, umbrella-shaped. The cryptocyst forms almost a complete cover up to the opercular hinge by the fusion of its spinous processes, leaving usually a number of irregular holes besides the true opesiules. The fusion of the cryptocystal spines easily differentiates this from the preceding species.

Smitt (1873: 14), Florida, 29 fathoms; Osburn (1914: 194, *C. lowei*) Tortugas, 12 to 22 fathoms; Canu and Bassler (1928: 64), various localities in the Gulf of Mexico. The species occurs as far north as North Carolina (Smitt 1873, and Osburn 1914), but it did not appear in our Porto Rican collections.

## Family **STEGANOPORELLIDAE** Hincks 1884

The limits of this family are not yet agreed upon. Three important genera, *Steganoporella* Smitt 1873, *Siphonoporella* Hincks 1880, and *Labioporella* Harmer 1926 (= *Labiopora* Levinsen 1909, preoccupied) are especially concerned. Harmer (1926: 280) created a new family, Labioporellidae, for the last mentioned genus and expressed the opinion that, "It may perhaps be necessary to establish a new family for the reception of Hincks' genus." Canu and Bassler (1929: 144–149) have reassigned them to the present family "because *Labioporella* and *Siphonoporella* to us are only simplified *Steganoporella.*" As very few species are known from Atlantic waters and my own material is scanty I leave them for the present where Canu and Bassler have placed them.

They all agree in having dithalamic zooecia, the body cavity partially subdivided by a descending portion of the cryptocyst; a more or less complete calcified zooecial tube through which the tentacles are protruded; and an anterior opesial area which is not quite occupied by the operculum. In *Steganoporella* there are two kinds of zooecia, one with a larger operculum which apparently represents an early stage in the development of the avicularium, the other zooecia of the ordinary type. In the other genera, large interzooecial avicularia are present, which show clearly their zooecial origin.

### Key to the Genera

1. Cryptocyst surrounding the opesium like a shelf....*Steganoporella,* page 375.
   Cryptocyst not surrounding the opesium........................................ 2
2. Polypide tube continued forward prominently and somewhat expanded, trumpet-shaped; opesium large.......................*Siphonoporella,* page 376.
   Polypide tube not free at the sides; opesium small....*Labioporella,* page 376.

### STEGANOPORELLA Smitt 1873

Zooecia completely covered by a frontal membrane, beneath which is a porous cryptocyst extending forward nearly to the operculum and ending in a median oral shelf, also continued around the sides of the aperture in the form of a projecting shelf. Normal individuals with a large operculum which is supported by an arched sclerite. Avicularian individuals with a much larger operculum with a pointed sclerite. Both types may have chitinous teeth on the chitinous opercular border. The avicularian individuals possess polypides and are therefore but little modified toward avicularia.

#### Steganoporella magnilabris (Busk) 1854

Zoarium encrusting, or erect and frill-like. Zooecia large, with raised walls. A porous, depressed cryptocyst descending deeply to the level of the polypide tube occupies nearly half of the frontal area. Beyond this is the median oral shelf, with the polypide tube beneath it, and this is separated from the lateral walls by a membranous area on each side in the form of a deep notch. Zooecia of two types. In one the operculum more or less semicircular with an inverted U-shaped main sclerite and with small chitinous teeth on the border; the other with a much larger operculum with an inverted Y-shaped main sclerite, which is usually somewhat broader distally with a straighter distal border armed with heavier teeth. This latter type of zooecium is in reality the avicularian individual, so little modified from the ordinary form that the polypide functions in the usual manner.

Zooecial length, variable, 0.75–1.45 millimeters, average about 1.00 millimeters; width, variable, 0.53–0.80 millimeters, average about 0.60 millimeters. Smaller operculum, length, average 0.40 millimeters. Larger operculum, length, average 0.60 millimeters.

Porto Rico, Stations 2347, 2363, 2377, 2385, all off shore from Guanica Harbor at 6 to 20 fathoms. This widely distributed warm water species was reported by Smitt (1873: 15, *S. elegans*) from the Florida Straits; by Verrill from Bermuda (1900: 594, *S. elegans*); Osburn from the Tortugas Is. (1914: 196); and Canu and Bassler (1928: 64) north of Cuba, east of Yucatan, Florida Straits, and from the Pliocene of Panama. The species is also known from Pedro Bank, south of Jamaica and from St. Vincent Island. It is therefore one of the most characteristic species of the West Indian region. My specimens are all encrusting except those from Station 2347, which rise in a bilaminate frill.

### SIPHONOPORELLA Hincks 1880

#### Key to the Species

Zoarium encrusting; zooecia somewhat elliptical, large, zooecial length, 0.70 millimeters; width, 0.50 millimeters.......................... *S. granulosa.*

Zoarium erect, cylindrical, bifurcated, rarely lamellar; zooecia more rectangular, a tubercle in each interzooecial angle; size smaller, length, 0.60 millimeters; width, 0.36 millimeters.................................... *S. dumonti.*

#### Siphonoporella granulosa Canu & Bassler 1928

Not taken in the Porto Rican collections. Recorded by Canu and Bassler (1928: 69), Gulf of Mexico and Straits of Florida, 30 to 56 fathoms.

#### Siphonoporella dumonti Canu & Bassler 1928

Not taken at Porto Rico. Canu and Bassler (1928: 68), Gulf of Mexico at 30 fathoms.

There is a possibility that *granulosa* may be only the encrusting phase of *dumonti*, the differences being due to the manner of growth, since they occurred together at one station, Albatross D. 2405.

### LABIOPORELLA Harmer 1926

Zooecia with distinctly raised marginal walls. Gymnocyst wanting. A porous cryptocyst, which does not extend forward around the opesium. Polypide tube bilabiate and connected on either side with the lateral wall by a vertical calcareous lamina. (*Labiopora* Levinsen 1909, preoccupied.)

#### **Labioporella sinuosa** NEW SPECIES

PLATE 5, FIGURES 40, 41

Zoarium encrusting. Zooecia in regular series, slightly broader near the middle, all of the outlines usually sinuated. Mural rim thin and raised, its border delicately beaded, continued without change around the distal end of the aperture. The perforated cryptocyst is nearly flat, descending slightly to just behind the opesium, where the middle portion is slightly raised to form the ventral lip of the inconspicuous polypide tube. On either side the tube is connected with the lateral walls by a vertical lamina which descends to the dorsal wall. Opesium rather large, broader than long, extending outward to the mural rim, which on the distal border is arched strongly forward where it overlies the base of the distal zooecium. The proximal border is more or less straight, slightly sinuated at its middle where the polypide tube scarcely projects. Avicularia wanting. The specimen was dead and the opercula eroded.

This species was listed by the writer (1914: 196) under the name of *Steganoporella connexa* Harmer, from the Tortugas Islands at 12 fathoms, encrusting a shell. It did not appear in the Porto Rican collections and, as far as I am aware, the genus has not hitherto been noted except in the western Pacific and Indian oceans.

### Family **THALAMOPORELLIDAE** Levinsen 1902

Zooecia with a polypide tube. Cryptocyst developed forward almost to the operculum. Two opesiules separated from the aperture, one or both of these usually in contact with a side wall. Calcareous spicules in the shape of compasses or curves lie free in the zooecial chamber. Avicularia pointed or spatulate, interzooecial. Very large and prominent hyperstomial ooecia.

#### **THALAMOPORELLA** Hincks 1887

Zooecia with a somewhat depressed, porous cryptocyst which is perforated by two asymmetrical opesiules. Opesia and orifice practically coextensive. The opesiules descend to the basal or the lateral walls. The ovicells have a cavity between the ectooecium and the entooecium divided by a median suture. The avicularium is situated at the base of a new zooecial series.

KEY TO THE SPECIES

1. Avicularium pointed .......... 2
   Avicularium rounded at tip .......... 3

2. Mandible short, in the form of a gothic arch ........................................................................ *T. gothica* var. *floridana*, page 378.
   Mandible elongate, curved sidewise....................*T. falcifera*, page 380.
3. Avicularian mandible and sister zooecium symmetrical...*T. mayori*, page 379.
   Avicularian mandible and sister zooecium unsymmetrical ........................................................................ *T. distorta*, page 380.

### Thalamoporella gothica NEW VAR. floridana

PLATE 5, FIGURES 42, 43

Zoarium encrusting or erect. Adoral areas present, sometimes with tiny, rounded tubercles. Opesia nearly circular with a rounded sinus without proximal shelf. Opesiules variable in size and form, one usually much smaller (this sometimes wanting). Larger opesiule continued to the dorsal surface where its insertion is closed. Avicularia with pointed mandibles of the form of a gothic arch, the point raised. Avicularian cryptocyst incomplete, leaving a semicircular or semielliptical membranous area behind the mandibles. Ovicells not observed. Spicules in the form of calipers, large or small and intergrading.

Zooecial length, average 0.55 millimeters, range 0.50–0.65 millimeters; width, average 0.23 millimeters; range 0.18–0.27 millimeters. Avicularium, total length, average 0.35 millimeters; mandible length, average 0.15 millimeters.

This form agrees rather closely with Levinsen's figures of *Thalamoporella rozierii* var. *labiata* (1909: 182). In Harmer's review of the genus (1926: 303), he places *labiata* under the synonymy of *Thalamoporella gothica* var. *indica* Hincks. I have a specimen of *labiata* from the China Sea sent me by Levinsen, and my Florida specimen agrees with this and with Harmer's description of the variety *indica* in the form of the avicularium, the nature of the opesiules, the depression of the cryptocyst at the level of the opesiules, and the form of the spicules. It differs, however, in the absence of the calcareous lower lip, in the somewhat smaller size of the avicularia, in the absence of the compass form of spicules and in the smooth inter- and disto-opesiular cryptocyst. It is probably better to keep it separate, at least for the present.

Porto Rico, encrusting a shell at 8 fathoms, off Guanica Harbor. Tortugas Islands, Florida, on a shell on the beach, and in 10 fathoms on sponges (Osburn 1914 under *T. rozierii*). Smitt's record (1873: 16. pl. 4, fig. 102) is probably the same species judging chiefly by the form of the opesia, but his figure and description do not indicate the avicularium and there still must be some doubt in regard to the record. I have very well developed specimens from Captive Island, Florida.

**Thalamoporella mayori** NEW SPECIES

PLATE 6, FIGURES 46, 47

Zoarium encrusting on shells and corallines. There is a fairly close resemblance to *T. granulata* Levinsen as restricted by Harmer, but the hinge denticles are less prominent, the border of the sinus usually distinctly granulated or crenulate. The adoral areas are well developed with strong and sharply pointed spines, but these may be entirely lacking, as in the author's figure (1914: 197). The sister zooecia of the avicularia are symmetrical, and the avicularian cryptocyst covers the avicularian chamber up to the hinge line except for two small opesiules. These avicularian opesiules may be separated from the border as in the author's figure of the species, or one or both may be in contact with the border. The avicularian mandible varies somewhat in form, but is nearly symmetrical as shown in my figure. The zooecial opesiules both descend to the dorsal side and are usually closed. The spicules are of two kinds: compasses and calipers of various sizes. The ooecia are smooth, glossy, semitransparent, evenly rounded, slightly broader than long, the aperture in the form of a pointed arch.

The zooecial measurements vary considerably, ranging from 0.40 to 0.80 millimeters in length, and from 0.20 to 0.40 millimeters in width. Most of the zooecia, however, will range pretty closely around the average, 0.60 millimeters long, by 0.30 millimeters wide. The avicularian measurements are about as follows: 0.20 millimeters to the hinge line and 0.35 millimeters for the mandible. The widest part of the mandible measures about 0.15 millimeters.

Harmer in his splendid review of this genus (1926: 297) indicates that the *T. granulata* of Osburn "appears not to belong to this species." After further study of the specific characters of this genus I am quite ready to accept Harmer's conclusion.

I dedicate this species to the memory of Dr. Alfred Goldsborough Mayor, a well-known authority on marine zoology, and for many years Director of the Carnegie Institution Laboratory for Marine Zoology at the Tortugas Islands.

Not found in our Porto Rican collections. Osburn (1914: 197. fig. 8, *T. granulata*), Tortugas Islands, Florida, encrusting shells and calcareous algae.

**Thalamoporella distorta** NEW SPECIES

PLATE 6, FIGURES 48, 49

Encrusting. Zooecia with perforated cryptocyst which descends very slightly to the region of the opesiules. Between the opesiules and distal to them the surface is finely tuberculated, including the proximal border of the sinuated opesium. The opesiules are large, usually in contact with the lateral wall, more or less symmetrical and both descend to the dorsal wall where the insertions are large, nearly symmetrical and open distally. Spicules in the form of wide open calipers present. Adoral pointed spines, sometimes wanting. The most striking characteristic of the species is found in the sister zooecium of the avicularium in which the oral aperture is turned at right angles to the long axis of the zooecia and directed toward the avicularium. Its aperture also differs, being much shorter than in the normal zooecia, though about the same width. The opesiules are at different levels, the outer one well in advance of the one next to the avicularium and the calcified zooecial tube is curved. The avicularian chamber is covered by the cryptocyst almost to the mandible, with a pair of small opesiules much as in *T. mayori*. The mandible of the avicularium is asymmetrical with a straight border next to the sister zooecium. Ovicells large, rounded, a little broader than long, the aperture in the form of a pointed arch.

Zooecial length, average 0.60 millimeters, range 0.53 to 0.66 millimeters; width, average 0.30 millimeters, range 0.26 to 0.40 millimeters. Covered portion of avicularian chamber, average length 0.27 millimeters; mandible, average length 0.29 millimeters.

Porto Rico, Station 2341, off mouth of Guanica Harbor, 27 fathoms, 3 colonies on dead coralline.

Two other species, *T. granulata* Levinsen and *T. novae-hollandiae* (Haswell), have the sister zooecium of the avicularium more or less asymmetrical, but neither of them is as much distorted as the present species. In *granulata*, as limited by Harmer (1926: 297), the adoral spaces have no tubercles and the cryptocyst of the avicularian chamber leaves a wide open space behind the mandibles. In *novae-hollandiae* the adoral spaces are vestigial and without tubercles, the avicularian cryptocyst incomplete, and the zoarium usually erect and tubular.

**Thalamoporella falcifera** Hincks 1880

PLATE 5, FIGURES 44, 45

Zoarium encrusting on algae. Zooecia with walls thin and delicate, cryptocyst thin, depressed toward the opesiules, with a few scattering pores, between and beyond the opesiules finely tuberculate; aperture somewhat longer than broad with a rounded sinus. Operculum with only a short small sclerite on each side near the hinge. Adoral areas well developed, with small pointed adoral spines. Opesiules unequal in size, the larger descending always to the dorsal side and its insertion usually open, the smaller sometimes reaching the dorsal side where its insertion may be open or closed. Avicularia small for this genus, very narrow and curved (in my specimens it is always curved away from the sister zooecium). Avicularian cryptocyst incomplete, reaching only about half way to the base of the mandible and leaving a semi-elliptical membranous area. Ooecia not present.

Zooecial length, average 0.60 millimeters, range 0.53 to 0.66 millimeters; width, average 0.30 millimeters, range 0.24–0.35 millimeters. Avicularian mandible, average length 0.30 millimeters, range 0.26–0.40 millimeters.

Tortugas Islands, 5 fathoms, one colony on algae (Osburn 1914: 197); Campeche Bank, Yucatan (Levinsen 1909: 186); otherwise known from Australian waters. My specimen compares closely with one from the Java Sea sent me by Levinsen. Not taken at Porto Rico.

## Family **ASPIDOSTOMATIDAE** Jullien 1888

Zooecia with a short polypide tube, not continued under the cryptocyst, usually provided with marginal flanges. The two opesiules in the form of narrow incisions connected with the aperture. Ovicell hyperstomial.

### **MOLLIA** Lamouroux 1821

Zooecia separated and united by cylindrical joints. Opesium trifoliate. Opercular valve not in contact with mural rim. Ooecia hyperstomial and closed by the operculum. Spines, avicularia, and dietellae wanting.

#### **Mollia patellaria** Smitt 1873

Zoarium encrusting. Zooecia separated, with a single point of junction to each adjacent zooecium. Opesium trifoliate. Operculum simple, membraniporidan, supported by cardelles, but not touching the zooecial wall. The opesial space behind the operculum may serve for the passage of opesiular muscles, but we have no knowledge of their presence and, as Canu and Bassler remark (1928: 70), this genus might "just as well be classed next to *Amphiblestrum*" in the Alderinidae. Ooecia prominent, globular and hyperstomial.

Recorded by Smitt (1873: 12), Florida, 36 fathoms; Canu and Bassler (1928: 69), Gulf of Mexico, 30 fathoms. The writer has a specimen from Captive Island, Florida. It did not occur in the Porto Rican collections.

## Division IV **PSEUDOSTEGA** Levinsen 1909

Zoarium usually erect and cylindrical. Zooecia in longitudinal series but usually appearing alternate because of the manner in which the base of each zooecium is overgrown by the sides of the neighboring zooecia. Frontal area completely filled in by an imperforate, depressed cryptocyst. Spines wanting. Avicularia vicarious, without transverse bar. Ovicell immersed in the base of the distal zooecium, with a special opening.

## Family **CELLARIIDAE** Hincks 1880

Cryptocyst covering the whole frontal zooecial wall. Operculum simple, well-chitinized, bilaminar, with a straight or concave proximal margin, a pair of strong supporting denticles (sometimes one broad median denticle). Avicularia vicarious, the submandibular area partly closed by a cryptocyst. Ovicell embedded in the distal zooecium, with a special opening.

### **CELLARIA** Ellis & Solander 1786

Zoarium typically jointed, with cylindrical internodes. Zooecia usually more or less lozenge-shaped. Cryptocyst imperforate, covering practically all of the front to the operculum, which occupies nearly all of the opesium.

#### **Cellaria nodosa** Canu & Bassler 1928

Smitt (1873: 4) recorded this species under the name *C. tenuirostris* Busk, but Canu and Bassler (1928: 72) have pointed out essential differences from Busk's species and have renamed the Florida form. Their reasons are as follows: "The ovicelled zooecia are wider than the others. Their presence occasions an enlargement of the segments, which present thus a very characteristic nodosity. The internodes are more slender, the avicularia are lozenge-shaped, and the aperture much smaller."

Smitt listed the species from Carysfort Reef, Caribbean Sea, 52 fathoms, and west of Tortugas Islands, 68 fathoms; Canu and Bassler, Gulf of Mexico, 35 fathoms, and also in the Pliocene deposits of Panama. It did not occur in the Porto Rico dredgings.

**Cellaria sinuosa** (Hassall) 1842

Zoarium dichotomously branched, internodes long and stout, cylindrical slightly thickened towards the top, the extremities rounded. Zooecia lozenge-shaped or hexagonal, or arched above and tapering off below. Area finely dotted, walls minutely granular. Orifice arched above, placed almost at the top of the area, with a much raised lower lip, which forms a broad and prominent plate in front. Avicularia at the top of a cell, often set obliquely, with a triangular mandible pointing downwards. Ovarian opening at the very top of the area, elongated transversely, with a broad tooth on the lower margin.

Porto Rico, a few dead fragments apparently belonging to this species dredged off Caribe Island at 8 fathoms. Canu and Bassler (1928: 72) have listed it for the North American coast, east of Cape Hatteras, at 102 fathoms.

## Division V **CELLULARINA** Smitt 1867

In Levinsen's revision of the Chilostomata in 1909 the members of the present group were placed in his first division, Malacostega. It has been found advisable to extend the number of divisions and in 1926 Harmer reestablished Smitt's old name for the present group, with a redefinition and the exclusion of certain forms. This change has been accepted generally.

### Key to the Families

1. Zooecia facing in opposite directions, usually in pairs back to back......... 2.
   Zooecia all facing in nearly the same direction.......................... 3.
2. Sessile avicularia only......................FARCIMINARIIDAE, page 399.
   Pedunculate avicularia also present..............EPISTOMIIDAE, page 402.
3. Zooecia separated, connected by tubular processes....BEANIIDAE, page 397.
   Zooecia directly attached to each other.................................. 4.
4. Avicularia sessile, a dorsal vibraculum usually present, a scutum usually partially covers the aperture............SCRUPOCELLARIIDAE, page 383.
   Avicularia pedunculate, vibraculum and scutum absent................... 5.
5. Avicularia very long pedunculate..........BICELLARIELLIDAE, page 396.
   Avicularia all short pedicellate "birds heads"........BUGULIDAE, page 388.

## Family **SCRUPOCELLARIIDAE** Levinsen 1909

This family is usually considered the basic one in this division. The zoarium is erect or spreading, unilaminar, usually biserial and attached to the substratum by radicles. A highly specialized spine, usually widened into a shield or branched (the scutum) bends over the membranous area, but is sometimes wanting. Sessile avicularia and vibracula usually present. It is a large and rather diversified family, but only two genera are known from the West Indian region.

### Key to the Genera

Branches attached to each other by cross radicles..............*Canda,* page 387.
Branches not attached to each other..................*Scrupocellaria,* page 384.

## SCRUPOCELLARIA van Beneden 1845

### Key to the Species

1. Ovicell with several rounded pores, only one axillary vibraculum.......... 2.
   Ovicell imperforate or with one large central fenestra, two axillary vibracula ... ............................................. *S. maderensis,* page 387.
2. Zooecia stout, not strongly narrowed below opesia......*S. regularis,* page 384.
   Zooecia slender, narrowed below opesia.................................. 3.
3. Opesia equal to half of frontal length, vibracular groove at right angles to zooecial axis.................................*S. berthollettii,* page 386.
   Opesia shorter than half the frontal length................................ 4.
4. Lateral avicularia very small and inconspicuous, vibracular groove at a 45 degree angle with zooecial axis...................*S. cornigera,* page 386.
   Lateral avicularia prominent, vibracular groove nearly in line with zooecial axis ....................................................*S. pusilla,* page 385.

### Scrupocellaria regularis NEW SPECIES

*Cellularia cervicornis* Smitt (1872) 14 (non *Scrupocellaria cervicornis* Busk, 1852).
*Scrupocellaria cervicornis* Verrill (1900) 594.—Osburn (1914) 192.

Among the species of the present list this may be distinguished by the short, wide zooecia, the opesia occupying more than half the frontal length. The frontal avicularia are moderate in size, numerous, none of them enlarged. Lateral avicularia quite small, not abundant. Vibracular chamber large, elongate (at least half as long as a zooecium), projecting, its groove straight and about median, the vibraculum about four times as long as a zooecium. Radicle fibers strong, straw colored, occasionally with retrorse hooks. Spines 2 to 6, the two lower ones opposite the operculum often forked. The scutum when fully developed is oval, nearly as broad as the opesia and with a very symmetrical aleiform decoration. The ooecia are large, spherical, or a little longer than broad, covering the front of the distal zooecium to or beyond the proximal lip of the aperture; the perforations rather regular and not tubular.

Zooecial length, 0.33 to 0.40 millimeters; width, 0.165 millimeters. Diameter of radicles, 0.053 millimeters; vibracula reaching a length of 1.5 millimeters, but usually shorter.

Florida Straits, Smitt; Bermuda, Verrill; Tortugas Islands, Osburn. Porto Rico, off Guanica Harbor, Stations 2343, 2347, 2359 and 2385, at 7 to 30 fathoms.

Apparently this is not *S. cervicornis* Busk 1852. Harmer states (1926: 377) that he has examined Busk's type material and he places *cervicornis* under the synonymy of *S. diadema* Busk 1852. The West Indian species which has masqueraded under the name of *cervicornis* for nearly 70 years differs in the following points:

1. The ovicell is longer, has a much narrower aperture and lacks the tubular pores of *diadema*.
2. There are no "giant" avicularia such as occur in both *diadema* and *cervicornis*.
3. The vibracular chamber is larger, nearly in line with the zooecia, its groove is straight and longitudinal, and the vibraculum appears to be longer.

Smitt's figures (1872. pl. 5, figs. 39–42) are excellent. As the species appears not to have been properly named I propose to call it *regularis* in reference to the appearance of the internodes and the even distribution of the appended structures.

### Scrupocellaria pusilla (Smitt) 1872

A slender and rather delicate species, spreading among algae and colonies of other bryozoa. The zooecia are curved and considerably narrowed below the opesia. The marginal avicularia prominent with a triangular beak which is decurved at the tip. Frontal avicularia rare and very large, elongate spatulate and straight, with a decurved tip. Ooecia hemispherical, with scattered pores which are slightly raised into short tubes.

Harmer (1926: 382) has placed this species under the synonymy of *S. spatulata* (D'Orbigny), but with this I must disagree for the following reasons. The giant avicularia are always frontal in position, usually on the axial zooecium below a bifurcation, though they are not always there and they may occur on other zooecia. They are directed downward and occupy practically the whole of the frontal gymnocyst. The marginal avicularia, which are often enlarged in *spatulata*, are entirely unmodified in *pusilla*. Smitt's figures (pl. 5. figs. 32 to 34) agree closely with my material, though he does not show the ovicell, and the frontal avicularium, if that is what is shown in his figure 32, is smaller. The arrangement, however, agrees and his description states that they are rare and limited to the median zooecium at the ramification.

Zooecial length, 0.44 millimeters; width at broadest part, 0.10 to 0.12 millimeters. Diameter of radicle, 0.025 millimeters; longest vibracula, 0.90 millimeters or more, usually about half that length; longest spines, 0.66 millimeters, usually much shorter.

Florida, Smitt (1872: 13, *Cellularia*) in Pourtales' collections; Tortugas Islands, Osburn (1914: 191, under *S. cornigera*, as a recent re-study of my material shows a mixture of the two species). In Porto Rican waters it occurred at Stations 2353, 2354, 2357, 2363 and 2367 off Guanica Harbor, and at Station 2377 off Tallaboa Bay, at 6 to 20 fathoms.

**Scrupocellaria cornigera** (Pourtales) 1867

Pourtales description of his *Canda cornigera* is very inadequate, but Smitt (1872: 14, *Cellularia*) had some of his material, furnished a full description and accepted the specific name. Osburn (1914: 191) recovered it at the Tortugas at 10 to 15 fathoms. The species did not occur in our Porto Rican collections, nor has it been noted elsewhere except for Marcus' recent (1937: 55) report of it at Rio de Janeiro, Brazil.

Harmer (1926: 383) indicates that *cornigera* "seems to be closely allied to *S. pusilla*." It differs from *pusilla*, however, in that the vibracular chambers are smaller and are broader than long, the marginal avicularia are smaller and the frontal avicularia are altogether different.

**Scrupocellaria bertholletii** (Audouin) 1826

The zooecia are somewhat elongate and are narrowed rather suddenly proximal to the opesia, which occupy about half of the frontal length. Three or four outer and one or two inner distal spines are present. The scutum, when fully developed, is a four-pointed spine. Two points are more frequent, or only one, and often there is no indication of the scutum. There are two types of frontal avicularia: a small triangular one immediately below the aperture, and a giant one with a longer pointed mandible in the same position. The latter is usually present on the axial zooecium below a bifurcation, but may appear elsewhere. Frontal avicularia are wanting on many zooecia. The small lateral avicularia indicated by various authors as usually present appear to be wanting from West Indian material. The ooecia are rounded, but may be somewhat longer than broad, with a number of pores, the openings of which may be raised somewhat above the surface. Radicle fibers strongly armed with retrorse hooks.

Zooecial length, 0.40 to 0.45 millimeters; width, 0.15 to 0.18 millimeters; diameter of radicle, 0.035 millimeters.

Porto Rico, Station 2381, off Guanica Harbor, several colonies at five fathoms. I have the species from the Tortugas Islands, and a colony from Bermuda collected by Dr. H. Prat. Marcus (1938: 24) lists it for Santos Bay, Brazil. It is widely distributed in the eastern Atlantic, Mediterranean, and Red seas, and Hastings has listed it from the Galapagos Islands. It has not previously been recorded from West Indian waters.

### Scrupocellaria maderensis Busk 1860

This species may be distinguished in West Indian waters by the presence of two axial vibracula, a broad crescentic cryptocyst in the proximal side of the opesium, and the broad scutum which is truncated next to the operculum. The ooecia are somewhat flattened and lack the usual pores.

Reported to the author (*in litt.*) by Dr. Anna B. Hastings, from the Tortugas Islands, in the Colman and Tandy collection.*

### CANDA Lamouroux 1816

The most striking character of this genus is the union of the branches by cross radicles which run from one vibracular chamber to another. The ovicell is usually surmounted by an avicularium. A scutum may or may not be present. Otherwise, like *Scrupocellaria*.

#### Key to the Species

1. No distal spines, no scutum........................... *C. caraibica*, page 387.
   One or two distal spines........................................ 2.
2. Scutum well developed............................... *C. retiformis*, page 388.
   Scutum absent........................................ *C. simplex*, page 388.

### Canda caraibica Levinsen 1909

This species is easily distinguished by the absence of both the scutum and the distal spines. The proximal gymnocyst is short, not more than one third of the frontal length. Vibraculum rather stout, about as long as the width of a branch. Neither ooecia nor avicularia have been noted.

Described by Levinsen (1909: 142) from "West Indian material," without exact data. Tortugas Islands, Osburn (1914: 192) at 15 fathoms. Porto Rico at Stations 2334 and 2357, Guanica Harbor, at 3 to 17 fathoms.

* Later Dr. Hastings has written that she has also found *S. frondis* Kirkpatrick 1888, in the Colman and Tandy collections from the Tortugas Islands.

**Canda retiformis** Pourtales 1867

Zoarium dichotomous, the branches connected every few zooecia by cross radicles which give a ladder-like appearance. Zooecia facing slightly outward. One or two short terminal spines. Opesia occupying about half the length, a broad scutum covering most of the aperture. Avicularia wanting. Vibracular chamber large, the sulcus somewhat curved and placed at an angle of about 45 degrees. Vibracula short, usually not longer than the width of a branch. Ooecia rounded with a small raised lip.

Florida, Pourtales (1867: 110); Gulf of Mexico and Straits of Florida, Smitt (1872: 16, *Caberea*); Gulf of Mexico and Straits of Florida, Canu and Bassler (1928: 43, *Scrupocellaria*), 30 to 270 fathoms. It did not occur in our collections from Porto Rico.

**Canda simplex** Busk 1884

Zoarium spreading, rather closely reticulate. A small spine at each upper angle. No frontal avicularia except on the summit of the ooecia.

Recorded by Busk from the Gulf of Mexico, 2 to 17 fathoms and off the Chesapeake Bay at 1700 fathoms.

## Family **BUGULIDAE** Gray 1848

The zoarium is erect and branching, flexible, usually without joints, attached by radicles and the zooecia all face in the same direction. The zooecia are little calcified, elongate quadrangular, somewhat narrowed toward the base, with the opesia occupying most of the frontal surface. The ooecia are attached by a short stalk and the avicularia are freely movable on longer or shorter pedicels.

Key to the Genera

1. Branches consisting of three or more parallel rows of zooecia ........................................................ *Dendrobeania,* page 392.
   Branches of only two rows of zooecia ........................................ 2.
2. Zooecial branches attached to slender jointed stems which consist of modified zooecia (kenozooecia) ............................ *Caulibugula,* page 392.
   Stems not so formed, stalk kenozooecia absent ............ *Bugula,* page 388.

### **BUGULA** Oken 1815

Key to the Species

1. Branches composed of 2 to 4 series of zooecia ......... *B. flabellata,* page 391.
   Branches with never more than 2 series of zooecia ........................ 2.
2. Color reddish brown ................................................ 3.
   Color pale, yellowish or grayish ...................................... 4.

3. Avicularia absent . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *B. neritina,* page 389.
   Avicularia present . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *B. minima,* page 390.
4. Colony simple; avicularia absent; opesia oval, not more than half the zooecial length . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *B. johnstoniae,* page 392.
   Colony more complex; avicularia present; opesia longer . . . . . . . . . . . . . . . . . . 5.
5. Ooecia very small, hemispherical, inconspicuous . . . . . . *B. microoecia,* page 391.
   Ooecia larger, conspicuous . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 6.
6. Avicularian beak long, gently decurved . . . . . . . . . . . . . . *B. avicularia,* page 390.
   Beak short, strongly decurved, ooecia blue-gray . . . . . . . . . *B. dentata,* page 389.

#### Bugula dentata (Lamouroux) 1816

Zoarium erect and branching, the branches narrow, biserial, the outer distal corners of the zooecia little projecting, radicles contributing to the formation of a short, stout stalk. Zooecia turned somewhat toward each other, the outer angle somewhat inrolled. Opesia about three-fourths as long as the front, narrowed proximally more or less. Three long, stout, jointed spines on the outer distal margin and a smaller one on the inner corner. Avicularia of two kinds, a smaller one of ordinary type with hooked beak which is slightly sinuated, situated below the middle of the zooecium on the outer border, and a much larger one (not present in Porto Rican specimens examined) with an elongate boat-shaped mandible. The ooecia are globular, situated between the inner and the distal outer spines. They are inclined toward the midline of the branch and rotated slightly so that their apertures open somewhat away from each other. In fresh specimens the ovicells are of a distinctly blue-gray color, but this fades in the course of time in alcohol.

The species has a wide distribution in warmer waters, but this is the first time it has been noted in the western Atlantic. Porto Rico, Station 2353 and 2367, off the mouth of Guanica Harbor, at 7½ to 13 fathoms. The material is very scanty, but ooecia are plentiful and all the characters of the species are well defined, except that none of the larger avicularia are present. I have also a small specimen collected by Dr. H. Prat at Bermuda.

#### Bugula neritina (Linnaeus) 1758

Zoarium erect, bushy, forming reddish brown tufts often three or four inches in height, the basal portion supported by numerous descending radicle fibers. Zooecia plain, not much expanded distally, the membranous area extending nearly or quite to the proximal end, the distal corners produced into sharp angles or points; avicularia and jointed spines wanting. The ooecium is subglobose, attached at the inner corner of the zooecium by a short pedicel and turned transversely across the top of the zooecium so that its aperture opens toward the outer corner. The reddish brown color of this species and *B. minima* is usually quite distinctive among our American forms.

Tortugas Islands (Osburn 1914: 186) and Curaçao Island (1927: 126); Bermuda Islands (Verrill 1900: 588). Porto Rico at Stations 2339 and 2385 off Guanica; 2334 and 2364 in the Harbor; 2347 off Parguera, and at Guayanilla; especially on piles of docks and on mangrove roots. This well known circumtropical species was very abundant in shallow water, becoming more rare in outside waters down to 6 fathoms. The writer has taken it in abundance as far north as Beaufort, North Carolina, and Marcus (1937: 67) records it as far south as Santos, Brazil.

### **Bugula minima** (Waters) 1909

*B. neritina* var. *minima* Waters (1909) 136.

It appears that this form should be raised to the dignity of a distinct species for the following reasons: (1) the characteristic differences listed by Waters (size of zooecia and ooecia, and the presence of avicularia) are distinctive wherever found throughout its range which appears to be circumtropical; (2) there is a difference in the mode of branching (Harmer's type 4 instead of type 5); (3) the colonies never reach the size of those of *B. neritina* even when growing under the same conditions. The avicularia are somewhat elongate and narrow with a long beak and are attached at the side of the lower end of the aperture.

Porto Rico, Guanica Harbor on piles of docks. Osburn (1914: 187) Tortugas Islands.

Since writing the above, I have received Dr. Anna B. Hastings' critical paper on cellularine Polyzoa (Oct. 1939, Novitates Zool.) in which she comes to the same conclusion. In the light of her paper I have re-examined my material and find my West Indian specimens to be definitely *minima*. Of her new species, *B. crosslandi,* I have a specimen from Bermuda.

### **Bugula avicularia** (Linnaeus) 1758

This species, which is not uncommon along the New England coast, has been listed by Canu and Bassler (1928: 41) for the Gulf of Mexico at 724 fathoms. They have incorrectly cited my reference to the species from the Woods Hole region (Osburn 1912: 226, *Bugula avicularia*) as *Synnotum avicularia,* apparently confusing it with my reference to *S. aviculare* (Pieper) at the Tortugas Islands (Osburn 1914: 191).

This species did not occur in our Porto Rico collections.

### **Bugula microoecia** Osburn 1914

*Bugula microoecia* Osburn (1914) 187. figs. 1, 2, 3.

Zoarium delicate, composed of a central stalk with long, narrowly flabellate branches arising in an irregularly dichotomous fashion from the main stem. The stalk, as well as the basal part of its branches, consists of very much elongated and modified zooecia arranged biserially. The form is therefore somewhat intermediate between *Bugula* and *Caulibugula,* but the stalk zooecia contain polypides and occasionally have avicularia. Definite joints are present at the bifurcations, but these are not so well developed as in *Caulibugula.* Numerous strong radicle fibers arise from the lower stem zooecia.

Zooecia long, slender, little expanded; frontal aperture extending almost to the base and facing somewhat towards the axis of the branch; avicularium short, stout, with strongly decurved beak, set on a very short stalk near the distal end of the outer border; the distal outer border is continued into a short, stout, pointed spine. Ooecia very small, hemispherical, set very low down, very inconspicuous and partially hidden by the spine.

Tortugas Islands (Osburn 1914: 188) at 18 fathoms, several colonies, the largest 2.5 inches tall. Porto Rico, Station 2353, off the mouth of Guanica Harbor, 7½ fathoms.

*Bugula mollis* Harmer (1926: 445) is much like *B. microoecia* in many respects, but it appears to be a coarser species with more spines and with the joints less completely developed. There appear to be differences in the ooecia also.

### **Bugula flabellata** (J. V. Thompson) 1847

Zoarium erect, flabellate, the branches usually beginning with two series of zooecia and ending with three or four. Zooecia elongate, the membranous area extending to the base; lateral margin free of spines, but 2 to 4 elongate spines may occupy the distal margin. Avicularia moderately large, longer than the width of a zooecium. Ovicell directly in line with the zooecial axis, hemispherical and somewhat hood-like.

Porto Rico, taken only once on the piles of a dock at Ponce. Florida (without locality), Smitt (1872: 18); Tortugas Islands, Osburn (1914: 187); Santos Bay, Brazil, Marcus (1938: 27). Northward along the Atlantic coast to Maine. Widely distributed, especially in temperate seas.

### Bugula (Halophila) johnstoniae (Gray) 1843

The zoarium is of a simple *Bugula* type, erect, branching. Zooecia in two series, aperture oval, about as long as the basal portion, which is much constricted; a very short spine, often wanting, on the outer distal angle; no avicularia; ovicell smooth, hemispherical.

Smitt (1872: 17) listed the species from Florida without locality. Canu and Bassler (1928: 42) report it from the Gulf of Mexico. It did not appear in the Porto Rico collections.

### DENDROBEANIA Levinsen 1909

This genus was separated from *Bugula* by Levinsen in 1909 to include species with multiserial branches in which the zooecia are provided with an operculum. Usually lateral spines are present, avicularia not limited to the outer margin, and several minor characters.

### Dendrobeania lamellosa Canu & Bassler 1928

Canu and Bassler described the species from east of Yucatan, the only record thus far. It is evidently related to the well known *D. murrayana* (Johnston) of more northern waters, but differs in the form of the avicularium, the heavier lateral spines and the smooth ovicell.

### CAULIBUGULA Verrill 1900

Bugulas with jointed stalks consisting of elongate, cylindrical kenozooecia; branches never more than biserial; proximal zooecia of branches differing more or less from distal ones; ooecia often incomplete.

This is the same as *Stirparia* Goldstein 1880 (preoccupied), and renamed *Stirpariella* by Harmer 1923, who at that time misunderstood Verrill's use of the genus. Later Harmer (1926: 456) corrected the error. The species have usually been allocated to *Bugula* until recent years.

#### Key to the Species

1. Ooecia completely formed .................... 2.
   Ooecia incomplete, wide open hoods .................... 3.
2. Ooecia large, prominent, longer than broad .................... *C. caraibica*, page 394.
   Ooecia moderate in size, broader than long .................... *C. armata*, page 393.
3. Primary zooecium of a branch little modified, spines few, no stem vesicles .................... *C. levinseni*, page 394.
   Primary zooecium modified, with about 8 spines, numerous membranous vesicles on stem internodes .................... *C. zanzibariensis*, page 395.

**Caulibugula armata** Verrill 1900

*Stirparia dendrograpta* Waters (1913).

A delicate, beautiful species, with stolon and radicles, and with erect jointed stalks from which there diverge at the upper end fan-like branches composed of zooecia in biserial arrangement. The stalks, which are often branched, are composed of kenozooecia of varying length. The first zooecium of a branch differs in form, bears no avicularium and has six to eight spines about its border. The ordinary zooecia have rather wide open opesia which extend well toward the base; they are curved outward somewhat distally, considerably narrowed proximally; the distal end rounded, angulated, or provided with 1 to 4 jointed spines. There is a peculiar distribution of the avicularia (Osburn 1914: 189), which on the lower zooecia are attached near the proximal end of the opesia, while in the next few succeeding zooecia they are situated more and more distally until the upper zooecia have the avicularia at the outer distal corner.

Porto Rican Survey at numerous stations, at low tide on mangrove roots and piles of wharves, down to 20 fathoms on sponges, corallines, etc., one of the most generally distributed species of the region. Verrill (1900: 588) Bermuda Islands; Osburn (1914: 188) Tortugas Islands; Marcus (1938: 29) Santos Bay, Brazil.

The *Stirparia dendrograpta* of Waters (1913: 470) is apparently the same as *C. armata* Verrill. Waters probably overlooked Verrill's inconspicuous paper and at the time of publication of my Tortugas paper (1914) I had not received Waters' paper on the Bryozoa of Zanzibar. Dr. Marcus, in his excellent review of *Stirpariella* (1925), has offered an analysis of 12 species and indicates differences between *armata* and *dendrograpta* as follows:

*C. dendrograpta:* ooecia on the inner corner; 8 spines on primary zooecia, 3 on other zooecia; internodes of stalk about equal, except the distal one which is shorter.

*C. armata:* ooecia on the outer corner; 6 spines on primary zooecia, 1 or 2 on other zooecia; internodes of stalk alternating longer and shorter.

With the abundance of material at my disposal I am able to determine that the spines of the primary zooecia vary from 5 to 11 usually 6 to 8; those of other zooecia from 0 to 4, usually 2 or 3 on the distal zooecia of a branch. The stalk internodes are subject to a great deal of variation in length, with no alternation or other regular arrangement. The distal internodes are usually short, but others may be. The internodes of two stalks from the same colony measure in millimeters as follows, from base to tip: 0.92, 1.45, 1.20, 1.06, 1.26, 1.06, 1.20, 1.08, 0.55, 0.46; 1.20, 1.26, 0.66, 1.32, 1.35, 1.58, 0.60, 0.53.

The tentacles and zooecial measurements are about the same and both have the peculiar distribution of the avicularia referred to above. Also there appears to be no difference in the position of the ovicell. Waters states only "The ovicell is lateral and pedunculate," but his figure (1913. pl. 66, fig. 4) shows it attached at the inner corner. In *armata* they are also attached to the inner corner, without any doubt. My earlier statement (Osburn 1914: 189) indicating attachment to the outer corner was either due to faulty observation or more probably to a *lapsus calami,* whatever the explanation, the statement is incorrect. I can find no characteristic differences between *armata* and *dendrograpta.*

*Caulibugula armata* appears therefore to have a circumtropical distribution, similar to that of many other warm water species.

### Caulibugula caraibica (Levinsen) 1909

Zoarium stolonate, rising into long-stalked tufts which may reach a height of 150 millimeters; the flabellate branches usually arranged alternately; the stalks composed of jointed kenozooecia and lateral stalks may arise from the main one. It has a fine purple color and when fully developed is one of the most conspicuous of the Bryozoa.

Zooecia biserial, with the areas turned somewhat inward, the distal end truncated and a single spine occasionally at the middle of the distal end; primary zooecium of a branch differing in form, not truncated and without spines; small avicularia with a curved beak are sparsely distributed; ooecia large, prominent, longer than broad, attached at the middle of the distal end of the zooecia and radiately striated. Radicles arise from the proximal ends of the stems.

Zooecial length, 0.45 millimeters; width, 0.16 millimeters. Avicularia, 0.11 millimeters; ooecia, 0.29 millimeters long by about 0.25 millimeters wide.

Levinsen (1909: 104, *Bugula*), St. Croix Island; Osburn (1914: 188, *Bugula*), Tortugas Islands on piles of docks; Canu and Bassler (1928: 40, *Bugula*), Gulf of Mexico, 24 fathoms. In our Porto Rican collections this species appeared only once, a small specimen on a dock at Ponce.

### Caulibugula levinseni NEW SPECIES

PLATE 4, FIGURES 36, 37, 38, 39

Zoarium stolonate with erect stalks composed of jointed kenozooecia, with flabellate, biserial branches. Zooecia moderate in size, rather narrow, about one-fourth as wide as long; facing nearly forward, opesia extending nearly to the base and narrowed proximally; distal corners usually with only a sharp angulation, but occasionally there is a very elongate spine on the inner angle, jointed at the base and chiefly on the distal zooecia of a branch. Avicularia moderately elongate, the sides of the beak flaring outward slightly, attached at the side of the opesia near the proximal end, not abundant. Ooecia of medium size, abundantly developed as wide open hoods.

Primary zooecium of a branch differing but little from ordinary zooecia, opesia extending nearly to the base, the distal angles usually only a little elongated but occasionally there are very elongate, jointed spines. Rarely two such spines occur on the outer angle.

Zooecial length, 0.33 to 0.40 millimeters; width, 0.08 to 0.10 millimeters. Avicularia, 0.13 millimeters; ovicell about 0.11 millimeters in width. The kenozooecia of the stalk vary in length 0.55 to 1.30 millimeters, and in width from 0.045 to 0.060 millimeters. Radicles arise from near either end of an internode, irregularly waved, 0.03 to 0.035 millimeters in diameter.

Dredged in the middle of Guanica Harbor, Porto Rico, at a depth of 2 to 3 fathoms, one much branched colony about 15 millimeters in height.

Dedicated to the memory of Dr. G. M. R. Levinsen, who described a number of West Indian Bryozoa and whose monumental work on the cheilostomatous Bryozoa (1909) is very important in the study of this group.

### ? Caulibugula zanzibariensis (Waters)

Stalk kenozooecia of what appears to be this species were found in one dredging near the mouth of Guanica Harbor, Porto Rico. The kenozooecia are abundantly provided with pear-shaped vesicles quite similar to those figured for *zanzibariensis* by Harmer (1926. pl. 33, fig. 10). Similar vesicles are known for *C. caliculata* (Levinsen), *C. glabra* (Hincks), and *C. mortenseni* Marcus, all of which are from the East Indian region. *C. zanzibariensis* is known from eastern Africa and the East Indies.

While no fully developed zooecia are present in the Porto Rican material, the nature of the kenozooecia, the vesicles, radicles, and a single basal zooecium of a branch all appear to be closer to *zanzibariensis* than any of the other species. The internodes, radicles and vesicles are all yellowish to light horn-colored. The internodes range in length from 0.65 to 2.70 millimeters, usually either about 1.50 or about 2.50 millimeters; in diameter they range from 0.13 to

0.20 millimeters. The radicles measure about 0.04 millimeters in diameter. The vesicles are sessile or very short stalked, elliptical or pear-shaped, variable in size and form ranging from 0.20 to 0.50 millimeters in height and 0.15 to 0.25 millimeters in diameter.

The stalk kenozooecia appear to be just starting to regenerate new branches, as several very young and only slightly chitinized basal zooecia are present. One of these is sufficiently developed to show the opesial form of *C. zanzibariensis* with eight partially developed spines.

This is the first time a species of *Caulibugula* with stalk vesicles has been observed in Atlantic waters.

## Family **BICELLARIELLIDAE** Levinsen 1909

### **CORNUCOPINA** Levinsen 1909

#### **Cornucopina antillea** Osburn 1940

*Cornucopina antillea* Osburn (1940) Smithson. Misc. Coll. **91** (30): 1–3. pls. 1, 2.

Zoarium erect, stalked, profusely branched. The type specimen is about 80 millimeters in height, free from branches for about 25 millimeters above the attachment, and the stalk is conspicuously thickened by the large number of radicle fibers. The central stalk and the stems of all the branches are formed primarily by the union of the tubular proximal ends of the biserial, alternating zooecia.

The nearly transparent zooecia are about 1.00 millimeters long, the basal half rather narrowly tubular, the distal half expanding rather suddenly outward at an angle of 45 degrees. The opesia occupy nearly all of the upper surface of the expansion; the operculum semilunar, thickened a little at the border. The distal margin, dorsally, is beset with a row of 4 or 5 exceedingly elongate, tubular, slightly curved spines, which are jointed at the base. There is no indication of a digitiform process; the spines originate separately from the zooecial wall. The longest spines are more than twice the zooecial length, reaching a maximum of about 2.50 millimeters. A smaller spine occurs at one side of the area near its base and above this on the side there may be another somewhat larger one.

Avicularia are of two kinds. One of these is excessive elongate, averaging about 1.40 millimeters (range 0.95 to 1.90 millimeters), originating on one side near the distal end of the aperture, with a slender tubular stalk and jointed at the base. It expands but little until near the distal end; both beaks are hooked, the mandible more strongly. There is much variation in the size of the mandibulate portion, the largest being only slightly smaller than a zooecium, the smallest very narrow in comparison, and the size is not coordinated with the length of the pedicel. The second type of avicularium is very small in comparison, only about 0.20 millimeters long, and is short pedicellate. They are not numerous and occur more frequently just above the bifurcation of the branches and at inner side of the opesia. The mandible is noticeably more transverse than in the elongate type.

Ooecia moderately large, about 0.32 millimeters in width, somewhat globular, the rim of the aperture a little flaring and the surface decorated with radiating lines; attached laterally in front of the elongated spines. The radicle fibers arise from the side of the zooecia near the base of the opesia, more frequently from the basal zooecia of the branches, and they follow the stalk down to its point of attachment before spreading out for anchorage.

Dredged by the Johnson-Smithsonian Deep Sea Expedition, a short distance west of Porto Rico, at 400 fathoms, only the type specimen known.

This record is of special importance as hitherto the genus has not been known from the northern hemisphere. (In Harmer's paper, 1926 p. 422, the occurrence of *C. dubitata* Calvet in the "Bay of Biscay" is evidently a typographical error for the Bay of Biscoe, Graham's Land, Antarctica.)

## Family **BEANIIDAE** Canu & Bassler 1927

Zooecia little calcified, well separated, connected by stolonate projections. Ooecia wanting. Pedunculate avicularia usually present. The zooecia all face in one direction and the opesia occupy all or nearly all of the frontal surface. Radicles for attachment in many cases.

### **BEANIA** Johnston 1840

Key to the Species

1. Zoarium multiserial.................................*B. hirtissima,* page 397.
   Zoarium uniserial, branching.................................................... 2.
2. Spines wanting.................................*B. intermedia,* page 398.
   Spines present........................................................................ 3.
3. Five or six weak spines on each side...............*B. cupulariensis,* page 399.
   About ten stronger spines on each side................*B. mirabilis,* page 398.

#### **Beania hirtissima** (Heller) 1867

Zoarium forming a unilaminar encrusting, spinous mat, or erect and branching in tubular form and bristling like a porcupine. Zooecia more closely associated than in the other species, the tubular connecting joints shorter. The opesium occupies all of the frontal surface to the constricted base and is bordered by very numerous slender, more or less erect spines. No avicularia.

The species is widely distributed in warmer waters, but has not hitherto been recorded from North American waters. One small specimen of a few zooecia was dredged off the mouth of Guanica Harbor, Porto Rico, and I have several other specimens from Bermuda, collected in May, 1936, by Dr. S. R. Williams. Dr. Marcus has also recorded it for the Bay of Santos, Brazil (1937: 62).

### Beania mirabilis Johnston 1847

Zooecia sharply divided into a body and an elongate tubular portion which is often as long as the body. The terminal, lateral, and radicle buds all arise near each other within a short distance from the proximal end of the body. The rather strong lateral spines curve over the area, except the most distal pair which are directed somewhat forward. In addition there is a pair of short stout distal spines. No avicularia.

Length of body portion about 0.60 millimeters; stalk portion 0.30 to 0.60 millimeters.

Porto Rico, Stations 2347, 2363, and 2381, all off the mouth of Guanica Harbor, at 5 to 20 fathoms. Previously recorded from the West Indian region by Osburn (1914: 189), Tortugas Islands, 18 fathoms. It is distributed around the world in temperate and tropical seas. Marcus (1937: 60) lists it for Santos Bay, Brazil.

### Beania intermedia (Hincks) 1881

Stalk not sharply differentiated, zooecium narrowing gradually. Distinct spines are wanting, but there is a pair of distal angulations and another opposite the operculum. An avicularium mounted on a short stalk on one or both sides of the distal end. The terminal bud arises distally on the dorsal side almost beneath the operculum; lateral buds arise about half way along the side of the zooecium; radicle buds originate in the midline of the dorsum a little proximal to the lateral buds. Total length of the zooecium including stalk about 0.90 millimeters.

Porto Rico, Stations 2337, 2339, and 2363, off Guanica Harbor at 6 to 35 fathoms. Tortugas Islands (Osburn 1914: 189). Distributed around the world in warmer waters. Marcus (1937: 61) records it for Santos Bay, Brazil.

**Beania cupulariensis** Osburn 1914

Zooccial stalk short and rather sharply narrowed from the body, the latter symmetrically elliptical and wider in proportion than in the two preceding species. About five or six weak spines (4 to 7) are curved over the area on each side and two small spines project forward close together at the distal end. An avicularium with a short peduncle at one or both of the distal corners. Terminal bud dorsal and distal, opposite the operculum; lateral (branch) buds about the middle of the side; radicle bud median and usually a little proximal to the lateral ones. Total length of zooecium 0.90 millimeters. It has the peculiar habit of growing inside the concavity of *Cupuladria* (*Cupularia*).

The species was described from the Tortugas Islands, where it was found on the dorsal side of *Cupuladria canariensis* (Osburn 1914: 190, *Cupularia guiniensis*). At Porto Rico one colony was found at Station 2349, off Parguera, at 10 fathoms. Harmer (1926) has recorded it from the Sulu Archipelago and the Aru Islands.

## Family **FARCIMINARIIDAE** Busk 1852

Zoarium erect, jointed, with narrow branches and few bifurcations; the joints round or flattened and unilaminar or bilaminar; radical fibers usually present. Zooecia elongate, little calcified, aperture large. Avicularia adventitious, sessile, sometimes wanting. Ovicell endozooecial, large, reduced, or sometimes wanting.

KEY TO THE GENERA

1. Avicularia paired........................................*Nellia,* page 399.
   Avicularia single, median........................................ 2.
2. Branches square, zooecia in four series................*Columnella,* page 401.
   Branches flattened, bilaminar, at least 3 series of zooecia on each face .....
   ........................................ *Farciminellum,* page 401.

### **NELLIA** Busk 1852

Zoarium erect and jointed, internodes rounded. Zooecia elongate without spines. Ovicells deeply immersed and difficult to observe. A pair of small avicularia on the proximal part of the gymnocyst.

KEY TO THE SPECIES

1. Internodes with six series of zooecia....................*N. cereus,* page 400.
   Internodes with four series of zooecia........................................ 2.
2. Avicularia inconspicuous, not raised, not divergent.......*N. oculata,* page 400.
   Avicularia larger, conspicuous, divergent, mandible hooked *N. tenuis,* page 400.

### Nellia oculata Busk 1852

The mural rim is somewhat raised, enclosing an elliptical area slightly narrowed at the level of the opercular hinge. The operculum is about as wide as the area behind it. There is a narrow cryptocyst proximally and laterally. A pair of small rounded avicularia situated on the proximal part of the gymnocyst, with a rather wide pivot. Radical fibers arise on the gymnocyst. The zooecia are in regular series.

This widely distributed species has been reported from this region as follows: Florida (Smitt 1873: 3) 17–138 fathoms, Texas and St. Thomas (Levinsen 1909: 120, *N. tenella*), Tortugas Islands (Osburn 1914: 191) 10–18 fathoms, and by Canu and Bassler (1928: 26) from the Gulf of Mexico, 24–30 fathoms, and also from the Pliocene of Panama. In our Porto Rican collections it occurred at Stations 2347, 2382, 2385 in considerable numbers, 5 to 10 fathoms.

### Nellia tenuis Harmer 1926

Habit typical, a series of upright stems being given off from creeping rootlets. Internodes short, narrow at the base which is composed of two zooecia. Aperture occupying most of the front, except in the proximal zooecia of the internode, the cryptocyst well developed proximally and narrower laterally. Avicularia opposite the proximal cryptocyst, diverging outwards and closely connected with the margins of the preceding alternate zooecia of the adjacent series; mandibles acute and hooked. Ovicells more developed than in *N. oculata*.

My two specimens, which are small and unbranched, agree with this description in every detail, but ovicells are wanting. The zooecia measure in length about 0.45 millimeters, and in width about 0.18 millimeters, so they also compare favorably in size.

Porto Rico, Station 2367, off mouth of Guanica Harbor, 13 fathoms. Otherwise known only from Harmer's material from the East Indies in the Siboga Expedition and from a specimen from Tizard Bank in the China Sea.

### Nellia cereus (Pourtales) 1867

Where this species may belong is a question which cannot be solved definitely until more material is available. The genus *Farcimia* Fleming 1828, to which Pourtales assigned it, is a synonym of *Cellaria* Ellis and Solander 1886. Smitt (1873: 3) reexamined Pourtales' material and thought it should be regarded as a distinct generic type but did not rename it. No one else has studied the material.

Canu and Bassler (1929: 43) suggest that the *Farcimia* of Pourtales is "probably a synonym of *Nellia*," but the species is certainly different from *N. oculata.*

Smitt figures this species (1873. pl. 1, figs. 55, 56) and compares it (p. 4) with *Nellia oculata.* He especially calls attention to the row of interzooecial pores and the frontal pores in the denuded specimen. The frontal area is not narrow as in *N. oculata* and is largely closed by the cryptocyst. The "pores" mentioned by Pourtales are a pair of small sessile avicularia.

Pourtales recorded the species as "rather abundant in 270 fathoms off Havana."

### COLUMNELLA Levinsen 1914

Branches square in transverse section, zooecia long, in four longitudinal rows, spines wanting, an avicularium typically present at the proximal end of the zooecium. Ovicells large and prominent. (After Harmer.)

#### Columnella brasiliensis (Busk) 1884

Zoarium about two inches high with five or six branches. Zooecia with opesia occupying practically the whole frontal area, slightly narrowed proximally. Ooecia prominent, somewhat flattened, surface coarsely rugose. A small sessile avicularium with a semicircular mandible. Recorded by Canu and Bassler (1928: 26, *Levinsenella*), Caribbean Sea, 683 fathoms. Otherwise known from the coast of Brazil, 9°, 5′, S. Lat. (Busk 1884: 50, *Farciminaria*).

### FARCIMINELLUM Harmer 1926

Branches pluriserial, bilaminar, flattened, with at least three series of zooecia on each face, those of the basal series being kenozooecial, without orifice or operculum, with the exception of the marginal row on each side. Median and lateral zooecia differentiated as in *Himantozoum,* their proximal ends not conspicuously forked and hardly overlapping their predecessors. Spines and avicularia present or absent, mandibles rounded. Ovicells present, or large eggs in the zooecial cavity. (After Harmer.)

#### Farciminellum (Farciminaria) atlanticum (Busk) 1884

Zoarium two to three inches high, arising in a single slender stem from a dense tuft of radical fibers, and dividing into several furcate branches. Zooecia multiserial, elongate-oblong, rounded at the top and slightly prominent; contracted downward; the sides of the front beset with numerous, simple incurved equidistant aculeate spines.

A rather large immersed avicularium of an oval form with a semicircular mandible pointing upwards at the bottom of the front in the middle. Ooecium immersed, surface smooth. (After Busk.)

Challenger Expedition, Station 23, off Sombrero Island, 450 fathoms; Station 24 off Culebra Island, 390 fathoms.

## Family EPISTOMIIDAE Gregory 1903

Zoarium branched, rising from a delicate stolon; zooecia in pairs, back to back, each pair beginning in short tubular processes; sessile and pedunculate avicularia. There is no ovicell, the gonozooecia slightly enlarged.

### SYNNOTUM Pieper 1881

#### Synnotum aegyptiacum (Audouin) 1826

Zooecia small, delicate, scarcely calcified, the area occupying nearly the whole length of the front. A small sessile avicularium at one or both of the distal corners, and occasional stalked avicularia arising distally on the dorsal side of one or both members of a pair. The stalked avicularia are short and bulbous, with a short hooked beak and a very short hooked mandible. Radicle fibers also arise at the distal end of the zooecia.

A widely distributed warm water species. Porto Rico, Station 2349 off Parguera and Stations 2353 and 2367 off Guanica Harbor, 7 to 13 fathoms. Tortugas Islands (Osburn 1914: 191 *S. aviculare*) and Curaçao Island (Osburn 1927: 126). Other specimens in the author's collection are from Beaufort, North Carolina, and Dr. H. Prat has sent me a specimen from Bermuda. It is probably well distributed in the West Indian region, but no other writer seems to have noticed it. Canu and Bassler (1928: 41) are in error in listing Osburn's record of *Bugula avicularia* from Woods Hole as *Synnotum avicularia* (no doubt a *lapsus calami*). Marcus (1937: 58) lists it from Santos Bay, Brazil.

## Division VI CRIBRIMORPHA Harmer 1926

This division of the Anasca is somewhat uncertain in our present knowledge of the genera concerned. With the subdivision of the chilostome Bryozoa undertaken by Levinsen (1909) it becomes necessary to assign the various families to their subdivisions. This is very desirable from the standpoint of the taxonomist, but in the evolution of any major group of organisms sharp lines may not always have been drawn. That appears to be the case with the forms which we assign to the division Cribrimorpha. There are several possibilities in the handling of this group. Levinsen (1909) erected only three divisions of the Anasca, and placed the members of the present group under his division 1, Malacostega. Since then the Anasca have been further subdivided and Harmer (1926: 470) has erected division VI to include the Cribrimorphs of Lang (1916). Marcus (1922: 47) placed them all in the Ascophora, and Canu and Bassler (1929: 27–30) divided the group between the Anasca and Ascophora, but Bassler (1935: 29) places the Cribrimorpha in division I of the Ascophora. Harmer (1926: 470–472) recognizes them as constituting an intermediate group with relations to both the Anasca and Ascophora and further states that "it is thus a matter for legitimate doubt whether they should be placed in the lower or higher of the two groups which they connect." At any rate this arrangement keeps together certain species which have a frontal shield or pericyst developed above the ectocyst, and in the present state of our knowledge of the development of the various members of this puzzling group, it appears to be a logical one, even though it be impossible to draw sharp lines. If Harmer (1926: 472) is correct in his interpretation of the conditions in *Figularia et altera*, we find in the cribrimorphs a series of stages leading up to the frontal and compensation sac which characterize Ascophora. Since the cribrimorphs have not fully developed either the Ascophora type of frontal or compensation sac, I prefer to leave this group where Harmer has placed them as a division of the Anasca, especially since the more primitive genera (*e. g. Membraniporella*) have no more than a series of anastomosed spines above a wide membranous area.

## Family **CRIBRILINIDAE**

### Key to the Genera

1. Avicularia frontal, dependent, at the side of the aperture.................. 2.
   Avicularia interzooecial, vicarious.................................... 4.
2. Frontal evidently of depressed spines, partly separated by transverse slits (lacunae) ....................................*Membraniporella*, page 404.
   Frontal more closed, lacunae smaller in radiating rows.................... 3.
3. Frontal with a large opening (spiramen) proximal to the aperture, besides marginal and central pores..........................*Gephyrotes*, page 405.
   Frontal shield without spiramen, rows of transverse pores between the costae .............................................. *Cribrilina*, page 404.
4. Costular area occupying most of frontal, ribs thickened, lacunae small ...... ................................................... *Puellina*, page 405.
   Costular area small, limited to the centro-distal area......*Figularia*, page 407.

### MEMBRANIPORELLA Smitt 1873

Frontal formed by more or less coalesced recumbent spines (costules), beneath which is the membranous ectocyst; one distal and two pairs of lateral dietellae; ovicell hyperstomial, closed by the operculum.

#### Membraniporella agassizii Smitt 1873

The zoarium is erect, branching, unjointed; the zooecia arranged in four series forming a rounded stem and facing four directions. Frontal formed by the union of 8 to 12 pairs of ribs; avicularia short-pointed, one on either side of the aperture.

Recorded by Smitt (1873: 11) off Cojima, Cuba, 450 fathoms, since when the species has not been noted.

#### Membraniporella petasus Canu & Bassler 1928

Zoarium encrusting. Zooecia distinct, elliptical, elongated, swollen; costules broad and flat, 9 or 10 in number, with linear lacunae on the side and some small irregular ones near the middle. Peristome with 3 or 4 short palmate bifid spines. Ovicell large, globular, smooth.

Recorded by Canu and Bassler (1928: 36) north of Cuba at 201 and 143 fathoms.

### CRIBRILINA Gray 1848

Frontal consisting of fused costules, forming a pericyst with the membranous ectocyst beneath. The costules are united at various places along their length, giving the frontal shield the appearance of being more or less regularly perforated in rows; a mucro usually present below the aperture. Dietellae present. Ooecia hyperstomial. Avicularia usually present, opposite the aperture.

#### Cribrilina lineata Canu & Bassler 1928

Zoarium encrusting. Zooecia isolated, arranged in linear series; large, elliptical, elongated; frontal very convex; costules 16, narrow, separated by very small and linear lacunae, median line raised. Peristome with 2 or 3 short, broad spines and 2 lateral tongues which sometimes unite to form an arch over the aperture.

Canu and Bassler (1928: 38), off Havana, 387 fathoms. Not otherwise known.

#### Cribrilina (Acanthocella) clypeata (Canu & Bassler) 1928

Zooecia distinct, elliptical, little elongated; frontal convex with the form of a shield; 8 or 9 transverse costules separated by large lacunae; each costule bears three lumen pores of which the most exterior is very salient and in the form of a hollow spine; peristome thin, salient, with 2 or 3 short hollow spines.

Canu and Bassler (1928: 39), off Havana, Cuba, 78 fathoms, and Gulf of Mexico, 25 fathoms. Not noted in our Porto Rican collections.

Canu and Bassler in 1917 erected the genus *Acanthocella,* mistaking the nature of the operculum. This error they corrected in 1928 (p. 39) where they indicate also that *Acanthocella* should rank only as a subgenus of *Cribrilina* to include those species with tubular lumen pores.

### GEPHYROTES Norman 1903

In the formation of the frontal shield (pericyst), a large opening (spiramen) is left in the midline proximal to the aperture, and there is a row of large lateral lacunae in addition to smaller, more central ones. A pair of avicularia opposite the aperture; ovicell small, imperforate; no dietellae.

#### Gephyrotes spinosum Canu & Bassler 1928

Zooecia distinct, separated by a furrow, elliptical, a little elongated; costules 16 to 18, narrow, a little distinct, transverse, separated by very small lacunae, and bearing two or three very salient lumen pores which give the frontal a spinous aspect. Peristome thin, with a short hollow spine on each side and distally with 2 broad bifid spines often joined together.

Canu and Bassler (1918: 30), north of Cuba 143 fathoms, and Straits of Florida, 56 fathoms. Not in our collections from Porto Rico.

### PUELLINA Jullien 1886

Costular area covering most of the frontal surface; the ribs thickened, the grooves between them provided with small lacunae in radiating rows. Aperture semicircular, oral spines present; avicularia acuminate, interzooecial. Ooecia hyperstomial.

#### Puellina innominata (Couch) 1844

There appears to be some question whether this is a distinct species or whether it intergrades with *radiata.* The presence of a single suboral pore seems hardly sufficient to separate it. However, it averages smaller in size, the costate area appears to occupy somewhat less of the frontal surface, and the costae are fewer in number and more prominent. The bases of the costae are also enlarged into a series of knobs encircling the frontal.

Not taken at Porto Rico. Smitt (1873: 22. fig. 110); Canu and Bassler (1928: 73), Gulf of Mexico, Straits of Florida and north of Cuba at 30 to 130 fathoms.

### Puellina radiata (Moll) 1803

Zoarium encrusting, small white colonies. Zooecia distinct, separated by deep grooves; frontal surface convex, the costate area covering nearly all of the frontal surface; costae usually 14 to 16 in number, between them radiating rows of small lacunae which are often elongated in the direction of the zooecial axis; one or more small pores in a median position near the aperture; an umbonate process sometimes present. The aperture is semicircular, straight on the proximal border, with about 5 oral spines. Ovicell rounded, smooth and glistening, usually with a small carina. Avicularia infrequent, vicarious, long pointed.

There is much variation in size. In three colonies which I measured the normally formed zooecia showed the following length ranges: 0.21 to 0.34 millimeters, 0.21 to 0.47 millimeters, and 0.26 to 0.60 millimeters. The average appears to be around 0.25 to 0.28 millimeters. In form also they vary greatly, usually they are about two-thirds as wide as long, but I have found individuals wider than long. The suboral median pores also vary greatly; there may be one or two, or more, when single they may be semilunate, rounded or elongated, when there are two they may be side by side or one in front of the other, when a larger number is present they are usually irregular in position.

Florida (Smitt 1873: 73), 60 to 176 fathoms; Canu and Bassler (1928: 73) off Havana, Cuba, 78 fathoms, and off Miami, Florida, 40 fathoms. In our Porto Rican collections it occurred at a number of stations, off the mouth of Guanica Harbor, down to 25 fathoms. Marcus (1937: 73) records it from Santos Bay, Brazil.

Some authors place this species in the genus *Colletosia.*

### Puellina floridana (Smitt) 1873

Zoarium encrusting. Zooecia well separated by deep grooves, convex, the costate surface occupying practically all of the front; costae about 12, rather slender, with rather large rounded lacunae in radial series between the costae. Aperture roughly semicircular, the proximal border straight or slightly concave and thin. A short, stout spine, sometimes flattened, on either side of the aperture, and a smaller median one sometimes present. Operculum well chitinized, brownish in color and bordered with a thick sclerite. Ovicells and avicularia have not been observed.

Florida, Smitt (1873: 23, *Cribrilina figularis* var. *floridana*) at 29 to 42 fathoms; Tortugas, Florida, Osburn (1914: 195), 5 to 15 fathoms; Gulf of Mexico, Canu and Bassler (1928: 74), 30 fathoms. Porto Rico, Station 2369, off Guanica Harbor, at 6 fathoms, encrusting shell. The Porto Rican specimens are somewhat larger than those recorded by Canu and Bassler, averaging about 0.50 millimeters.

### FIGULARIA Jullien 1885

Frontal shield limited to the centro-distal region, costate, the costae partially separated by rows of lacunae or occasionally by slits. Operculum completely chitinized, closing the aperture. Ovicell large, hyperstomial. Avicularia when present vicarious. No dietellae.

#### Figularia (?) ampla Canu & Bassler 1928

Zoarium encrusting. Zooecia distinct, very large and little elongated; frontal very convex, with six pairs of very broad costules which are separated by series of minute lacunae; a salient median suture line. Ovicell large, smooth, carinated. Zooecial length, 1.5 millimeters; breadth, 1.0 millimeters. Aperture length, 0.26 millimeters; width, 0.30 millimeters.

Off Havana, Cuba, 201 fathoms (Canu & Bassler 1928: 75). Not otherwise recorded.

## Infraorder ASCOPHORA Levinsen 1909

This group is characterized especially by the presence of a compensation sac, instead of the membranous ectocyst, beneath the calcified frontal surface. This sac usually opens at the proximal border of the aperture, but may open more proximally by means of a special pore (ascopore). The operculum, usually chitinized to a greater or less extent, is compound in most cases; that is, it is hinged in such a manner that the larger distal part opens upward at the same time the proximal part opens downward. The former movement permits the passage of the tentacles, while the latter opens the compensation sac. When other provision has been made for opening the compensatorium the operculum is simple, having only the larger anterior part. As a rule the members of this group are more fully calcified than those of the Anasca.

## Family **HIPPOTHOIDAE** Levinsen 1909

The zooecial front is usually transversely wrinkled, showing lines of successive calcification, and the zooecia are without a covering membrane. Rudimentary zooecia often present. Spines usually wanting. Dietellae present. Ooecia (sometimes on dwarfed gonozooecia) covered by kenozooecia, or by avicularia.

The family appears not to be a natural one, and may have to be dismembered.

### **HIPPOTHOA** Lamouroux 1821

Zooecia distinct, often disposed in single series; front transversely wrinkled and without pores; aperture with a well-developed sinus and strong cardelles; avicularia wanting. The reproductive individuals are gonozooecia reduced in size and without polypide, with a conspicuous porous ovicell.

#### **Hippothoa distans** MacGillivray 1868

A very delicate species, white and glistening, the zooecia in a single series. The zooecia measure without the caudate portion only about 0.26 to 0.30 millimeters, while the caudate part is variable measuring from 0.13 to 0.26 millimeters. The "two short processes arising from the side of the zooecium" described by Waters (1904: 54), mentioned by the writer as occurring on Tortugas specimens, occur also on the Porto Rican material.

A very widely distributed species. Porto Rico off Guanica Harbor at 27 fathoms, on the stem of a coralline alga. Tortugas Islands, Osburn (1914: 198), low water to 12 fathoms.

#### **Hippothoa divaricata** Lamouroux 1821

Not taken at Porto Rico. Recorded by Canu and Bassler (1928: 77), Gulf of Mexico and Bahamas Islands; Marcus (1939: 134) from Brazil.

#### **Hippothoa eburnea** (Smitt) 1873

*Gemellipora eburnea* Smitt (pars) (1873) 35. pl. 9, fig. 178, but not pl. 7, figs. 152–156, which are *Pasythea eburnea* Smitt).

Not taken at Porto Rico. Canu and Bassler (1928: 76) have recorded it from the Gulf of Mexico, north of Cuba and east of Yucatan. In the writer's opinion they would have done better to rename the species, for certainly Smitt never distinguished it as different from his *Pasythea* (*Gemellipora*) *eburnea*, but since they have accepted it as a species of *Hippothoa* the name may be allowed to stand.

### TRYPOSTEGA Levinsen 1909

The genus may be recognized by the constant presence of a zooeciule (dwarf zooecium) immediately distal to each zooecium. This possesses a minute aperture closed by a membrane, but without a polypide. In the case of fertile zooecia the zooeciule is enlarged to cover the ooecium.

#### Trypostega venusta (Norman) 1864

*Lepralia inornata* Smitt (1873) 61. pl. 11, figs. 215–6.
*Gemellipora glabra* forma *striatula* Smitt (1873) 37. pl. 11, fig. 207.

Zooecia distinct, rhomboid, inflated, with numerous pores and an umbonate process proximal to the aperture. The aperture is rounded in front of the strong cardelles and behind these is a rather large triangular sinus. The zooecia measure about 0.40 to 0.45 millimeters in length, by 0.26 to 0.30 millimeters in width. The ooecium with its enclosing zooeciule is about 0.25 millimeters long, by 0.20 millimeters broad, narrowed distally and surmounted by an umbonate process.

Porto Rico off Guanica Harbor at 20 fathoms. Smitt, Floridan seas at 26 to 60 fathoms; Osburn (1914: 198) Tortugas Islands; Canu and Bassler (1928: 77) north of Cuba, Straits of Florida and Gulf of Mexico, 30 to 201 fathoms; Marcus (1938: 35), Santos Bay, Brazil.

### Family PETRALIIDAE Levinsen 1909

Frontal a tremocyst with moderately large pores. Proximal margin of aperture usually with one to three teeth (lyrulae) above the operculum. Peristome weakly developed. Spines rare. A perforated area (radicular pores) on the dorso-distal region. Avicularia usually one or two just proximal to the aperture. Ooecia hyperstomial, recumbent, with small pores.

The above description requires emendation to include *Coleopora* which Canu and Bassler have placed in this family, and still further change to accommodate *Hippopodina* which appears to be related. All of these genera have in common the large size of the zooecium, the nature of the frontal tremocyst, the large ovicell, the general form of the primary aperture, and the nature of the operculum with a chitinized border and lateral attachment of the muscles.

Key to the Genera

1. Peristome a high flaring tube............................*Coleopora,* page 410.
   Peristome not tubular.................................................... 2.
2. Aperture with two or more teeth on the proximal border *Petraliella,* page 410.
   Aperture without proximal teeth......................*Hippopodina,* page 411.

### PETRALIELLA Canu & Bassler 1927

A part of the older genus *Petralia* MacGillivray 1868, separated chiefly on account of the fact that the ovicell is not closed by the operculum. The peristomial shield is broad but not elevated.

#### Petraliella bisinuata (Smitt) 1873

Zoarium encrusting or rising in frills. Zooecia rather large and coarse, not much raised on the frontal surface, which is a tremocyst; a broad shield surrounds the aperture, bearing on one or both sides an avicularium, one often larger than the other; but frequently the avicularia are altogether wanting. The aperture is rounded in front, but bisinuate on the proximal border, a broad square lyrula separating the two narrow sinuses. The operculum is thin and light colored, but chitinized at the border in front of its attachment. The radicelled area on the dorso-distal surface appears as a deep round hole in calcined specimens. Ovicell large, hemispherical, minutely punctured.

There is considerable variation in size. Canu and Bassler give the measurements of the zooecial length as 0.90 to 1.15 millimeters, and the operculum 0.24, or 0.25 by 0.26 millimeters; and the var. *grandis* (1928: 80) from the Pliocene of Panama as 0.30; Smitt (1873: 59) gives the breadth of the aperture as 0.26, while some of the individuals among my Florida material measure as much as 0.30. The form of the proximal border of the aperture also varies, the sinuses sometimes almost wanting, or sometimes the median lyrula is narrow or pointed.

Porto Rico, near Caribe Island, 8 fathoms. Smitt (1873: 59, *Escharella*), Florida, 9 to 19 fathoms; Osburn (1914: 217, *Petralia*), 10 to 18 fathoms; Canu and Bassler (1928: 78) east of Yucatan, at 25 and 21 fathoms, and Gulf of Mexico, at 26 fathoms.

#### Petraliella marginata Canu & Bassler 1928

A species with a pectinate proximal margin of the aperture. Not taken at Porto Rico. Canu and Bassler (1928: 80), Gulf of Mexico at 26 to 43 fathoms.

### COLEOPORA Canu & Bassler 1927

With the characters of the family, but with the peristomial shield raised into a tubular peristome. Ovicell hyperstomial and not closed by the operculum, the latter with a long muscle attachment on either side separated somewhat from the border.

**Coleopora americana** NEW SPECIES

PLATE 6, FIGURE 50

Zoarium encrusting. Zooecia large, distinct, elongate, the front ventricose, with numerous minute tremopores and with usually one or more (as many as 6) tall tubular processes which when fully developed may flare out, trumpet-shaped, at the tip. The peristomial shield is extended into a high, flaring peristome, which sometimes presents a wavy border. At the bottom of this is the aperture, which is semicircular in front of the cardelles while behind this the poster is narrowed somewhat and nearly straight on the proximal border, with a broad but slightly salient lyrula (sometimes wanting). The dorsal-distal radicular area is large and short elliptical in form. Avicularia and ovicells not present.

Zooecial length, 0.92 to 1.06 millimeters; width, 0.53 to 0.66 millimeters. Aperture length, 0.18; width, 0.18 to 0.21 millimeters.

Porto Rico, Station 2363, off Guanica Harbor, in 20 fathoms.

This species is apparently very close to *C. verrucosa* Canu and Bassler (1929: 267) from Jolo, the Philippine Islands, but has somewhat smaller zooecial measurements and the aperture is notably smaller; the aperture appears to differ somewhat in form also and the presence of the lyrula is not mentioned in the description of *verrucosa.* The tubular processes of the front also appear to be longer (as much as 0.15 millimeters in height). It is possible that it may be found to vary into *C. verrucosa.*

**HIPPOPODINA** Levinsen 1909

Levinsen (1909: 353) took *Lepralia feegeensis* Busk out of its old catch-all genus and erected the present one for this species. Unfortunately he made a very serious mistake in the nature of the ovicell which he described as endozooecial, while it is merely a deeply embedded hyperstomial ovicell. Dr. Anna B. Hastings examined Busk's type of *feegeensis* and I have studied material from the West Indies, Brazil, and Australia and in all cases the ovicell is hyperstomial. Canu and Bassler in 1927 established the genus *Coscinopsis* with *C. coelata* Canu and Bassler as the type, to include species with a hyperstomial ovicell and renamed their specimens of *feegeensis* as *fallax* under the supposition that it was only superficially similar to *feegeensis* Busk.

The genus *Hippopodina* will stand, as Levinsen made *feegeensis* Busk the genotype, with the description amended to include the hyperstomial ovicell. The family Hippopodinidae Levinsen will have to be dropped, and Bassler (1936: 161) has given the family name Cheiloporinidae to the group of species with an endozooecial ooecium.

The genus *Cosciniopsis* will apparently stand also, since its opercular characters seem to differentiate it sufficiently, and these characters appear to place it in the family Galeopsidae. Just where to place *Hippopodina* is more of a problem, but the general characters, the nature of the frontal, the peristomial shield, the character and arrangement of the avicularia, the deeply embedded ooecium and especially the operculum with the muscle attachments on the lateral rib, are all reminiscent of the Petraliidae, though it does not possess dorsal radicular pores.

### **Hippopodina feegeensis** (Busk) 1884

Plate 7, figures 54, 55

*Lepralia feegeensis* Busk (1884) 144. pl. 22, fig. 9.—Macgillivray (1891) 10. pl. 43, figs. 1, 2.—Waters (1913) 514. p. 70, figs. 21, 22.

*Lepralia pulcherrima* Canu & Bassler (1928b) 25. pl. 6, figs. 1, 2.

? *Escharella audouinii* Smitt (1873) 56. pl. 11, fig. 211.

*Hippopodina feegeensis* Levinsen (1909) 353. pl. 24, figs. 3a-f.—Osburn (1927) 130.—Canu & Bassler (1928a) 133. pl. 34, figs. 1, 2.—Hastings (1930) 729; (1932) 413.

*Cosciniopsis fallax* Canu & Bassler (1929) 276. pl. 28, fig. 7.

Zoarium encrusting. Zooecia very large, well separated, broad and somewhat inflated, the frontal granulated and with small tremopores. Aperture large, elliptical or sometimes as broad as long, peristome low and usually thin, a pair of triangular cardelles of variable size; operculum slightly chitinized, with lateral ribs to which the muscles are attached. Ovicell very large, with small tremopores, deeply embedded. Avicularia long triangular to very elongate, situated at the side of the aperture and turned either forward or backward.

Porto Rico off Guanica Harbor, 8 fathoms. Levinsen (1909: 353), St. Thomas; Osburn (1914: 209, *Lepralia audouinii*), Tortugas.

In his original description Busk (1884: 144) indicated the ovicells as "inapparent," since then Levinsen (1909: 354) has described them as endozooecial and figured them so, probably being misled by their deeply embedded nature; Canu and Bassler (1929: 276) created a new species (*fallax*) in the genus *Cosciniopsis* to include the supposedly different form with hyperstomial ovicells, and another questionably new species *Lepralia pulcherrima* from Brazil (1928b: 25). Hastings (1932: 413) has reexamined Busk's original "Challenger" material and finds large hyperstomial ovicells, throwing *fallax* back into the synonymy of *feegeensis*. Waters (1913: 514) and Osburn (1927: 130) have also added to the knowledge of the species. The writer has examined the type of *Lepralia pulcherrima* Canu and Bassler and finds it also to be synonymous.

The variations appear to have considerable range. The ovicells from different regions differ much in size; according to Hastings those of the type measure as much as 0.76 millimeters in width and those from Gorgona, Colombia only 0.40 to 0.45 millimeters; in the material I have studied, Tortugas specimens measure about 0.45 millimeters, Curaçao specimens 0.65 millimeters, *L. pulcherrima* from Brazil (type specimen) about 0.70 millimeters, and a specimen from Queensland, Australia, 0.78 millimeters. This is certainly a remarkable range for one species, but it intergrades, and there appear to be no other differences.

As to the avicularia, either there is much variation, or else several different species are involved. In the type they are directed forward and inward distal to the aperture; in other cases they may be directed inward and backward proximal to the aperture, or they may occasionally be directed straight forward or backward at the side of the aperture and I have seen one directed straight across proximal to the aperture; in the type and some others they may be very elongate, in other cases they are much shorter; they may be on both sides, or only on one side and very frequently they are wanting altogether.

The aperture shows considerable variation in size,—length, 0.18 to 0.30 millimeters; and width, 0.17 to 0.25 millimeters,—but as I have measured single colonies in which practically this whole range is exhibited, I take it to be of little importance. The cardelles appear to be similarly variable, often scarcely noticeable and again heavy triangular denticles; they seem to grow with increasing calcification of the zooecium.

Whether Smitt's description of *Escharella audouinii* D'Orbigny refers to this species is a question, but much of it is applicable. He observed no avicularia on his one colony, but frequently these may be wanting over considerable areas or entirely absent from a colony. There is a possibility that it refers to the following species (*H. irregularis* Osburn) on account of its heavier calcification and lack of avicularia. The tremopores, as drawn by Smitt, are fewer and larger than in either *feegeensis* or *irregularis*.

It is possible that there may be more than one species involved in the material from various parts of the world, but I do not feel warranted in separating them at present. Dr. Anna B. Hastings has kindly given me the distribution of the avicularia as represented in the British Museum material. The long distal form, as in the type, is known from the western Pacific and Indian Oceans and the West Indies; the long proximal form from the West Indies and Brazil (*pulcherrima* Canu and Bassler); and the short distal form from Australia, Africa, Colombia and the West Indies.

As to the statement by Canu and Bassler (1928a: 25–26) that in *pulcherrima* the frontal is a "cryptocyst" there is evidently an error as I have examined the type which has a well developed tremocyst exactly like that of typical *feegeensis*. Their illustration (pl. 6, fig. 1) figures an early stage of calcification. If the form with reversed avicularia should be considered worthy of a varietal name, *pulcherrima* Canu and Bassler is available.

### Hippopodina irregularis NEW SPECIES

PLATE 7, FIGURES 51, 52, 53

? *Escharella Audouinii* Smitt (*non* D'Orbigny) (1873) 56.

Zoarium encrusting corallines, etc., with a coarse single layer; color yellowish or light brownish. Zooecia heavily calcified, very irregular in size and form; large, length, 1.40 millimeters (0.90 to 1.60 millimeters), width, 0.85 millimeters (0.60 to 1.30 millimeters); gibbous, separated by well marked grooves; frontal a tremocyst with numerous small pores covered by a very thick ectocyst; lateral and distal walls with pore chambers. Aperture large, length, about 0.30 millimeters, width, about 0.27 millimeters; very heavy hinge denticles; distal part rounded, proximal part arcuate, large, nearly as broad as the anterior. Operculum well chitinized, darker in color than the frontal; a heavy chitinized rib around the distal portion slightly within the border, the muscle attachments situated on the rib; proximal border more broadly but less heavily chitinized than the anterior rib. Peristome low, not expanded, wanting entirely on the proximal border where the operculum is practically on a level with the frontal. Ovicell very large, width, 0.80 millimeters, length, 0.75 millimeters, heavily calcified, porous like the frontal and similarly covered with a very thick, smooth ectocyst; embedded for half of its depth in the distal zooecium, its exposed portion evenly rounded, encircling the aperture back to the cardelles. Avicularia not observed.

Porto Rico, Stations 2341, 2347 and 2377, off Guanica Harbor, at

5 to 27 fathoms, several colonies. Smitt (1873: 56, *Escharella audouinii*), Tortugas Islands, 37 fathoms. The colonies are not large, seldom more than 6 millimeters across, but the large size of the zooecia renders them fairly conspicuous.

This species is quite similar in general appearance to *Cosciniopsis coelatus* Canu and Bassler. It cannot belong to that genus however, as the operculum is quite different with the muscular attachments on the marginal rib. The characters of the operculum, aperture and ovicell place it close to *H. feegeensis* from which it differs in its deeper zooecia, much greater calcification, the heavy ectocyst, somewhat different shaped ovicell and entire lack of avicularia. It is almost certain that this is the *Escharella audouinii* of Smitt, though his specimen must have had the ectocyst eroded.

## Family **GALEOPSIDAE** Jullien 1903

Characterized by the presence of a large pore (spiramen) extended into a tubule proximal to the aperture, wanting in some cases, but a pair of avicularia is directed across the aperture. Ovicell hyperstomial, opening into the peristomice above the aperture.

### **GEPHYROPHORA** Busk 1884

A prominent avicularium on either side of the peristome and pointing directly across the aperture, in some cases meeting and fusing to form a bridge above the aperture.

#### **Gephyrophora rubra** NEW SPECIES

PLATE 7, FIGURE 59

Zoarium encrusting, encircling an alga stem; brick red in color; rough in texture. Zooecia moderately large, swollen, with deep grooves between; surface roughly granular. Aperture oval; operculum moderately chitinized, with a heavy chitinized border proximally; attached by a strong pair of cardelles. Peristome low proximally, higher and thin distally; on either side a sharp pointed avicularium is directed straight across the aperture at about its middle: occasionally the points of the mandible nearly touch, but there is no evidence of fusion of the avicularia such as occurs in *G. polymorpha* Busk. Uniporous communication pores 10 or 12, forming a row at the base laterally, and 4 or 5 distally. Ooecia not present.

Porto Rico, Station 2362, off the mouth of Guanica Harbor, at 18 fathoms, the type specimen only. The genus has not hitherto been noted in American waters.

### STENOPSIS Canu & Bassler 1927

Aperture rounded quadrangular, without cardelles; peristome elongated into a tube; spiramen broad and salient; frontal a tremocyst; avicularia present.

#### Stenopsis fenestrata (Smitt) 1873

Not found at Porto Rico. Smitt (1873: 47, *Hippothoa*), Florida, 17 fathoms; Canu and Bassler (1928: 84), Gulf of Mexico, 30 fathoms.

## Family SCLERODOMIDAE Levinsen 1909

Zoarium erect and branched. Zooecia with a very thick tremocyst with tubules; primary aperture at the bottom of a very long peristomial tube; ascopore present; avicularia usually on or within the peristome; ooecia hyperstomial, visible only on young zooecia.

### SEMIHASWELLIA Canu & Bassler 1917

Zooecia on only one side of the zoarium, with some avicularia on the dorsal side; both faces of the stem covered by a tremocyst with sulci.

#### Semihaswellia sinuosa Canu & Bassler 1928

Not taken at Porto Rico. Canu and Bassler (1928: 85), Gulf of Mexico at 724 fathoms.

#### Semihaswellia proboscidea (Waters) 1888

Not taken at Porto Rico. Waters (Suppl. Rep. Polyzoa, Challenger Exp. 31 (79): 1, *Porina*), off St. Thomas Island at 729 fathoms.

### TESSARADOMA Norman 1868

Zoarium erect, branched, the stems rounded with zooecia on all sides. The frontal is a pleurocyst with a row of marginal areolae.

#### Tessaradoma gracile (Sars) 1850

Zoarium of rounded stems, branching irregularly dichotomously, the zooecia facing in all directions. The frontal surface is smooth, with a row of pores around the border; peristome salient, with a rounded aperture; primary aperture with a pair of cardelles; the ascopore at the base of the peristome is really a spiramen which opens internally into the peristomie just above the operculum. Avicularia wanting.

Off the west end of Porto Rico, 400 fathoms, Johnson-Smithsonian Deep-Sea Expedition. Smitt (1873: 32, *T. boreale*), Florida, 82 to 450 fathoms; Canu and Bassler (1928: 86), Caribbean Sea, 683 fathoms. Widely distributed northward, even to Arctic seas.

## Family **STOMACHETOSELLIDAE** Canu & Bassler 1917

Frontal wall an exceedingly thick tremocyst; built up around the aperture and notched proximally to form a spiramen which is guarded by small avicularia. Ovicell hyperstomial, deeply embedded. Primary aperture simple, without lyrule and usually without cardelles.

### **CIGCLISULA** Canu & Bassler 1927

Erect or frond-like. Ovicell with a large grill-like area which remains exposed in calcification.

#### **Cigclisula serrulata** (Smitt) 1873

Not taken at Porto Rico. Smitt (1873: 27, *Porina*), Florida, 35 to 42 fathoms; Canu and Bassler (1928: 125), south of Miami, Florida at 40 fathoms.

## Family **SCHIZOPORELLIDAE** Bassler 1935

This is a large and to external appearances, a loosely connected family, presenting many structural differences, but agreeing in the nature of the larva. Front a tremocyst usually. The ovicell is hyperstomial, sometimes wanting. The operculum is rigid and well chitinized and closes the aperture, the compensatrix and often the ovicell. A vestibular arch usually present, oral spines occur in most cases and dietellae, less frequently uniporous or multiporous septulae. Canu and Bassler (1917: 39) have indicated four subfamilies, distinguished by the following characters:

1. Operculum with two small muscular attachments, more or less removed from the border. Proximal border of aperture with a sinus, rounded or slit-like (rimule), opening into the compensatrix. .SCHIZOPORELLINAE, page 418.
2. Operculum with a projection on each side for muscular attachment. Aperture with two cardelles for the attachment of the operculum; proximal border without a distinct sinus, but rounded to enclose a considerable space, the "poster" .................................... HIPPOPORININAE, page 428.
3. Aperture slanting forward (oblique), without cardelles, lyrula or rimule. Ovicell hyperstomial but embedded in the distal zooecium and opening into a cavity above the operculum.................... EXOCHELLINAE, page 432.
4. A distinct ascopore (micropore) at some distance from the aperture. Ovicell closed by the operculum...................... MICROPORELLINAE, page 432.

## Subfamily SCHIZOPORELLINAE Bassler 1935

### Key to the Genera

1. Frontal a tremocyst (secondary layer porous)........................... 4.
   Frontal an olocyst (primary layer) or pleurocyst (secondary layer with only lateral pores) ........................................................ 2.
2. Frontal a pleurocyst, avicularia not oral................. *Lacerna,* page 426.
   Frontal an olocyst, oral avicularia....................................... 3.
3. Sinus rounded, frontal with radiating veins........... *Buffonellaria,* page 418.
   Sinus broad V-shaped, frontal irregularly thickened.. *Stephanosella,* page 423.
4. Sinus narrow or slit-like, ovicell huge.................. *Stylopoma,* page 423.
   Sinus not slit-like, ovicell normal........................................ 5.
5. Aperture and sinus rounded, muscle attachments of operculum remote from the border.................................... *Schizoporella,* page 419.
   Sinus broadly arcuate, muscle attachments at border...................... 6.
6. Aperture elongate oval, no oral avicularia, zoarium erect, cylindrical ......... ............................................ *Gemelliporina,* page 426.
   Aperture shorter, oral avicularia irregular........... *Gemelliporidra,* page 425.

### **BUFFONELLARIA** Canu & Bassler 1927

Ovicell not closed by the operculum. Frontal an olocyst, with vein-like markings. A small oral avicularium.

#### **Buffonellaria divergens** (Smitt) 1873

Zoarium encrusting. Zooecia distinct, separated by grooves, very broad, slightly convex; frontal without pores, showing radial threads characteristic of the genus; aperture rounded in front of the cardelles, broadly sinuate behind; a short pointed avicularium placed on one or both sides of the aperture. Ovicell very fragile, opening widely above the operculum. Zooecial length, 0.65 millimeters; width, 0.45 to 0.55 millimeters.

Smitt (1873: 47. pl. 9, fig. 179, *Hippothoa divergens* forma *typica*) Florida, 135 fathoms; Canu and Bassler (1928: 88), north of Cuba, at 201 to 130 fathoms. Not noted in Porto Rican waters.

#### **Buffonellaria reticulata** Canu & Bassler 1928

Zoarium encrusting. Zooecia indistinct; frontal with salient reticulations which divide it into small compartments: aperture at the bottom of an infundibuliform peristomie, the proximal border with a deep rounded sinus; peristome very salient, thin, nodular, with a small avicularium. Ovicell globular, with two orbicular areas symmetrically arranged. Zooecial length, 0.40 to 0.50 millimeters; width, 0.30 millimeters.

Canu and Bassler (1928: 89), Gulf of Mexico, at 30 fathoms.

### SCHIZOPORELLA Hincks 1877

Frontal a tremocyst, often with a small suboral umbonate process; aperture semicircular distally, with a slight vestibular arch, slightly rounded proximally with a rounded sinus; muscular attachments at some distance from the border; ovicell hyperstomial and closed by a special membrane; avicularia present, often at the side of the aperture.

Canu and Bassler (1917: 40) erected a new genus "*Schizopodrella*," with *S. unicornis* Johnston as the genotype, to include the species sufficiently described to locate definitely, retaining *Schizoporella* for the species of uncertain generic affinities. Hastings (1932: 415 footnote) shows that *Schizoporella* Hincks 1877 was properly established as a genus, with *S. unicornis* as the genotype and that *Schizopodrella* becomes therefore a synonym.

#### Schizoporella unicornis (Johnston) 1847

*Hippothoa isabelleana* Smitt (1873) 44.
*Schizopodrella isabelleana*, and *S. pungens* n. sp. Canu & Bassler (1928) 95, 97.
*S. unicornis* and *S. pungens* Marcus (1937) 83–87.

Zoarium encrusting shells, stones, algae, worm tubes, *et altera*, often very irregular, sometimes forming tubular branched colonies, the zooecia often not oriented. Zooecia of the primary layer usually oriented, quadrangular or hexagonal; the frontal a thick tremocyst with rather large pores; an umbonate process often present proximal to the aperture but often wanting entirely. Aperture rounded distally, a rounded sinus on the proximal border; the thickening of the frontal does not encroach on the aperture but leaves a smooth shelf surrounding it on all sides. The ovicell is salient, porous and often decorated with marginal costae and occasionally with an umbonate process on the top in higher calcification. Pointed oral avicularia, usually with one at the side of the aperture with the mandible directed obliquely forward and outward, though they may be turned in any direction even on the same specimen; often they are entirely wanting and they vary greatly in size and height of the avicularian chamber.

Zooecial length, 0.50 to 0.60 millimeters; width, 0.30 to 0.45 millimeters. Aperture length, 0.13 to 0.15 millimeters, width, 0.12 to 0.14 millimeters.

Porto Rico, Guanica Harbor on piles, not common. Osburn (1914: 205) Florida, (1927: 126) Curaçao; Smitt (1873: 44, *Hippothoa isabelleana*) Florida; Canu and Bassler (1928: 98, *S. isabelleana*) St. Thomas, and (p. 95, *S. pungens*) Gulf of Mexico at Cedar Keys, Florida, and East of Yucatan; Marcus (1937: 83, *S. unicornis*, 86, *S. pungens*), Bay of Santos, Brazil.

This is a very variable species in all secondary details, not only geographically, but locally as well. At different stages of growth and on different substrata the zoarium may be smooth, nodular, thrown up in irregular frills, or rising in tubes of irregular form. The color likewise is of no significance as it ranges from colorless to a deep purple; apparently the color becomes more intense toward the tropics, though I have seen deeply colored specimens as far north as Massachusetts.

The zooecia are fairly well oriented in the primary layer, but in additional layers they may be turned in various directions. The shape is also variable, usually elongate quadrate or hexagonal, but they may be three times as long as broad, or broader than long. Variations in calcification of the frontal and ovicell often give these structures quite different appearances. A pointed umbonate process is often present on the frontal proximal to the aperture but may be entirely wanting on some individuals or on whole colonies. Canu and Bassler distinguish *isabelleana* from *pungens* by the absence of the umbo in the former, but this is evidently not true for the species though it may have been for their specimens. The avicularia differ so much in size, position, orientation and erection, often in the same colony, that they are of little importance in diagnosis. Usually they are located at one side of the aperture and pointed obliquely forward and outward, but they may show any position or orientation and they are frequently absent. The avicularian mandible varies in length as much as 100%; the chamber may be small or rarely it may be so large as to cover most of the frontal, resembling *S. floridana* Osburn; the mandible may lie flat at the level of the frontal or it may be pointed upward at varying degrees, in some cases nearly vertical.

Even the primary aperture and operculum vary in size and form to some extent. The average is about 0.13 by 0.13 millimeters, but I have measurements made on the same colony of 0.12 to 0.15 millimeters in length and 0.11 to 0.14 millimeters in width. A specimen of *pungens* given me by Dr. Bassler shows characteristically the longer apertures, but among these are shorter ones, one measuring 0.13 by 0.13 millimeters, which is the average measurement of *unicornis* on Florida specimens.

In *unicornis* there is a series of several basal projections extending forward from the proximal wall, easily seen after the removal of the frontal, as described by Barroso in 1918. These structures are present in *pungens*, *isabelleana*, and all of the other numerous variations of *unicornis* which I have studied. The species has been described more than a dozen times under as many names.

Marcus (1937: 83–87) discusses *unicornis* and *pungens*, which he separates on the characters given by Canu and Bassler,—the larger size of the avicularia, the greater height of the avicularian chamber and the greater length of the zooecial aperture. These characters, however, are not always associated in the same colony. I have specimens with the shorter aperture in which the avicularia are salient and their chambers of various sizes, and others with longer apertures in which the avicularia and their chambers show a similar range. My conclusion must be that *S. pungens* Canu and Bassler is only a variety in which these characters appear together rather regularly, just as in *isabelleana* the umbo is usually wanting.

### Schizoporella unicornis var. isabelliana (Smitt) 1873 (non D'Orbigny 1839)

Zoarium multilamellar, encrusting algae and forming branching tubes. Zooecia rhomboidal or irregular, not always oriented; frontal a thick tremocyst with a thick ectocyst, no umbo. Aperture transverse; a rounded sinus with a very small indentation on each side of it. Ovicell porous like the frontal, globular, covering about half of the distal zooecium. On the dorsal side, seen by transparency, several rib-like projections run forward from the proximal wall. Zooecial length, 0.50 to 0.60 millimeter; width, 0.30 to 0.35 millimeter. Aperture length, 0.13 to 0.14 millimeter, width, 0.12 to 0.14 millimeter.

Smitt (1873: 44, *Hippothoa*), Florida, 17 to 42 fathoms; Canu and Bassler (1928: 97, *Schizopodrella*), St. Thomas, Virgin Islands. Apparently the commonest variety throughout the West Indian region, occurring on piles and shells at Guanica, Porto Rico.

### Schizoporella unicornis var. pungens (Canu & Bassler) 1928

Zoarium encrusting, unilamellar or multilamellar. Zooecia distinct, separated by a deep furrow, elongate elliptical; frontal convex, a granular tremocyst with large pores; a more or less salient umbo below the aperture. Aperture somewhat elongated, anter large and semicircular, poster small with a broad rounded rimule; peristome thin, salient, with very short spines. Oral avicularium thin, triangular, with a very salient beak, placed obliquely, adjacent to the poster on one side only. Ovicell large, globular, porous, covering a large portion of the distal zooecium. Zooecial length, 0.60 to 0.75 millimeters; width, 0.30 to 0.40

millimeters. Aperture length, 0.14 to 0.15 millimeters; width, 0.12 millimeters (after Canu and Bassler).

Canu and Bassler (1928: 95, *Schizopodrella*), Gulf of Mexico at Cedar Keys, Florida, and east of Yucatan, at 25 fathoms; Marcus (1937: 86), Santos, Brazil. Occasional specimens taken off Guanica Harbor, Porto Rico at 5 to 15 fathoms.

### Schizoporella floridana Osburn 1914

Encrusting, forming nodular masses of considerable size. Zooecia of the primary layer oriented and rather regularly disposed, those of later layers turned in any direction. Frontal a tremocyst, with large scattered pores. Oral avicularia usually placed somewhat anterior to the aperture with the beak curved in front of it, but the mandible may be straight and directed forward, sideways or backward and occasionally the avicularium may be situated farther back, even proximal to the aperture. The secondary zooecia often bear a huge avicularium with a long pointed mandible, mounted on a very ventricose, irregularly hemispherical chamber as large as a zooecium, the mandible turned in any direction. Ovicell rather small, usually broader than long, salient and with very small pores. Zooecial length, about 0.90 millimeter, breadth, variable averaging about 0.45 millimeters. Aperture length, 0.18 to 0.20 millimeters; width 0.15 to 0.18 millimeters.

Osburn (1914: 205, figs. 17, 18), Tortugas Islands, 15 to 18 fathoms; Curaçao Island (1927: 126), and Tarpon Springs and Captive Island, Florida; Canu and Bassler (1928; 93, *Schizopodrella*), east of Yucatan, at 21 fathoms. Not common at Porto Rico, but dredged at a few stations off the mouth of Guanica Harbor, at 6 to 19 fathoms.

### Schizoporella canui NEW SPECIES

*Schizopodrella incrassata* Canu & Bassler (1828) 93.

Canu and Bassler apparently overlooked the fact that Hincks in 1882 had given the name *incrassata* to another species of *Schizoporella*. It therefore becomes necessary to rename the present species. I take pleasure in dedicating it to the memory of Ferdinand Canu, one of the master worker on the Bryozoa.

Zoarium encrusting on algae, often rising into bilaminar fronds, dichotomous and compressed laterally. Young zooecia distinct, elongated, convex; older ones indistinct with a thick tremocyst perforated by very large scattered pores; avicularia irregularly arranged. Ovicell globular, embedded in older stages, finely porous. Two small avicularia symmetrically arranged on each side of the sinus; a large frontal avicularium, orbicular and salient on older zooecia. Young zooecia length, 0.40 millimeters, width 0.30 millimeters. Aperture length, 0.10 millimeters; width, 0.06 to 0.08 millimeters.

Not taken at Porto Rico. Canu and Bassler, Gulf of Mexico and Straits of Florida at 30 to 56 fathoms.

### **STEPHANOSELLA** Canu & Bassler 1917

Schizoporellas with the ooecium radiately grooved and surrounded by a raised border; sinus broadly V-shaped; a small salient avicularium on one or both sides of the aperture.

#### **Stephanosella rugosa** NEW SPECIES

PLATE 7, FIGURE 57

Zoarium encrusting, irregularly roughened, shining. Zooecia small, length 0.25 to 0.35 millimeters, in the younger stages resembling *S. biaperta* (Michelin) but the frontal pores smaller and fewer. The aperture is much like that of *biaperta* but is smaller, about 0.10 millimeters long by 0.08 wide, the operculum delicate but thickened at the edge. The oral avicularia are similar in size and position to those of *biaperta,* with a bluntly pointed mandible. The ovicell is also like that of *biaperta,* but is considerably smaller and the raised border may be continued across the front, leaving merely a central area through which the rib-like sculpturing can be observed.

As calcification proceeds a very peculiar raised, more or less circular ridge develops on the frontal surface and covers most of it, leaving a central area through which the small pores may be seen. Occasionally the whole frontal surface may be covered with high irregular ridges, which almost completely obscure the nature of the original frontal wall. Vicarious avicularia wanting.

Porto Rico, Station 2347, off Guanica Harbor, at 5 to 8 fathoms, two small colonies, encrusting a shell and a worm tube. Also two small colonies from Bermuda, at 3 fathoms, collected by Dr. S. R. Williams.

Distinctly smaller than *S. biaperta* and altogether different in the mode of secondary calcification. The growth of this layer appears to be similar to that of *Buffonellaria reticulata* Canu and Bassler, but in that species the frontal is not porous and the ovicell is quite different.

### **STYLOPOMA** Levinsen 1909

The hyperstomial ovicell is very large, covering the aperture and oral avicularia. Frontal a tremocyst with small pores. The sinus of the aperture is slit-like, sometimes enlarged proximally or V-shaped.

**Stylopoma informata** (Lonsdale) 1845

Plate 7, figure 58

*Stylopoma* (*Schizoporella*) *spongites* auctt., non Pallas.
*Schizopodrella falcifera* Canu & Bassler (1928) 95.

Zoarium encrusting or rising in irregular frills. Zooecia rather regularly quadrangular; frontal with numerous small tremopores, little convex, smooth (roughened in older zooecia); a low umbonate process sometimes proximal to the aperture; aperture semicircular, the proximal border straight with a slit-like sinus (often V-shaped, but sometimes enlarged proximally); oral avicularia usually short and narrowly pointed, on one or both sides of the aperture but often wanting. The frontal is often decorated with small avicularia and the ovicell occasionally also; large avicularia of various sizes and shapes may also be present, these may be straight or falciform, pointed or spatulate. Ovicell globular, very salient, huge (often twice as broad as a zooecium) and enclosing both the aperture and oral avicularia. Zooecial length, about 0.50 millimeters; width, about 0.35 millimeters, but with considerable variation. The aperture is often placed in one corner of the quadrangular zooecium.

Common in Porto Rico at a number of stations, especially at Station 2369, off Guanica Harbor, where numerous colonies were dredged at 6 fathoms. Smitt (1873: 42, *Hippothoa spongites*) Florida; Verrill (1900: 592, *Hippothoa* or *Schizoporella spongites*) Bermuda; Levinsen (1909: 324, *S. spongites*) St. Thomas and St. John Islands; Osburn (1914: 207, *Schizoporella spongites*) Tortugas Islands, and (1927: 128, *S. spongites*) Curaçao; Canu and Bassler (1928: 91, *S. spongites*) North of Cuba, 143 fathoms and Gulf of Mexico, 30 fathoms, and (p. 95. *Schizopodrella falcifera* n.sp.) east of Yucatan, 24 fathoms.

This species is remarkable for the size of the ovicell and for the range in size, form and distribution of the avicularia. Characteristically there is a small sharp pointed avicularium on one side of the aperture, sometimes on both sides, often wanting. In addition other avicularia, sometimes much smaller, may be present to the number of 5 or 6 on the frontal and even several on the ovicell. Occasionally long acicular, or spatulate, or falcate interzooecial avicularia are present scattered irregularly over the zoarium, measuring as much as 0.50 millimeters in length. *Schizopodrella falcifera* Canu and Bassler (1928: 95) is merely one of these variations of *informata* with falciform avicularia. The type specimen agrees entirely with specimens from Porto Rico in my collection. Canu and Bassler state "Our specimen was in reproduction January 30, 1905," but the type specimen shows no ovicells, so there is an error somewhere.

### GEMELLIPORIDRA Canu & Bassler 1927

Ovicell hyperstomial, closed by the operculum; frontal and ovicell with tremopores; aperture with two small lateral indentations separating a large suborbicular anter from a very small poster; operculum with linear muscle attachments; oral and interzooecial avicularia.

#### Gemelliporidra typica Canu & Bassler 1927

Plate 8, figures 60, 61, 62

Zoarium encrusting, often multilaminar. Zooecia large, distinct, oriented in all directions; frontal convex, a tremocyst with larger lateral pores; aperture suborbicular with a small arcuate poster. Ovicell globular, covered by the tremocyst of the distal zooecium. On either or both sides of the aperture is a triangular avicularium (often wanting). In one case the ovicell was surmounted and partially obscured by two avicularia, one on either side. The avicularia appear to be very inconstant in occurrence and orientation.

Porto Rico, several small colonies off the mouth of Guanica Harbor, 5 to 19 fathoms. Canu and Bassler (1928: 100), north of Cuba 121 to 201 fathoms; also from the Pleistocene of the Canal Zone.

#### Gemelliporidra aculeata Canu & Bassler 1928

Plate 8, figure 63

Zoarium encrusting. Zooecia elongated, elliptical or subrectangular; frontal convex, a granular tremocyst with very small pores; aperture orbicular or somewhat transverse, cardelles small; peristome a little salient, granular, formed by the tremocyst. Ovicell globular, salient, closed by the operculum. Interzooecial avicularia with a very long narrow mandible.

Porto Rico, off the mouth of Guanica Harbor, not common. Canu and Bassler (1928: 102), 15 miles south of Miami, Florida, 40 fathoms.

#### Gemelliporidra magniporosa (Canu & Bassler) 1923

Zoarium encrusting, multilamellar, zooecia of the secondary layers not well oriented. Zooecia irregular in form, generally separated by a salient thread, somewhat convex, the frontal a tremocyst with unusually large pores. Two small triangular oral avicularia, often one of them wanting. Ovicell globular and covered with large tremopores like the frontal.

Not taken in our Porto Rican collections. Canu and Bassler (1928: 103), Gulf of Mexico, north of Cuba and east of Yucatan at 25 to 78 fathoms; also from the Pleistocene of Panama.

### GEMELLIPORINA Bassler 1936

Operculum subtriangular, or long oval with a small projection on either side near the proximal end corresponding to the cardelles; muscular attachment close to the border of the operculum; aperture of fertile zooecia wider.

#### Gemelliporina glabra (Smitt) 1873

Zoarium formed of dichotomous cylindrical branches. Zooecia indistinct except at the ends of the branches; frontal wall very thick and perforated by numerous tubular pores; distal part of the zooecium raised, with several stout short oral spines. Oecium globular, becoming covered by the tremocyst except for a median cicatrix.

Smitt (1873: 37, *Gemellipora*) west of Tortugas Islands; Canu and Bassler (1928: 98, *Gemellipora*) Gulf of Mexico, Straits of Florida, and 15 miles south of Miami at 30 to 56 fathoms. Not noted in the Porto Rican collections. Marcus (1939: 140) reports it from Brazil.

#### Gemelliporina limbata (Smitt) 1873

Zoarium encrusting, the zooecia in single series. Zooecium tubular at the proximal end, oval and ventricose distally and rising into a tubular portion which bears the primary aperture at its top. Around this a flaring irregularly expanded peristome. Ovicell globular, distally placed on the erect tubule, into which, judging by Smitt's figure (1873. pl. 11, fig. 214) it opens below the aperture.

Smitt (1873: 40, *Gemellipora*), Florida, 471 fathoms; Canu and Bassler (1928: 99) north of Cuba, at 387 and 130 fathoms.

This is a remarkable species, probably not correctly placed in this genus and in need of further study. It did not appear in our Porto Rican collections.

### LACERNA Jullien 1888

Ovicell hyperstomial, closed by operculum; aperture rounded with a small rounded sinus (rimule); a slight vestibular arch; frontal a pleurocyst with numerous areolae; frontal avicularia.

#### Lacerna horstii (Osburn) 1927

*Schizopodrella horstii* Osburn (1927) 127. figs. 3–5.
*Schizoporella horstii* Marcus (1937) 87; (1938) 39; (1939) 139.

Zoarium flat and encrusting, often several layers thick, reddish or yellowish in color. Zooecia in radiating lines; frontal an olocyst with a pleurocyst cover, glistening, roughened, with a row of rather large areolar pores between which are short costae; aperture round, with a rounded sinus (rimule) which is of the same form as the aperture; a slight vestibular arch; peristome raised about the whole border of the aperture and continued forward across the front of the ovicell; a single row of regularly placed septulae. Ovicell evenly rounded, with numerous fine pores; a raised border appears about the base and finally covers the whole ovicell.

Zooecial length, 0.45 to 0.65 millimeters; width about 0.30 millimeters. Aperture including sinus, length 0.16 millimeters; width 0.12 millimeters. Avicularia variable, averaging about 0.20 millimeters.

Porto Rico, off Guanica Harbor, 5 to 8 fathoms. Osburn (1927: 126, *Schizopodrella*) Curaçao Island; Marcus (1937: 87, *Schizoporella*), Santos Bay, Brazil, 20 meters.

This species resembles *Lacerna* (*Smittia*) *signata* Waters 1899, so closely that there seems no doubt of their congeneric relationship. For that reason *horsti* is here placed in *Lacerna*, even though the genotype *L. hosteensis* Jullien 1888, is said by Marcus (1939: 140) to possess pore chambers. Hastings, 1932, and Marcus (1939) present excellent discussions of *signata* Waters and *horsti* Osburn.

### LEPRALIA Johnston 1847

This group is now merely reserved for a "catch-all" for species that cannot be definitely allocated to modern genera.

#### Lepralia uvulifera Osburn 1914

The writer described this species from the Tortugas (1914: 210). It has appeared again in our Porto Rican collections, several colonies at Station 2367, near the bell buoy off Guanica Harbor, at 6 fathoms, encrusting shell. The colonies are all so small as to be practically microscopic, but are mature and in reproduction.

To my previous description I can add the measurements. Zooecial length, about 0.25 millimeters; width about 0.20 millimeters. Ovicell before secondary calcification, 0.13 millimeters long by 0.15 millimeters wide. Aperture, 0.08 millimeters long by 0.10 wide. In younger stages of calcification the frontal is a smooth olocyst; the suboral rostrum is simple and median; the ovicell smooth and globose, raised, not closed by the operculum and with a very characteristic labellum. The denticles are small but distinct and the poster broadly arcuate.

My material is still very scanty and difficult to study on account of the small size of the zooecia and I hesitate to place in any modern genus.

#### Lepralia palliolata Canu & Bassler 1928

Not taken at Porto Rico. Recorded by Canu and Bassler (1928: 109) from the Straits of Florida at 56 fathoms.

### Subfamily **Hippoporininae** Bassler 1935

Operculum usually thick, with a projection on each side for muscular attachment; two prominent cardelles. Ovicell hyperstomial.

#### Key to the Genera

1. Aperture much longer than broad, contracted proximally, frontal an olocyst .......... *Hippoporina,* page 428.
   Aperture rounded or but little longer than broad .......... 2.
2. Frontal a tremocyst with numerous pores.......... *Hippodiplosia,* page 430.
   Frontal a pleurocyst with marginal pores .......... 3.
3. Oral spines present, avicularia long pointed .......... *Hippomenella,* page 430.
   No oral spines, a small median avicularium.......... *Hippadenella,* page 431.

### **HIPPOPORINA** Neviani 1895

Aperture elongated, operculum much contracted laterally, the cardelles prominent, separating a narrow poster from the much larger anter; frontal a thick olocyst.

#### **Hippoporina porcellana** (Busk) 1860

*Lepralia cleidostoma* Smitt (1873) 62.

Zoarium encrusting. Younger zooecia rhombic, distinct, but with later calcification becoming heavy walled and confluent. Frontal an olocyst; pores few, marginal. Pointed avicularia on one or both sides of the aperture or a little proximal to it and directed laterally or somewhat forward. The aperture is claviform, ellipsoid distally but transverse and much smaller proximal to the cardelles. Ooecia globose, imperforate, with radiating striae which are often difficult to observe. The ooecia and apertures vary greatly in size, becoming larger from the ancestrula outward.

Smitt (1873: 62, *Lepralia cleidostoma*), Florida, 30 to 120 fathoms; Osburn (1914: 209, *Lepralia*), Tortugas Islands; Canu and Bassler (1928: 104, *H. cleidostoma*), off Havana, east of Yucatan, Gulf of Mexico and Straits of Florida, 24 to 201 fathoms. At Porto Rico the species occurred off Guanica Harbor at 8 fathoms.

Marcus (1937: 96) has recorded it from Santos Bay, Brazil. He gives a good discussion of the species with reasons for including *cleidostoma* Smitt in the synonymy of *porcellana* Busk, as does also Hastings (1930: 721).

#### **Hippoporina contracta** (Waters) 1899

*Lepralia contracta* Waters (1899) 11.—Norman (1909) 306.
*Lepralia serrata* Osburn (1912) 242.
*Lepralia contracta* var. *serrata* Osburn (1914) 211.
*Perigastrella contracta* Canu & Bassler (1920) 576; (1929) 403.—Marcus (1927) 98.—Hastings (1930) 722.

Zoarium encrusting, sometimes rising into ridges or frills, unilamellate or multilamellate. Zooecia ovate or hexagonal, distinct when young, but later becoming immersed in a common crust. Frontal a granular pleurocyst, thick, vitreous, with marginal areolae; aperture somewhat elongate, rounded in front of the strong bifid cardelles, behind which is a rather broadly rounded sinus; a beaded vestibular arch; peristome thickened irregularly, often mucronate on the proximal border in secondary calcification, interrupted distally where 4 or 6 oral spines are present. Ooecia prominent, not embedded except in extreme calcification, nearly hemispherical, with a large membranous area on the front near the aperture (sometimes extended downward into a broad short labellum). Avicularia ovate to spatulate in form, oral or frontal, immersed or mounted on a mamillate process, the aperture beaded like the oral margin. The species is very variable in secondary calcification, but the primary characters appear to be quite constant, except for the form and position of the avicularia.

Zooecial length, 0.30 to 0.60 millimeters; ovicell about 0.15 millimeters long by 0.18 millimeters wide. The zooecia are smaller near the center of the colony and increase in size outward, and the aperture is similarly larger in the peripheral zooecia.

At Porto Rico the species was taken only once, two small colonies on dead shells between Rotones and Caribe Islands at 6 fathoms. Osburn (1914: 211), Tortugas Islands, 5 to 18 fathoms. Waters and Norman's material came from the Madeira Islands. Hastings listed it from the Galapagos Islands and from Gorgona, Colombia, in the Pacific. Along the Atlantic coast of N. A., it occurs from Woods Hole, Massachusetts, to the Bay of Santos, Brazil. The species is best developed in the southern New England region and all of the colonies I have seen from other regions are smaller and less heavily calcified.

It appears very evident that this species cannot remain in the genus *Perigastrella* where Canu and Bassler (1920: 576) placed it, even if that genus should be removed from the Phylactellidae. Hastings recognized its affinities by placing it next to *Hippoporina* and Marcus suggests its relation to *Hippomenella*. After a careful study of much material I place it for the present in the genus *Hippoporina* for the following reasons: a beaded vestibular arch, oral spines, aperture narrowed proximally, thick pleurocyst, heavy cardelles, absence of lyrula, lateral oral avicularia, ovicell salient and not closed by the operculum, with a semicircular membranous area and a short broad labellum, zooecia increasing in size from the center of the colony outward. *Hippomenella* also appears to be related, but differs in the low, broad and immersed ovicell which is closed by the operculum. It is possible that a new genus will have to be erected for *Lepralia contracta,* but so many of its primary characters agree with *Hippoporina* that I leave it there for the present.

### HIPPODIPLOSIA Canu 1916

This genus was erected by Canu to include certain escharellidan species with a broad poster, the aperture narrowed at the cardelles, a hyperstomial ovicell closed by the operculum, and a frontal tremocyst. The tremocyst is incomplete about the aperture, leaving a small portion of the olocyst exposed. The ovicell rests on the olocyst of the succeeding zooecium.

#### Hippodiplosia pertusa (Esper) 1794

Zoarium encrusting. Zooecia moderately large, somewhat convex; front a tremocyst with small pores, becoming granular in older specimens; aperture rounded, but a pair of cardelles give the appearance of a very broad shallow sinus. The globular ovicell is perforated, becoming granular with an occasional umbonate process on the top in advanced calcification. An umbonate process also develops occasionally on the front proximal to the aperture.

Zooecial length, 0.60 to 0.70 millimeters; width 0.40 to 0.50 millimeters. Aperture length, about 0.18 millimeters; width, 0.18 to 0.20 millimeters.

Porto Rico at two stations near Caribe Island, 6 to 11 fathoms. Canu and Bassler (1928: 106), east of Yucatan, 25 fathoms; Smitt (1873: 55, *Escharella*), Tortugas Islands; Marcus (1938: 41), Santos Bay, Brazil. A widely distributed species and apparently more common farther north in temperate waters.

### HIPPOMENELLA Canu & Bassler 1917

Frontal an olocyst with a more or less developed pleurocyst and areolar pores; aperture semi-elliptical; ovicell hyperstomial, not closed by the operculum; oral spines and avicularia usually present.

Key to the Species

1. Ovicell with a longitudinal groove or fissure ........ *H. fissurata,* page 431.
   Ovicell not grooved longitudinally ........ 2.
2. Avicularia present ........ *H. rubra,* page 430.
   Avicularia wanting ........ *H. mucronata,* page 431.

#### Hippomenella rubra Canu & Bassler 1928

Not taken at Porto Rico. Gulf of Mexico, Canu and Bassler (1928: 108), 30 fathoms. This species will probably be found identical with the following, though avicularia are present and the ooecial umbo is more proximal.

**Hippomenella mucronata** (Smitt) 1873

*Hippothoa mucronata* Smitt (1873) 45.

Not taken at Porto Rico. Smitt records it from Florida at 29 fathoms.

**Hippomenella fissurata** (Canu & Bassler) 1928

Plate 8, figure 64

*Lepralia fissurata* Canu & Bassler (1928) 110. pl. 33, fig. 1.

Zoarium encrusting, white, rather delicate. Zooecia moderate in size (length about 0.40 millimeters, width about 0.25 millimeters), distinctly separated by grooves; frontal moderately rounded, with small pores in addition to areolae, somewhat roughened. Aperture subcircular, with a pair of strongly projecting pointed cardelles, behind which a broadly arcuate sinus or rimule is nearly as wide as the distal portion (length and width about 0.13 millimeter); peristome low and thin with about 4 very small and evanescent spinules on the oral border. A little proximal to the aperture is a small high prominence which bears a small avicularium with a pointed mandible; occasionally two such avicularia are present.

The chief peculiarity of the species is found in the ovicell which is very prominent, subcordate in outline and grooved in the middle of the front. The groove begins at the ooecial aperture and extends about two thirds of the way across the ovicell where it ends in a small pore; the pore may become closed and the groove obliterated with complete calcification, and in younger stages the frontal is cleft back to the position of the pore. The ooecial aperture is very small, a rounded opening which is invisible from above and can only be seen by tilting the specimen backward.

Porto Rico, Station 2347, between Cape Caribe and Cape Parguera at 5½ fathoms, two small colonies in reproduction.

The author believes himself correct in identifying his material with the *Lepralia fissurata* which Canu and Bassler described from the Pliocene of Panama. Also the genus *Hippomenella* appears to fit it in most respects, the nature of the aperture, the presence of the minute oral spines, and the nature of the ovicell.

**HIPPADENELLA** Canu & Bassler 1917

Frontal a pleurocyst surrounded with areolar pores; aperture suborbicular, with well marked cardelles; a median avicularian chamber, the mandible with a lucida.

**Hippadenella floridana** Canu & Bassler 1928

Not found at Porto Rico. Canu and Bassler record it from Cedar Keys, Florida.

## Subfamily EXOCHELLINAE Bassler 1935

Aperture oblique, without lyrula, cardelles or rimule. Ovicell hyperstomial and embedded in the distal zooecium. A frontal mucronate process. No peristome.

### ESCHAROIDES M.-Edwards 1836

**Escharoides costifera** (Osburn) 1914

*Escharella costifera* Osburn (1914) 203.

Zoarium small, encrusting algae. Zooeica very distinct, elliptical; frontal margined by large areolae between which are strong costae which fade out toward the middle, rising strongly toward the aperture, proximal to which is a strong pointed mucronate process; aperture oblique, with 6 or 8 long jointed spines; avicularia commonly one on each side of the aperture, large, pointed and directed outward. Ovicell globular, areolate and costate like the frontal and with a strong raised rib about its base.

Zooecial length, 0.40 milimeters; width 0.26 millimeters. Aperture length, 0.13 millimeters; width, 0.12 millimeters.

Porto Rico, off the mouth of Guanica Harbor, at 30 fathoms. The species was described from the Tortugas Islands, 2 fathoms, and Marcus (1938: 38) has recently recorded it for Santos Bay, Brazil.

## Subfamily MICROPORELLINAE Bassler 1935

A distinct ascopore (micropore) at some distance proximal to the aperture. Ovicell hyperstomial and closed by the operculum.

### MICROPORELLA Hincks 1877

Frontal a tremocyst of the usual type; operculum simple, semicircular and closing the ooecium. Avicularia present.

**Microporella ciliata** (Linnaeus) 1758

Zoarium encrusting. Zooecia distinct, separated by deep grooves, elliptical; frontal a tremocyst with small pores, smooth or roughened in older stages; aperture semicircular with a straight proximal border; ascopore situated at a little distance from the aperture, usually semilunar; avicularia (one or two) with triangular or elongate pointed mandible, situated usually at the side of or a little proximal to the ascopore. Ooecium globose, with small pores. Younger zooecia usually show about three spines on the distal border of the aperture and in older ones a thin peristome often rises to considerable height, especially proximal to the aperture and between it and the ascopore (variety *personata* Busk, 1854). A well known and widely distributed species.

Zooecial length, about 0.50 millimeters; width more variable, about 0.30 millimeters. Aperture length, about 0.08 millimeters; width, about 0.12 millimeters.

Smitt (1873: 26, *Porellina*), Florida, 7 to 60 fathoms; Osburn (1914: 208), Tortugas Islands, 5 to 18 fathoms (1927. 129), Curaçao Island; Canu and Bassler (1928: 110), Fowey Light, 40 fathoms, Gulf of Mexico at 30 fathoms, and Straits of Florida, 56 fathoms. Porto Rico, rather common at various stations off Guanica Harbor, 3 to 30 fathoms.

#### **Microporella ampla** Canu & Bassler 1928

Not taken at Porto Rico. A much larger species with a round, marginated ascopore. Canu and Bassler (1928: 111), 2½ miles northwest of Havana Light, 387 fathoms.

### **FENESTRULINA** Jullien 1888

Frontal with stellate tremopores; no avicularia.

#### **Fenestrulina malusi** (Audouin) 1826

Plate 7, figure 56

A very characteristic species distinguished by the stellate frontal pores and the arcuate ascopore situated at a considerable distance from the aperture.

A single colony off the mouth of Guanica Harbor, Porto Rico, at 8 fathoms. I have a specimen from Bermuda also. Recorded for the Gulf of Mexico at 30 fathoms by Canu and Bassler (1928: 112).

## Family **SMITTINIDAE** Levinsen 1909

Frontal usually not perforated except around the margin. Peristome usually produced and channeled in front. Aperture usually with cardelles and lyrula. Operculum very thin as a rule, with the muscular attachments on a ridge at the border. Oral spines often present. Avicularia usually present, of various types, frequently associated with the aperture. Ovicell hyperstomial, more or less imbedded in the distal zooecium, usually perforated in front.

### Key to the Genera

1. Front an olocyst (primary layer) .......................................... 2.
   Front a pleurocyst (secondary imperforate layer) .......................... 3.
2. Front with ribs (costules) between the areolae; asymmetrical sinus with a lyrula ....................................... *Rhamphostomella*, page 439.
   Without ribs; oral avicularian chamber covers most of the front; erect, branching, flabelliform ....................................... *Cystisella*, page 439.
3. Lyrula and cardelles well developed; areolar pores conspicuous .............. ....................................................... *Smittina*, page 434.
   Lyrula and cardelles wanting ................................................ 4.
4. Peristome very thick and high, with several small avicularia on its margin .... ....................................................... *Palmicellaria*, page 439.
   No lateral oral avicularia, but one median ................................. 5.
5. Front ribbed ....................................... *Umbonula*, page 439.
   Front without ribs ....................................... *Bryocryptella*, page 439.

### SMITTINA Norman 1903

The frontal surface is a pleurocyst, granular or costate, with a row of marginal areolae; a lyrula of varying width is present on the proximal lip of the aperture at the level of the operculum and a pair of cardelles (hinge teeth) on the sides; peristome variously developed, often high proximally or laterally; operculum little chitinized; avicularia various, often one or two related to the aperture.

The species in this genus are often very difficult to identify because of variations due to secondary calcification and to the number, form and distribution of the avicularia. The primary characters only appear to be dependable.

### Key to the Species

1. Zooecia large, 0.60 to 0.80 millimeters long; ovicell large, 0.35 millimeters wide ....................................................... *S. labellum*, page 438.
   Zooecia smaller, 0.35 to 0.60 millimeter long ................................ 2.
2. Operculum with transverse ribs, zooecia rather flat ...*S. egyptiaca*, page 437.
   Operculum without ribs, zooecia more inflated ............................. 3.
3. Zoarium tubular, with short conical branches giving the colony a spiny appearance ....................................... *S. echinata*, page 438.
   Zoarium and zooecia very variable but not with above characters ............ ....................................................... *S. trispinosa*, page 434.

### Smittina trispinosa (Johnston) 1838

The irregularities of form due to secondary calcification and the variations shown by the avicularia in form and position make it almost impossible to describe this species. Osburn (1914: 208) has indicated a number of these, and Canu and Bassler (1929: 340–349) have attempted an analysis of the varieties listed under *trispinosa.*

Only the primary characters are of much value, for the secondary features due to calcification are so varied and intergrade to such an extent that they seem to be of little importance. Many varietal names have been applied. The avicularia especially vary and on the same colony one may find larger and smaller pointed, oval and spatulate or ligulate avicularia. The development of the peristome is not far behind in variability. There is not so much variation within the colony, but in colonies which otherwise appear to be very similar, we may find the peristome almost lacking, limited to lappet-like projections at the sides of the aperture, or extending in a high frill around the sides and proximal border and extending forward across the anterior border of the ooecium. In the infertile zooecia there is usually a break in the peristome distally, but even this varies and sometimes there is a complete ring about the aperture. The thickness and sculpture of the pleurocyst is similarly variable. One, two, or three spines, and occasionally as many as five are present. Only the size and form of the primary aperture and the size of the ovicell (about 0.18 millimeters broad) show little variation.

The typical *trispinosa* does not seem to be present as all the West Indian specimens from various localities show either ligulate, oval or spatulate avicularia of various sizes and forms, either with or without the characteristic triangular ones.

### Key to the Varieties

1. Peristome high around proximal border .................................. 2.
   Peristome low or wanting on proximal border .......................... 3.
2. Peristome folded proximally and on the sides, forming a false sinus (pseudo-rimula), lyrula wide ..................................*munita,* page 436.
   Peristome not folded but ending in two points with a notch between, lyrula narrow, ovicell umbonate ...........................*protecta,* page 437.
3. Secondary aperture somewhat elongate, avicularia spathulate or ligulate (others may be present) ..................................*spathulata,* page 435.
   Secondary aperture more rounded, avicularia oval (sometimes with pointed ones) ...........................................*nitida,* page 437.

#### Smittina trispinosa var. spathulata (Smitt) 1873

*Escharella jacotini* var. *spathulata* Smitt (1873) 60. pl. 10, fig. 200.

My specimens all have larger areolae than are shown in Smitt's figure, but the primary aperture and lyrula, the secondary aperture, with the peristome raised chiefly on the sides, and the combination of forms of avicularia agree. Even in older zooecia the lyrula can usually be seen since the peristome is not raised very high at the proximal border. In the infertile zooecia the peristome is not continued forward and the spines (usually two, occasionally one or three) may be seen. The fertile zooecia show the same condition at the proximal border of the aperture and on the sides, and the peristome is carried forward, usually on the anterior corners of the ovicell, occasionally around the front border of the ovicell. The pores of the ovicell are moderately large and sometimes slightly marginated, and a raised border in older zooecia sometimes covers a considerable part of the ovicell. The avicularia may be pointed, ligulate, oval or spatulate, of varying dimensions, orientation, numbers and combinations. Occasionally only the ligulate and spatulate forms are present.

Zooecial length, averaging about 0.40 millimeters (ranging from 0.35 to 0.60 millimeters); width about 0.30 millimeters (ranging from 0.26 to 0.40 millimeters). Aperture length, about equal to breadth, averaging about 0.12 millimeters. Lyrula usually not more than one-fourth the width of the aperture.

Smitt (1873: 59–60, pl. 10, fig. 200, but not ? 199), Florida; Osburn (1914: 208), Tortugas, low water to 12 fathoms; (1927: 129, *spathulosa* by an error), Curaçao; Canu and Bassler (1928: 114), Fowey Light, Florida, and east of Yucatan, 24 to 40 fathoms. Porto Rico, common and found at a number of stations off Guanica from low water to 30 fathoms. I also have specimens from Beaufort, North Carolina, at 13 fathoms.

**Smittina trispinosa** var. **munita** Hincks 1884

Zoarium encrusting shells and almost anything which will afford attachment, unilamellar to multilamellar. The zooecia are of moderate size, 0.40 to 0.50 millimeters, the frontal irregularly roughened, with a row of medium-sized areolar pores. Peristome high, folded into a proximal sinus (pseudorimula) the borders of which may be continued into short spinose processes; in fertile zooecia the peristome is high on the sides and is continued forward upon the border of the ovicell to form a more or less complete rib; in sterile zooecia it descends rapidly to about the middle of the sides, leaving space for 2 to 4 long slender spines. The lyrula is moderately wide, at least a third as wide as the aperture. Ovicell rounded, with rather numerous small pores evenly distributed; the pleurocyst forms a band around the base of the ovicell, leaving a considerable porous area above. The avicularia are long-pointed and usually straight (occasionally falciform), characteristically placed on the frontal touching the peristome and directed backward; in the infertile zooecia they are usually in the midline, but in fertile zooecia they are turned to one side avoiding the ovicell; occasionally they may be directed forward at the side of the aperture, and short-pointed and oval avicularia may also be present. Some specimens are close to the type species.

Characteristic specimens were dredged at Stations 2347 and 2364, off the mouth of Guanica Harbor, at 4 to 8 fathoms. Marcus (1937: 108) has taken it at Santos Bay, Brazil, 17 meters.

### Smittina trispinosa var. protecta Thornely

This variety differs from the typical form in the nature of the peristome which is thin and rises high and almost vertically proximally to the aperture; it is not folded but usually ends in two sharp points, one on either side of a rounded notch; on the sides it drops away sharply to the level of the primary aperture, leaving space for the attachment of two slender, elongate spines; in ovicelled zooecia the peristome rises again to form a partial or complete rib on the front of the ovicell. It also differs in the covering of the ovicell, as the pleurocyst of the distal zooecium covers most of the perforated area in mature calcification and usually rises into an erect, thin, transversely laminate process or umbo on the top of the ovicell. The avicularia, usually situated at one or both sides of the aperture are pointed or oval, or occasionally long spatulate with the mandible ending in 3 or 4 points.

Taken at several places off Guanica Harbor, Porto Rico, 5 to 15 fathoms. I have the same form also from the Tortugas and Bermuda Islands. Smitt's figure (pl. 10, fig. 199) resembles this variety in its younger stages. It is known from the Red Sea and Indian Ocean (Waters 1913: 513).

### Smittina trispinosa var. nitida (Verrill) 1879

Occasional specimens approach more nearly the *nitida* of Verrill in the character of the avicularia, which are usually small oval, though small pointed and spatulate forms are more sparsely represented; the peristome also resembles that of *nitida*, being less developed than in *spathulata* or the typical *trispinosa* and usually present as lappets on the side of the aperture.

Osburn (1914: 208, *S. trispinosa*, part), Tortugas, Florida; Porto Rico, Station 2347, off Guanica Harbor, at 6 to 10 fathoms.

### ? Smittina egyptiaca Waters 1909

The zoarium is peculiar in that "the zooecia are in two longitudinal rows side by side, and then on each side of the two rows there is a straight, very thick divisional wall" (Waters 1909: 157). Hastings, 1927, has shown that this biserial arrangement does not always appear. In my specimen it is present in a part of the colony. The zooecia are broad and rather flat, distinctly separated, a row of well-marked areolae, surface granular but not greatly thickened. The aperture has a broad lyrula; the peristome scarcely raised and only on the sides, though in ovicelled zooecia it may continue forward to the ovicell but does not form a rib across its front. Avicularia are of various sizes and forms; sometimes a small triangular avicularium at the side of the peristome, but this may be replaced by an oval one or by a very large spatulate form; occasionally others may be present on the frontal. The ovicell is evenly rounded, perforated on the top, the pores slightly marginated; the pleurocyst of the distal zooecium nearly covers the ovicell with a smooth layer in older calcification.

A single colony dredged in 6 fathoms at the mouth of Guanica Harbor (Station 2338) appears to belong here, but unfortunately the specimen was dead and the most distinctive character (the transverse chitinous ribs of the operculum) is wanting. Canu and Bassler (1928: 118, *Mucronella*), Gulf of Mexico, 28 fathoms.

Canu and Bassler place this species in the genus *Mucronella* without stating their reasons, except that they mention a little-salient mucro. *Mucronella* however is without avicularia and the ovicell is imperforate.

### **Smittina labellum** Canu & Bassler 1928

A very large ovicell, 0.35 millimeters broad, and a tall spout-like peristome distinguish this species.

Not taken at Porto Rico. Canu and Bassler (1928: 116), north of Cuba, 191 fathoms, and Straits of Florida, 56 fathoms.

### **Smittina echinata** Canu & Bassler 1928

The zoarium emits short conical or flabelliform branches in every direction, giving the colony a spiny aspect.

Not taken at Porto Rico. Canu and Bassler (1928: 115), Cedar Keys, Florida.

### **Smittina (?) landsborovii** (Smitt) 1873

What this species may prove to be is a question. It has not been recovered by recent workers on West Indian Bryozoa. It can hardly be the *landsborovii* of Johnston as the aperture, lyrule and peristome are different. It differs also from *S.* (*Porella*) *bella* Busk 1860, with which Canu and Bassler (1923: 147) have questionably associated it.

Smitt (1873: 60, *Escharella*), Florida, 176 fathoms.

### RHAMPHOSTOMELLA Lorenz 1886

Aperture with an asymmetrical sinus and a lyrule; frontal an olocyst, with costules; a large oblique avicularium excentrically placed below the aperture; ovicell hyperstomial and closed by the operculum.

#### Rhamphostomella magnirostris Canu & Bassler 1928

Not taken at Porto Rico. Canu and Bassler (1928: 120), Cedar Keys, Florida.

### UMBONULA Hincks 1880

Aperture suborbicular without cardelles or lyrula; frontal a pleurocyst with areolae and costules; a prominent suboral umbo; ovicell hyperstomial, opening widely above the aperture.

#### Umbonula undulata Canu & Bassler 1928

Not found at Porto Rico. Canu and Bassler (1928: 119), Cedar Keys, Florida.

### CYSTISELLA Canu & Bassler 1917

Resembling *Porella*, from which genus it was separated. The front wall is an olocyst and it bears a very wide avicularian chamber which extends over the whole or most of the front and contains a pair of large glands. There is usually a well marked cicatrix or two pores, above the aperture.

#### Cystisella americana Canu & Bassler 1928

The species of *Cystisella* hitherto known are northern in distribution, but Canu and Bassler (1928: 113) have found the above species near New Orleans in the Gulf of Mexico, at 32 fathoms. Like other species of the genus, it is erect and branching, flabelliform.

### PALMICELLARIA Alder 1864

Aperture orbicular, semicircular or semielliptical, without lyrula or cardelles. Frontal a granular pleurocyst, with areolar pores. Peristome much developed, with the ovicell opening into it and usually with an avicularian mucro partially covering the aperture.

#### Palmicellaria aviculifera Canu & Bassler 1928

Not taken at Porto Rico. Canu and Bassler (1928: 118), Bahama Islands, at 369 fathoms.

### BRYOCRYPTELLA Cossman 1906

Zoarium erect with flattened branches, zooecia on one side only; frontal a pleurocyst; aperture subquadrilateral, without lyrula or cardelles; a median oral avicularium; ovicell not closed by the operculum.

#### **Bryocryptella reticulata** (Pourtales) 1867

*Cellepora reticulata* Pourtales (1867) 110.
*Retepora reticulata* Smitt (1873) 69. pl. 13, figs. 242–244.
*Bryocryptella reticulata* n. sp. Canu & Bassler (1928) 121. pl. 18, figs. 1–3.

Not found at Porto Rico. Pourtales and Smitt, off Havana, Cuba at 270 fathoms; Canu and Bassler, north of Cuba, 279 fathoms. The latter authors have raised the question whether their *reticulata* may be a different species but I believe them to be the same. The "longitudinal slit" on the ovicell as shown in Smitt's illustration appears to be a ridge rather than a slit, when one compares his drawing of *reticulata* with that of his *marsupiata* on the same plate.

### Family **TUBUCELLARIIDAE** Busk 1884

Zoarium erect, jointed with radicles. Zooecia tubular, thick-walled, porous. Peristome much produced. Multiporous septulae. Ascopore present. Avicularia rare. The ooecium is peristomial consisting of an expansion of the tube.

#### **TUBUCELLARIA** D'Orbigny 1852

Characters of the family.

#### **Tubucellaria cereoides** (Solander) 1786

Zoarium erect and branched, consisting of rounded segments joined by chitinous tubules; radicles are developed for the attachment of the colony. Zooecia elongate, embedded in the general crust, the tubular peristomes rising well above the general level and somewhat fluted on the outer surface; aperture rounded; ascopore round and situated at or near the base of the peristome. The ovicell is an enlargement of the peristome. Avicularia wanting.

A well known species, but apparently not common in American waters. Osburn (1914: 203), Tortugas Islands at 15 fathoms, one colony, first listed it. Canu and Bassler (1928: 113), Fowey Light, Florida, three segments only. In Porto Rican waters it was taken at several stations, off Guanica Harbor, at 6 to 12 fathoms.

### Family **RETEPORIDAE** Smitt 1867

Zoarium various, erect and branched, unjointed, often reticulate, sometimes encrusting. Frontal with only marginal pores. Proximal border of primary aperture usually with a sinus, secondary orifice folded or notched above to form a spiramen, or ascopore. Usually with oral avicularia and spines. Ooecial cover deficient, wide open or with a slit or other opening, or with a slightly calcified or membranous area on its frontal surface, labellum usually present.

### Key to the Genera

1. Zoarium erect and flabellate or fenestrate .................................. 2.
   Zoarium encrusting ................................*Rhynchozoon,* page 442.
2. Zoarium fenestrate ................................*Reteporellina,* page 441.
   Branches not anatomosed (a "catch-all" genus) ..........*Retepora,* page 442.

### RETEPORELLINA Harmer 1933

Zoarium reteporelliform, or the branches anastomosed with very long fenestrae. Peristome long and tubular, with a sinus. One pair of frontal pores usually. Frontal avicularium large, usually bifid at tip, below peristome, often wanting. Ovicell ovate, usually with persistent median fissure and simple labellum.

#### Reteporellina marsupiata (Smitt) 1873

Zoarium erect, branched and somewhat reticulate. Zooecia rhomboid, front convex and provided usually with two pores. In young zooecia these are seen definitely as lateral areolae, but as calcification proceeds they approach each other on the proximal part of the front. I have not observed them to develop any small rounded avicularia. The primary aperture is nearly semicircular and slightly beaded about the anterior border. The peristome is long and tubular, with a small sinus which is continued downward as an internal groove; the margin is irregular and thin. There is a large frontal avicularium, often wanting, below the base of the peristome, usually bifid, though sometimes blunt as figured by Smitt (1873. pl. 13). The avicularian chamber bears two small areolae near its base. On the dorsal side, at the edges are smaller avicularia, usually with a triangular mandible. The ooecium is ovate to long ovate, with a median slit (sometimes closed by calcification) and a small median labellum which is truncate and without ridge. The color in life is a delicate pink.

The writer feels certain that this is Smitt's species, although he did not mention nor figure the bifid avicularium nor the labellum. The latter is wanting in younger ovicells so he may have overlooked it. Neither does he mention the lateral avicularia but these are often wanting. The species apparently comes closest to *R. denticulata* (Busk), but differs in the absence of the large infrafenestral avicularium, in the form of the labellum, which is short and broad, and in other minor characters.

Porto Rico, off Caño Gorda Island at 30 fathoms. Smitt (1873: 67, *Retepora*), Florida, 16 to 262 fathoms; Osburn (1914: 200, *Retepora*), Tortugas Islands, 10 to 18 fathoms; Canu and Bassler (1928: 122, *Retepora*), Gulf of Mexico, 27 fathoms and Caribbean Sea at 683 fathoms.

### RETEPORA Lamarck 1801

This "genus" is now used as a "catch-all" for those species whose exact generic distinctions cannot be determined.

#### Retepora prominens Canu & Bassler 1928

*Reteporella prominens* Canu & Bassler (1928) 124.

Not found at Porto Rico. Canu and Bassler, east of Yucatan, 130 fathoms.

### RHYNCHOZOON Hincks 1877

Frontal an olocyst with marginal areolae. Aperture rounded with a well developed sinus which is usually asymmetrical. A beaded vestibular arch. Operculum with the muscular attachments remote from the border. Peristome variously developed, often with processes proximally or laterally. Usually an avicularium at one side of the sinus. Ovicell only partly covered by the secondary layer, leaving the primary layer exposed next to the aperture and often extended into a short wide labellum. Secondary calcification quite variable, occasionally very thick so that the primary aperture lies at the bottom of a long tube and the ovicells are completely covered. Numerous pointed spines may appear on the frontal, especially near the aperture, and various kinds of frontal avicularia are known.

#### Key to the Species

1. Zooecia small, 0.25 to 0.40 millimeters long .............................. 2.
   Zooecia larger, 0.45 to 0.55 millimeters long .............................. 3.
2. Peristome thin, high, without spines .............*R. tuberculatum,* page 442.
   Peristome with blunt spines; calcification heavy .......*R. solidum,* page 443.
3. Sinus not evident; occasional long spatulate avicularia with truncate mandible ..........................................*R. phrynoglossum,* page 444.
   Sinus evident; no giant spatulate avicularia, exceedingly variable in secondary calcification ................................*R. verruculatum,* page 444.

#### Rhynchozoon tuberculatum Osburn 1914

Zoarium encrusting, small and thin. Zooecia small, length about 0.40 millimeters, width about 0.25 to 0.30 millimeters; thin walled and delicate for a member of this genus. Frontal at first smooth but later covered with numerous small tubercles. Marginal pores few and small; peristome thin and high, bearing a minute avicularium placed laterally on the inner side. When ovicells are present the peristome is continued forward around the aperture and over the ooecium. Aperture ovate, about 0.12 by 0.12 millimeters. At one side near the proximal border a strong tooth extends often more than half way across the orifice and curves backward. Opposite this a minute projection sometimes appears. Ovicell prominent, about 0.15 millimeters long by 0.18 millimeters wide, finely tuberculate like the front in complete calcification. A rounded lucida or thin area on either side near the base. Labellum scarcely developed. A very inconspicuous species due to the small zoaria and the thin, semitransparent nature of the zooecia.

Osburn (1914: 200. fig. 9), Tortugas Islands, 18 fathoms; Curaçao (Osburn 1927: 130), shallow water. Porto Rico at Station 2369 off Guanica Harbor at 6 fathoms. Also a colony attached to a specimen of *Trigonopora tenuis* (Busk) taken off the Northeast coast of Porto Rico, "Caroline" Station 68.

### Rhynchozoon solidum Osburn 1914

Zoarium encrusting, small, white, heavily calcified. Zooecia very small, 0.25 to 0.30 millimeters long by 0.20 to 0.25 millimeters wide; when young, ventricose with a smooth veined surface, but with age they become very thick walled and more or less immersed in a common crust; areolar pores few. Distally the frontal rises continuous with the peristome into several blunt conical processes around the proximal part of the aperture, usually there is one asymmetrically placed near the middle and another on each side. On younger zooecia there are 4 or 5 stout oral tubercles or short spines. The aperture is evenly rounded, with a beaded vestibular arch, and a rounded sinus in the proximal border. The true sinus is formed by a pair of denticles and shaped like that of many schizoporellas but above this is a second pair of denticles, one usually larger than the other, with the points directed toward each other. The operculum is thin, symmetrical and the muscle attachments remote from the border. The aperture, with the sinus, measures about 0.10 millimeters in length and width. A small avicularium is occasionally present on the suboral prominence but usually this appears to be wanting. Frontal avicularia are frequently present, usually on a slightly raised base and with a triangular or acute mandible. The ovicell becomes very heavily calcified, except for the usual semicircular membranous frontal area, and often bears a pointed or irregular umbonate process on the top. The labellum is short and broad. A very inconspicuous species as none of the colonies observed is more than 5 millimeters across.

Osburn (1914: 201. figs. 10–12), Tortugas Islands at 8 fathoms. Porto Rico, inside and outside of Guanica Harbor and at Caya Caribe, numerous colonies at 4 to 10 fathoms.

### Rhynchozoon verruculatum (Smitt) 1873

*Cellepora verruculata* Smitt (1873) 50.—Osburn (1914) 214.

Zoarium encrusting, bluish white, often irregular on the surface, while the numerous pointed processes give it a very spiny appearance. Zooecia varying much in size, averaging about 0.50 to 0.55 millimeters in length, and 0.30 to 0.35 in breadth; in the young stage ventricose, distinct, a row of marginal areolae from between which short costae run toward the center. Primary aperture symmetrical with a rounded sinus and beaded vestibular arch. Width of aperture 0.13 to 0.15 millimeter. A large bulbous avicularian chamber develops at one side of the sinus, the beak is long, curved inward and the mandible opens above the orifice. The ovicell is large, 0.20 to 0.25 millimeters broad, smooth, with a nearly circular membranous area and a short, wide labellum.

The secondary calcification is so varied that it is impossible to describe it in detail. The ooecia become completely immersed. The frontal layer sometimes becomes thicker than the polypide space within. The primary aperture comes to lie at the bottom of a tube. A large frontal avicularium appears with a pointed mandible, and a varying number of spinous processes arise around the secondary aperture which differs entirely from the primary aperture.

Porto Rico, common, taken at a number of stations off Guanica Harbor at 6 to 27 fathoms. Smitt (1873: 50), west of Tortugas Islands, 42 fathoms; Osburn (1914: 214), Tortugas Islands, low water to 15 fathoms. In the author's collection are specimens from Bermuda, from Beaufort, North Carolina, and as far north as No Man's Land Island, Massachusetts. To the southward, Marcus (1939: 153) reports it for San Sebastian Island, north of Santos, Brazil. The species is also known from the Mediterranean.

### Rhynchozoon phrynoglossum Marcus 1937

Zoarium encrusting, large and irregular, white. Resembling *R. verruculatum* in the general manner of growth, but differing in several points as follows: (1) the aperture is slightly smaller and is nearly round, lacking the evident sinus of *verruculatum;* (2) the ovicell has a very large conspicuous whitish area, semicircular in form and radiately grooved; (3) the triangular frontal avicularia are smaller and more salient and among these there are occasionally giant avicularia with very elongate, linear-spatulate mandibles truncate at the tip. These characters appear to agree well with *phrynoglossum* which Marcus has recently (1937: 115. pls. 22, 23, figs. 61a, b, c) described from Santos Bay, Brazil.

Porto Rico, near the mouth of Guanica Harbor, encrusting large worm tubes at 6 fathoms.

## Family ADEONIDAE Jullien 1903

Frontal a very thick pleurocyst with tubular areolar pores which connect with the septulae; primary aperture at the bottom of a deep peristomial tube; ovicells developed on special gonozooecia which are usually larger than the zooecia.

### Key to the Genera

1. Zoarium encrusting, ascopore present........................*Adeona,* page 445.
   Zoarium erect or free, ascopore wanting .................................. 2.
2. Primary aperture semicircular, without sinus; avicularia frontal, median ...... ............................................... *Bracebridgia,* page 446.
   Primary aperture longer than broad, with a sinus; avicularia lateral, beside the aperture....................................*Trigonopora,* page 446.

### ADEONA Lamouroux 1816

Zoarium encrusting. Frontal wall thick, with ascopore situated somewhere near the middle; avicularia usually situated between the ascopore and the aperture; gonozooecia slightly larger than zooecia, with a wider, more transverse aperture.

#### Adeona violacea (Johnston) 1847

Zoarium encrusting, usually purplish in color, but ranging from white and pale blue to blue black. Zooecia subhexagonal to subquadrate; the frontal irregularly roughened, somewhat costate about the border; the rounded ascopore indented near the middle of the frontal. Aperture semicircular, straight on the proximal border and somewhat rounded at the corners; avicularium typically median and pointing straight forward toward the middle of the aperture, but variations are found in which the avicularium is directed toward the side and sometimes it may be lateral in position. The gonozooecia are somewhat larger than normal zooecia and have a larger and more transverse aperture. Zooecial length, 0.40 to 0.55 millimeters; width 0.25 to 0.30 millimeters. The width of the aperture appears more variable than usual and on the same colony may vary from 0.10 to 0.14 millimeters. The aperture of the gonozooecium measures about 0.15 millimeters wide.

Porto Rico at the mouth of Guanica Harbor and near Caya Caribe at 6 to 10 fathoms. Smitt (1873: 30, *Porina violacea* and *P. plagiopora*), Tortugas Islands; Osburn (1914: 199) Tortugas Islands; Canu and Bassler (1928: 126, *A. plagiopora*), Gulf of Mexico, Florida Straits and north of Cuba, 30 to 143 fathoms.

There appears to be no constant difference between *violacea* Johnston and *plagiopora* Busk. In the latter the size is somewhat larger, the aperture larger, the oral avicularium larger and directed toward the side of the aperture, but all of these characters vary and intergrade even in the same colony. In my Tortugas paper (1914: 199) I called attention to this intergradation. Since then Dr. Anna B. Hastings (1930: 728) has placed them in synonymy, and Marcus (1939: 147) has given an extended synonymy including *plagiopora* under *violacea*. The species has a very wide distribution.

### BRACEBRIDGIA MacGillivray 1886

Zoarium of flattened dichotomous branches. Ascopore wanting. Avicularia of two kinds, suboral and vicarious, the latter larger. Gonozooecia somewhat larger than ordinary zooecia.

#### Bracebridgia subsulcata (Smitt) 1873

Zoarium erect, dichotomous, the branches flattened; reaching a height of two or more inches, yellowish pink to orange. Zooecia elongate, subcylindrical; frontal with a row of areolar pores and a depressed area below the aperture bearing anteriorly the median oral avicularium which is usually directed toward the aperture; aperture subcircular, wider than long; large vicarious avicularia at the margin of the branch and smaller ones sometimes interpolated between the zooecia.

Smitt (1873: 28, *Porina*), Florida Straits, 10 to 48 fathoms; Osburn (1914: 199), Tortugas, 10 to 12 fathoms; Canu and Bassler (1928: 127), Gulf of Mexico at 30 fathoms and Fowey Light, 15 miles S. of Miami, Florida, 40 fathoms. The species was taken only once at Porto Rico, broken fragments at Station 2347, near Caya Caribe, at 8 fathoms.

### TRIGONOPORA Maplestone 1902

*Metrarabdotos* Canu (1914).

Frontal a pleurocyst with marginal areolae; primary aperture rounded or elongate, with a rather deep rounded sinus and pointed cardelles; very large ovicells borne on gonozooecia which have large lunate apertures. The zooarium is erect, branched, unjointed, bilaminate; or free and unilamellar.

**Trigonopora tenuis** (Busk) 1884

*Smittia tenuis* Busk (1884) 150. pl. 20, figs. 1, 1a, 1b.

Zoarium erect, branched irregularly, without joints, bilaminate, with 4 to 8 rows of zooecia on each side. Zooecia quite regularly arranged in quincunx; frontal a pleurocyst which becomes very thick but does not obscure the marginal areolar pores; in younger zooecia the frontal rises strongly into a salient peristome, but this soon becomes immersed in the general crust. In younger zooecia there is a pair of very small pointed avicularia surmounting the peristome one on either side of the aperture, but these also become immersed. The primary aperture is visible only at the bottom of the tubular peristome; it is short elliptical in form with a pair of long and slightly recurved cardelles behind which is a nearly round sinus. The secondary aperture has much the same form, constricted proximally to form a spiramen. Occasional large pointed or narrowly spatulate avicularia with a strong, complete pivot are situated distal to the aperture at one side and directed backward close along side the peristome; these measure from 0.30 to 0.50 millimeters in length. Zooecial length, about 0.65 millimeters; width, about 0.30 to 0.35 millimeters. Primary aperture, length 0.20 millimeters (including the sinus); width, 0.14 millimeters. Gonozooecia not observed.

Off the northeast coast of Porto Rico, "Caroline" Station 68, the specimen from Dr. R. S. Bassler. Busk's description of the type from Bahia, Brazil, is very inadequate, but his figures are fairly satisfactory.

**Trigonopora unguiculatum** (Canu & Bassler) 1928

*Metrarabdotos unguiculatum* Canu & Bassler (1928) 128.

Not found at Porto Rico. Canu and Bassler, Gulf of Mexico, Straits of Florida and east of Yucatan, 21 to 56 fathoms. The zooecia are much larger and the avicularia with curved mandibles point forward.

## Family **CHEILOPORINIDAE** Bassler 1936

Ovicell endozooecial. No peristome. Frontal wall thin, with scattered pores.

Key to the Genera

1. Zoarium encrusting .................................................. 2.
   Zoarium erect, jointed, dichotomous ...................*Tetraplaria,* page 448.
2. Frontal without pores except conspicuous areolae .....*Hippaliosina,* page 448.
   Frontal wall porous .................................................. 3.

3. Zooecia moderate in size, frontal with very small pores, not pigmented ....... ........................................... *Tremoschizodina,* page 450.
Zooecia large, frontal with large pores, conspicuously dark pigmented ........ ........................................... *Watersipora,* page 449.

### TETRAPLARIA Tenison-Woods 1878

*Arborella* Osburn (1914) 202.

Zoarium articulated, with corneous joints, dichotomous. Zooecia arranged in four series in pairs back to back. Frontal a tremocyst; aperture with a broad shallow sinus. Ooecia endozooecial, somewhat prominent.

#### Tetraplaria dichotoma (Osburn) 1914

Zoarium erect, forming loosely branching colonies less than an inch in height, dichotomous. Zooecia broad fusiform, wedge-shaped at the base, very distinct, each pair placed back to back and alternating with the next pair. Frontal a tremocyst with small pores; aperture rounded, with an evident rounded sinus; operculum well chitinized, strengthened by an arched rib running forward from the denticles. No spines or avicularia. The fertile zooecia are somewhat shorter and wider than the others, with a larger aperture. Ooecia endozooecial, rather prominent, porous like the frontal and ornamented by the same kind of roughened surface.

Zooecial length, about 0.60 millimeters; width, 0.30 to 0.35 millimeters. Aperture, about 0.14 millimeters in length and breadth. Ooecia length 0.25 millimeters; width 0.35 millimeters. The aperture of fertile zooecia about one-fourth larger in both dimensions.

Porto Rico, off Parguera at 6 fathoms, two small colonies. Osburn (1914: 202, *Arborella* n. g.), Tortugas Islands, at 10 fathoms. There are other specimens in my collection from Beaufort, North Carolina, and the Bahamas Islands.

### HIPPALIOSINA Canu 1918

Ovicell endozooecial; aperture elongate, elliptical, constricted at the cardelles, with larger anter and smaller poster. Frontal a granular pleurocyst with areolar pores. Usually an avicularium at each side of the aperture.

#### Hippaliosina rostrigera (Smitt) 1873

Zoarium encrusting. Zooecia of moderate size, a little elongate, distinct; the frontal nearly flat, with fine tubercles and margined very distinctly and regularly by areolar pores. Avicularia usually one on each side opposite the anterior end of the aperture, with long pointed mandibles directed inward and distally. When only one avicularium is present it is usually larger, and there is often some variation in the size of the avicularia and the length of the mandibles. Aperture elongate oval or elliptical, the denticles small; operculum well chitinized, with a chitinized rib parallel to the border. Ovicelled zooecia larger, with the aperture broader than long. Ooecium endozooecial and inconspicuous.

Zooecial length, about 0.40 millimeters, ranging from 0.30 to 0.60 millimeters; width, 0.26 to 0.30 millimeters.

Porto Rico, dredged at two stations off the mouth of Guanica Harbor, 6 to 15 fathoms. Smitt (1873: 57, *Escharella*) Florida, 35 to 43 fathoms; Osburn (1914: 211, *Lepralia*) Tortugas Islands, 10 to 15 fathoms; Canu and Bassler (1928: 130) north of Cuba at 143 fathoms, and Gulf of Mexico at 30 fathoms. The writer also has specimens from the Captive Islands, west of Florida.

### WATERSIPORA Neviani 1895

Frontal a tremocyst with numerous rather large pores. Ovicell endozooecial. Aperture usually with a broad rounded proximal sinus and strong cardelles; operculum with a chitinized border and a broad axial band, leaving a large clear space on each side beyond the cardelles.

#### Watersipora cucullata (Busk) 1853

Zoarium encrusting, brownish purple to nearly black in color. Zooecia large, elongate, rather regular in form, distinct. Frontal regularly curved, with numerous large tremopores which are indistinguishable from the areolar pores. Aperture large, peristome scarcely noticeable, evenly rounded in front of the strong cardelles, behind these a broad shallow rounded sinus; operculum brownish with a paler rounded area on either side in advance of the cardelles, sometimes nearly evenly chitinized over the whole surface. The ovicell is said to be endozooecial, cucullate and porous, but I have not observed it on any of my material. The species is conspicuous because of its color and the size of the zooecia. Florida specimens measure as follows:

Zooecial length, about 1.10 millimeters; width, about 0.43 millimeters. Aperture, length 0.23; width, 0.25 millimeters; width between cardelles, 0.13 millimeters.

Osburn (1914: 211, *Lepralia*) common in shallow water at the Tortugas Islands. In Porto Rican waters only a single young colony was obtained on a pile of a wharf in Guanica Harbor.

Dr. Anna B. Hastings (1930: 729) has devoted considerable space and eleven figures to the variations of this species, if indeed all the recorded forms belong to one species. My material shows little variation among the zooecia and, in the form of the aperture and operculum appears to approach most closely her figure 104, plate 15, of a specimen from Cape Verde Islands.

#### TREMOSCHIZODINA Duvergier 1921

Aperture with a very broad sinus; frontal a tremocyst. Avicularia lateral, rare or wanting.

#### Tremoschizodina lata (Smitt) 1873

Not noted at Porto Rico. Smitt (1873: 36, *Gemellipora*), Florida Straits, 68 fathoms; Canu and Bassler (1928: 131), Gulf of Mexico, 30 fathoms and off Havana Light, 387 fathoms.

### Family PHYLACTELLIDAE Canu & Bassler 1917

The ovicell is recumbent, its orifice very large and closed by a special operculum. "Viewed laterally it appears attached like a sack on the back of a porter" (Canu and Bassler), sometimes it is free, or it may rest on the distal zooecium.

Apparently there are some irregularities in the allocation of certain genera and species to this family. The inclusion of forms which show such fundamental differences as the presence or absence of a lyrule, a beaded or smooth vestibular arch, a pleurocyst or tremocyst frontal, dietellae or septulae and a completely covered ovicell or one with a membranous frontal area, is probably not justified.

Whether the genus *Perigastrella* Canu and Bassler 1917, can be retained in this family may be reserved for future judgment, but certainly the *Lepralia contracta* Waters 1899, belongs neither in *Perigastrella* nor in the family Phylactellidae, where Canu and Bassler have placed it. Apparently the only genus of the Phylactellidae we have to deal with in this report is the following one.

#### LAGENIPORA Hincks 1877

"Colonies consisting of a number of cells immersed in a common crust. Zooecia recumbent, lageniform; oral extremity free, tubular, with a terminal orbicular orifice" (Hincks). The colonies are usually small and irregular, and the projecting tubules give it a rough aspect.

#### Lagenipora verrucosa Canu & Bassler 1928

PLATE 8, FIGURE 65

Zoarium encrusting, more or less uniserial. Zooecia in uniserial lines, more or less ramified, elongate, lageniform; frontal smooth to verrucose, terminated by a long, smooth, cylindrical peristome. Aperture orbicular, at bottom of peristome; the peristome thin, entire or notched at the margin. Ovicell small, globular, opening into peristome above the operculum.

Zooecial length, 0.55 millimeters; width, 0.30 to 0.35 millimeters.

Porto Rico, a single colony at Station 2385, from 6 fathoms. The ovicell has a semicircular perforated area, similar to that of the genus *Costazia*, but the more numerous rounded pores and the absence of oral pedicellate avicularia will easily distinguish it. Canu and Bassler (1928: 137) Straits of Florida at 56 fathoms, and north of Cuba at 33 to 143 fathoms.

## Family **CREPIDACANTHIDAE** Levinsen 1909

Zooecia aperture with strong cardelles. Operculum well chitinized. Long oral spines and sometimes marginal spines as well. Avicularia long, pointed, setose or pediform, usually paired on either side of aperture. Septulae usually alternating with intermediate chambers which bear the frontal marginal pores. Ooecia hyperstomial with small pores.

#### Key to the Genera

Aperture with a very narrow, slit-like sinus ........... *Mastigophora,* page 452.
Aperture broad proximally, without sinus ............. *Crepidacantha,* page 451.

### **CREPIDACANTHA** Levinsen 1909

The frontal is surrounded by a row of long setose marginal spines situated between the areolae and corresponding in position to the parietal diatellae (porechambers). Ovicell recumbent, closed by the operculum.

#### Key to the Species

1. Avicularia situated behind the aperture ............... *C. poissonii,* page 451.
   Avicularia farther forward beside the aperture ............................ 2.
2. Avicularian mandible shorter than the zooecia .......... *C. setigera,* page 452.
   Avicularian mandible longer than the zooecia ........ *C. longiseta,* page 452.

#### **Crepidacantha poissonii** (Audouin) 1826

Zoarium encrusting, small, vitreous and glistening. The zooecia, 0.40 to 0.50 millimeters long, are somewhat ventricose and distinct. The marginal areolae are very small and between are situated the marginal setiform spines, on the anterior border the spines are distinctly in advance of the rim of the aperture. A pair of small avicularia with long setiform mandibles symmetrically placed on small mamillate processes distinctly proximal to the aperture. The aperture is nearly circular in front of the strong cardelles and, behind these, widens abruptly to form a very broad shallow sinus or spiramen which may be even wider than the anterior aperture, the proximal border straight or slightly curved forward; peristome little developed and unarmed; length of aperture, 0.10 to 0.12 millimeters; width 0.08 to 0.09 millimeters. Ovicell rather broad and flattened above, situated in front of the distal zooecial spines which project somewhat from beneath beyond the ooecium.

Porto Rico near Caribe Island, a small colony attached to a dead shell at 6 fathoms. I have a specimen also from Bermuda. The species has not previously been noted for the West Indian region, though Canu and Bassler (1928: 136) record it as a fossil from Panama.

#### Crepidacantha setigera (Smitt) 1873

Not taken at Porto Rico. Smitt recorded it (p. 58, *Escharella*) from the Tortugas Islands at 60 fathoms, and Canu and Bassler (1928: 135) recorded it from Florida Strait at 56 fathoms. The setiform avicularian mandible is shorter than the length of the zooecia.

#### Crepidacantha longiseta Canu & Bassler 1928

Not taken at Porto Rico. Canu and Bassler (1928: 135) record it from three stations north of Cuba at 67 to 201 fathoms. As *C. setigera* (Smitt) has never been fully described, *longiseta* may prove to be synonymous.

#### MASTIGOPHORA Hincks 1880

"Zooecia with a semicircular orifice, the inferior margin straight, with a central sinus; furnished with lateral vibracula" (Hincks). Levinsen did not include this genus in his family Crepidacanthidae, but it evidently belongs here, as Canu and Bassler have indicated, because of its recumbent ovicell, pore chambers, etc.

#### Mastigophora pesanseris (Smitt) 1873

Zoarium encrusting. Zooecia moderate in size, frontal slightly convex, rising sharply into the peristome which is ornamented with six or eight erect spines. Aperture rounded distally, straight proximally, with a narrow deep sinus. On either side of the aperture and well forward is a peculiar avicularium the mandible of which is shaped like a goose's foot. Eroded specimens are often difficult of identification.

Zooecial length, 0.55 to 0.70 millimeters; width, about 0.50 millimeters.

Smitt (1873: 43, *Hippothoa*), Tortugas Islands, 42 fathoms; Osburn (1914: 207, *Escharina*), Tortugas Islands, 8 fathoms; Osburn (1927: 130), Curaçao Island; Canu and Bassler (1928: 133), north of Cuba at 143 fathoms, Straits of Florida at 56 fathoms, and Fowey Light, Miami, Florida, 40 fathoms. In Porto Rican waters the species was taken several times, at Caya Caribe, Caya Parguera, and southwest of Pt. Brea in 5½ to 8 fathoms. The colonies are always small, less than a centimeter across.

#### Mastigophora porosa (Smitt) 1873

Differing from *M. pesanseris* (Smitt) especially in the form of the avicularian mandible which is setiform and moderately short. Not taken in Porto Rican waters. Smitt (1873: 41, *Hippothoa*), Florida 40 to 70 fathoms; Canu and Bassler (1928: 134), Gulf of Mexico, Straits of Florida and off Miami, Florida.

### Family **CELLEPORIDAE** Busk 1852

Zooecia usually erected and not oriented, though at the growing edge of a colony they may be horizontal and oriented. Ordinarily the zooecia are heaped upon each other and turned in all directions in the most irregular manner. The ooecia are recumbent, on the dorsal surface of the peristome and vary greatly in the different genera. Oral avicularia are present in most of the genera in various positions and often raised. Vicarious avicularia of various shapes and sizes are often present.

Waters (1913: 510) subdivided the family on the basis of the form of the aperture into schizostomatous (with a sinus) and holostomatous (without a sinus) groups, and Canu and Bassler (1920: 596) added a third group with a clithridate (keyhole-shaped) aperture. The family is numerously represented, found in all seas, and is difficult of study since the primary characters are often obscured.

#### Key to the Genera

1. Aperture keyhole-shaped, with strong cardelles .......... 2.
   Aperture otherwise, merely sinuate or rounded proximally .......... 3.
2. Frontal with areolar pores only .......... *Hipporidra,* page 454.
   Frontal a tremocyst with numerous scattered pores ... *Hippotrema,* page 454.
3. Aperture without a sinus, proximal border nearly straight .......... 4.
   Aperture with a more or less developed sinus .......... 5.

4. Ovicell imperforate, an open hood ..................*Holoporella,* page 455.
   Ovicell with a central pore, more completely developed ....................
   .......................................... *Trematooecia,* page 457.
5. A suboral avicularium usually mounted on a strong rostrum, ovicell without a flat frontal area ..................................*Schizmopora,* page 460.
   An avicularium on either side of the aperture, ovicell with a flattened frontal area ...........................................*Costazia,* page 461.
6. A "catch-all" for insufficiently studied species ...........*Cellepora,* page 461.

### HIPPOPORIDRA Canu & Bassler 1927

Frontal with areolar pores and small avicularia. Aperture with strong cardelles separating off a broad poster. Large acuminate interzooecial avicularia. Ovicell hyperstomial with a frontal area.

#### Key to the Species

Suboral umbo usually well developed, aperture about 0.06 millimeters wide .....
........................................................... *H. edax.*
Suboral umbo absent or weak, aperture 0.08 to 0.09 millimeters wide ............
...................................................... *H. calcarea.*

#### Hippoporidra edax (Busk) 1859

Not taken at Porto Rico. Smitt (1873: 63, *Lepralia*), Elbow Reef, Florida; Canu and Bassler (1928: 139), east of Yucatan at 21 fathoms. It occurs as far north as the coast of New Jersey.

#### Hippoporidra calcarea (Smitt) 1873

Not taken at Porto Rico. Smitt (1873: 63, *Lepralia edax* forma *calcarea*), Florida, 49 to 79 fathoms; Osburn (1914: 212, *Lepralia*), Tortugas Islands, 12 fathoms; Canu and Bassler (1928: 140), Gulf of Mexico and Straits of Florida.

### HIPPOTREMA Canu & Bassler 1927

Frontal a tremocyst with numerous scattered pores. Strong cardelles separate off a broad poster. Ovicell hyperstomial, not closed by the operculum.

#### Hippotrema janthina (Smitt) 1873

Resembling the species of *Hippoporidra,* but the frontal pores and blue-black color easily distinguish it. Not taken at Porto Rico. Smitt (1873: 63, *Lepralia edax* forma *janthina*), Florida, 13 fathoms; Osburn (1914: 213, *Lepralia janthina*), Tortugas Islands, 6 fathoms; Canu and Bassler (1928: 141), north of Cuba, 130 fathoms.

### HOLOPORELLA Waters 1909

Celleporidan species with the proximal lip of the aperture more or less straight and without sinus. Ovicell an open hood. Frontal with a few large areolar pores and occasionally with a few tremopores. Zooecia usually not well separated. Suboral and frontal avicularia and usually large irregularly placed interzooecial avicularia.

KEY TO THE SPECIES

1. Ectocyst with dark pigment .......................................... 2.
   Without dark pigment .......................................... 3.
2. Zooecia large, aperture 0.28 millimeters wide; suboral rostrum low .......... ........................................ *H. magnifica*, page 455.
   Aperture 0.14 millimeters wide; suboral rostrum very high, pointed, the tip white ........................................ *H. albirostris*, page 455.
3. Aperture with a small unsymmetrical notch in the proximal border ........... ........................................ *H. vagans*, page 456.
   Aperture entire on the proximal border .......................................... 4.
4. Aperture 0.17 millimeters wide; suboral rostrum and avicularium vestigial .... ........................................ *H. subalba*, page 456.
   Aperture very small, 0.06 to 0.09 millimeters wide; suboral rostrum moderately developed ........................................ *H. pusilla*, page 457.

### Holoporella albirostris (Smitt) 1873

*Discopora albirostris* forma *typica* Smitt (1873) 70. pl. 12, figs. 234–239.

The zoarium is encrusting, or erect and tubular, with irregular branching. When fully developed the species is easily determined by the white tips of the tall, sharp pointed rostra which stand out in sharp contrast to the dark pigmented frontal. The aperture is moderately small, 0.14 millimeters in width, evenly rounded in front with the proximal border nearly straight (sometimes a little concave). In marginal zooecia there are sometimes several oral spines. The ovicell is a wide open hood. Younger stages are often difficult to identify as they may entirely lack the dark pigmentation and the suboral rostrum may be shorter. The size and form of the aperture appear to be constant.

Porto Rico at a number of places outside of Guanica Harbor at 5 to 18 fathoms. Smitt (1873: 70), Florida, 25 to 35 fathoms; Osburn (1914: 215), Tortugas Islands; Canu and Bassler (1928: 142), Gulf of Mexico and Straits of Florida. The species has a wide distribution in tropical waters and is known geologically as far back as the Oligocene.

### Holoporella magnifica Osburn 1914

Zoarium encrusting, sometimes rising in broad vase-shaped forms as though developed about the base of sponges. The species is easily determined among our West Indian cellepores by the very large aperture, 0.28 millimeters wide, and the dark brown pigment of the front. The operculum is heavy and nearly black in color and the mandible of the large avicularia is also heavily pigmented. The small oral avicularia often show only a little pigmentation. The frontal wall is thick, the suboral rostrum but little developed, oral spines wanting, and the ovicell is a wide open hood.

Porto Rico, near the mouth of Guanica Harbor at 8 fathoms. Osburn (1914: 216), Tortugas Islands, 10 fathoms, and Biscayne Key, Florida; Canu and Bassler (1928: 144), east of Yucatan and Gulf of Mexico, down to 30 fathoms. I have the species also from Bermuda and from Beaufort, North Carolina.

### ? Holoporella vagans (Busk) 1885

Zoarium encrusting, vitreous, white to flesh colored. Zooecia oriented at the margin, irregularly disposed in the secondary layers; frontal thickly covered with small round bosses which extend upon the suboral avicularium. Aperture with an irregular shaped unsymmetrically placed "sinus" or small notch in the proximal border; width of aperture 0.16 to 0.18 millimeters; peristome low, thick and irregularly calcified; a small preoral umbo bearing a small avicularium with a serrate beak. Interzooecial avicularia large and salient, with a coarsely serrate beak and linear or narrow spatulate mandible. Ooecium a wide open hood.

Porto Rico, off Salinas Cove, Station 2383, at 8 fathoms. Canu and Bassler (1928: 148), off Miami, Florida and Florida Straits, 40 to 56 fathoms. I have the same species also from Bermuda.

I am not at all certain that this is the *vagans* of Busk, though it resembles it in many respects, and it is similar to what Canu and Bassler (1928: 148) have identified as *vagans*. It lacks entirely the dark pigment of typical *vagans,* though one of the colonies is well developed. While the mandible of the vicarious avicularium varies much in size and form there are none of the expanded membranous ones mentioned by Busk, also the peristome seems to be less tubular.

### Holoporella subalba Canu & Bassler 1828

Zoarium encrusting or tubular, multilaminar, white. Zooecia of moderate size, distinct, with usually a thin raised line of separation, little erect. The frontal is rather smooth and thinner than is usual in this genus. The aperture is nearly round, more straight on the proximal border. The peristome is thin and somewhat raised and above the proximal border develops a thickening or umbonate process which sometimes bears a minute avicularium but more often this is entirely lacking. The interzooecial avicularia are usually large and long spatulate. The ovicell is salient, thin walled and is more closed than in most species of the genus. Canu and Bassler (1928: 146) fail to mention the presence of oral spines which are occasionally developed to the number of three or four on young marginal zooecia. The aperture measures about 0.14 to 0.17 millimeters in width.

Porto Rico near Punta Brea, 4 fathoms. Canu and Bassler, east of Yucatan, 25 fathoms. I have also a specimen from Dr. Bassler dredged off Havana, Cuba.

### Holoporella pusilla (Smitt) 1873

*Discopora albirostris* forma *pusilla* Smitt (1873) 70. pl. 12, fig. 233.

Not noted at Porto Rico. Smitt recorded it from Florida at 9 to 60 fathoms; Osburn (1914: 215), Tortugas Islands at low tide.

This is a species with small zooecia and a very small aperture, 0.06 to 0.09 millimeters wide. It is encrusting, white, with oral spines.

### Holoporella (?) tubulosa Canu & Bassler 1928

Not found at Porto Rico. Canu and Bassler (1928: 147), Gulf of Mexico and off Havana, Cuba, 30 to 167 fathoms. Canu and Bassler have wisely refrained from placing this species positively in *Holoporella,* as it does not seem to belong there. However, as I am unable to place it definitely I leave it tentatively in that genus.

*Holoporella* is abundantly represented in the tropics and the West Indian region has its full share of the species. Probably several more will be listed in the future.

### TREMATOOECIA NEW GENUS

Zoarium encrusting, in older stages often with many superimposed layers. Zooecia erect, not oriented (except at the edge of rapidly growing colonies), very heavily calcified. Frontal with a few scattered tremopores in addition to the rather large marginal areolae. Aperture semicircular, with a straight or slightly curved proximal border. A low rostrum with a small oral avicularium seated low down near the primary aperture, sometimes wanting even from whole colonies. Peristome thick and slightly raised and usually provided with strong tubercles or spines, which may sometimes bear minute avicularia. Ooecium roughly hemispherical, not widely open as in *Holoporella,* opening into the peristome and not closed by the operculum; heavily and roughly calcified, with tuberosities, but with an uncalcified area or large pore on its frontal side toward the aperture. Avicularia, in addition to the suboral one, of two kinds, usually one or more small rounded ones and occasional large spatulate ones which may vary in size. The operculum has the lateral sclerites strongly extended downward to form a thick lappet on either side a little distal to the hinge.

Genotype, *Lepralia turrita* Smitt 1873.

It has been recognized that *turrita* does not fit the description of *Holoporella*. Waters (1914: 516) returned it to the "omnium gatherum" of *Lepralia*. Hastings (1930: 732) states that "this species can hardly be considered congeneric with the typical Holoporellae," and Canu and Bassler (1930: 75) suggest that it will be necessary to create a special genus for this species. A close study of material from the type locality and other regions of the West Indies, and the discovery of another species related to *turrita* have led the writer to the same opinion.

**Trematooecia turrita** (Smitt) 1873

Plate 8, figure 72

*Lepralia turrita* Smitt (1873) 65.
*Holoporella turrita* Osburn (1914) 217; (1927) 131.—Canu & Bassler (1928) 145.

Zoarium encrusting, rough, forming nodular masses of a yellowish pink to brick red color, occasionally of considerable size. A specimen from Curaçao Island measured 100 by 120 millimeters across and was about 20 layers in thickness. The zooecia are large, marginal ones measure about 90 millimeters long, roughly and heavily calcified, with usually a few pores in addition to the marginal areolae. Superimposed zooecia are erected and turned in every direction. The aperture is roughly semicircular, 0.16 to 0.20 millimeters in width, with a heavy low rostral process near the middle of the proximal border, on the anterior face of which is a small, oval avicularium (often wanting). The peristome is thick and rather low, though the presence of prominent tubercles may give it the appearance of being raised. The tubercles, ranging in number from 0 to 6, may be low or high, rounded at the tip or bearing minute rounded avicularia. Small rounded avicularia are of frequent occurrence on the frontal surface, and large spatulate avicularia of varying size are not infrequent.

The ooecium is nearly spherical, closed to the edge of the peristome into which it opens, but with a rounded membranous area or large pore on the frontal surface at a little distance from the aperture. The ovicell is rounded when first formed, but soon becomes heavily calcified with tubercles of varying size and form which often quite obscure it and may even cover the central pore.

The operculum is slightly chitinized, with a narrow thickened border. On each side just in advance of the point of attachment is a strong, downward-projecting lappet-like process, at the anterior end of which is the muscle attachment.

Porto Rico, dredged at several stations outside of Guanica Harbor, 5 to 18 fathoms. Florida, 26 to 44 fathoms, Smitt; Tortugas, 12 to 15 fathoms, Osburn; Curaçao Island, Osburn; north of Cuba and east of Yucatan, 24 to 143 fathoms, Canu and Bassler.

The species has been listed for several other regions; Southern Brazil (Ridley), East Africa (Waters), Philippine Islands (Canu and Bassler). It seems pretty certain, however, that more than one species has been confused under this name, otherwise discrepancies in statement are difficult to understand. Thus Canu and Bassler (1929: 420) describe the ovicell in Philippine material as being small, smooth and globular, and they make no mention of a frontal pore; Ridley (1881: 55) states that the ovicells bear small scattered punctures, and Hastings (1930: 732) makes no mention of the central pore but comments on the absence of an oral avicularium. Smitt in his original description says in regard to the ooecium "*rotunda, interdum bimucronata, media parte frontis supra aperturam poris perforantur*", but the ovicells are usually difficult to see as the thickening of the wall and the development of the processes renders them so much like the zooecia. Ridley's *Cellepora turrita* certainly must be a different species, and possibly those from the Philippines and Galapagos also. The oral avicularia are certainly present on West Indian material though many zooecia of a colony may lack them. The operculum varies somewhat in form, but none of them resemble the figure by Waters (1913: 516, pl. 73, fig. 10) with the muscle attachments removed from the border.

### **Trematooecia protecta** NEW SPECIES

PLATE 8, FIGURES 66, 67, 68, 69, 70, 71

Zoarium encrusting, surface irregular, glistening white, multilamellate. Zooecia moderately large, marginal ones about 0.75 millimeters long, heavily calcified, erected and not oriented except at the growing edge of the colony. Frontal area rough, with a row of marginal areolae and a few additional scattered pores. About the aperture there are usually 4 or 5 (range 0 to 6) tall, conical, erect spines, none of which bear avicularia. In the marginal zooecia these spines may be low or wanting or tall and slender, but in older parts of the colony they are usually tall and stout and tapering rather evenly to a point. Rarely the rostrum is capped by a spine, but usually this is low with a spine on either side and other spines of similar size and form more anteriorly placed around the aperture on the peristome. One or two spines of a similar nature may be present on the ovicell. Avicularia of two types; an oval suboral one similar to that of *turrita* in form and position and often wanting, and small interzooecial ones with a rounded mandible, which are infrequent.

The primary aperture, width about 0.18 millimeter, is somewhat semicircular, a little broader just behind the attachment of the operculum, and the proximal border is broadly arcuate without a sinus. The operculum is yellowish in color, slightly thickened at the margin and with lateral sclerites, which, like those of *T. turrita* (Smitt), extend dorsally in the form of lappets. The muscle attachments are similar to those of *turrita*.

The ooecia are of moderate size, a little less than the breadth of the zooecia, and soon become heavily encrusted and often surmounted by one or two stout spines; the pleurocyst is incomplete, leaving an irregularly rounded membranous area or large pore on the frontal side toward the orifice. The aperture opens into the peristome and is not closed by the operculum. The ooecium corresponds closely to that of *turrita* and does not have the form of an open hood.

The pointed, instead of blunt, spines; the glistening white, instead of reddish, color; the somewhat smaller size of the zooecia and the slightly different shape of the aperture and operculum serve to differentiate this species from *turrita*.

Porto Rico at two stations (2370 and 2381) due south of the Guanica Harbor bell buoy, at 5 and 10 fathoms.

### SCHIZMOPORA MacGillivray 1888

Cellepores with the ovicell perforated by numerous small pores; the frontal smooth; a proximal sinus (rimule); suboral avicularia; no spines.

#### Schizmopora dichotoma (Hincks) 1864

Not found at Porto Rico. Smitt (1873: 53, *Cellepora avicularis*), Florida at 9 to 111 fathoms; Osburn (1914: 214, *Cellepora dichotoma*), Tortugas Islands, 10 fathoms. The species is well known in the middle North Atlantic.

#### Schizmopora margaritacea (Pourtales) 1867

Not taken at Porto Rico. Pourtales (1867: 110, *Vincularia margaritacea*), off Sand Key at 100 and off Havana at 270 fathoms. It occurs in very well branched colonies off Beaufort, North Carolina, at 13 fathoms.

### COSTAZIA Neviani 1895

*Siniopelta* Levinsen (1909).

Cellepores with a sinuate orifice. Ovicell with a limited, perforated frontal area; usually with a small avicularium on either side of the aperture mounted on a tall erect process.

#### Costazia ignota (Norman) 1909

*Lagenipora ignota* Norman (1909) 309.

Zoarium forming small white nodules on shells, corals, etc. Zooecia erected, the frontal smooth with only a few marginal pores. Peristome rising high proximally and on the sides with usually a small pedicellate avicularium on each side of the aperture. The aperture is subcircular with a moderately developed sinus. The ovicell is globular with a rounded area which is perforated usually by a single row of slit-like pores. The area does not reach the proximal margin, and the peristome is not continued around on the ovicell. Interzooecial avicularia are rare.

Porto Rico, common and taken at a number of stations off Guanica Harbor at 6 to 20 fathoms. Osburn (1914: 214, *Lagenipora*), Tortugas Islands, 10 fathoms. I cannot be absolutely sure that this is Norman's species, since his description is brief, but it approaches it closely.

#### Costazia costazii (Audouin) 1826

This species resembles the preceding in the presence of the high peristome with a somewhat pediculate rounded avicularium on either side of the aperture, but differs in the following points: (1) the marginal pores are more numerous and regular in distribution; (2) the ooecial area is semilunar in form, and has two or three rows of more or less rounded pores; (3) the peristome extends across the ovicell next to the aperture like a broad lip when fully formed. The ovicell appears to be exactly like that figured by Hincks (1880. pl. 55, fig. 12, *Cellepora*).

Porto Rico, several colonies dredged at 6 to 11 fathoms off Tallaboa Bay. Not otherwise recorded from American side of the Atlantic.

### CELLEPORA Linnaeus 1767

This old Linnaean genus is now used as a "catch-all" for those celleporine species which have not been sufficiently studied to be properly allocated in the newer genera. There a number of these in the West Indian fauna as follows:

*Cellepora coronata* Smitt (1873: 51). Possibly a *Schizmopora*. If it is ever recovered and studied it should be renamed, as Chiaje's use of the name preoccupies it.

*Cellepora gigas* Smitt (1873: 52). Probably an *Osthimosia,* as Smitt describes it as having a sinus and an imperforate ovicell.

*Cellepora tuberosa* Smitt (1873: 52). Smitt's figure (pl. 9, fig. 180) resembles a species of *Holoporella,* but his description of the perforated ovicell indicates *Schizmopora.* Smitt used D'Orbigny's specific name, but it is probably not the same species.

*Cellepora minutiporosa* Canu & Bassler (1928: 150). A species with a sinuate orifice, but the authors do not indicate whether the ovicell is perforate or not.

## Family **PASYTHEIDAE** Davis 1934

A creeping stolon from which arise free, jointed branches, the zooecia arranged in pairs or triads. Zooecial aperture with a broad, shallow sinus. No avicularia or ovicells.

This family contains two genera which have been confused and shifted about for many years. Ellis and Solander, 1786, described *Cellaria tulipifera* from Jamaica. Lamouroux, 1812, removed *tulipifera* from *Cellaria* and erected the genus *Pasythea;* and was followed in turn by Lamarck, 1816, *Liriozoa;* Blainville, 1834, *Tuliparia;* and Hincks, 1881, *Epicaulidium;*—all of whom based their descriptions on *tulipifera.* Evidently *Pasythea* has priority and the other names are pure synonyms.

Smitt (1873: 35 *et seq.*) erected the genus *Gemellipora* for his species *eburnea* and several others which have been removed. Busk (1884) and Canu and Bassler (1928, 1929) confused matters by placing *eburnea* under *Pasythea.* Levinsen (1909) separated *Liriozoa* (syn. *Pasythea*) and *Gemellipora* satisfactorily, but Bassler (1935) lumped them both together again under *Pasythea.* Apparently all this shifting has been done without sufficient knowledge of the species which show very distinct generic characters, as indicated below:

1. Branches consisting of an axis of elongated kenozooecia, from the opposite sides of which, near the upper end, appear zooecia in paired triads. Radicle fibers developed in three ways (1) between and a little below the triads, (2) replacing one of the triads, and (3) rarely from the end of a kenozooecium. Branches few and unpaired. ................ *Pasythea,* page 462.
2. Branches consisting entirely of paired zooecia (dyads) placed back to back (kenozooecia wanting); internodes composed of 2 to 10 dyads, daughter zooecia developed at the terminus of the preceding pair, either with or without corneous joints; branches numerous and usually paired; radicle fibers apparently only basal. ...................... *Gemellipora,* page 463.

### **PASYTHEA** Lamouroux 1812

#### **Pasythea tulipifera** (Ellis & Solander) 1786

Plate 9, figures 75, 76, 77

Zoarium erect from a stolonate base, irregularly branching, stem composed of elongated kenozooecia separated by flexible joints. Zooecia always joined in triads which usually arise from the stalk kenozooecia near their upper ends in opposite pairs, occasionally the stolon may give rise to a very short kenozooecium which develops a single triad at its tip. In the triads the median zooecium alone is connected with the kenozooecium, the lateral ones being budded off at the sides of the median one. The zooecia do not give rise to other zooecia or to branches or radicles. The zooecial and kenozooecial walls are provided with scattered pores. The kenozooecia vary much in length, 0.40 to 1.10 millimeters, and occasionally are barren of triads. Lateral branches arise from the sides of the kenozooecia between and a little below the origin of the triads.

Radicle fibers may appear on any part of the colony, replacing a branch, a triad, or a kenozooecium at the end of a series. The zooecial aperture is very small, 0.07 to 0.08 millimeters long by 0.06 millimeters wide, slightly sinuate; operculum little chitinized; a short terminal spine frequently developed, especially on the lateral zooecia. No ovicells nor avicularia. The triads measure about 0.40 to 0.45 millimeters in length.

Porto Rico, rather common off the south shore at 5 to 15 fathoms and taken at six stations. Ellis and Solander, 1786 (*Cellaria*) Jamaica; Marcus (1938: 37), Santos Bay, Brazil.

### **GEMELLIPORA** Smitt 1873

#### **Gemellipora eburnea** Smitt 1873

PLATE 9, FIGURES 73, 74

Zoarium erect from a stolonate base, pinnately branched, the whole formed of successive pairs of zooecia (dyads) arranged back to back, with horny joints here and there. The internodes vary considerably, 2 to 10 dyads, but a joint is always present at the base of each branch.

Zooecia somewhat tubular, the pairs joined for most of their length, the terminal portion turned sharply outward and slightly twisted so that their apertures face in opposite directions. Branches arise opposite each other between the members of a dyad, a little above the middle of the zooecia. No ovicells and no kenozooecia of any sort except the radicle fibers at the base. Length of dyads about 0.55 millimeters (0.45 to 0.65 millimeters).

Not taken in our collections but found by the Challenger Expedition at near-by Culebra and Sombrero Islands. Smitt described the species from Florida and it has since been reported from the Gulf of Mexico, north of Cuba, off the coast of Brazil, the Gulf of Gascogne, and the Madeira Islands, always in rather deep water, down to 450 fathoms.

## Family **CATENICELLIDAE** Busk 1852

Erect, jointed, branching colonies, often with radicles for attachment. Zooecia all facing the same direction, one, two or three to an internode. Ovicells or gonoecia in different positions according to the genus. Avicularia usually present.

The family is scarcely represented north of the equator, but is abundantly developed in the Australian seas. Hitherto none have been recorded for North American waters of either coast.

### **VITTATICELLA** Maplestone 1900

Characterized by the presence of a vitta (a longitudinal groove with pores) on either side of the front. Occasionally very minute pores on the frontal surface. The ovicell, which is surrounded by a "beaded border," is rather deeply embedded in the base of the next distal zooecium, which in this genus is functional and not reduced to a kenozooecium.

Key to the Species

Avicularia present on either side of the aperture ..........*V. elegans,* page 464.
Avicularia wanting; instead there are conical processes at the distal corners ....
.............................................. *V. contei,* page 465.

### **Vittaticella elegans** (Busk) 1852

Plate 9, figures 78, 79

Zoarium erect, flexible, dichotomously branched, zooecia in a single series, one or two to an internode, colonies 12 millimeters or more in height. Zooecia rather slender and tubular, dorsal outline curved; length, 0.50 to 0.60 millimeters, the fertile zooecium and the one distal to it are shorter, the two combined about 0.80 millimeters; width of zooecia and ooecia, about 0.20 millimeters. The front in some cases is slightly papillose. At each distal corner is a small avicularium with a somewhat triangular mandible which has a sharp, recurved point. Rarely one of these is replaced by a giant avicularium with a long spatulate mandible similar to those described by Waters (1913: 484) for specimens from Zanzibar and the Arafura Sea. Rarely, also, the avicularium is wanting, in which case there is a stout conical process.

Ooecia abundantly developed on specimens taken in February, but wanting from those collected in mid-summer; nearly round in outline, flattened on the front surface and deeply embedded in the distal zooecium. The beaded border, characteristic of the genus, is well developed. The distal zooecium, attached without a joint, is functional. Radicles are developed from circular chambers at about the middle of the dorsal side. Branches arise from a daughter zooecium directly connected to the mother zooecium without a joint and take the place of the avicularium on that side.

Porto Rico at five stations, all in or off the mouth of Guanica Harbor at 5 to 30 fathoms. Dr. R. S. Bassler of the U. S. National Museum has also sent me specimens taken by the Johnson-Smithsonian Expedition in February, 1933, just north of the east end of Porto Rico at 10 fathoms. Widely distributed in warmer waters, but not reported for the American coasts.

### Vittaticella contei (Audouin) 1826

Plate 9, figures 80, 81, 82

Zoarium small and delicate. Zooecia quite transparent, very small, short and rather broad in proportion, length about 0.26 millimeters; width, 0.15 millimeters; the fertile zooecia and the next in series somewhat shorter. The frontal area is somewhat papillose in the earlier zooecia of the colony. The vittae are variable in length but usually not more than half the length of the frontal area. Aperture rounded, the proximal border obscured to the level of the small hinge teeth by a projecting lip of the frontal. Avicularia entirely wanting, replaced by a strong process at each distal corner. The lateral zooecia occupy about the distal half of the border of the mother zooecia. Ooecia rather large, nearly as broad as the "covering" zooecia in which they are embedded; "beaded border" well developed; frontal surface perforated by a number of scattered, rounded pores and with an indefinite longitudinal sulcus; the "covering" zooecia functional and not reduced. Radicle chambers present on the dorsal surface, but no radicles are developed in my material. In one case a branch arises from the basal zooecium in the dorsal position.

Porto Rico, one mature colony with ovicells at 6 fathoms, taken one mile south of Caño Gorda Island; another near the Guanica Harbor bell buoy at the same depth. The larger specimen is only about 2 millimeters in height, consisting of 24 zooecia, with 7 ovicells. In my collection is another specimen from Bermuda at 3 fathoms, collected by Dr. S. R. Williams.

Marcus (1937: 76, *Catenicella*) records the species from Santos, Brazil. The species is widely distributed, Madeira, Mediterranean and Red seas, Java, but has not been noted with any frequency, no doubt because it is so small and inconspicuous.

## Family SAVIGNYELLIDAE Levinsen 1909

*Catenariidae* D'Orbigny (1851).

Zoarium erect, branched, jointed, each segment consisting of a single zooecium. Zooecia elongated, tubular, only slightly calcified, the frontal surface with pores and separated from the dorsal surface by a more or less sharp line. Ovicell recumbent. Avicularia and spines present.

### SAVIGNYELLA Levinsen 1909

*Catenaria* Lamouroux (1824) preoccupied.

#### Savignyella lafontii (Audouin) 1826

The trumpet-shaped zooecia forming a chain, with the prominent suboral avicularium and circumoral spines, characterize the species. The colonies are erect or trailing among other bryozoa, algae, etc., and in spite of their small size are conspicuous by their brick red color. The aperture is semicircular, without sinus, its distal border surrounded by strong erect spines. The globular ooecia as well as the zooecial walls are perforated by numerous conspicuous pores. The zooecia vary greatly in length, from 0.75 to as much as 1.50 millimeters, the difference being chiefly in the stalk-like base. Daughter zooecia are produced on the dorsal side near the distal end, and in branching two daughter zooecia appear at the same level, side by side.

Porto Rico, off the mouth of Guanica Harbor at 5 to 30 fathoms. Osburn (1914: 197), Tortugas Islands, down to 10 fathoms. I have the species also from Bermuda, and Marcus (1937: 78) records it for the Bay of Santos, Brazil. It occurs around the world in warmer waters.

## Family MAMILLOPORIDAE Canu & Bassler 1927

Zoarium orbicular in outline, cupuliform, the zooecia oriented toward the apex of the colony; fertile zooecia enlarged.

### MAMILLOPORA Smitt 1873

#### Mamillopora cupula Smitt 1873

Not found at Porto Rico. Smitt (1873: 33), Florida, 30 to 68 fathoms; Canu and Bassler (1928: 153), Gulf of Mexico and Straits of Florida, 27 to 56 fathoms.

## Order PHYLACTOLAEMATA Allman

No systematic attempt to collect the freshwater Bryozoa was made, but the following species was taken in considerable numbers.

### Family FREDERICELLIDAE

**Plumatella repens** (Linnaeus)

Branched chitinous tubes spreading over the under sides of stones in the stream at Rio Piedras. Some of the branches were erect, but for the most part they were adherent.

## LIST OF NEW GENERA, SPECIES, AND VARIETIES

### New Genera



### New Species



### New Varieties

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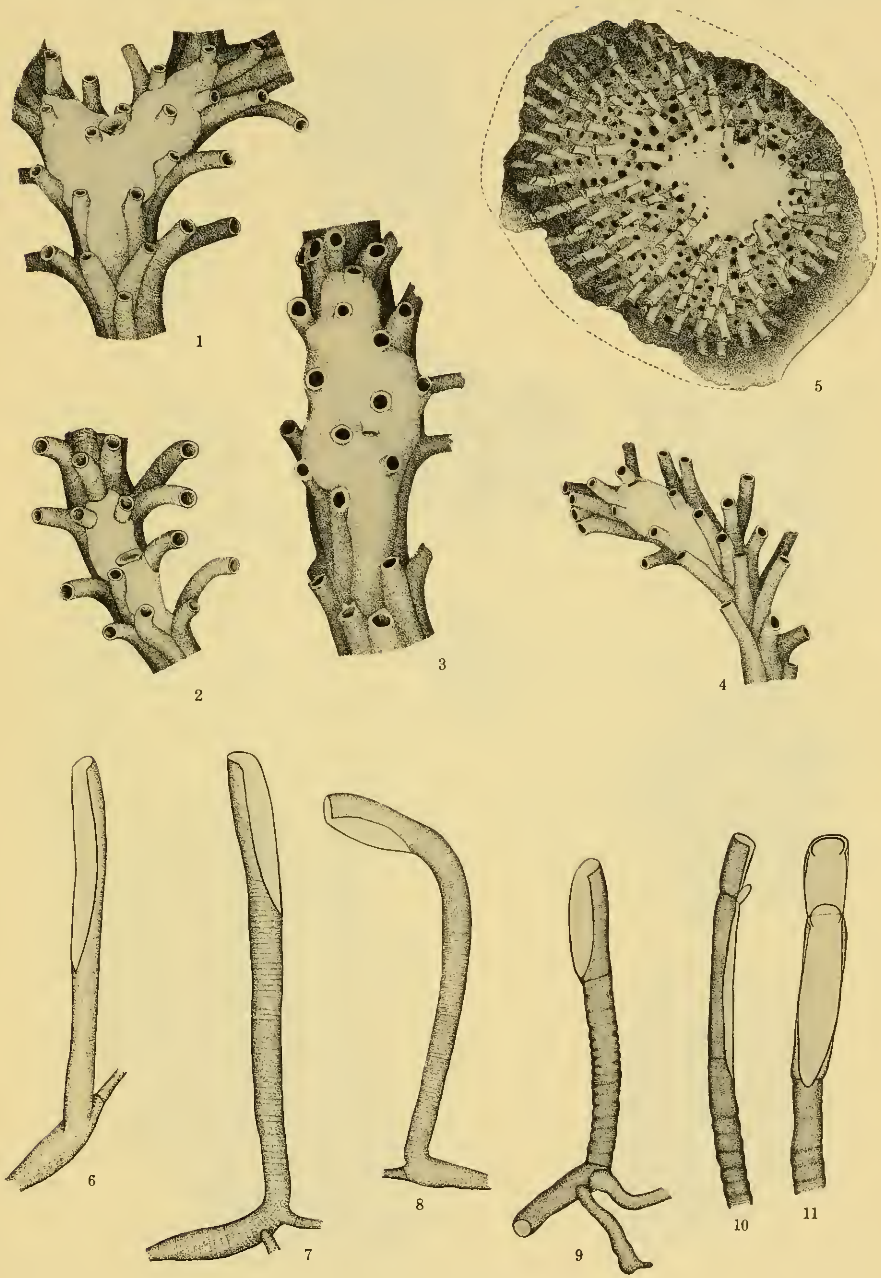
# EXPLANATION OF PLATES

The figures were all drawn under camera lucida to the same scale, with a few exceptions which are indicated.

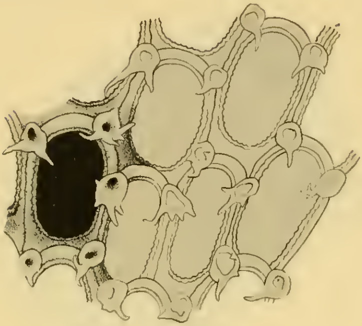
Many of the drawings were made by my former student Dr. Mary D. Rogick, an authority on the freshwater Bryozoa, whose outstanding work as an artist in this field is already well known (see especially the figures under *Parellisina, Exechonella, Labioporella, Thalamoporella, Coleopora,* etc.). The illustrations were completed by Miss Frieda Busch, to whom also I owe a debt of gratitude for her patient and careful work.

## Plate 1

Figure 1. *Diaperoecia rugosa* n. sp., with branched ovicell.
Figure 2. *Diaperoecia rugosa* n. sp., with simple ovicell.
Figure 3. *Diaperoecia floridana* n. sp.
Figure 4. *Entalophora delicatula* (Busk). Note ooeciostome at base of a zooecial tube.
Figure 5. *Lichenopora buski* Harmer. Note lateral ooeciostome.
Figure 6. *Aetea truncata* (Landsborough).
Figure 7. *Aetea recta* Hincks.
Figure 8. *Aetea anguina* (Linnaeus).
Figure 9. *Aetea ligulata* Busk. A young zooecium, note corrugated stalk.
Figure 10. *Aetea ligulata* Busk. Lateral view showing regeneration. The original operculum is still present, with a new one terminally situated.
Figure 11. *Aetea ligulata* Busk. Ventral view showing regenerated portion with the two opercula.




OSBURN: BRYOZOA OF PORTO RICO



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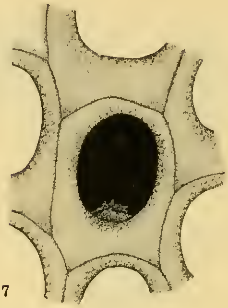

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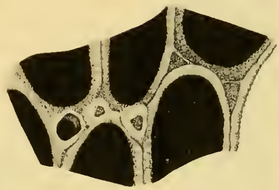

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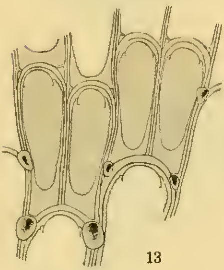

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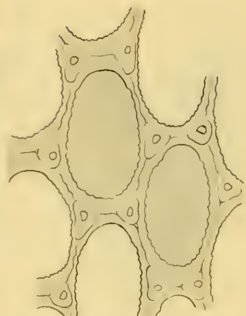

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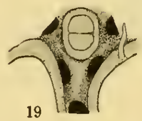

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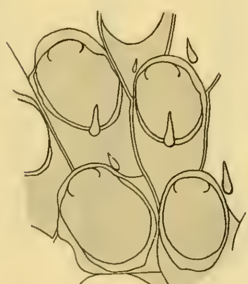

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OSBURN: BRYOZOA OF PORTO RICO

PLATE 2

FIGURE 12. *Conopeum tubigerum* n. sp. Fully developed with trumpet-shaped tubular spines.

FIGURE 13. *Conopeum tubigerum* n. sp. At rapidly growing edge of zoarium, showing development of tubes from the triangular basal corners.

FIGURE 14. *Conopeum reticulum* (Linnaeus). Note interzooecial kenozooecium at left, a pair of nodules and the triangular basal corners from which the nodules develop.

FIGURE 15. *Conopeum reticulum* (Linnaeus). Outline sketch showing characteristic arrangement.

FIGURE 16. *Acanthodesia savartii* (Audouin). Younger stage.

FIGURE 17. *Acanthodesia savartii* (Audouin). Highly calcified.

FIGURE 18. *Hincksina periporosa* Canu & Bassler.

FIGURE 19. *Hincksina periporosa* Canu & Bassler. Interzooecial avicularium.

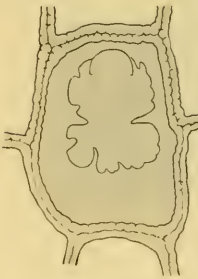
FIGURE 20. *Electra bellula* (Hincks) n. var. *ramosa*. Branching stage. Note position of joints and nature of spines.

FIGURE 21. *Electra bellula* (Hincks) n. var. *ramosa*. When a branch comes into contact with a flat surface and becomes unilaminar. The spines are much reduced.

PLATE 3

FIGURES 22 to 30. *Acanthodesia tenuis* (Desor). Variation in zooecial form, size, nodulation and development of cryptocyst in a single large colony on an oyster shell from Beaufort, North Carolina. FIGURES 29 and 30 show regeneration. Calcification of the cryptocyst is usually about as in FIGURES 26 and 28, less frequently the cryptocyst is much larger as shown in FIGURES 22, 23 and 27.

FIGURE 31. ? *Aplousina gigantea* Canu & Bassler.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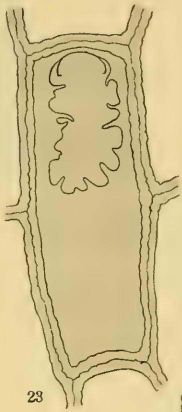
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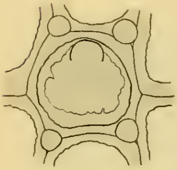
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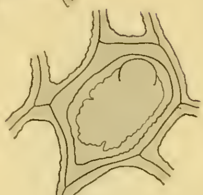
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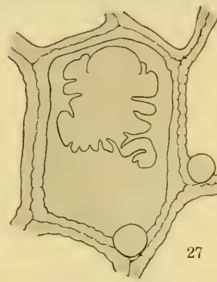
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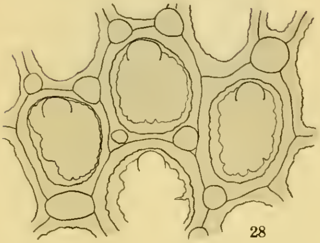
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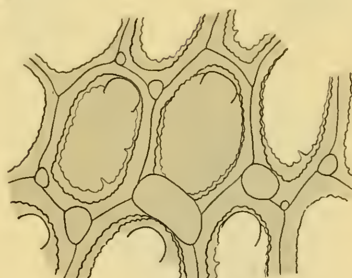
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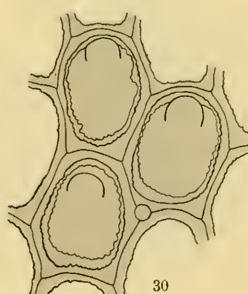
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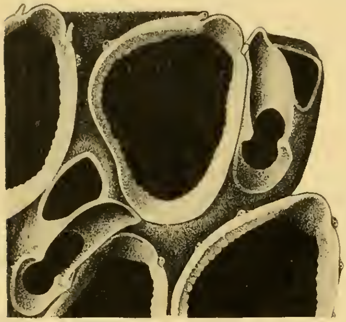
OSBURN: BRYOZOA OF PORTO RICO



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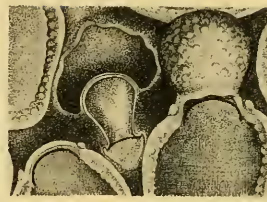

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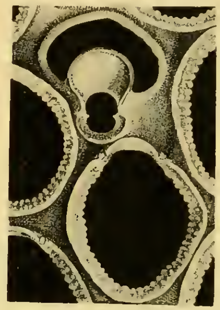

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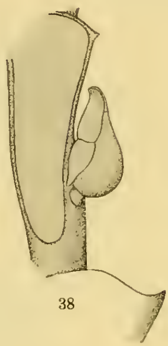

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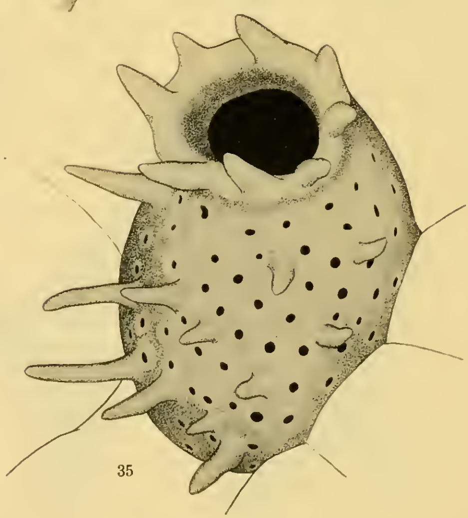

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OSBURN: BRYOZOA OF PORTO RICO

PLATE 4

FIGURE 32. *Parellisina curvirostris* (Hincks). Showing relation of avicularium chamber to kenozooecium.

FIGURE 33. *Parellisina latirostris* n. sp. From dried specimen with chitinous parts intact.

FIGURE 34. *Parellisina latirostris* n. sp. Calcined specimen showing details of structure. There is some variation in the form and size of the avicularium and kenozooecium, but they are always broad.

FIGURE 35. *Exechonella antillea* (Osburn) n. var. *spinosa*.

FIGURE 36. *Caulibugula levinseni* n. sp. Form of zooecia.

FIGURE 37. *Caulibugula levinseni* n. sp. Outline sketch of ovicell with ovum.

FIGURE 38. *Caulibugula levinseni* n. sp. Form and position of avicularium.

FIGURE 39. *Caulibugula levinseni* n. sp. Elongate jointed spine occasionally present.

PLATE 5

FIGURE 40. *Labioporella sinuosa* n. sp.
FIGURE 41. *Labioporella sinuosa* n. sp. Dorsal view.
FIGURE 42. *Thalamoporella gothica* n. var. *floridana*.
FIGURE 43. *Thalamoporella gothica* n. var. *floridana*. Dorsal view.
FIGURE 44. *Thalamoporella falcifera* Hincks.
FIGURE 45. *Thalamoporella falcifera* Hincks. Dorsal view.

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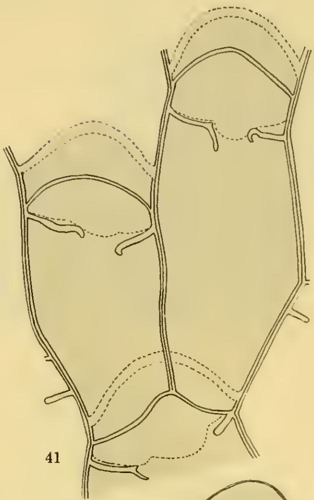

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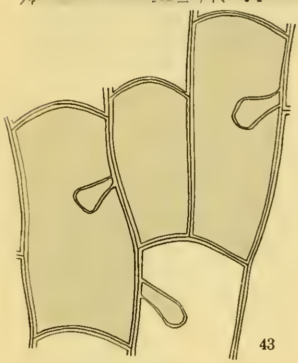

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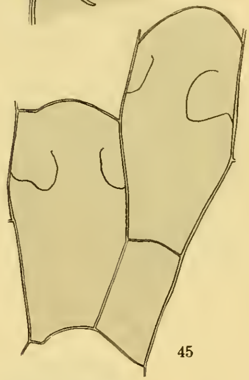

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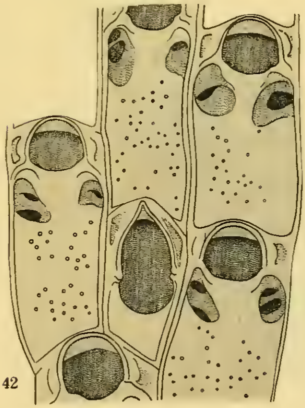

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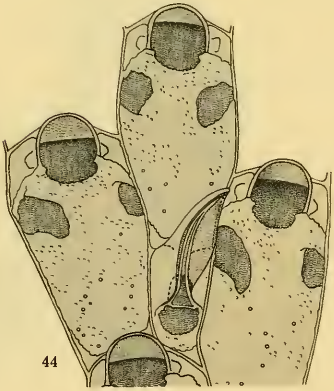

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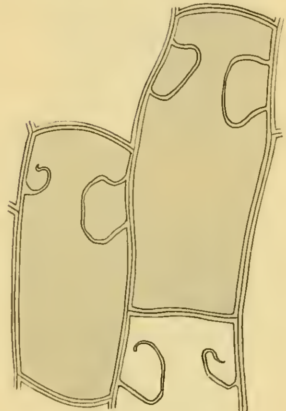

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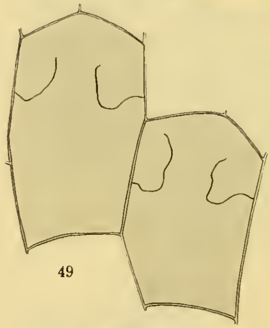

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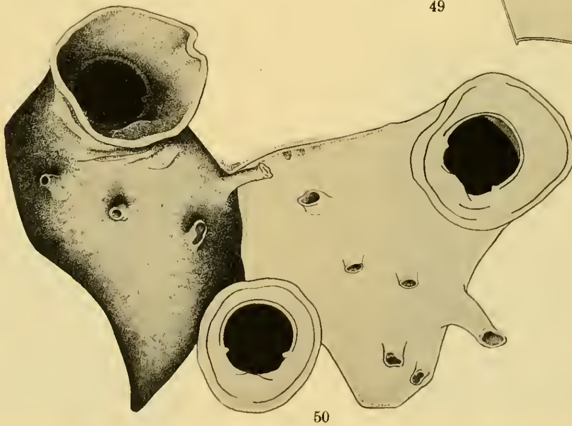

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OSBURN: BRYOZOA OF PORTO RICO

PLATE 6

FIGURE 46. *Thalamoporella mayori* n. sp. Note especially the avicularian opesiules.

FIGURE 47. *Thalamoporella mayori* n. sp. Showing dorsal side.

FIGURE 48. *Thalamoporella distorta* n. sp. The distorted zooecia are always paired with a distorted avicularium.

FIGURE 49. *Thalamoporella distorta* n. sp. Dorsal view.

FIGURE 50. *Coleopora americana* n. sp.

Plate 7

Figure 51. *Hippopodina irregularis* n. sp. Ovicell as covered with a thick pellicle.

Figure 52. *Hippopodina irregularis* n. sp. Details of aperture.

Figure 53. *Hippopodina irregularis* n. sp. Operculum.

Figure 54. *Hippopodina feegeensis* (Busk). A young zooecium with reversed avicularium.

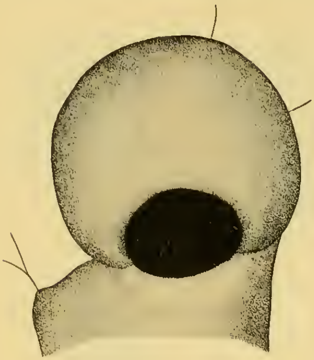
Figure 55. *Hippopodina feegeensis* (Busk). With paired reversed avicularia.

Figure 56. *Fenestrulina malusi* (Audouin).

Figure 57. *Stephanosella rugosa* n. sp. A younger zooecium with the beginning of the frontal decoration.

Figure 58. *Stylopoma informata* (Lonsdale). Showing large falcate interzooecial avicularium.

Figure 59. *Gephyrophora rubra* n. sp.



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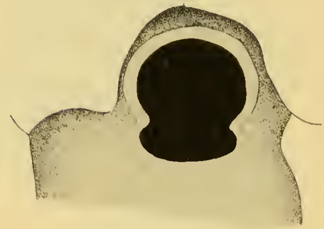

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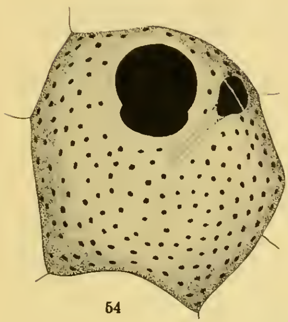

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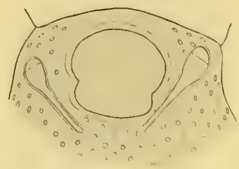

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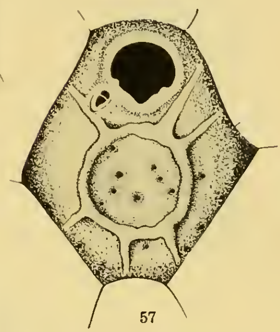

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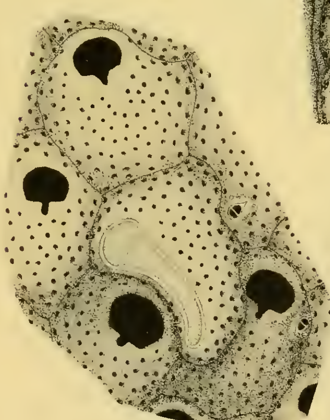

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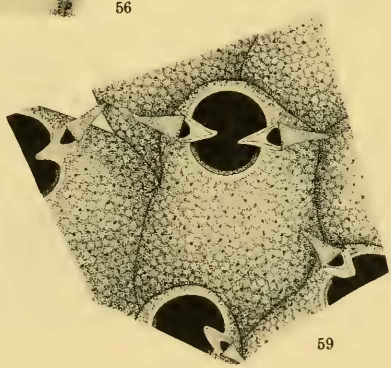

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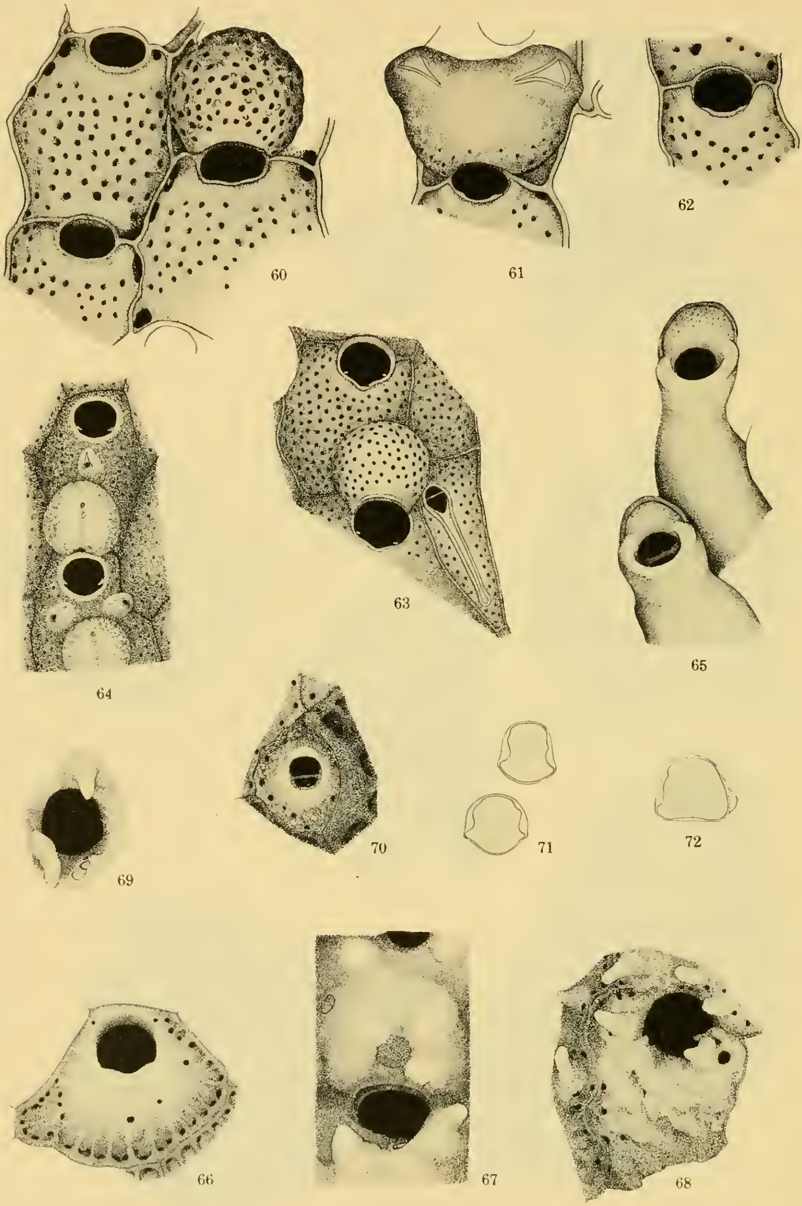
OSBURN: BRYOZOA OF PORTO RICO




OSBURN: BRYOZOA OF PORTO RICO

## Plate 8

Figure 60. *Gemelliporidra typica* Canu & Bassler. Zooecia with ovicell.

Figure 61. *Gemelliporidra typica* Canu & Bassler. An ovicell surmounted by two avicularia, rare.

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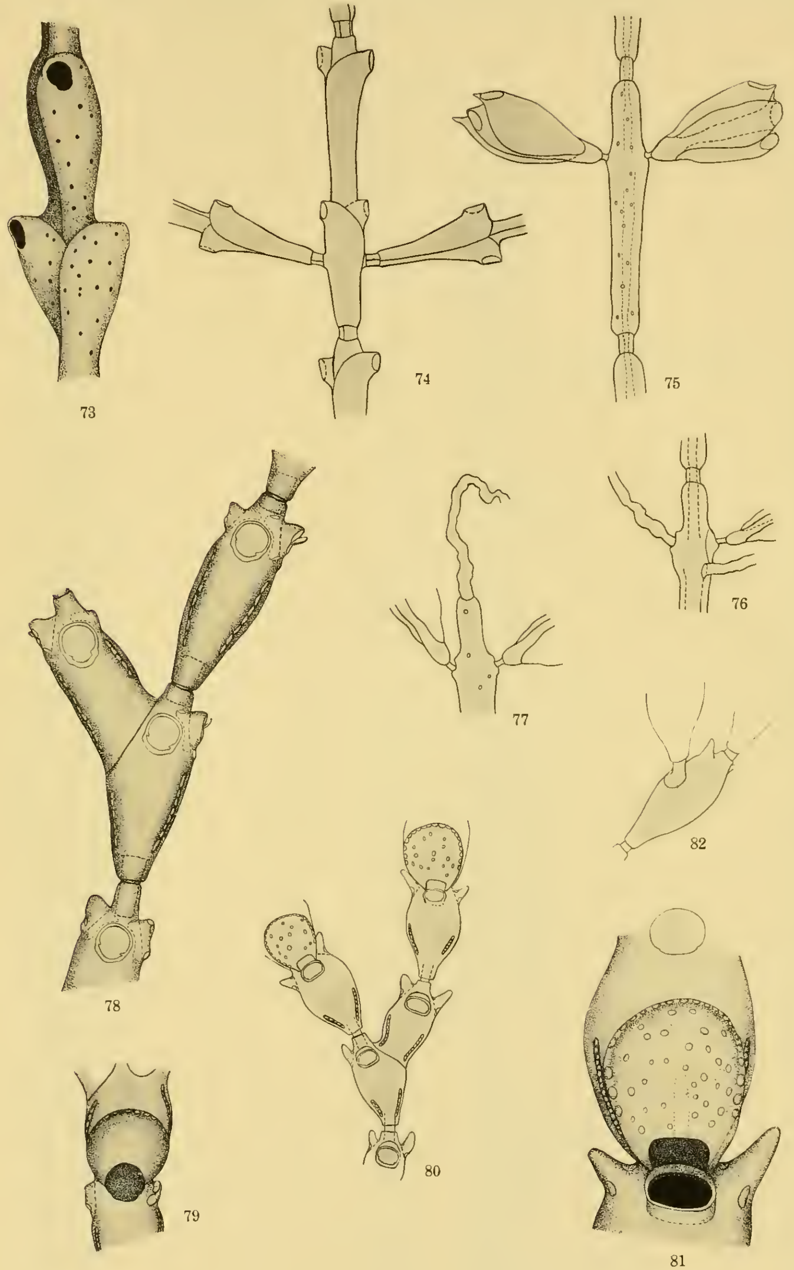


OSBURN: BRYOZOA OF PORTO RICO

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* New genera, species, and varieties, and pages where treated, are in bold faced type.

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THE NEW YORK ACADEMY OF SCIENCES

# SCIENTIFIC SURVEY
## OF
# PORTO RICO and the VIRGIN ISLANDS

VOLUME XVI—Part 4

## Marine Cercariae of Puerto Rico

*Raymond M. Cable*

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ROY WALDO MINER

*SCIENTIFIC SURVEY OF PORTO RICO AND THE VIRGIN ISLANDS*

*This natural history survey of Porto Rico and the Virgin Islands, conducted by The New York Academy of Sciences, was established in 1913 and carried out with the cooperation of the Porto Rican government. The results of this survey have appeared from time to time as investigations by specialists have been completed.*



*Printed in the United States of America*

## Preface

This study was made possible by sabbatical leave from Purdue University, Ind., and a Fellowship granted by the John Simon Guggenheim Memorial Foundation, New York, N. Y. It was greatly facilitated by a number of fortunate circumstances and the generous aid of many persons. It so happened that Mr. L. A. Le Zotte, Jr., who had just applied for study toward a doctorate under the author's direction, had lived in Puerto Rico and hence was not only thoroughly familiar with the locale but interested, as well, in the study of parasites. A grant from the Purdue Research Foundation made it possible for him to work with the author in Puerto Rico, an arrangement that was of great mutual advantage.

After considerable deliberation, it was decided that the College of Agriculture and Mechanic Arts at Mayagüez was best situated as a base for such an investigation, and that choice proved to be a happy one from every standpoint. Vice-Chancellor Luis Stefani extended to the author and his family the generous hospitality of the college with all the privileges of the faculty and none of the responsibilities. The pleasant experiences and associations of the year at the college will be long remembered. Many needed facilities were provided by the Department of Biology, thanks to Professor Jose A. Ramos, Head, and members of his staff, especially Doctor N. T. Mattox and Doctor Virgilio Biaggi.

The collection and identification of hosts is a major problem in a study of this type, but it proved to be far less difficult than was anticipated, thanks to the assistance of Doctor Mattox, Mrs. H. E. Warmke, who has an excellent collection of identified marine mollusks of Puerto Rico, and Mr. J. A. Weber of Miami, Fla., who spent several days in the field showing the author the ways of mollusks and submitted some of the more difficult specimens to Doctor H. A. Rehder of the Smithsonian Institution, Washington, D. C., for identification.

If this report were an imposing volume, it could well be dedicated to Professor Horace W. Stunkard, who has made outstanding contributions to our knowledge of the marine digenetic trematodes. Professor Stunkard first stimulated the author's interest in that group over 20 years ago. The manuscript of this study has been read by him and it has benefited greatly from his many helpful suggestions and criticisms.

Raymond M. Cable

Purdue University, 1956.

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# MARINE CERCARIAE OF PUERTO RICO

*By* Raymond M. Cable

## INTRODUCTION

Larval trematodes developing in marine mollusks of tropical America are very imperfectly known and apparently have received no attention whatever in Puerto Rico. Situated about midway of the Antilles chain, that island is well located for their study. Its coast offers a variety of habitats and exposure to adjacent waters and ocean currents. The marine fauna is rich with an abundance of fishes, shore birds, and sea turtles, all of which are potential definitive hosts of digenetic trematodes whose larval stages would be expected to develop in the varied and abundant mollusks of the region.

From September 1951 until August 1952, the writer undertook a threefold study in Puerto Rico: (1) a survey of adult trematodes parasitizing marine fishes; (2) the collection and study of cercariae developing in marine mollusks; and (3) the determination of as many life histories as time permitted, following leads suggested by morphological resemblances of larvae and adults and the ecology of their hosts. Toward the end of the time available, the survey of adult forms was extended to include those occurring in as many shore birds as could be obtained because a number of the cercariae found were such that birds seemed likely to serve as hosts of their adult stages. This likelihood was suggested not only by inability to account for such adults among those recovered from the many fishes examined, but also by previously solved life histories and the ecology of several cercarial species to whose habitats fishes had very limited if any access.

This report is limited to larval trematodes; *i.e.*, cercariae and the generation producing them. For the sake of conciseness, descriptions are in brief telegraphic style, and discussion with reference to the literature is kept to a minimum. Some of the life histories that were determined have been or will be reported in separate papers and are mentioned briefly here. Clues to other cycles suggested by the study as a whole are given in the hope that they may stimulate other investigators to continue the work begun. The number of adult trematode species collected by the writer in Puerto Rico has not been compiled, and cannot be, for a considerable time. It is certain to exceed greatly, perhaps by several fold, the number of cercarial species reported here. This study, therefore, is but a beginning so far as the larval marine trematodes of Puerto Rico are concerned. Cercariae usually are found a species at a time, and rarely in a high percentage of the mollusks in which they develop. Thus a large number of any one such host species must be collected and examined to disclose all the larval trematodes that may develop in it. This procedure is readily followed only if the host species is abundant and fairly accessible, and these conditions probably are not met by the majority of the mollusks harboring larval generations of the adult trematodes that were found. Collecting numbers of the less common or less accessible mollusks of the region called for more time, equipment, and knowledge of their ecology than were at the writer's command.

The 51 species of larval trematodes included in this report were found in mollusks collected on the western and southwestern coasts of Puerto Rico with one exception, a species developing in *Neritina virginea* collected at Luquillo at the northeastern corner of the island. Although that snail is extremely abundant and was collected in large numbers elsewhere, neither the species found at Luquillo nor any other larval trematode was recovered. It thus seems certain that a more extensive coverage of the island would have yielded many additional cercariae in common mollusks that were examined fairly adequately in only a few localities. The writer's collecting was confined mostly to coastal waters from Rincón southward to Cabo Rojo and east to Guánica. During 11 days spent at Mona Island, several thousand snails representing several species were examined by isolation without finding a single larval trematode, even though fishes taken there harbored many species of adults. The same was true of mollusks collected from exposed parts of the Puerto Rican coast that are swept by heavy surf, a condition that prevails along most of the north coast and entirely around Mona Island. It seems very likely, however, that mollusks preferring such an exposed habitat serve as hosts to a number of larval trematodes, and that some of them would have been disclosed had all the mollusks collected been cracked and examined.

It was found that the locality had much to do with the presence and abundance of cercariae. On several occasions, a species of mollusk was found to harbor a particular cercaria in a high incidence when collected from one locality and but rarely or not at all in another. For this reason, percentages of infection are meaningless unless the locality is pin-pointed and the rate of infection is determined by collecting many specimens and examining them individually by cracking. Because time was limited, as a rule only those mollusks that were difficult to obtain in numbers or died quickly under laboratory conditions were examined by cracking to find infections not revealed by spontaneously emerging larvae. A study of seasonal incidence of infection was begun but abandoned when it became apparent that the project would require more time than the end justified.

The larval stages of the digenetic trematodes, as of several other groups of animals, were known long before their status as larval forms was established. The term *Cercaria* thus acquired use as a generic name and larval trematodes were described and named as species of that genus. Not infrequently, subsequent investigations have revealed that both the cercaria and adult of a trematode have been described as distinct species and that the specific name of the cercaria may hold priority over that of the adult. However, the life histories of relatively few of the known cercariae have been demonstrated beyond doubt, and the practice of assigning specific names to such larvae has persisted as a convenient means of designating those whose cycles are unknown. It is clear, however, that the term *Cercaria* implies a far more inclusive category than that of a genus. Species named under that designation have adults belonging to different families, superfamilies, and even orders.

Several investigators, especially those dealing with a number of species, have preferred to designate cercariae by numbers or letters sometimes preceded by a name qualifying them as to locality or type. For example, Sewell (1922) described a number of cercariae from India and designated each species by the name *Cercariae indicae* followed by a Roman numeral (*e.g.*, *Cercariae indicae* XL); Petersen (1931) designated cercariae by type and number (*e.g.*, *Furcocercaria No. 4*); and Miller (1925a) simply assigned each species a letter (*e.g.*, *Cercaria F*). Much can be said in favor of such schemes for dealing with a number of cercariae, especially when the life cycles of some of them are known and it is very likely that the adults of at least a few others have already been described and named. Accordingly, a system patterned after that of Sewell has been adopted in this report but using, however, the singular, *Cercaria caribbea*, rather than the plural form, and numbering species in the order in which they are considered.

Known life histories, including those determined in connection with this investigation, and clues to others afforded by the survey of adult trematodes and the ecology of larval and adult stages make fairly evident the family or superfamily status of most of the cercariae here reported. It therefore seems time to abandon the complex and often artificial system of classifying cercariae in the manner begun by Lühe (1909) and extended by Sewell (1922). That system, which has been followed by most subsequent investigators, the writer included, has outlived its usefulness to the extent that present knowledge makes it possible to assign larvae to adult groups. It is evident that to classify cercariae according to suckers and caudal structure leads in many instances to groupings that hardly could be more artificial. For example, if cercariae now evidently the larvae of the opisthorchioid superfamily were classified according to the prevailing scheme, they would find themselves scattered through the following categories: *Monostome*, *Distome*, *Gymnocephalous*, *Leptocercous*, *Pleurolophocercous*, *Parapleurolophocerous*, *Rhopalocercous* (*Magnacercous*), and *Zygocercous* (*Rattenkönig*). Yet all but two of these categories (*i.e.*, *Pleurolophocercous* and *Parapleurolophocercous*) contain some larvae whose adults probably are not at all closely related to the Opisthorchioidea. Although caudal structure is important and may be rather constant in certain groups, the tail is subject to diverse ornamentation and other modifications, especially reduction or even loss, the occurrence of which in almost any family would not be surprising to anyone familiar with known life histories. Thus the terms *Microcercous* and *Cercariaeum*, although useful in a descriptive sense, are outmoded as categories in classifying larval trematodes.

On the other hand, the cercarial body is much more conservative than the tail and, when features of body structure are considered collectively, it is found that larvae of the same family or superfamily have in common characteristics possessed by the cercariae of no other such group. Another important and often neglected clue to affinities between larval trematodes is the type of molluscan host. There may be a few exceptions but, as a rule, cercariae that are similar, especially in the appearance of the tail, but develop in such distantly related mollusks as gastropods and lamellibranches are to be viewed with extreme suspicion, so far as their being larvae of the same family is concerned. On the other hand, the occurrence of cercariae with very dissimilar tails in mollusks of the same class may, in some instances, give strong support to a close relationship indicated by a critical study of body structure.

## METHODS

Most of the molusks were collected from shallow water, either individually by hand, or with the aid of a scraper net. Seaweed, stones, and other objects were shaken in a pail of water to dislodge minute species which were later picked from the sediment taken to the laboratory in bulk. On several occasions, a dredge was used in deeper water where bivalves mostly were obtained. Once, a great many still living mollusks were cast up on the beach by a storm. When plentiful and fairly hardy, they were isolated in finger bowls of sea water and examined under the dissecting microscope at intervals during several days to detect spontaneously emerging cercariae. If delicate or scarce, the mollusks were usually cracked and examined, and those that shed cercariae spontaneously were eventually cracked to observe developmental stages of the parasites.

Living cercariae were studied in the usual manner, both with and without neutral red as an intra-vitam stain. Unless otherwise noted, descriptive matter is based on cercariae that emerged spontaneously from the host. When properly taken, measurements are important specific characters that are useful in recognizing a species when it is found again. Because of their activity, living cercariae are extremely difficult to measure unless restrained by coverglass pressure and, because of the difficulty of judging or controlling such pressure, measurements of living material are variable and unreliable in the hands of different workers. To a less degree, the same is true of stained specimens, especially those having vesicular tissues which often tend to collapse during preparation, especially in clearing agents. To avoid these sources of error, the following method was used throughout the study to prepare material that was to be measured. It is a rapid method and gives results that can be reproduced by anyone. Several active, freshly emerged cercariae were transferred to a few drops of water in a small Stender dish, and sea water heated to boiling was poured quickly into the dish. When the larvae had settled to the bottom, several were transferred to a slide with enough water to prevent the exertion of pressure on them when the cover glass was added. The hot water caused instantaneous contraction of all muscles, with the result that almost all species died moderately extended and were very uniform in size and shape. In the case of a few species that tended to die with the body somewhat flexed ventrally and hence presented a side view when mounted for taking measurements, the water was withdrawn very slowly with filter paper and the process followed under the dissecting microscope. As this was done, at least a few of the cercariae usually rolled until the dorsal or ventral surface was uppermost. If this did not occur, the cover glass was then manipulated with the larvae under light but sufficient pressure to roll them into the desired position. Water was then added to the edge of the cover glass and, as its pressure was relieved, the larvae would return to their original size and shape. Measurements of body length were always taken in a straight line. The chief disadvantage of this method is that thick-bodied species are sometimes rendered so opaque that some structures such as the pharynx are difficult to see and measure. Rarely, however, was it necessary to resort to larvae handled otherwise for measuring such structures.

All drawings of entire cercariae are free-hand and to scale from numerous measurements and, as a rule, all cercariae of the same type are drawn to the same scale to show relative sizes at a glance. Details were added free-hand from observations on living specimens and, in some instances, on stained whole mounts and sections that are the only material suitable for precise observations on genital primordia in cercariae. Small, free-hand sketches of entire cercariae not drawn to scale are included to show the resting attitude, appearance while swimming, and shape of living specimens in some instances in which the appearance is considerably altered when the larvae are killed in hot water.

All measurements are in millimeters.

### Key to Marine Cercariae of Puerto Rico

1. Oral sucker with a stylet, tail not forked, but slender and unadorned or stumpy and glandular.......... 23
   Oral sucker without a stylet, tail variable in structure.......... 2
2. Tail bifid distally to form equal furcae that may be simple, flattened, or long and filamentous.......... 3
   Tail not divided distally into 2 equal parts.......... 4
3. Excretory vesicle single, U-shaped with long voluminous arms and filled with concretions; eyespots absent, caudal excretory tubule wide and prominent to tips of furcae, tail without flame cells; host a lamellibranch.......... 41
   Excretory system variable, either with a single vesicle which is never U-shaped with long arms, or a pair of vesicles which in biocellate, cystocercous, forms are elongate and may converge so closely at the posterior end of the body as to give the impression of a single V-shaped vesicle; caudal excretory tubule not conspicuous; tail usually with flame cells.......... 42

**Monostome cercaria**

4. Ventral sucker absent; triocellate with a median eyespot between 2 lateral ones; posterior end of body with a pointed projection at each side of tail. Excretory system with concretions and forming a continuous circuit reaching almost to oral sucker. Body filled with cystogenous glands.......... *Cercaria caribbea* I

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   Ventral sucker present or absent; eyespots if present, always 2 in number, posterior end of body without pointed projections. Ringlike excretory circuit absent.......5
5. Excretory vesicle thin-walled and essentially Y-shaped with short stem and long arms reaching oral sucker; shape masked, however, by complex lateral branching of both stem and arms, giving body a vacuolated appearance from end to end.......... 11
   Excretory vesicle variable; if Y-shaped, always definite in contour, without lateral diverticula of both stem and arms.......... 6
6. Excretory vesicle small, thin-walled; main excretory canals reach sides or oral sucker, turn and extend posteriorly to or beyond mid-level of body before receiving secondary tubules, usually with refractile concretions and sometimes with diverticula in forebody.......... 7
   Excretory vesicle variable; main excretory canals rarely reach oral sucker and, when they do, neither contain prominent concretions nor, on turning posteriorly, reach mid-level of body before receiving secondary tubules..........13
7. Anterior end with a collar bearing spines; eyespots absent.......... 8
   Anterior end without a collar bearing spines; eyespots present or absent.......... 9

**Echinostome cercariae**

8. Collar with a single row of 23 spines, no additional angle spines at ventral termination of row on each side; main excretory canals with diverticula in forebody, filled with refractile concretions. Caudal fins absent.......... *Cercaria caribbea* II
   Collar with a row of 27 and 2 additional angle spines on each side (total 31). Main excretory canals without diverticula in forebody; refractile concretions large and conspicuous. A tail with a dorsal and a ventral fin.......... *Cercaria caribbea* III

**Echinostomelike gymnocephalous cercariae**

9. Eyespots and brownish body pigment present. Spines not evident on forebody.......... *Cercaria caribbea* IV
   Eyespots and body pigment absent, forebody with spines.......... 10

10. Posterior end of tail invaginated.......................... *Cercaria caribbea* V
Posterior end of tail not invaginated.......................... *Cercaria caribbea* VI

### Gymnocephalous "troglotrematid" cercariae

11. Ventral sucker poorly developed, easily overlooked; more evident in embryonic stages .......................... *Cercaria caribbea* VII
Ventral sucker well developed, almost the size of oral sucker.......................... 12
12. Arms of excretory vesicle diverge at a level well posterior to ventral sucker; yellowish pigment concentrated in mid-line anterior and posterior to that sucker.......................... *Cercaria caribbea* VIII
Excretory vesicle almost reaches ventral sucker before divergence of arms is evident; pigment diffuse.......................... *Cercaria caribbea* IX

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13. Eyespots present or absent, ventral sucker well developed. Oral sucker not protrusible and without spines on dorsal lip. Intestine usually developed; excretory vesicle thin- or thick-walled.......................... 36

### Opisthorchioid cercariae

Eyespots present, ventral sucker rudimentary or lacking. Oral sucker protrusible, with cephalic gland ducts opening into crypt above mouth; dorsal lip with spines, intestine undeveloped; excretory vesicle with wall of thick, granular cells.......... 14
14. Tail slender, with a dorsal and ventral fin continuous around distal tip and sometimes also a pair of lateral fins. Excretory vesicle wider than long and at least slightly concave anteriorly; cephalic glands usually not extending to posterior end of body.... 15
Tail very long and swollen, usually its width exceeding that of body. Caudal fins absent. Excretory vesicle spherical, cephalic glands extend to posterior end of body.. 20
15. Tail with a pair of lateral fins as well as a dorsoventral one...... *Cercaria caribbea* X
Tail without lateral fins, dorsoventral fin usually well developed but may be very narrow and inconspicuous.......................... 16
16. Tail set in a socket at posterior end of body. Fin shorter on ventral than dorsal side and narrows ventrally without again increasing in width before terminating anteriorly although cuticle of base of tail may be elevated. Tail sigmoid or straight at rest.. 17
Tail inserted ventrally, at a distance from posterior end of body which is flattened and overhangs base of tail. Fin along entire ventral length of tail, widest distally, becoming very narrow and then widening slightly before terminating anteriorly. Tail looped over dorsally when at rest.......................... 18
17. Body over 0.15 and tail about 0.3 long. Dorsoventral fin well developed. Circumoral spines not enlarged. Cephalic gland ducts in 3, 4, 4, 3 arrangement.......................... *Cercaria caribbea* XI
Body less than 0.11 and tail not over 1.0 long; fin rudimentary. Two rows of enlarged circumoral spines interrupted ventrally. Cephalic gland ducts in 5, 2, 2, 5 arrangement.......................... *Cercaria caribbea* XII
18. Anterior portion of body containing oral sucker retractile with formation of a secondary fold of body wall so that the oral sucker can be drawn back to a level between or even posterior to eyespots in living specimens.......................... 19
Anterior end of body not retractile with the formation of a secondary fold of body wall .......................... *Cercaria caribbea* XIII
19. Ten pairs of cephalic glands, ducts 4, 6, 6, 4.......................... *Cercaria caribbea* XIV
Seven pairs of cephalic glands, ducts 3, 4, 4, 3.......................... *Cercaria caribbea* XV
20. Body spines enlarged to form 2 prominent ventrolateral patches near mouth........ 21
Ventrolateral spines near mouth no larger than adjacent body spines. Body and proximal part of tail arched ventrally. From a proximal swollen region, the tail narrows abruptly to a long attenuated end by means of which the larvae become entangled to aggregate in spherical clusters.......................... *Cercaria caribbea* XVI
21. Tail with abrupt expansion a short distance from body, base with black pigment extending as distinct lines into anterior part of expansion which is especially muscular .......................... *Cercaria caribbea* XVII
Tail without an abrupt expansion but may become wider than body.......................... 22
22. Tail wider than body at a distance from base and with a zone of purplish pigment about as long as distance zone is from base of tail.......................... *Cercaria caribbea* XVIII
Tail narrower than body and not pigmented.......................... *Cercaria caribbea* XIX

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23. Tail elongate, slender, used in swimming.......................... 28

**Opecoelid cercariae**

Tail short and glandular, larvae unable to swim .......... 24
24. Seven pairs of cephalic glands with a single bundle of ducts on each side .......... 25
Less than 7 pairs of cephalic glands with ducts in either one or two bundles on each side .......... 26
25. Body less than 0.031 and tail less than 0.04 in length .......... *Cercaria caribbea* XX
Body over 0.36 and tail over 0.050 long .......... *Cercaria caribbea* XXI
26. Cephalic glands 4 pairs .......... 27
Cephalic glands 5 pairs with 3 ducts in lateral and 2 in median bundle on each side .......... *Cercaria caribbea* XXII
27. Cephalic gland ducts on each side in 2 bundles of 2 each; tail narrow and elongate. Slender .......... *Cercaria caribbea* XXIII
Cephalic gland ducts in a single bundle of 4 on each side; tail short and wide. Robust species .......... *Cercaria caribbea* XXIV
28. Ventral sucker present and partly embraced by short arms of the excretory vesicle which is Y-shaped with long stem. Stylet and cephalic glands inconspicuous, the latter being obscured by dense cystogenous glands .......... 35

**Microphallid cercariae**

Ventral sucker undeveloped, excretory vesicle short U- or V-shaped; conspicuous stylet and cephalic glands of which there are always 4 pairs, usually of 2 types. Cystogenous glands not evident .......... 29
29. Stylet laterally compressed, over 0.025 long; all cephalic glands about equally conspicuous and with ducts opening in a longitudinal row on each side near tip of stylet .......... *Cercaria caribbea* XXV
Stylet not laterally compressed, less than 0.025 long. Two pairs of cephalic glands more anterior, large, and with conspicuous ducts that turn ventrally to open at sides of stylet; posterior cephalic glands less well defined and with delicate ducts opening at tip of stylet .......... 30
30. Stylet without a distinctly sclerotized shaft but tapering from near the base. Anterior cephalic glands near oral sucker and with wide ducts .......... 31
Stylet with shaft; anterior cephalic glands near or even posterior to mid-level of body .. 33
31. Body less than 0.1 long; dorsal side of stylet concave but less so than ventral side from lateral aspect .......... *Cercaria caribbea* XXVI
Body at least 0.1 long; stylet curved ventrally so that in lateral aspect, dorsal side is convex, ventral concave .......... 32
32. Body slender, 3 to 4 times as long as wide; tip of stylet slightly blunt in lateral aspect .......... *Cercaria caribbea* XXVII
Body stout, less than 3 times as long as wide; tip of stylet acute from all aspects .......... *Cercaria caribbea* XXVIII
33. Stylet not swollen at junction of shaft and point. Cephalic glands posterior to middle of body .......... *Cercaria caribbea* XXIX
Stylet enlarged at junction of shaft and point; cephalic glands near middle of body, their ducts not especially sinuous .......... 34
34. Stylet 0.018 to 0.020 long, anterior cephalic glands large and conspicuous; tail longer than body .......... *Cercaria caribbea* XXX
Stylet 0.016 to 0.017 long, cephalic glands small and inconspicuous; tail shorter than body .......... *Cercaria caribbea* XXXI

**Plagiorchid cercariae**

35. Body over 0.2 and tail over 0.12 long; stylet bullet-shaped and sclerotized only about half its length. Three pairs of cephalic glands opening near tip of stylet .......... *Cercaria caribbea* XXXII
Body less than 0.16 and tail less than 0.1 long. Stylet almond-shaped and sclerotized most of length. Six cephalic gland ducts on each side with a bundle of 3 opening at tip of stylet, the remaining 3 with openings scattered from anterior end of body to posterior edge of ventral sucker .......... *Cercaria caribbea* XXXIII

**Hemiuroid cercaria**

36. Tail with a conspicuous basal enlargement from which a long process extends at an acute angle to body .......... *Cercaria caribbea* XXXIV

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Tail without a conspicuous basal enlargement and more or less in line with body .... 37

37. Tail well developed, with prominent lateral structures in the form of fins, fingerlike processes or setae.......................................................... 39

### Monorchiid cercariae

Tail either well developed and with indistinct cuticular lappets along sides or reduced to a mere knob. Body extremely spinose. Host a lamellibranch.................. 38

38. Tail well developed, eyespots present; excretory vesicle short and sac-shaped, with wall of large granular cells and receiving main excretory tubules at its anterior end........ ............................................................ *Cercaria caribbea* XXXV

Tail a minute knob of cells, eyespots absent; excretory vesicle elongate, tubular, reaching or overlapping ventral sucker and receiving main tubules laterally.............. ............................................................ *Cercaria caribbea* XXXVI

### Megaperid cercaria

39. Eyespots present, tail with a pair of notched, undulant lateral fins and a low ventral fin difficult to observe. Excretory vesicle with rather thin but granular wall, and Y-shaped with short arms deflected ventrally, their tips receiving main excretory tubules ............................................................ *Cercaria caribbea* XXXVII

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Eyespots present or absent, tail with lateral appendages not in the form of a continuous fin and lacking a ventral fin; excretory vesicle with a thin, nongranular wall...... 40

### Haplosplanchnid cercaria

40. Tail with paired lateral fingerlike processes and a terminal one; eyespots present; intestine rhabdocoele and prominent; excretory vesicle small, spherical and without concretions. Host a gastropod.......................... *Cercaria caribbea* XXXVIII

### Fellodistomatid cercariae

Tail with a number of lateral finlets, each consisting of setae of various lengths joined by a transparent web; eyespots absent; intestine with 2 ceca; excretory vesicle U-shaped with arms extending anterior to ventral sucker. Host a lamellibranch...... ............................................................ *Cercaria caribbea* XXXIX

41. Tail large, well developed; stem with paired lateral multiple setae and furcae with long single setae............................................ *Cercaria caribbea* XL

Tail small, poorly developed; spinose but lacking setae of any type on stem or furcae.. ............................................................ *Cercaria caribbea* XLI

### Bucephalid cercaria

42. Tail with a short, wide stem and long, slender furcae that can be extended until filamentous and many times length of body. Tail stem without flame cells. Anterior organ not connected with digestive system, the mouth being ventral with a pharynx and rhabdocoele intestine. Host a lamellibranch.............. *Cercaria caribbea* XLII

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Tail stem longer than wide, with flame cells, and always longer than furcae, which are not especially extensible. Host a gastropod.................................. 43

43. Base of tail not enlarged to form a caudal vesicle into which body can be withdrawn. Furcae not especially flattened but may have fins............................ 49

### Bivesiculid cercariae

Base of tail enlarged to form a conspicuous caudal vesicle into which body may be withdrawn. Body always with eyespots and a pair of long tubular excretory vesicles expanded anteriorly and each continuous with a separate caudal tubule, there being no fusion between right and left halves of the system in either body or tail.......... 44

44. Tail stem measured from attachment to caudal of vesicle to base of furcae is at least 1.4 times length of vesicle.................................................. 45

45. Tail stem exclusive of vesicle less than 0.5 long; vesicle not bell-shaped; *i.e.*, with a distinct posterior flange in either living or heat-killed specimens.................. 46

Tail stem exclusive of vesicle over 0.5 long; vesicle with a posterior flange.......... 47

46. Tail with yellowish pigment only and that concentrated in anterior half of vesicle...... ............................................................ *Cercaria caribbea* XLIII

A wide band of diffuse, purplish-black pigment about midway of tail stem and a reticulum of such pigment in the posterior end of the caudal vesicle.... *Cercaria caribbea* XLIV

47. A lateral and a dorsoventral pair of black, ocelluslike pigment masses in the caudal vesicle.......................................... *Cercaria caribbea* XLV
No discrete masses of black pigment, the caudal vesicle being a deep, purplish-red color ............................................... *Cercaria caribbea* XLVI
48. Larger species, tail stem over 0.4 long. Vesicle inflated to several times volume occupied by body. No prominent pigmentation in any part of tail...................... ............................................... *Cercaria caribbea* XLVIII
Small species, tail stem from base of vesicle to base of furcae being less than 0.3 long. Vesicle largely filled by retracted body and bright red in color; stem and furcae pink ............................................... *Cercaria caribbea* XLVII

### Schistosomatid cercaria

49. Eyespots present, pharynx absent, ventral sucker well developed. Furcae not over half length of tail stem and without fins. One pair of flame cells in tail stem........ ............................................... *Cercaria caribbea* XLIX

### Cyathocotylid cercariae

Eyespots absent, pharynx present, ventral sucker embryonic. Furcae at least half as long as tail stem and with fins. Three pairs of flame cells in tail stem........ 50
50. Body at least 0.25 and tail stem over 0.50 long. Distinct caudal bodies along excretory tubule of tail stem. Caudal flame cells well separated along stem. . *Cercaria caribbea* L
Body less than 0.225 and tail stem less than 0.35 long. Caudal bodies not evident. Flame cells in tail stem crowded close together and near its base. . *Cercaria caribbea* LI

## MONOSTOME CERCARIA

Sewell (1922) classified as monostome cercariae diverse types of larvae that lack a ventral sucker. Since that time, life-history studies have demonstrated beyond question that the adults of many such larvae are distomatous. There simply is a delayed appearance of the ventral sucker, associated perhaps with the remarkable modifications of the genitalia in the adults. Furthermore, critical study of their larvae has revealed that many of them actually posses a partially developed ventral sucker that is minute and could easily be overlooked. Conversely, it is known that a distome cercaria may become a monostome adult (see Stunkard, 1934) and that some families of digenetic trematodes contain both monostomatous and distomatous species. This diversity within a natural group seems to be associated with the habitats of its members within the host and with the development of secondary types of adhesive organs. Species living in secluded and protected parts of the host tend to lose their adhesive organs and others that do not inhabit such sites have had the ventral sucker largely or entirely replaced by other adhesive structures; *e.g.*, the gonotylgenital pit complex of certain heterophyids and the tribocytic organ in some of the cyathocotylids.

By excluding from the monostome category, then, such cercariae as larvae of the Opisthorchioidea, Microphallidae, and Cyathocotylidae, there remains a natural, well-defined group of which a single representative was found in this study. The following species is typical of that group in every respect.

### Cercaria caribbea I (FIGURE 1)

Specific diagnosis: large, triocellate monostome with finely spined body cuticle. Caudal insertion somewhat ventral; tail well developed, its proximal region with 2 or 3 pairs of large yellowish cells, which become paler posteriorly, and flanked by a pair of pointed, evidently glandular processes of the body;

posterior end of tail slightly inflated in lateral aspect. Body with a reticulum fine pigment granules denser in lines posterior to eyespots and scarce or lacking in two longitudinal bands on ventral surface. Mouth with a distinct oral ring. Excretory vesicle thin-walled, with spherical base and a pair of arms filled with concretions and extending anteriorly to unite in a loop near oral sucker; a tubule extends from posterior end of vesicle into base of tail. Internal structures obscured by dense cystogenous glands with cytoplasmic rodlets filling all but extreme anterior end of body. Ducts of 3 pairs of cephalic glands open at anterior margin of oral sucker. Measurements: body 0.562 to 0.588 long and 0.190 to 0.195 in maximum width about one-third body length from anterior end; tail 0.50 to 0.55 long and 0.047 to 0.050 wide near base; oral sucker 0.040 to 0.042 long and 0.048 to 0.050 wide. Develop in simple rediae with fairly long intestine in branchial region of snail host and encyst on or beneath operculum.

Host: *Cerithidea costata.*

Locality: Mudflat at head of Sucia Bay adjacent to the *salinas*, Cabo Rojo.

This cercaria swims smoothly but rather clumsily, and is photopositive, especially when obtained by cracking the snail. Such cercariae also are prone to encyst on the bottom of the dish. The repeated finding of metacercariae attached to the operculum of the snail host suggests, however, that the life cycle is completed in the manner described for fresh-water species of *Macravestibulum*; *i.e.*, by the ingestion of snails rather than metacercariae in the open or on vegetation. The mud flat where infected snails were collected is covered with water only at high tide and then rarely to a depth of over two or three inches near the margin, where snails were abundant. As many shore birds feed there on snails and fiddler crabs, it is very likely that the adult of *Cercaria caribbea* I is a monostome that was found in the spotted sandpiper, *Actitis macularia*, and the rufous-naper plover, *Pagolla wilsonia rufinucha*, specimens of which were collected from the flat. The ecology of the larva suggests that its adult is not one of the monostomes for which marine turtles are notorious, or either *Pleurogonimus candibulus* or *Barisoma erubescens*, two monostomes that were common in angelfishes.

## ECHINOSTOME CERCARIAE

In this category are included larvae with a collar of spines and other features making them very similar to well-known echinostome cercariae. The two species reported here have in common the following characters, which need not be repeated in the specific diagnosis of each form:

Distome cercariae with well-developed suckers and tail. Anterior end with a collar bearing a row of spines interrupted by a broad space ventrally. Eyespots absent. Prepharynx about as long as pharynx, esophagus long, reaching almost to ventral sucker. Body dense with cystogenous glands. Excretory vesicle thin walled, small, and spherical or sacculated, with a short median anterior stem from which a pair of prominent arms with refractile concretions extend almost to anterior tip of body, bend on themselves and return to or beyond the mid-level of the body, where each divides into an anterior and a posterior collecting tubule. Produced by rediae with a collar and "feet," develop in gastropod, and often encyst in these snails or lamellibranchs.

### Cercaria caribbea II (FIGURES 2 and 3)

Specific diagnosis: echinostome cercaria of medium size with collar of 23 spines in a single row. Excretory vesicle slightly sacculated and muscular, excretory canals sinuous posterior to ventral sucker and with numerous diverticula between pharynx and ventral sucker. Body crowded with cystogenous glands with finely granular, not rodlike, cytoplasm. Glands in oral sucker with a single duct on each side opening anteriorly and, between these openings, the pores of 3 additional pairs of gland ducts that extend posteriorly and become obscured by the cystogenous glands and excretory diverticula. Tail simple, without fins. Measurements: body 0.377 to 0.40 long and 0.142 to 0.145 in maximum width at about mid-level; tail 0.430 to 0.435 long and 0.038 to 0.041 wide near base. Oral sucker 0.046 to 0.048 long and 0.047 to 0.050 wide; ventral sucker 0.064 to 0.066 long, 0.067 to 0.070 wide and situated at beginning of posterior half of body; pharynx 0.024 long and 0.022 wide. Redia with prominent circular muscle bands and orange pigment concentrated between them, especially near posterior end. Birth pore with protruding lips just posterior to collar. Intestine may be over 0.7 long but does not reach "feet" by some distance in older rediae.

Host *Cerithidea costata.*

Locality: Mud flat at head of Sucia Bay, Cabo Rojo.

This cercaria swims in the manner typical of echinostome larvae; *i.e.*, with the body contracted and tail lashing smoothly. It exhibited no phototactic tendencies. The metacercaria was found a few times in the molluscan host but evidently is commoner in small lamellibranchs abundant on the mud flat. The cyst is thin-walled and easily ruptured. What may well be the adult, an echinostome with 23 collar spines, was recovered from the intestine of *Pagolla wilsonia rufinucha* taken while feeding on the mud flat.

### Cercaria caribbea III (FIGURES 4 and 5)

Diagnosis: Echinostome cercaria of large size, with collar of 27 spines in a row and 2 additional angle spines on each side (total 31). Body with prominent transverse rows of spines becoming indistinct posterior to ventral sucker. Tail with dorsal and ventral fin along most of its length. Anterior end of body with sensory papillae. Excretory vesicle spherical, arms expanded posterior to ventral sucker, without diverticula in forebody, and filled with irregular concretions. Embryonic excretory pores at sides of tail a short distance from body. A ciliated excretory tubule was observed close to posterior end of body on each side. Oral sucker with several glands and slender ducts opening anteriorly; no other cephalic glands or ducts observed. Cystogenous glands with granular cytoplasm. Measurements: body 0.884 to 0.904 long and 0.28 in maximum width about 2/3 length from anterior end; tail 0.58 to 0.59 long and 0.053 to 0.055 wide near base, maximum width of caudal fin dorsally 0.024, ventrally 0.032. Oral sucker 0.049 to 0.051 long and 0.06 wide; ventral sucker 0.096 long and 0.110 wide, situated at about mid-level of body; pharynx 0.035 long and 0.024 wide. Redia may attain a length of over 2.0 with birth pore near collar and long intestine with yellow globules reaching the "feet." Encysts in the molluscan host after swimming period.

Host: *Cerithidea costata.*

Locality: Mud flat at head of Sucia Bay, Cabo Rojo.

This species swims in a typically echinostome manner and exhibits no phototactic behavior. Its metacercaria occurs in almost every snail of the species in which the cercaria develops and the cyst separates cleanly from the snail's tissues when teased apart. There usually are 1 to 4 cysts per snail, but over a dozen were found occasionally. The cyst is spherical, and the wall thick and transparent. It is extremely difficult to rupture and peels away in layers when rolled under pressure between a slide and cover glass. In the birds examined, no adult trematodes with collar spines and excretory system agreeing with this cercaria were found despite the abundance of metacercariae. This was true also of another larva, *Cercaria caribbea* XLI, whose metacercaria, like this one, was present in almost every snail of the species concerned here. This observation suggests that the birds taken at the mud flat and examined either did not feed on this snail or were unsuitable hosts for the adults of these trematodes. Thus it is likely that when the adult of *Cercaria caribbea* III is found, that of *Cercaria caribbea* XLI will be found also. All evidence points to a migratory bird, probably a duck, as ducks are abundant on the mud flat during the winter. Unfortunately, the rich trematode fauna of this locality was not discovered until after a number of birds, including ducks, had migrated.

## ECHINOSTOMOID CERCARIAE

The three species included in this category agree with the general diagnosis of echinostome cercariae given above except that a collar of spines is lacking, the esophagus may not be long, and one species possesses eyespots and body pigment. All three, however, are evidently closely related to the echinostomes, and their adults probably occur in birds.

### Cercaria caribbea IV (FIGURES 6 to 9)

Diagnosis and measurements: body 0.410 to 0.465 long and 0.172 to 0.185 in maximum width at about mid-level; tail 0.856 to 0.890 long and 0.058 to 0.072 wide at a short distance from base. Oral sucker 0.065 long and 0.095 to 0.110 in maximum width, including the lappet on each side; ventral sucker spherical, 0.046 to 0.048 in diameter, poorly developed and well within posterior half of body. Eyespots subspherical to oval, 0.027 to 0.031 in diameter. Prepharynx evidently lacking, pharynx 0.025 to 0.027 long and 0.029 to 0.030 wide. Cuticle thin and evidently without spines; beneath it is scattered brownish pigment, often concentrated in longitudinal streaks posterior to eyespots; pigmentation interrupted dorsally above oral sucker, where there is a slight transverse ridge devoid of pigment (FIGURE 7). Oral sucker with several glands along its posterior wall and fine ducts opening at anterior end. Two additional pairs of cephalic glands have ducts opening ventrally on each side of the mouth. Cystogenous glands of two types, a dorsal layer with cytoplasm containing distinct rodlets and a ventral with finely granular cytoplasm. Prepharynx lacking, esophagus long, reaching almost to ventral sucker, intestinal ceca extend to posterior end of body. Excretory system with a prominent atrium between base of body and tail and, anterior to this, a very short tubular vesicle from which the expanded excretory trunks filled with concretions extend anteriorly to sides of oral sucker. Embryonic pores at sides of tail well removed from base. Redia with feet but lacking collar; birth pore not seen, intestine about half as long as older redia and yellow in color. Redial excretory pores well anterior to mid-level, flame cell pattern of redia partly determined.

Host: *Turritella exoleata.*

Locality: Mayagüez Bay.

This species was found in three of 162 specimens of *T. exoleata* cast up on the beach from deeper water by a storm, but was never recovered from numerous *T. exoleata* collected from Boquerón Bay. The presence of eyespots and body pigment, shape of the oral sucker and excretory vesicle, and apparent absence of a prepharynx and body spines make this species sufficiently different from others placed in this category to make knowledge of its life history particularly desirable. Such information might give an important clue to relationships between the Echinostomatoidea and some other group of adult trematodes.

### Cercaria caribbea V (FIGURE 10)

Diagnosis: body 0.630 to 0.654 long and 0.192 to 0.220 in maximum width at about mid-level; tail 0.445 to 0.480 long and 0.061 to 0.063 wide just posterior to basal taper. Oral sucker spherical, 0.057 to 0.060 in diameter, ventral sucker 0.078 to 0.080 in diameter, situated about middle of body length. Eyespots and pigmentation lacking. Cuticle thick, granular, with transverse rows of spines seeming to extend to posterior end ventrally but not dorsally. Anterior end with sensory papillae, and a row of about 14 pores, the openings of ducts leading posteriorly to cephalic glands obscured by the dense cystogenous glands which contain cytoplasmic rodlets. Prepharynx a little shorter than pharynx, esophagus moderately long but terminating well anterior to ventral sucker, the intestinal ceca extend almost to posterior end of body. Excretory vesicle spherical, thin-walled; excretory trunks not expanded and with a few tiny droplets instead of refractile concretions. Tail simple, vacuolated in appearance, and with invaginated posterior tip. Develop in plump rediae with yellow intestine about half their length which may be up to 1.3. Collar and "feet" not evident. Encyst in the open.

Host: *Cerithidea costata.*

Locality: Mud flat at head of Sucia Bay, Cabo Rojo.

In structure and behavior, this species resembles very closely the cercaria of *Parorchis acanthus* and the fresh-water species, *Cercaria megalura* Cort. All of these larvae have the invaginated tip of the tail and other structural features in common, encyst in the open, and swim in a characteristic manner. The tail and body extend greatly and the two lash together with whiplike movements that are not at all effective in propelling the larva. Occasionally it settles to the bottom, attaches by the suckers, and moves in an exploratory manner. After a time, it encysts, the cystogenous material spreading out over the substratum beyond the part occupied by the body, thus forming a thin irregular extension of the flattened underside of the metacercaria. Exclusive of this extension, the cyst is slightly oval in shape and measures approximately

0.295 by 0.280. The adult of this larva may well be a species of *Parorchis* found in the cloaca of birds taken while feeding at the mud flat where infected snails were collected. Another possibility is a species of *Cloacitrema* which was found more often than *Parorchis* in such birds. These genera differ principally in the absence of a collar of scalelike spines in *Cloacitrema*.

### Cercaria caribbea VI (FIGURES 11 and 12)

Diagnosis: body 0.575 to 0.595 long and 0.165 to 0.178 in maximum width just anterior to ventral sucker; tail 0.465 to 0.493 long and 0.043 to 0.047 wide just posterior to taper toward attachment. Oral sucker 0.052 to 0.055 long and 0.058 to 0.060 wide; ventral sucker 0.068 to 0.071 long and 0.073 to 0.075 wide; pharynx 0.027 to 0.030 long and 0.023 to 0.025 wide. Cuticle thick and granular, with a slight ridge encircling oral sucker and, posterior to this, transverse rows of broad spines which seem to disappear before reaching ventral sucker. Numerous papillae with short bristles are scattered over body. Oral sucker with glands and fine ducts opening in a row of about 10 pores at anterior edge of sucker. Two pairs of cephalic gland ducts with openings near these pores extend posteriorly to join granular gland cells in anterolateral body region of each side. Body posterior to pharynx filled with cystogenous glands containing cytoplasmic rodlets. Prepharynx about length of pharynx, esophagus moderately long but terminating well anterior to ventral sucker. Intestinal crura, long and slender, reach almost to posterior end of body. Excretory vesicle slightly crenate, ascending trunks sinuous, not greatly enlarged, filled with small spherical concretions; recurrent tubule with tufts of cilia and each receiving just posterior to ventral sucker an anterior and a posterior collecting tubule. Excretory formula probably $2[(6 + 6 + 6) + (6 + 6 + 6)]$; each anterior and posterior collecting tubule is joined by 3 flame cell groups but the number per group was verified only for the anteriormost and posteriormost group in the body. Tail simple, with the embryonic excretory pores opening laterally in its basal portion. Development in rediae up to 1.0 long and with collar, feet, and yellowish pigment in the body wall.

Host: *Cerithium muscarum*.

Locality: Salinas Bay near Punta Jagüey, Cabo Rojo.

Although similar and probably closely related to the preceding cercaria, this species is readily distinguished by the lack of a posterior invagination of the tail and, especially, its swimming activity, which is very different, being much like that of the echinostome species described above. It stops occasionally, and the body stretches at full length. Decaudation was frequently noted. There was no obvious phototactic behavior. The definitive host of this species probably is a bird, and the adult trematode should be closely related to *Parorchis* and *Cloacitrema*.

### "TROGLOTREMATID" CERCARIAE

Assigned to this category are three species that are similar and, although they lack lateral caudal fins, they are otherwise very similar to *Cercaria rhodometopa* Perez as redescribed by Stunkard (1932). Later, Rothschild (1935) described six species, all with caudal fins, and set up a "Rhodometopa group." She mentioned *Cercaria purpuracauda* Miller (1925b) in connection with the group, but that species is to be aligned with *Cercaria caribbeae* XVI–XIX and is not at all closely related to the *rhodometopa* type.

Several features of these cercariae, especially the excretory system, make it possible to exclude as their adults all trematodes of which the author is aware except species of *Renicola*, a genus thus far allocated to the family Troglotrematidae by most helminthologists. These trematodes inhabit the kidneys and ureters of aquatic birds, especially piscivorous species, and what could hardly be other than metacercariae of one of the larvae found was recovered from the liver of a gobiid fish. Very recently, Timon-David (1953) has also found such a metacercaria in a sardine, and he attributed the infection to a larva of the *rhodometopa* type. That these cercariae may be larva of the genus *Renicola* has been suspected by at least three investigators, Stunkard (1946), Wright (1953), and the author. It is interesting to note that each evidently arrived at this opinion independently. Confirmation of this conclusion would prove that the family Troglotrematidae, as constituted at present, is yet another unnatural grouping of genera, as is indeed suggested to some extent by certain features of adult morphology. It is obvious that a natural family would not include trematodes having such dissimilar larvae and life histories as have been reported for species of *Troglotrema*, *Sellacotyle*, and *Paragonimus* on the one hand, and what would seem to be the situation in respect to species of *Renicola* on the other.

A general characterization of the larvae in this category will avoid repetition in each of their descriptions:

Distome cercariae with small, sometimes poorly developed suckers and a slender tail that may be greatly attenuated. Eye spots lacking, although body may contain pigment. No prepharynx. Cuticle spinose but no collar or enlarged spines anteriorly. Excretory system characteristic; thin-walled, Y-shaped vesicle with short stem and long arms extending almost to anterior end of body; stem and arms complexly branched with lateral outpocketings giving the body a vacuolated appearance. Minute spherical granules in the excretory fluid move back and forth with body activity. Embryonic excretory pores at junction of body and tail. Fine ducts of numerous cephalic glands open along the anterior margin of oral sucker and cystogenous glands fill almost all space not occupied by the excretory reticulum. Develop in simple, elongate sporocysts, observed in one species to have a terminal birth pore. Hosts are marine prosobranch snails.

### Cercaria caribbea VII (FIGURES 13 to 16)

Specific diagnosis: body 0.295 long and 0.10 to 0.11 in maximum width slightly anterior to mid-level; tail 0.35 to 0.36 long and 0.041 to 0.048 in maximum width near base, as wide as body in contracted living specimens. Oral sucker spherical, 0.030 to 0.032 in diameter; ventral sucker hardly recognizable in emerging larvae, more distinct in living cercarial embryos where it measures about 0.014 in diameter under considerable cover-glass pressure; pharynx a very small and poorly developed mass of cells just posterior to oral sucker. Cuticle thin, entire body spinose, more distinctly so anteriorly. Oral sucker with distinctive orange-yellow pigment; a few similar pigment granules just posterior to oral sucker but body otherwise colorless. Over 24 cephalic gland ducts open on dorsal lip, gland cells and their position not distinct but the ducts are in four loose bundles, the median pair of which converges posterior to oral sucker. Excretory vesicle divided well posterior to ventral sucker. Flame cell pattern of mature cercaria not determined, but embryology of system indicates there are 6 flame cell groups on each side, 3 on the anterior and 3 on the posterior tubule. The point at which main tubule joins branched arm of vesicle on each side evidently near ventral sucker and not at anterior end of arm as in echinostomes. Sporocysts yellow, nonmotile, and in branchial region of mollusk. Difficult to separate from host's tissues and seem to be enclosed in a secondary covering, possibly a paletot.

Host: *Tegula fasciata.*

Locality: Boquerón Bay.

This species swims at the surface of the water with frequent rest periods, during which it is suspended with the body and tail coiled in a manner (FIGURE 15) distinguishing this species from others of its type. There is no noticeable phototactic behavior.

### Cercaria caribbea VIII (FIGURES 17 and 18)

Specific diagnosis: body 0.445 to 0.485 long and 0.126 to 0.148 in maximum width near ventral sucker; tail 0.376 to 0.397 long and 0.038 to 0.040 in maximum width near base; with a granular central core which expands at distal end. Oral sucker 0.032 to 0.034 long and 0.028 to 0.031 wide; ventral sucker 0.031 to 0.033 in diameter, its anterior margin 0.205 to 0.225 from anterior end of body; pharynx 0.010 to 0.012 in diameter. Cuticle rather thick, spinose over entire body, and with a few papillae anteriorly. Yellowish pigment is concentrated in median region ending with an especially distinct aggregation just anterior to bifurcation of excretory vesicle. Numerous poorly defined cephalic glands in a median mass just anterior to ventral sucker with fine ducts opening on dorsal lip of oral sucker. Bifurcation of excretory vesicle far posterior to ventral sucker. Excretory formula probably $2[(3 + 3 + 3) + (3 + 3 + 3)]$, although it was verified for only 4 flame cell groups. Sporocysts rather plump and with much orange-yellow pigment.

Host: *Cerithium algicola.*

Locality: Dredged off Joyuda.

Like *Cercaria caribbea* VII, this species has a distinctive behavior. It swims actively near the surface in a jerky manner and then rests with the posterior end of the body bent strongly ventrad, it and the tail forming a loop, while the anterior end is expanded until narrow and pointed (FIGURE 18). No phototactic behavior was observed.

### Cercaria caribbea IX (FIGURES 19 and 20)

Specific diagnosis: body 0.355 to 0.384 long and 0.090 to 0.093 in maximum width slightly anterior to ventral sucker; tail greatly attenuated, 0.510 to 0.530 long and 0.019 to 0.021 wide near base, motile but does not lash; oral sucker 0.032 long and 0.028 to 0.030 wide; ventral sucker 0.028 to 0.032 in diameter and 0.147 to 0.156 from anterior end of body; pharynx 0.009 to 0.011 in diameter. Cuticle 0.004 thick, crackled in texture and with transverse rows of spines distinct anterior to ventral sucker; a few papillae near anterior end. Yellow pigment granules rather generally scattered in forebody but more concentrated in median line posterior to ventral sucker. Numerous cephalic glands in median region anterior to ventral sucker with fine ducts opening at anterior edge of oral sucker. Sacculated stem of excretory vesicle extends almost to ventral sucker before bifurcating. Sporocysts elongate, with terminal birth pore.

Host: *Cerithium variabile.*

Locality: Lagoon behind reef, Punta Arenas.

This species was found once in one of 24 snails cracked and examined. It did not emerge spontaneously from any of several thousand snails from the same place that were examined by isolation. The larvae were fully developed, but apparently this species is unable to swim. It stretched to full length and then contracted, and the tail did not lash but moved feebly in a manner suggesting that the larva may become entangled in vegetation or debris. It was in the lagoon where this species occurred that gobiid fishes were found to have in their livers encysted metacercariae of a larva that could scarcely be other than of this type.

## OPISTHORCHIOID CERCARIAE

Ten species are assigned to this group. The first 6 are so much like larvae whose life cycles are well understood that there is little doubt that their adult stages are members of the superfamily Opisthorchioidea. *Cercaria caribbea* X, is parapleurolophocercous, while the next five are pleurolophocercous, although the caudal fin is barely recognizable in the minute *Cercaria caribbea* XII. Since no opisthorchiids were recovered from any of the hosts examined, and since heterophyids were abundant in birds, it seems probable that the first three cercariae, all found in snails from a mud flat frequented by birds, are larvae of the Heterophyidae. The next three, *Cercariae caribbeae* XIII–XV, are larvae of the Cryptogonimidae, the adults of which are intestinal parasites of fishes. One was determined to be the larva of a species of *Metadena*, and the adult of another seems certain to belong to that genus. The third probably is the larva of a species of *Siphodera*, which was found on several occasions; this cercaria is almost indistinguishable from the larva of *Siphodera vinaledwardsii*, a common species in New England waters.

Assigned to this group also are 4 species, *Cercariae caribbeae* XVI–XIX, which were very puzzling to the writer for a long time. In body structure, they resemble rather closely that of cercariae known to be larval opisthorchioids. The chief differences are in shape of the excretory vesicle, and the presence of conspicuous ventrolateral patches of spines near the mouth in 3 of the 4 species. The tail is utterly different, however, from that of any cercariae demonstrated to be larval opisthorchioids. Instead of being slender and provided with fins, the tail is unadorned in these forms and may be enormously swollen and strikingly pigmented. Furthermore, one species is zygocercous. It was not until some of the larger shore birds were collected and examined that the writer had any idea as to what the adults of these cercariae might be. Among the parasites collected from those birds were several species belonging to the heterophyid subfamily Galactosominae. Birds that were found to harbor these trematodes in large numbers feed primarily off shore and along reefs where the snails infected with magnacercous larvae were found. Such birds have an entirely different helminth fauna from that of sandpipers and plovers that frequented the mud flat at Cabo Rojo, where all opisthorchioid larvae except these peculiar forms and the three cryptogonimid cercariae were found. In pleurolophocercous and parapleurolophocercous larva, the excretory vesicle is transversely elongate and usually somewhat U-shaped. In their adults, at least a suggestion of this shape is usually retained, possible exceptions being some of the Opisthorchiidae, a family not represented in the writer's collection of trematodes from Puerto Rico. On the other hand, the excretory vesicle of the Galactosominae is sac-shaped or tubular, rounded anteriorly, without a suggestion of a bifurcation and, hence, more likely to be derived from the spherical vesicle possessed by the four species of magnacercous larvae than from the vesicle of other types of opisthorchioid cercariae. It is for these reasons, and because it has not proved possible to account for their adults otherwise, that the 4 magnacercous species are believed likely to have, as their adults, trematodes of the subfamily Galactosominae, family Heterophyidae. Miller (1925b) described a very similar larva, *Cercaria purpuracauda*, from Puget Sound, and it is evident from his brief reports on larval trematodes from Tortugas, Fla., that cercariae of this type, possibly including some of the species found in Puerto Rico, occur there also.

Because of the great variation in caudal structure, a general diagnosis of the opisthorchioid group is restricted to the morphology of the body and host relationships:

Biocellate cercariae developing in simple rediae in the digestive gland of prosobranch gastropods. Oral sucker a protrusible penetration organ with spines on the dorsal lip. When the oral sucker is retracted, a fold above the mouth forms a crypt into which open the ducts of cephalic glands, usually 7 pairs. Ventral sucker rudimentary or lacking; digestive system usually undeveloped posterior to pharynx. Excretory vesicle thick-walled and granular, embryonic excretory pores in proximal region of tail. Encyst as a rule in fishes; adults in piscivorous vertebrates. Metacercariae of some related freshwater forms in amphibians.

### Cercaria caribbea X (FIGURES 21 to 23)

Specific diagnosis: parapleurolophocercous, with body 0.117 to 0.125 long and 0.060 to 0.063 in maximum width at about mid-level. Tail 0.224 to 0.234 long and 0.018 to 0.020 wide near base, exclusive of lateral fins, which extend from near proximal end of tail for a distance of 0.126 to 0.130 and have a maximum width of 0.014. Dorsal and ventral fin continuous around tip of tail and about half total length of tail; maximum width of fin 0.014 dorsally and 0.009 ventrally; lateral fins conspicuously undulant, vertical fin with a few plicae. Oral sucker 0.022 to 0.024 in diameter; pharynx 0.008 long and 0.012 wide, posterior to eyespots, which are cuboid, with a length of about 0.009;

other pigment absent. Ventral sucker undeveloped. Entire body spinose and with several delicate setae. Oral sucker with a single row of 6 spines on dorsal lip; 7 pairs of cephalic glands between pharynx and posterior end of body with ducts in bundles of 3, 4, 4, 3. Nerve trunks distinct, cystogenous glands not distinct. Genital primordium a conspicuous mass anterior to excretory vesicle.

Host: *Cerithidea costata.*

Locality: Mud flat at head of Sucia Bay, Cabo Rojo.

The adult of this species probably is one of the heterophyids occurring in birds which feed at the mud flat.

### Cercaria caribbea XI (FIGURE 24)

Specific diagnosis: cercaria typical of the pleurolophocercous group. Body 0.164 to 0.166 long and 0.052 wide, tail 0.295 to 0.315 long and 0.020 wide near base exclusive of distinct cuticular swelling enclosing that region; dorsal fin about three fourths length of tail and a maximum of 0.020 wide, continuous around tip with much shorter ventral fin attaining a maximum width of 0.013. Oral sucker 0.023 to 0.026 in diameter, ventral sucker undeveloped, pharynx embryonic and just posterior to level of the small eye spots. Body with scattered brownish pigment granules more numerous posteriorly at sides of tail socket. Cuticle of body ringed transversely, entirely spinose, and with several posteriorly curved setae and longer, more delicate straight ones. Spines on dorsal lip of oral sucker in 2 rows, about 4 in the row nearest mouth and about 8 in the other. Seven pairs of cephalic glands in midbody anterior to excretory vesicle, their ducts in bundles of 3, 4, 4, 3 opening above mouth; numerous refractile cystogenous glands scattered posterior to pharynx. Excretory vesicle slightly U-shaped, 2 flame cells per group with at least 5 (probably 6) groups on each side.

Host: *Cerithidea costata.*

Locality: Mud flat and adjacent mangrove swamp, head of Sucia Bay, Cabo Rojo.

In structure, swimming activity, and behavior, this species is much like others of its type, whether fresh-water or marine. It swims in a jerky manner for a short time and then rests body downward with the tail sigmoid in shape. If shadowed while at rest, it responds by swimming, and almost all the cercariae in a dish soon collect at the side most strongly illuminated. The species was not common in snails on the open mud flat but occurred in a high incidence of those collected in an extensive growth of mangroves nearby. Through this growth are narrow lagoons where herons and clapper rails feed in large numbers, whereas these birds were rarely seen on the open mud flat where sandpipers, plovers, and least terns were far more abundant.

### Cercaria caribbea XII (FIGURES 25 to 27)

Specific diagnosis: extremely minute pleurolophocercous species, body 0.010 to 0.0106 long and 0.047 to 0.057 wide slightly posterior to mid-level. Tail 0.082 to 0.098 long and 0.014 wide near base, straight rather than sigmoid when at rest; caudal fin very narrow and seen as a line along tail extending slightly beyond the tip. Oral sucker 0.02 in diameter, pharynx 0.005 to 0.007

and slightly anterior to eyespot level. No general body pigmentation; eyespots spherical, 0.004 to 0.005 in diameter. Entire body covered with rather long, sharp spines, those in 2 circumoral rows being enlarged and interrupted ventrally; long delicate setae more numerous anteriorly. Dorsal lip of oral sucker with 3 rows of spines in 4, 5, 4 arrangement. Seven pairs of cephalic glands anterior to excretory vesicle with ducts in bundles of 5, 2, 2, 5. Body with numerous refractile globules, especially posteriorly. Excretory vesicle not appreciably U- or V-shaped, but decidedly wider than long. A ventral protuberance in region of genital primordium may be an embryonic ventral sucker. Rediae up to 0.275 long and with a prominent birth pore near anterior end.

Host: *Cerithidea costata.*

Locality: Mud flat and adjacent mangrove swamp at head of Sucia Bay, Cabo Rojo.

This minute cercaria was found to be very common. It is a poor swimmer, hardly rising from the bottom. It moves a short distance and rests body downward and flexed, with the tail almost straight. A minute heterophyid with two rows of circumoral spines was found in birds shot on the mud flat and may well be the adult of this cercaria.

The next three species are much alike and, while they are of the pleurolophoocercous type, they differ from the preceding two in structure and behavior. The tail has a bilobed ventral fin, the proximal widening being very inconspicuous, however, and the tail instead of being set in a socket at the end of the body, is inserted ventrally, so that the posterior end of the body overhangs the base of the tail. The resting attitude (FIGURE 33) is a diagnostic feature of marine cryptogonimid larvae. The tail, instead of being sigmoid or straight as in other pleurolophocercous species, coils dorsally to form a loop. The excretory vesicle is farther anterior than in other species, and it also tends to be more U-shaped. These cercariae swim in a jerky manner back and forth across the dish from the lighter to the darker side and, although they rest at intervals, swimming periods are usually longer than in other pleurolophocercous larvae.

### Cercaria caribbea XIII (FIGURE 28)

Specific diagnosis: body 0.142 to 0.158 long and 0.0062 to 0.0067 in maximum width. Tail 0.192 to 0.213 long and 0.022 wide at posterior end of body. Maximum width of dorsal fin, 0.005; of distal widening of ventral fin, 0.011; of proximal widening, 0.006. Oral sucker 0.024 long and 0.022 wide, pharynx an embryonic mass 0.012 in diameter in living specimens under cover-glass pressure. Ventral sucker barely visible, 0.004 in diameter. Eyespots cuboid, 0.009 long; general body pigmentation lacking. Cuticle of anterior end with spines that apparently fade out posterior to eyespots. Seven pairs of cephalic glands in midbody with ducts passing dorsal to oral sucker in 2 flattened bundles to separate and open in a 3, 4, 4, 3 pattern above mouth. Cystogenous glands granular, generally scattered beneath cuticle posterior to eyespots. Retrorse setae and longer straight ones along sides of body. Anterior end of body not capable of secondary retraction. Excretory formula $2[(2 + 2) + (2 + 2)]$.

Host: *Bittium varium* on algae.

Locality: Punta Mojá Casabe, Boquerón Bay.

This species is so similar to the cercaria of *Siphodera vinaledwardsii* that it seems certain to be the larva of what may be the same trematode found in fishes seined in shallow water. It is at least a species of *Siphodera*, but whether it is *S. vinaledwardsii* remains to be determined when the collection of adult trematodes is studied further.

### Cercaria caribbea XIV (FIGURES 29 and 30)

Specific diagnosis: body 0.155 to 0.164 long and 0.063 in maximum width; tail 0.222 to 0.237 long and 0.022 to 0.024 wide at posterior end of body; maximum width of dorsal fin, 0.012; of distal widening of ventral fin, 0.020; and of proximal widening, 0.005. Oral sucker 0.028 long and 0.024 wide; eyespots cuboid, about 0.013 long and 0.010 wide. Anterior end of body capable of retracting to form a collarlike fold. Cuticle spinose and with setae along sides of body, shorter ones more ventrad, longer more dorsad. Ventral sucker not observed. Cephalic glands, 10 pairs, in mid-body, with ducts opening in a 4, 6, 6, 4 arrangement above mouth. Excretory pattern not determined.

Host: *Bittium varium*.

Locality: Punta Mojá Casabe, Boquerón Bay.

This species is unusual in respect to the number of cephalic glands, 10 pairs, whereas all other opisthorchioid cercariae reported here have 7 pairs. The characteristic secondary retraction of the anterior end marks this cercaria as being the larva of a species of *Metadena*, a cryptogonimid genus possessing this distinctive feature also in the adult stage.

### Cercaria caribbea XV (FIGURES 31 and 32)

Specific diagnosis: body length 0.171 to 0.205, maximum width 0.090 to 0.094. Tail 0.28 to 0.30 long, 0.023 to 0.026 in maximum width near posterior end of body; maximum width of dorsal fin, 0.015; distal widening of ventral fin, 0.018; and of proximal expansion, 0.003. Oral sucker 0.036 long and 0.032 wide, ventral sucker undeveloped. Eye spots cuboid, 0.010 by 0.007 to 0.009. Cuticle spinose anteriorly and with delicate setae, especially along sides of posterior half of body. Anterior end capable of secondary retraction. Seven pairs of cephalic glands with ducts in a 3, 4, 4, 3 arrangement above mouth. Rediae up to 0.5 long, body wall with golden-brown granules and eyelash-like pigment crescents sometimes closed to form circles. Excretory formula $2[(2 + 2) + (2 + 2)]$.

Host: *Cerithium variabile*.

Locality: Widely found wherever snail host occurred.

This species was one of the commonest encountered, although its incidence was much higher at some places than others. It is the larva of *Metadena adglobosa* Manter, an extremely common parasite of the schoolmaster, *Lutjanus apodus*, a snapper abundant in shallow water. It was determined experimentally that this species encysts in gerrids and, when the metacercaria in these fishes is eaten by snappers, especially the schoolmaster, it develops to maturity in the intestine.

### Cercaria caribbea XVI (FIGURES 34 to 37)

Special diagnosis: magnacercous opisthorchioid cercaria with proximal portion of tail swollen, and the distal region long and slender; in living specimens, enlarged portion sigmoid in lateral aspect and strongly arched at anterior end. The larvae become entangled by the attenuated ends of the tails to form zygocercous clusters that separate slowly from masses of cercariae emerging at aperture of host's shell. Proximal portion of tail vacuolated, the vacuoles being outlined anteriorly by a reticulum of purplish-black pigment that fades out a short distance from the body and reappears in its most concentrated form in the narrow posterior portion of the tail, giving the center of the cluster a dark shadow in contrast to the general lavender color of the whole in reflected light. Body 0.10 to 0.11 long and 0.050 to 0.054 wide; tail about 1.4 long and 0.135 to 0.140 in maximum width of expanded portion just before abrupt taper toward posterior filament. This portion collapses, and the tail contracts on aging. Oral sucker 0.027 to 0.030 long and 0.025 to 0.026 wide; eyespots spherical, about 0.007 in diameter; pharynx an embryonic mass just posterior to eyespots. Spines over entire body, but not enlarged to form ventrolateral patches near mouth. Cuticle thin and evidently without setae, no general body pigmentation. Dorsal lip of oral sucker with 2 rows of about 12 spines each. Seven pairs of large cephalic glands filling most of the body from pharyngeal level to posterior end; their ducts in 4 bundles anteriorly, opening in a 3, 4, 4, 3 pattern. Develop in simple rediae up to 0.9 long and without an obvious intestine.

Host: *Cerithium algicola.*

Locality: Bar and reef off Punta Arenas near Joyuda.

This species provides additional evidence that the so-called zygocercous or *Rattenkönig* group of cercariae is not a natural one, and that aggregation of cercariae might occur as a specialized adaptation in almost any group. In this species, clusters are not as firmly united as in *C. clausii* Monticelli, but can be pulled apart with needles, the individuals assuming a position resulting in two spherical masses. Cercariae united in small numbers as well as many separate larvae were observed. Although the cercariae move in the clusters, no concerted swimming activity was observed, and the individual larva is decidedly a poor swimmer in contrast with the other magnacercous species described below. Miller (1930) reported aggregation of a similar cercaria from Tortugas, Fla.

### Cercaria caribbea XVII (FIGURES 38 to 40)

Specific diagnosis: magnacercous with distinctive tail and pigmentation thereof; tail narrower than body for a short distance from base, then with an abrupt swelling and again narrowing distally. Proximal region with dense black pigment from which paired lateral, a single dorsal, and branched ventral streaks extend into beginning of expanded portion. Laterally, this region is yellowish due to concentration of longitudinal muscle fibers, which are much less numerous elsewhere. Body 0.16 to 0.17 long and 0.055 to 0.062 in maximum width; tail 1.0 to 1.1 long and up to 0.13 in maximum width of expanded position. Oral sucker 0.023 to 0.026 in diameter, pharynx embryonic, more distinct in embryos than fully developed larvae, ventral sucker absent. Eyespots about 0.005 by 0.008. Scattered golden-brown pigment granules beneath cuticle. Entire body spinose with spines in transverse rows, those ventrolateral to mouth enlarged to form a conspicuous patch on each side with approximately 6, 5, and 4 spines in successive rows. Dorsal lip with 2 rows of about 7 spines each. Seven pairs of cephalic glands with ducts in 4 bundles anteriorly, arranged 3, 4, 4, 3. Numerous conspicuous cystogenous glands obscure internal structures posterior to eye spots. Rediae with a birth pore near anterior end.

Host: *Turritella exoleata.*

Locality: Mayagüez Bay.

This species was found by cracking snails cast up on the beach by a storm. Obtained in this manner, the larvae were photopositive and swam actively with figure-8 lashing of the enormous tail. Numerous specimens of *T. exoleata* obtained elsewhere, mostly in Boquerón Bay, were negative for this or other species of larval trematodes.

### Cercaria caribbea XVIII (FIGURES 41 to 46)

Specific diagnosis: magnacercous opisthorchioid cercaria with an extremely long tail widest at a distance from body and not abruptly enlarged. Tail lavender in reflected light, and with a pigmented zone about as long as its distance from body. Body 0.275 to 0.295 in length and 0.087 to 0.090 in maximum width. Tail 3.25 to 3.6 long and 0.116 in maximum width at the pigmented zone. Oral sucker, 0.036 to 0.039 in diameter; eyespots cuboidal about 0.013 by 0.011. Entire body with spines, the enlarged ones in each ventrolateral adoral patch, being about 4 and 5 in the first two rows; posterior to these rows, the enlarged spines become smaller and difficult to count as they blend into adjacent body spines. Dorsal lip of oral sucker with 3 rows of spines of apparently 4, 4, and 3 spines respectively. Pharynx embryonic, body posterior to it almost filled with 7 pairs of large cephalic glands with ducts opening anteriorly in the usual 3, 4, 4, 3 arrangement. Brown pigment granules scattered throughout body but much more concentrated near and anterior to eyespots. Excretory vesicle spherical, thick-walled; main excretory tube on each side extends anteriorly well beyond mid-level of body, where it receives an anterior and a posterior collecting tubule. Complete excretory pattern $2[(3 + 3 + 3) + (3 + 3 + 3)]$. A redia containing a single redia in addition to cercarial embryos observed. Redial excretory pattern $2[(1 + 1 + 1) + (1 + 1 + 1)]$.

Host: *Cerithium algicola.*

Locality: Boquerón Bay.

This species is an active swimmer, moving with the main part of the tail lashing smoothly in a figure 8, and the posterior end greatly attenuated and trailing while the body is strongly flexed on the base of the tail and often grasping it with the oral sucker (FIGURE 43). The excretory pattern was studied in greater detail in this species than others because it was larger and easier to observe. Study showed that the embryology of the excretory system is very similar to that of pleurolophocercous species, as FIGURES 44 and 45 show. It is worth noting that the excretory pattern is basically the same in the redia as in the cercaria, there being a single flame cell in the redia for each flame cell group in the cercaria.

### Cercaria caribbea XIX (FIGURES 47 to 49)

Specific diagnosis: magnacercous opisthorchioid cercaria with tail elongate but not swollen or noticeably pigmented. Body 0.15 to 0.16 long and 0.050 to 0.055 in maximum width; tail 0.485 to 0.515 long and 0.024 to 0.026 in maximum width a short distance posterior to attachment. Oral sucker 0.025 long and 0.020 wide, 0.024 thick dorsoventrally. Eyespots cuboid, about 0.007 by 0.008; general body pigmentation lacking. Body spinose, enlarged cuticular spines in ventrolateral patches in three rows of about 7, 6, and 5 spines in successive rows. Dorsal lip of oral sucker apparently with 7 spines in anterior and 6 in posterior row. Pharynx embryonic, posterior to eyespots; body posterior to pharynx largely filled with 7 pairs of cephalic glands, the thick-walled, spherical excretory vesicle, and cystogenous glands. Cephalic gland ducts anteriorly in 4 bundles opening in the common 3, 4, 4, 3 arrangement. Rediae up to 0.7 long.

Host: *Cerithium variabile.*

Locality: La Gata, off Parguera and Salinas Bay, near Punta Jagüey, Cabo Rojo.

This species swims in a characteristic manner, in which eel-like undulations of the tail increase in amplitude until the larva is moving in a figure 8 (FIGURE 43). With decrease in swimming activity, this process is reversed.

## OPECOELID CERCARIAE

Cercariae of the Opecoelidae are a well-recognized type, of which 5 representatives are reported here. Adult opecoelids are one of the commonest types of trematodes in marine fishes, and the cercariae included here can be but a small fraction of those that must occur in the vicinity. The larvae are characterized by the following general diagnosis:

Distome cercariae with short, truncate tails and, hence, unable to swim. Tail either cuplike, with glands in the wall, or filled with a core of glands, with ducts forming a papilla that may or may not be protrusible. Devoid of eye spots, pigmentation, or body spines, although the cuticle may be thick and provided with papillae-bearing delicate setae, presumably sensory in function. Suckers well developed, oral sucker with a stylet set vertically in its anterior wall. A variable number of cephalic glands are situated between pharynx and ventral sucker, their ducts extending forward in 1 or 2 bundles on each side and opening near tip of stylet. Cystogenous glands not obvious; parenchyma often with refractile spherules resembling oil droplets. Excretory vesicle sac-shaped, wall with thick granular cells. On each side, main excretory tubule extends from vesicle anteriorly an appreciable distance and receives an anterior and a posterior collecting tubule, each of which is joined by 2 flame-cell groups, usually 2 flame cells per group. Excretory pores lateral at junction of body and tail. Cercariae develop in elongate sporocysts in prosobranch gastropods and encyst in various animals, often crustaceans. Adults in intestine of fresh-water and marine fishes.

### Cercaria caribbea XX (FIGURES 50 to 52)

Specific diagnosis: opecoelid cercaria with a body length of 0.028 to 0.305 and maximum width of 0.118 to 0.126 at level of anterior margin of ventral sucker. Tail 0.033 to 0.035 long and 0.031 to 0.033 wide. Oral sucker 0.041 to 0.043 long and 0.046 to 0.049 wide, pharynx 0.023 in diameter, prepharynx about length of pharynx; ventral sucker 0.060 to 0.063 in diameter, with 6 papillae around opening and situated at about mid-level of body. Stylet poorly developed, 0.008 to 0.01 long. Cuticle thick, wrinkled, and with papillae set with setae along sides of body, 1 pair at prepharyngeal level and 3 pairs posterior to anterior margin of ventral sucker. Seven pairs of cephalic glands with ducts in a single bundle on each side. Numerous refractile globules rather evenly distributed throughout the parenchyma. Main excretory tubules leave vesicle some distance from its anterior end which is deflected to left of ventral sucker; excretory formula $2[(2 + 2) + (2 + 2)]$. Sporocysts up to 2.0 long and 0.225 wide, with reddish-brown pigment and estimated to contain over 50 advanced embryos and cercariae.

Host: *Diodora cayenensis.*

Locality: La Gata Island, off Parguera, and dredged off Punta Ostiones, near Joyuda.

### Cercarcia caribbea XXI (FIGURES 53 and 54)

Specific diagnosis: opecoelid cercaria with body 0.370 to 0.397 long and 0.10 to 0.103 wide at anterior edge of ventral sucker. Tail 0.063 long and 0.061 in maximum width. Oral sucker 0.057 to 0.059 long and 0.053 to 0.055 wide. Pharynx 0.022 to 0.025 in diameter, prepharynx about twice length of pharynx. Ventral sucker 0.062 to 0.065 long, with 6 papillae, and situated within posterior half of body. Stylet poorly developed, about 0.010 long, simple, and may be cast out by living cercaria. Cuticle of medium thickness, finely granular and with few papillae, but a single pair at sides of body near posterior end being observed. Seven pairs of cephalic glands with finely granular cytoplasm, just preacetabular in location, and with ducts in a single bundle on each side opening near tip of stylet. Main excretory tubule on each side extends anteriorly to a level about midway between pharynx and ventral sucker. Excretory formula $2[(2 + 2) + (2 + 2)]$. Sporocysts elongate sausage-shaped, up to 3.5 long, in digestive gland of host.

Host: *Astraea imbricata.*

Locality: La Gata Island, off Parguera.

This species was found but once, in one of several moribund snails that were cracked and examined. Only a few cercariae were alive and in good condition for study, but these, evidently, were fully developed.

### Cercaria caribbea XXII (FIGURES 55 to 58)

Specific diagnosis: opecoelid larva with a body length of 0.219 to 0.253 and a maximum width of 0.082 at or slightly anterior to mid-level; tail 0.025 to 0.026 long and 0.028 in maximum width, slightly narrower toward base. Oral sucker 0.043 long and 0.040 to 0.041 wide, ventral sucker 0.051 to 0.054 in diameter, near mid-level of body. Pharynx 0.023 to 0.025 in diameter and about that distance from oral sucker. Cuticle thick and uneven, with setae set in papillae scattered along sides of body from near anterior end to base of tail. Stylet simple, but 0.007 long. Five pairs of granular cephalic glands with ducts on each side in 2 bundles, 2 in median and 3 in lateral bundle. Refractile globules of various sizes extremely numerous posterior to ventral sucker, less abundant anterior to it. Wall of excretory vesicle with rounded cells protruding into lumen and containing cytoplasmic globules and granules of various sizes. Main excretory tubules ciliated, each receiving collecting tubules at about level of anterior edge of ventral sucker. Excretory formula $2[(2 + 2) + (2 + 2)]$. Sporocysts elongate sausage-shaped, up to 1.3 long, and with prominent blotches of orange-yellow pigment giving the whole an orange color.

Host: *Turbo castaneus.*

Locality: Joyuda.

### Cercaria caribbea XXIII (FIGURES 59 and 60)

Specific diagnosis: slender opecoelid larva with a body length of 0.225 to 0.240 and a maximum width of 0.045 to 0.046 at mid-level. Tail elongate for its type, with a glandular core in life and not cup-shaped, 0.035 long and and 0.017 wide; when heat-killed, the core may protrude 0.006 or more beyond length given. Oral sucker 0.031 in diameter, ventral sucker 0.030, situated well posterior to mid-level of body and protruded in heat-killed specimens. Prepharynx 0.055 to 0.058 long, pharynx 0.013 long and 0.015 wide. Stylet simple, 0.008 to 0.09 long. Cuticle not especially thick or uneven, with several papillae set with setae anterior to pharyngeal level. Four pairs of cephalic glands between pharynx and ventral sucker, with ducts in 2 equal bundles on each side. Excretory pattern not determined, with at least 3 flame cells on each side. Sporocysts in digestive gland of host, sac-shaped, up to 0.6 by 0.24 when measured alive under no pressure.

Host: *Nitidella cribraria.*

Locality: Rocky shore near lighthouse, Cabo Rojo.

### Cercaria caribbea XXIV (FIGURE 61)

Specific diagnosis: data are insufficient to give a satisfactory diagnosis of this species, known only from a single cercaria that emerged soon after the snail host was isolated. From that individual it was determined that in the species the cuticle is rather thick, the tail is very short and wide, the stylet is simple and poorly developed, and there are 4 pairs of cephalic glands with ducts in a single bundle on each side. The next morning after the snail was isolated, it was dead and badly decomposed. Other snails infected with this cercaria could not be found.

Host: *Tegula fasciata.*

Locality: Boquerón Bay.

## PLAGIORCHIOID CERCARIAE

Larvae of the superfamily Plagiorchioidea constitutes perhaps the largest group of fresh-water cercariae. They are much less common, however, in marine habitats. Nine species were found to develop in marine mollusks of Puerto Rico. Of that number, 7, *viz.*, *Cercariae caribbeae* XXV to XXXI, are larvae of the family Microphallidae. The determination of an additional life history in that group has further confirmed the pattern for the family, as have observations pointing to the solution of several others. Thus on the mud flat at Cabo Rojo, where 3 of the 7 species were found, fiddler crabs harbored the same number of metacercariae, and a variety of adult microphallids was obtained from birds that fed there. If time had permitted, it should have been a relatively simple matter to determine several microphallid life cycles. Although microphallid larvae are small and look alike, it is of interest to note that they can be separated into groups on the basis of stylet shape and features of the cephalic glands as utilized in the key. It seems very likely that these differences are correlated with generic differences in the adult stage, and that the solution of several life histories would accordingly aid in the interpretation of genera in this family, which is so interesting because of the structure of the genitalia, the diversity of which is unequalled by any other group of trematodes. The following general diagnosis applies to the microphallid larvae described below:

Small xiphidiocercariae with ventral sucker and pharynx undeveloped; oral sucker with poorly defined musculature, stylet prominent. Body spinose, tail with unarmed, ringed cuticle. Cephalic glands 4 pairs, usually 2 pairs of each of 2 types distinguished by their size, appearance, location, and the disposition of their ducts. One type usually anterior to other and with more prominent ducts separating anteriorly and again converging to open, usually not at the tip of the stylet. Other cephalic gland type more posterior as a rule, smaller, with more refractile cytoplasm, and less well defined, the ducts extending anteriorly together, usually close to the lateral ducts of the first type and opening at tip of stylet. Cystogenous glands not evident if present. Excretory vesicle short, U- or somewhat V-shaped when distended, and with excretory tubes entering the arms anterolaterally. Develop in sporocysts in prosobranch gastropods. Flame-cell pattern, where known, is $2[(1 + 1) + (1 + 1)]$. Species described below probably all encyst in crustaceans and develop to adults in the intestines of birds and, less often, of fishes.

### Cercaria caribbea XXV (FIGURE 62)

Specific diagnosis: monostome xiphidiocercaria large for its type. Body 0.158 to 0.162 long and 0.062 to 0.065 wide at about mid-level. Tail 0.185 to 0.120 long and 0.016 to 0.018 in maximum width. Oral sucker 0.044 to 0.046 long and about 0.035 wide. Stylet 0.028 to 0.030 long, laterally compressed and with blunt tip in lateral aspect. Cephalic glands in posterior half of body, and all four pairs more alike in size and appearance than in other species of the type. Openings of their ducts also distinctive, being in a row on each side of the stylet point with pores of the anteriormost pair of glands first, then, close together, those of the posterior two pairs followed by the openings of the next to the most anterior pair. Excretory pattern not determined.

Host: *Cerithidea costata.*

Locality: Mud flat at head of Sucia Bay, Cabo Rojo.

This species is a powerful swimmer for its type, staying close to the surface, with the body rotating slowly as the tail lashes vigorously. The cercaria pauses for short rests, during which the body may extend and contract once or twice before swimming is resumed.

If there is any correlation between size in larvae and adults, the adult of this cercaria may well be a species of *Levinseniella* found in the ceca of a sandpiper shot on the mud flat where this cercaria and a large metacercaria of *Levinseniella* in fiddler crabs are extremely abundant. This larva, however, is similar in several respects to the cercaria of *Gynaecotyla nassicola* and may have, as its adult stage, a species of *Gynaecotyla* that was found to occur in shore birds. It may be observed that *Cercaria caribbea* XXV and the genus *Gynaecotyla* are both distinctively different from other microphallid larvae and adults.

### **Cercaria caribbea** XXVI (FIGURES 63 and 64)

Specific diagnosis: monostome xiphidiocercaria with body 0.087 to 0.090 in length and 0.040 to 0.043 in maximum width. Tail 0.076 to 0.078 long and 0.006 to 0.008 in maximum width. Oral sucker 0.025 long and 0.022 wide. Stylet 0.015 to 0.016 long, sclerotized and tapering from near base to a sharp point; not decidedly curved ventrally, the dorsal edge being but slightly less concave than is the ventral side when observed in lateral aspect. Anterior 2 pairs of cephalic glands large, anterior to middle of body, and with wide ducts opening ventrally at about mid-level of oral sucker; posterior 2 pairs of cephalic glands smaller and poorly defined, their ducts opening at tip of stylet. Sporocysts oval-round, about 0.08 by 0.10.

Host: *Cerithium variabile.*

Locality: Widespread, especially abundant at Guaniquilla and Punta Arenas.

The life cycle of this species was determined. The cercaria penetrates and encysts in the blue crab, and the adult occurs in the intestines of fishes. Every blue crab examined contained hundreds of metacercariae.

### **Cercaria caribbea** XXVII (FIGURE 65)

Specific diagnosis: monostome xiphidiocercaria with slender body, 0.137 to 0.161 in length and 0.038 in width. Tail 0.084 to 0.093 long and 0.008 in maximum width. Oral sucker 0.030 to 0.034 long and 0.023 to 0.025 wide; stylet 0.019 long, sclerotized and tapering from near base, curved ventrad with tip slightly blunt in lateral aspect. Large cephalic glands anterior to middle of body, small ones at about mid-body level. Opening of ducts as in preceding species. Sporocysts up to 0.5 long and 0.023 wide.

Host: *Nerita tessellata.*

Locality: La Gata Island, off Parguera.

This species swims poorly and in a distinctive manner. Instead of the body being contracted or strongly flexed while swimming, it is C-shaped and rotates slowly and jerkily about the long axis as the tail vibrates rather weakly. The similarity of this species to the preceding one in respect to cephalic glands, stylet, and ecology suggests that the adult stage may occur also in a fish. Another such trematode was found during the study of fish parasites.

### Cercaria caribbea XXVIII (figure 66)

Specific diagnosis: monostome xiphidiocercaria with a body length of 0.106 to 0.118 and 0.055 in maximum width. Tail 0.095 to 0.103 long and 0.011 wide a short distance from base. Oral sucker 0.033 long and 0.029 wide. Stylet 0.016 to 0.018 in total length, with sclerotized point 0.012 to 0.013 in length and tapering to a sharp point from near base. Stylet distinctly curved ventrad. Cephalic glands as in the 2 preceding species except that the small posterior ones are close to the posteriormost of the larger glands.

Host: *Neritina virginea.*

Locality: Luquillo.

This species is the only cercaria that was found at a distance from the western coast of Puerto Rico and, although its host is a common snail there, examination of large numbers revealed no infections with larval trematodes of any kind. Similarity of this cercaria to the preceding two species suggests that it, too, may have an adult stage occurring in a fish.

### Cercaria caribbea XXIX (figure 67)

Specific diagnosis: monostome xiphidiocercaria with a body length of 0.102 to 0.110 and maximum width of 0.042 to 0.045. Tail 0.123 to 0.126 long and 0.009 wide near base. Oral sucker 0.022 to 0.024 long and with about the same width. Stylet 0.014 to 0.015 long, with straight, sclerotized shaft and short point turned ventrad. Cephalic glands close together in posterior half of body and with ducts more elongate and sinuous than in other species. Excretory vesicle not noticeably U-shaped. Flame-cell pattern not determined.

Host: *Cerithidea costata.*

Locality: Mud flat at head of Sucia Bay, Cabo Rojo.

This species is readily distinguished by the stylet and cephalic glands. Its adult seems most likely to be one of several microphallids recovered from birds collected on the mud flat.

### Cercaria caribbea XXX (figure 68)

Specific diagnosis: monostome xiphidiocercaria with a body length of 0.119 to 0.125 and a maximum width of 0.05; tail 0.166 to 0.174 long and 0.012 in maximum width. Oral sucker 0.029 to 0.031 long and 0.026 wide. Stylet 0.019 to 0.020 long, shaft sclerotized and enlarged at base of point which is turned somewhat ventrad. Cephalic glands in posterior half of body, ducts not especially sinuous. Excretory vesicle somewhat sacculated; flame-cell formula $2[(1 + 1) + (1 + 1)]$. Sporocysts more elongate than in other species.

Hosts: *Cerithium algicola* and *C. variabile.*

Localities: Boquerón Bay and Salinas Bay, Cabo Rojo.

### Cercaria caribbea XXXI (figure 69)

Specific diagnosis: rather slender, monostome xiphidiocercaria with a body length of 0.137 to 0.152 and maximum width of 0.042. Tail 0.075 to 0.085 long and 0.008 in maximum width near base. Oral sucker 0.032 long and 0.025 wide. Stylet 0.017 long, swollen ventrally at base of point which is not curved ventrally. Cephalic glands small, near middle of body. Excretory vesicle U-shaped, flame-cell pattern not determined.

Host: *Batillaria minima.*

Locality: Sucia Bay mud flat, Cabo Rojo.

It was observed that this species reacts to mechanical stimuli, such as touch and stirring the water, by cessation of swimming activity, often for several seconds. This behavior may well be an adaptation aiding its reaching the next host, probably a crab. Thus the cercaria would be carried passively into the gill chamber with the respiratory current and lodge between the gill lamellae, which it could then penetrate, reaching the preferred site of encystment by way of the circulation.

The two remaining plagiochioid cercariae differ from microphallid larvae in several respects, being very similar to *Cercaria parvicaudata* Stunkard and Shaw, 1931, and *Cercaria roscovita* Stunkard, 1932. In a restudy of the former species, Stunkard (1950) gave descriptions of the cephalic glands and excretory system in much greater detail than was observed by the author. Several factors, especially the ecology of the larvae, support Stunkard's view that their adults are to be sought in birds or perhaps mammals. The two species characterized below are very similar, and a general diagnosis can be given for them:

Distome, xiphidiocercariae with a small, poorly-developed stylet set horizontally in the oral sucker. Tail slender, unadorned, with ringed cuticle. Body spinose, filled with conspicous cystogenous glands that obscure all except ducts of cephalic glands. Excretory vesicle Y-shaped, with long stem almost reaching ventral sucker, which is partly embraced by the short arms of the vesicle. Main excretory tubules join stem close to base of arms; pattern probably same in species below as in *C. parvicaudata*, *i.e.*, with main tubules each receiving an anterior and a posterior tubule at level of ventral sucker and an empirical flame-cell formula of $2[(n + n + n) + (n + n + n)]$. Develop in sporocysts which are sometimes irregular in shape, closely adherent, and difficult to separate from tissues of the marine prosobranch snail, which serves as host.

### Cercaria caribbea XXXII (FIGURES 70 and 71)

Specific diagnosis: distome xiphidiocercaria. Body 0.215 to 0.225 long and 0.080 to 0.087 in maximum width near mid-level. Tail 0.128 to 0.135 long and 0.017 to 0.019 wide a short distance from base. Oral sucker 0.032 to 0.035 long and 0.030 to 0.032 wide, ventral sucker 0.032 to 0.036 in diameter. Pharynx not observed but probably present. Stylet about 0.012 long, bullet-shaped, sclerotized, and tapering about half its length. Body from midway between suckers to posterior end crowded with yellowish, granular cystogenous glands. Cuticle thin and with very distinct spines over entire body. Scattered refractile spherules throughout the parenchyma. Three cephalic gland ducts on each side.

Host: *Cerithidea costata.*

Locality: Mud flat at head of Sucia Bay, Cabo Rojo.

**Cercaria caribbea** XXXIII (FIGURES 72 to 75)

Specific diagnosis: distome xiphidiocercaria; body 0.130 to 0.152 long and 0.054 to 0.057 in maximum width at mid-level. Tail 0.090 to 0.095 long and 0.012 to 0.014 in maximum width near base. Oral sucker 0.022 to 0.024 in diameter, ventral sucker 0.025 to 0.028; no prepharynx, pharynx an embryonic mass attached to oral sucker. Stylet 0.008 to 0.010 long, sclerotized, and tapering from near base. In addition to 3 pairs of cephalic gland ducts opening at tip of stylet, there are 3 additional pairs, 1 opening at anterior end of body, 1 ventrally with pores far apart at the stylet level and a third pair with openings somewhat closer together on the ventral surface near the posterior margin of oral sucker (FIGURE 74). Granular cystogenous glands and minute refractile spherules essentially as in the preceding species.

Hosts: *Cerithidea costata* and *Batillaria minima*.

Locality: Mud flat at head of Sucia Bay, Cabo Rojo.

## HEMIUROID CERCARIA

Only one species of cercaria referable to the hemiuroid trematodes was found although adults of that group were extremely common in the marine fishes examined. From life-history studies, it is evident that hemiuroid cercariae are cystophorous; *i.e.*, the tail forms a hollow vesicle into which the body, of some species at least, may be withdrawn before escape from the snail host. A long, slender structure, usually called the delivery tube because of its function, also develops and is withdrawn into the vesicle which, in some forms, bears other peculiar and often striking appendages. In the 2 known life histories, the cercaria is ingested by copepods and, in the intestine, there occurs a sort of explosive process in which the delivery tube shoots out forcibly, and the body of the cercaria passes through it. Presumably, the tube may pierce the copepod's intestine, so that the cercarial body is deposited in the hemocoele of the copepod to develop into a large, unencysted metacercaria well advanced toward the adult stage. Although some of these cercariae can swim feebly by means of appendages on the caudal vesicle, others cannot, and the cercarial body would seem to be entirely passive in reaching and entering the second intermediate host, as indicated not only by its relationship to caudal structures and the manner of "excystation" but also by the fact that the body of described species is extremely poorly developed and without the usual aids to penetration. The form below differs in many respects from cystophorous cercariae having the above characteristics, as will be apparent from its description.

**Cercaria caribbea** XXXIV (FIGURES 80 to 88)

Specific diagnosis: cystophorous cercaria with body well developed and broadly joined to caudal vesicle into which it does not withdraw. Vesicle with two appendages; a posterior prolongation of the vesicle not set off from it, and a long, extremely motile appendage extending anteroventrally from the vesicle in an acute angle to the long axis of body. Body 0.548 to 0.585 long and 0.15 in maximum width just anterior to slight constriction between body and tail; cuticle spinose anteriorly. Caudal vesicle about 0.172 long and 0.140

wide, posterior appendage about length of vesicle. Ventral appendage 1.0 to 1.1 long and 0.067 to 0.070 wide near base. Suckers well developed, oral sucker 0.045 to 0.047 long and 0.044 wide, ventral sucker 0.063 in diameter, protrusible, and with opening surrounded by a circlet of radial spines. Prepharynx 0.085 to 0.090 long, pharynx 0.016 to 0.018 in diameter, esophagus very short, ceca voluminous sacs extending to extreme posterior end of body, possibly with posterior confluence. Prominent eyespots 0.015 to 0.016 long and 0.011 to 0.012 wide; yellow-orange pigment in hind body and caudal vesicle, pigment in body being concentrated in the denser parenchyma surrounding excretory bladder, a median strand from the vesicle to ventral sucker and a pair of strands extending anteriorly from anterolateral margins of excretory vesicle. Five pairs of conspicuous cephalic glands between eyespots and ventral sucker, ducts in 2 bundles on each side, a lateral with 3 ducts and a median with 2, opening at anterior margin of oral sucker. What may be cystogenous glands forms a dense zone of very minute, elongate, almost opaque bodies in a band extending from ventral sucker to excretory vesicle, and there are frequently detached areas of these bodies in lateral region posterior to others. Excretory vesicle thick-walled, with numerous columnar cells diminishing in height with distension of vesicle. Main excretory tubules extend from anterolateral margins of vesicle through parenchymal strands to slightly beyond pharynx, where each receives an anterior and posterior collecting tubule. Excretory pattern as observed $2[(3 + 4 + 4) + (4 + 4 + 4)]$, but cephalic glands and their ducts may have obscured flame cells that would make the number per group uniformly 4 flame cells. One flame cell in posterior group on each side with a long capillary and situated very near junction of body and tail but, apparently, never in the tail vesicle, which evidently is devoid of flame cells. Excretory tubules, capillaries, and flame cells largely restricted to strands of dense parenchyma mentioned above. From excretory vesicle, a narrow passage enters cavity of caudal bulb derived embryologically from enlargement of common caudal excretory tubule in base of tail, along with modification of that region to form the bulb or vesicle. Embryonic excretory pores open laterally on part of tail becoming the long ventral appendage. Develops in simple, elongate rediae with a short gut in digestive gland of host. Excretory pattern of redia $2[(1 + 1 + 1) + (1 + 1 + 1)]$, empirically the same as in the cercaria.

Host: *Pyrene mercatoria.*

Locality: Reef off Punta Arenas near Joyuda.

This species, one of the most unusual and interesting cercariae found in this study, has been reported in an abstract (Cable, 1952b). Unlike described larvae of its type, this form is an excellent swimmer by virtue of the long caudal appendage which, as embryological observations show (FIGURES 82 to 87), corresponds to the major portion of the tail in cercariae of other types. The larva is photopositive and swims toward the light in a jerky manner. The body is extremely motile. The behavior of the cercaria and the presence of eyespots, well developed suckers, and cephalic glands all suggest that this species, unlike related forms, takes an active part in seeking and penetrating the next host instead of depending passively on ingestion by it.

*Cercaria caribbea* XXXIV probably is the most primitive hemiuroid larva yet described. Morphologically, it is clearly intermediate to cercariae of the usual type and described cystophorous larvae, which probably are the most highly modified of all cercariae. Its morphology and embryology afford an interpretation of how the cystophorous type was derived from cercariae with a simple tail. They also deny an affinity between the hemiurids and trematodes of the order Strigeatoidea, as has been suggested. *Cercaria californiensis* Cort and Nichols, 1920, bears a superficial resemblance to certain larvae of that order, but the two paired long processes at the posterior end of the vesicle in that fresh-water species are to be interpreted as secondary structures.

Ornamentation of the tail in cystophorous cercariae varies remarkably from species to species, being very simple in the larva of *Lecithaster confusus*, as described by Hunninen and Cable (1943), and attaining perhaps its greatest complexity in *Cercaria sinitsini* Rothschild, 1938, in which the caudal vesicle bears five appendages. Sinitsin (1911) described two species, *C. sagittarius* and *C. laqueator*, in which there are four such appendages. Earlier, the author interpreted the long ventral appendage in *C. caribbea* XXXIV as the homologue of the delivery tube (appendage I of Rothschild, the "arrow" of Sinitsin). As FIGURES 82 to 87 show, however, that region bears the definitive excretory pores, and both Hussey (1941) and Sinitsin observed the pores to be on an appendate other than the delivery tube. It therefore seems evident that the ventral appendage in *C. caribbea* XXXIV corresponds to the excretory bulb of Hussey (appendage II of Rothschild; "ribbon" of Sinitsin). In this connection, it may be significant that the excretory bulb is the first appendage to develop in other species after demarcation of the body and tail occurs. Although that appendage may disappear later, it persists in several species and becomes as long as the delivery tube, or longer, in *C. laqueator*. All evidence indicates that the delivery tube grows out from deep within the caudal vesicle near its posterior end and, although its position and appearance before withdrawal into the vesicle are very remindful of the ventral appendage in *C. caribbea* XXXIV, that species evidently is so little specialized that a delivery tube or the homologue thereof has not yet developed. It is evident that the posterior prolongation of the vesicle corresponds to the "handle" of Hussey (appendages IV and V of Rothschild, the "cap" of Sinitsin) and that the species lacks a homologue of appendage III of Rothschild ("plume" of Sinitsin) as do many other species of cystophorous larvae.

As to the adult stage of *Cercaria caribbea* XXXIV, one can but guess and eliminate certain possibilities on the basis of cercarial structure. It seems impossible, for example, that the adult could belong to one of the more familiar genera included in the family Hemiuridae in the restricted sense of Dollfus (1932, 1940). Not only do members of that group lack remnants of eyespots but, also the excretory vesicle narrows anteriorly to form a median tube that is often of considerable length. In almost all hemiurids, there are other features of the excretory system such as an anterior commissure and cross-connections elsewhere that scarcely can be harmonized with features of *C. caribbea* XXXIV.

It was at first thought likely that the species might be the larva of *Hirudinella*, a genus of giant trematodes for which Dollfus (1932) erected a separate family. The shape of the cercarial body, especially after decaudation, and the voluminous ceca are very remindful of *Hirudinella*. It was found also in very young specimens in that genus that the two are reconcilable in respect to the excretory vesicle and relationship of the main tubules to it. No trace of eyespot pigment, however, could be found in such specimens and, furthermore, these specimens showed a complexity of the main excretory tubules with cross-commissures anteriorly, which cannot be harmonized with the cercaria unless there are extremely radical changes in the excretory system during postcercarial development.

Eyespot pigment and voluminous ceca had been noted previously in immature trematodes of the type for which Yamaguti (1942) inadvisedly erected the genera *Monilicaecum* and *Torticaecum*. These forms were commonly encountered in fishes and, in some species, the eyespots were still well organized, being bright red in one form. In one instance, perhaps an anomaly, there was a single median eyespot shaped like that of a miracidium and also red in color. It was observed in these forms, however, that there was no pharynx or, at most, an embryonic one immediately posterior to the oral sucker, and the excretory system (FIGURE 89) was so different from that of *Cercaria caribbea* XXXIV that the two scarcely could be stages in the same life history. It therefore is not possible to assign that larva to any particular hemiuroid group, although the adult obviously is to be sought in some such group.

As to the status of the "genera" *Monilicaecum* and *Torticaecum*, the author is in full accord with Manter's (1934) opinion that they are immature members of the family Didymozoidae. FIGURE 89 shows the gross features of the excretory system observed in a species of *Torticaecum*. A comparison with what Yamaguti (1938) has described of the excretory system in didymozoids shows complete agreement, as do features of the digestive system. On the other hand, there is a striking resemblance between the excretory system of *Torticaecum* and that of hemiurids. A close relationship between the Hemiuridae and Didymozoidae thus suggested is supported by other common features, including the cecal "stomachs" in *Monilicaecum* and certain hemiurids in which, also, the reproductive glands may approach the tubular form exhibited by the gonads and vitellaria of the Didymozoidae. G. R. La Rue has reminded the author of further important evidence of such a relationship, namely, similarities in the miracidia as described by Van Beneden (1870) and Thomas (1939).

Certain described species of marine cystophorous cercariae have a body structure identical with that of *Torticaecum*. In discussing *Distomum fenestratum*, Manter (1934) noted such a resemblance in the case of *Cercaria L.* Miller, 1925a. Arvy (1952) described as *C. franci* a larva found within the redia of *C. tregouboffi*, a cystophorous cercaria. This larva is identical with *Torticaecum*. Because of its unusual location and the absence of a tail, *C. franci* probably is a postcercarial stage, possibly of *C. tregouboffi*. In this connection, it may be observed that known metacercariae of the hemiurids do not become encysted, and thus could easily be mistaken for tail-less cercariae (cercariaea) if they should occur in a mollusk.

If, then, as morphological comparisons suggest, experimental studies should demonstrate that certain cystophorous larvae become species of "*Torticaecum*" and that these worms are immature didymozoids, it would become desirable to give taxonomic expression to the close affinity that thus would be established between the Hemiuridae and Didymozoidae. Perhaps the most satisfactory way of expressing that relationship would be to propose a superfamily for them. Such a group would not be equivalent, however, to the superfamily Hemiuroidea of Dollfus (1932). Dollfus proposed and included in that superfamily several families which, in the opinion of most helminthologists, are equivalent to a single family or at most two, the Hemiuridae and Halipegidae. In his phylogenetic scheme, Poche (1926) derived the Didymozoonidae from the hemiurids as suggested by Odhner (1907) on the basis of the morphology and habitat of adult stages. Elsewhere, Odhner also expressed the view that the hemiurids may be closely related to the opisthorchioids and, indeed, the morphology and development of *Cercaria caribbea* XXXIV provide strong support of that opinion.

## MONORCHIID CERCARIAE

One of the two cercariae assigned to the Monorchiidae and described below is very similar to the larva of *Monorcheides cumingiae* as determined experimentally by Martin (1940). *Cercaria myocerca* Villot also is undoubtedly a monorchiid larva. The second species reported here shows evidence of suppression of free-living activity as in certain other trematode families. The tail is reduced to a tiny knob of cells, and the eyespots present in other species are lacking. In a personal communication, Professor S. H. Hopkins has provided a drawing of an undescribed marine cercaria developing in a lamellibranch on the gulf coast of Texas. That species is intermediate to the two reported here and, although it could be mistaken for an opecoelid larva, the resemblance is superficial. The cuticle is spinose, a stylet is absent and, although the base of the tail forms a cup remindful of the Opecoelidae, there protrudes from it posteriorly a segment having precisely the same structure as that of the entire tail in species having that organ well developed. Yamaguti (1938) described *Asymphylodora japonica* and referred to that species a cercariaeum that developed and encysted in *Bulimus s. japonicus*, a gastropod. Certainly it would not be surprising to find that some monorchiids, or members of almost any other family for that matter, have such tail-less larvae but, in the author's opinion, it is extremely doubtful that cercariae in the same family develop in mollusks of two classes. Although there could well be exceptions, it seems likely that the case of *A. japonica* is not such, for the status of the genus *Asymphylodora* as a member of the Monorchiidae is open to serious question. The single testis and spiny genitalia in that genus are characters that not only are not constant in the Monorchiidae but also are by no means restricted to that family. The position of the genital pore, absence of a metraterm sac, and bipartite seminal vesicle are all characters that are more in keeping with the Zoogonidae than the Monorchiidae. Furthermore, in known zoogonid life cycles, the cercaria is tail-less and develops in a gastropod, as has been described for *Asymphylodora*. That genus, and perhaps some others that have been assigned to the Monorchiidae, therefore may well belong elsewhere, their natural affinities being masked by secondary modifications of reproductive organs.

A brief general diagnosis of monorchiid cercariae, based largely on structure of the body, may be stated as follows:

Distome, pharyngeate larvae developing in elongate sporocysts in marine lamellibranchs. Cuticle very spinose, eyespots present in forms with well developed tails, absent in others; stylet lacking, cephalic glands present. Excretory vesicle sac-shaped, not thin-walled; main excretory tubules not reaching appreciably anterior to ventral sucker; anterior and posterior collecting tubules each with 2 groups of flame cells, 2 per group where known, so that the flame-cell formula is $2[(2 + 2) + (2 + 2)]$. Definitive excretory pores are probably at junction of body and tail. Tail either long and slender with lateral cuticular lappets, reduced, or perhaps even lacking. Encyst, so far as known, in invertebrates, especially mollusks, and develop to maturity in intestines of marine fishes.

### Cercaria caribbea XXXV (FIGURES 76 and 77)

Specific diagnosis: distome, biocellate, tail well developed, with indistinct lateral lappets having the appearance of cuticular annuli detached at their posterior edges. Body 0.170 to 0.183 long and 0.057 to 0.065 in maximum width about mid-level. Tail 0.170 to 0.175 long, and 0.014 to 0.015 wide near base. Oral sucker 0.027 to 0.032 long and 0.033 to 0.039 wide, pharynx 0.015 in diameter, prepharynx shorter than pharynx. Esophagus long, ceca narrow, extending about midway between ventral sucker and posterior end. Ventral sucker well developed, 0.029 to 0.038 in diameter, and situated well within posterior half of body. Cuticle thick; entire dorsal surface with spines rather scattered in irregular pattern, a prominent patch of larger spines ventrally near base of tail, remainder of ventral surface transversely wrinkled but apparently without spines. Eyespots blocklike, about 0.006 by 0.008, at pharyngeal level. Two pairs of cephalic glands immediately anterior to and slightly overlapping ventral sucker with ducts in 2 bundles extending anteriorly close to digestive tube, diverging slightly dorsal to oral sucker and opening anteriorly on a papilla distinct in living specimens. Scattered, minute granules in parenchyma, but obvious cystogenous glands absent. Genital primordium a mass of cells just posterior to ventral sucker. Excretory vesicle short, oval in shape, with wall of tall granular cells rather few in number. Main excretory tubules with cilia difficult to see except in moribund specimens; excretory formula $2[(2 + 2) + (2 + 2)]$. Encyst in siphons, foot, and mantle of molluscan host after swimming period. Metacercarial cyst thin-walled, oval-round, 0.085 to 0.095 by 0.080 to 0.083.

Host: *Macoma cerina.*

Locality: Sucia Bay, Cabo Rojo.

This species is photopositive on emerging, but later becomes photonegative. It swims smoothly with body contracted and tail lashing in a figure 8.

Metacercariae fed to a schoolmaster and a demoiselle failed to become established and develop to maturity, but the adult doubtless is a monorchiid that has remnants of eyespots. Such species were found several times in Puerto Rican fishes.

**Cercaria caribbea XXXVI** (FIGURES 78 and 79)

Specific diagnosis: distome cercaria devoid of eyespots and with tail reduced to a tiny knob of cells. Body 0.316 to 0.335 long and 0.068 to 0.072 in maximum width at about middle. Tail about 0.010 in diameter, easily lost. Oral sucker and pharynx transversely elongate, oral sucker 0.035 to 0.048 long and 0.063 wide, pharynx 0.025 long and 0.030 wide. Prepharynx about length of pharynx, entering oral sucker posterodorsally. Esophagus short, ceca extend almost to posterior end of body; esophagus and ceca very muscular. Ventral sucker 0.042 to 0.048 in diameter, and situated at mid-level of body. Prominent cuticular spines in transverse rows as far posteriorly as ventral sucker, extremely minute if present beyond sucker. An undetermined number of what seem to be cephalic glands far anteriorly, at sides of prepharynx; prominent cystogenous glands scattered throughout length of body. Excretory vesicle elongate, reaching or slightly overlapping ventral sucker, its interior finely scalloped in contour by numerous small cells of wall. Main excretory tubules join vesicle at a considerable distance from its anterior end; cilia in them not observed. Flame-cell formula $2[(2 + 2) + (2 + 2)]$.

Host: *Gemma purpurea.*

Locality: Mud flat at head of Sucia Bay, Cabo Rojo.

Although large numbers of the minute clams were collected and isolated this cercaria was never seen to emerge spontaneously. It was found only when the mollusk was opened and examined. Although metacercariae were not observed in that host, it is possible that the cercaria may encyst without emerging, or if it does emerge, the minute tail may be lost before doing so. It was observed in this species that the embryonic excretory pores are at the junction of the body and tail (FIGURE 79), and this probably holds for monorchiid larvae having well-developed tails. The adult of this cercaria probably is one of the monorchiids found in which no trace of eyespot pigment occurred.

## MEGAPERID CERCARIA

Assigned to the Megaperidae is a single species whose life cycle has been reported elsewhere (Cable, 1952a, 1954a). The adult evidently is a species of *Megapera*, probably *M. gyrina* but, as the cycle was not determined experimentally, the larva is here given a numerical designation only.

**Cercaria caribbea XXXVII** (FIGURES 90 and 91)

Specific diagnosis: distome, biocellate cercaria with well-developed tail bearing a pair of lateral fins and a narrower ventral one along most of its length. Body 0.305 to 0.308 long and 0.113 in maximum width at level of eyespots. Tail 0.616 to 0.685 long and 0.038 in maximum width exclusive of lateral fins. These fins are granular, begin near base of the tail, and widen to a maximum of about 0.040. Their free margin is notched and, in edge view, the fin is seen to be regularly undulant. Thus, in a surface view, the lateral fins have the appearance of setae joined by a granular webbing. The long ventral fin lacks this appearance and attains a maximum width of about 0.008. Oral sucker 0.072 to 0.074 long, 0.077 wide, and devoid of a stylet; mouth elongate. Ventral sucker 0.047 in diameter and near middle of body. Pharynx 0.052 long and 0.040 wide, prepharynx wide and with ridgelike thickenings extending into pharynx; esophagus absent; ceca voluminous, arched, widely confluent anteriorly and extending well posterior to ventral sucker. Eyespots spheroid, about 0.022 in diameter, close to oral sucker. Cephalic glands absent, body crowded from end to end with cystogenous glands with granular cytoplasm. No general body pigmentation. Genital primordia an ovarian mass just posterior to ventral sucker, with line of nuclei extending to its anterior margin and a minute testicular mass on each side just anterior to the arch of the cecum and lateral to pharynx. Excretory vesicle Y-shaped with long stem and short arms directed toward ventral surface of body at posterior margin of ventral sucker, filled with refractile concretions. Wall of vesicle finely granular and not very thick. Main excretory tubule on each side extends from tip of vesicle arm anteriorly to prepharyngeal level, turns and runs posteriorly a short distance and receives an anterior and posterior collecting tubule, each with 3 groups of flame cells. Flame cells difficult to observe because of thick body and cystogenous glands. Anterior 4 groups on each side definitely with 8 flame cells each; this number probably in all groups, making the flame cell formula $2[(8 + 8 + 8) + (8 + 8 + 8)]$. A distinct sphincter at posterior end of vesicle and an excretory atrium at junction of body and tail. Develops in simple, sac-shaped rediae up to almost 1.0 long and with yellowish-brown pigment confined to the short intestine. Encysts in the open on vegetation or other objects eaten by definitive host, a trunk fish.

Host: *Crepidula convexa* on shell of living *Cerithium variabile.*

Locality: Salinas Bay, Cabo Rojo.

This species is a powerful swimmer, changing directions frequently in an erratic manner. It swims with the tail first, lashing in a figure 8 but not smoothly, as in some species. Cercariae obtained by cracking the snail are photopositive. Spontaneously emerging ones are extremely difficult to study before encystment takes place, and the excretory system is observed easiest after this has occurred and from the lateral aspect, because of the thickness of the body. When heat-killed, the larva exudes cystogenous material, giving the body a fuzzy and indefinite outline. This species and *Cercaria K.* Miller, from Tortugas, Fla., are similar and may be identical.

## HAPLOSPLANCHNID CERCARIA

Although superficially resembling the preceding species and evidently having a similar life history, a cercaria that has been found to be a larva of the Haplosplanchnidae (Cable, 1952a, 1954b) is unique in the combination of its characters. Since but a single species of this type was found, a general diagnosis is unnecessary.

### Cercaria caribbea XXXVIII (FIGURES 92 to 94)

Specific diagnosis: biocellate distome cercaria with rhabdocoele intestine and a slender tail with eight pairs of lateral fingerlike processes and a terminal one. Body 0.178 to 0.243 long and 0.092 to 0.095 wide somewhat anterior to mid-level; tail 0.225 to 0.232 long exclusive of terminal process and 0.028 to 0.030 in maximum width just posterior to basal taper. Lateral processes of tail 0.038 to 0.054 in length, terminal one 0.052 to 0.055 long. Eyespots somewhat variable in shape, about 0.013 to 0.015 in greatest dimension. Oral sucker 0.050 to 0.052 long and 0.054 to 0.060 wide, ventral lip with a conspicuous median papilla; expanded sucker with irregular margin and ridges radiating from mouth. Ventral sucker 0.046 to 0.048 long and 0.049 to 0.052 wide. Opening with six knoblike papillae. Prepharynx 0.011 to 0.015 long, pharynx 0.022 to 0.024 long and 0.027 to 0.030 wide. Esophagus very muscular, intestine saclike, extending well posterior to ventral sucker, with large cells staining pink with neutral red. Cuticle devoid of spines, thick, and granular. Pigment granules scattered throughout body including cuticle. Cephalic glands absent; abundant and prominent cystogenous glands with cytoplasmic rodlets. Excretory vesicle small, thin-walled, and oval in shape with a narrower anterior common connection with the main excretory tubules which extend anteriorly to level of pharynx, and turn posteriorly as ciliated recurrent tubules, each of which receives an anterior and a posterior collecting tubule at about the mid-level of the ventral sucker. Excretory formula $2[(2 + 2 + 2) + (2 + 2 + 2)]$. Embryonic excretory pores at sides of tail well removed from base. Develop in elongate motile sporocysts up to 0.825 long by 0.14 wide; with one end more pointed, more active, and redialike in appearance due to passage of birth canal though it and presence of numerous yellowish glands. Redial excretory formula $2[(1) + (1)]$ with excretory pores well toward posterior end. Cercaria encysts in the open on vegetation or other objects eaten by definitive host, a fish.

Host: *Cerithium variabile.*

Locality: Salinas Bay near Punta Jagüey, Cabo Rojo.

This species is photopositive and swims tail first in a jerky manner with the body contracted until almost spherical. The tail remains active and swims about for a considerable time after the body encysts. This cercaria is the larva of a species of *Haplosplanchnus*, probably *H. acutus*, a common parasite of needlefish and halfbeaks in Salinas Bay.

## FELLODISTOMATID CERCARIAE

As shown in the key and discussed in other papers (Cable, 1953, 1954c), this category includes species varied as to caudal structure and development. Hence, reliance must be placed largely on body structure and host relationships in devising the following general diagnosis:

Distome cercariae usually without eyespots, lacking a stylet, and developing in sporocysts in marine lamellibranchs. Tail either well developed, reduced, or evidently lacking in species not included here; tail either not bifid distally and with paired multiple setae in the form of finlets along sides (trichocercous) or bifid and with (trichofurcocercous) or without setae (furcocercous). Suckers well developed, prepharynx very short or lacking, intestine with ceca varying from short and widespread to slender, elongate, and reaching almost to posterior end of body. Excretory system characteristic; vesicle thin-walled, U- or Y-shaped with short stem and long arms extending anterior to ventral sucker, in some almost to oral sucker; vesicle filled with concretions. Main excretory tubules ciliated, extending posteriorly from arms of vesicle to receive anterior and posterior collecting tubules. Flame cells absent in tail stem of furcocercous species, although caudal excretory tubule is wide and conspicuous all the way to pores at tips of furcae. Metacercariae in invertebrates so far as known; adults in intestines and gall bladders of fishes and aquatic birds.

### Cercaria caribbea XXXIX (FIGURE 95)

Specific diagnosis: trichocercous distome cercaria with body characters outlined in general diagnosis. Tail not forked, sides with 28 pairs of finlets each composed of setae joined by a delicate web; longest finlets with 6 or 7 setae or rays and up to 0.125 in length. Body 0.205 to 0.210 long and 0.10 to 0.104 in maximum width near mid-level. Tail 0.34 to 0.35 long and widest at about mid-length, measuring there about 0.045 exclusive of lateral appendages. Oral sucker 0.035 in diameter; in living specimens the pharynx measures about 0.016 in diameter; the ventral sucker is about 0.030 in diameter and just within anterior half of body. Cuticle about 0.005 thick and appears to be finely spinose. Body yellowish in color and with scattered golden-brown pigment granules. Esophagus about length of pharynx, ceca rather narrow and terminating about midway between ventral sucker and posterior end of body. Genital primordia a median ovarian mass well posterior to ventral sucker and a pair of larger testicular masses well separated, and just median and slightly anterior to terminations of ceca. Excretory vesicle U-shaped with broad arms extending slightly anterior to ventral sucker; filled with granulelike concretions. Each recurrent excretory tubule receives anterior and posterior collecting tubules slightly posterior to ventral sucker. The anterior collecting tubule has 2 groups of 3 flame cells each; the posterior, a single such group. Excretory formula thus is $2[(3 + 3) + (3)]$. Sporocysts elongate, tapering toward the ends, one of which seems to have a birth pore; sporocysts up to 3.15 long and 0.2 wide, yellowish in color.

Host: *Tellina pauperata.*

Locality: Extreme southeast tip of Cabo Rojo.

This species was found but once in a clam collected from a grass-sand bottom in shallow water between the reef and shore. The cercaria is an extremely rapid swimmer, moving tail first and stopping abruptly with tail coiled ventrally. Rest periods are of considerable duration if not disturbed. No phototropic responses were observed. This species is very similar to the cercaria of *Bacciger bacciger* as described by Palombi (1934) and several similar species. Its adult probably is one of the fellodistomatids that were common in herbivorous fishes examined.

### Cercaria caribbea XL (FIGURES 96 to 99)

Specific diagnosis: trichofurcocercous distome cercaria with well-developed tail. Sides of tail stem with about 19 pairs of multiple setae not joined by webbing and, near posterior end, about 5 pairs of more dorsal single ones. Base of each furca with a group of short setae on anterior edge and, opposite these, a much more prominent group of longer setae. More distally, each furca bears a continuous dorsal and ventral row of long setae and what seems to be a sensory papilla with a short bristle on posterior edge near tip. Entire body finely spinose; a row of long delicate setae encircles the openings of both suckers. Body 0.452 to 0.466 long and 0.13 in maximum width slightly posterior to mid-level. Tail stem measured along lateral margin from attachment to base of furcae 0.314 to 0.342, widest near posterior end where breadth is about 0.068. Furcae 0.233 to 0.260 long and 0.046 wide near base. Oral sucker somewhat funnel-shaped, 0.052 to 0.063 long and 0.068 to 0.074 in maximum width. Prepharynx very short but evident. Pharynx elongate, 0.055 to 0.062 in length and 0.038 to 0.049 wide. Esophagus reaches anterior margin of ventral sucker, intestine difficult to see in emerging cercariae but, in embryos, a wide pouch with ceca of considerable length is evident. Ventral sucker 0.095 in diameter, in a fleshy protrusion of the body 0.110 in diameter and situated just within posterior half of body. Cephalic glands not observed, numerous glands, presumably cystogenous in nature, fill the body posterior to pharynx. Excretory vesicle with voluminous arms narrowing anteriorly and reaching pharyngeal level. Vesicle filled with globular concretions that extend into the atrium between body and tail and even into the wide caudal tubule that bifurcates with the tail to open at tips of furcae. Each recurrent excretory tubule receives anterior and posterior collecting tubules slightly anterior to ventral sucker. Each collecting tubule is joined by 2 groups of flame cells, making 4 such groups on each side of the body. The complete number of flame cells was determined for all except the posteriormost group, which probably has 8, as observed in the others. The excretory formula would accordingly be $2[(8 + 8) + (8 + 8)]$. Flame cells are absent in the tail stem. Sporocysts up to 3.0 long, rather slender, orange in color, and with tapered ends that move in an exploratory manner. Excretory system of sporocyst near its mid-level, not approaching either end. From the excretory pore on each side, the main tubule extends anteriorly a short distance and receives an anterior and a posterior collecting tubule. The anterior tubule has 2 groups of 3 flame cells each; the posterior tubule, a single such group situated posterior to excretory pore. Excretory formula of sporocyst accordingly is $2[(3 + 3) + (3)]$, the same as in *Cercaria* XXXIX.

Host: *Tellina martinicensis.*

Locality: Dredged near Isla de los Ratones, off Joyuda.

This cercaria is an excellent swimmer, darting about rapidly, tail first, in an erratic path. It rests body downward with furcae spread and in contact with the surface. No phototactic response was observed. Its adult probably is one of the larger, elongate members of the Fellodistomatidae, possibly one belonging to the subfamily Haplocladinae. The excretory system is far too complex, however, for the cercaria to be the larva of any species for which the adult pattern is known. Relationships are discussed in a recent paper (Cable, 1953) in which the life cycle of the following species is reported.

### **Cercaria caribbea XLI** (FIGURE 100)

Cercaria of **Parvatrema borinqueñae** Cable, 1953.

Specific diagnosis: minute furcocercous distome cercaria with poorly developed tail. Body and tail entirely spinose but furcae without setae; about three short setae in papillae on each side of body anterior to mid-level. Body

0.095 to 0.098 long and 0.040 to 0.042 in maximum width posterior to mid-level; tail stem 0.038 to 0.041 long when measured along median line from attachment to notch where posterior edges of furcae meet, and 0.012 in maximum width at slight swelling just posterior to attachment. Furcae broadly joined to stem and therefore difficult to measure; about 0.032 long. Oral sucker 0.020 long and 0.022 to 0.024 wide; ventral sucker 0.021 to 0.023 in diameter and situated well within posterior half of body. Prepharynx very short, pharynx about 0.012 in diameter, esophagus 0.018 long, ceca short and thick-walled, barely reaching ventral sucker. A single pair of cephalic glands occupies triangle formed by ceca and ventral sucker, overlapping those structures slightly. The cephalic gland ducts open at anterior end through refractile, expanded terminations remindful of the hollow spines capping ends of cephalic gland ducts in schistosome cercariae. Each arm of excretory vesicle with a short median diverticulum at anterior margin of ventral sucker and a larger main portion not reaching pharyngeal level. Island of Cort absent, caudal tubule prominent, constricted at intervals, and with pores at tips of furcae. Two pairs of flame cells observed in the body, none in tail. Sporocyst rather short and thick, with terminal birth pore, and containing many fully developed cercariae. Sporocyst difficult to separate from host's tissues.

Host: *Gemma purpurea.*

Locality: Mud flat at head of Sucia Bay, Cabo Rojo.

This minute larva is a poor swimmer. It moves body first with tail flexed ventrally at the base and lashing feebly from side to side. It enters and becomes an unencysted metacercaria enclosed in a mucoid mass in the snail, *Cerithidea costata.* Adults were obtained by feeding metacercariae to baby chicks as reported by Cable (1953).

## BUCEPHALID CERCARIA

Cercariae of the Bucephalidae are familiar larvae that develop in both freshwater and marine lamellibranchs. Since a single representative of the group is reported here, a general diagnosis is omitted.

### Cercaria caribbea XLII (FIGURES 101 to 104)

Specific diagnosis: "oxhead" cercaria with characteristics common to all bucephalid larvae; *viz.*, body with an anterior organ having no connection with the digestive system, the mouth, instead, opening on ventral surface, and leading into a pharynx followed by a rhabdocoele intestine; tail essentially furcocercous, stem a broad basal piece bearing laterally a pair of furcae which are capable of extreme elongation and contraction. Body 0.199 to 0.205 long and 0.044 to 0.046 wide. Tail stem 0.033 long and 0.056 between bases of furcae. Furcal length 1.37 to 1.65, width at base 0.008. Anterior organ 0.033 to 0.035 long and 0.027 to 0.029 wide, with a mouthlike depression on ventral side and anteriorly a pit containing a protrusible plug on which open the ducts of about 10 glands contained in the anterior organ. Cystogenous glands irregular peripheral masses with granular contents. Pharynx 0.016 in diameter, well posterior to mid-level of body; intestine thick-walled, anterior to pharynx. Body spinose, especially anteriorly. Excretory vesicle thin-walled, elongate sac-shaped, deflected to left of pharynx. Excretory pattern not determined. Distinct primordium of cirrus sac extends from posterior end of body along left side of excretory vesicle.

Hosts: *Donax denticulata* and *Tellina lintea*.

Localities: Playa de Maní, (north of Mayagüez) and Sucia Bay, Cabo Rojo.

Unlike certain other bucephalid cercariae, this species is almost motionless in the water, although the furcae are capable of contracting until about the length of the body. With any movement of the water at all, such as respiratory currents set up by the host, the larvae remain suspended with furcae extended and threadlike, either parallel or divergent (FIGURE 104). Otherwise, they settle to the bottom with furcae extended in a tangled mass.

From other life-history studies, it may be assumed that this species encysts in a fish that is eaten by a larger fish serving as the definitive host. Thus the adult of this cercariae probably is among the bucephalids that were often found in the intestines of fishes.

## BIVESICULID CERCARIAE

Since the family Bivesiculidae is represented by a single known adult species in the Gulf-Caribbean area, it was most unexpected to find 6 species of cercariae that could hardly be other than larvae of that group. It was equally surprising to find that the life history affords convincing evidence that the Bivesiculidae, hitherto believed related to the Monorchiidae, instead are to be included in the Strigeatoidea. The writer's student, L. A. Le Zotte, Jr., has made this group the subject of his doctoral thesis, and his observations have been published elsewhere (Le Zotte, 1952, 1954). For completeness, however, brief descriptions of the cercariae he reported are included here. Their common characteristics are given in the following general diagnosis:

Furcocystocercous, *i.e.*, with tail bifid distally and base enlarged to form a caudal vesicle into which the body typically is withdrawn in fully developed, spontaneously emerging larvae; caudal vesicle sharply set off from remainder of tail. Tail often strikingly pigmented, stem and furcae flattened laterally and efficient in swimming. Body small, spherical when in caudal vesicle, rather spindle-shaped with more rounded anterior end when free or outside vesicle but attached to it. Entire body spinose. Body pigment restricted to a pair of black eyespots. Mouth terminal, a short atrium leading into muscular bulb having more the appearance of a pharynx than an oral sucker, as it has been interpreted in adult bivesiculids. Esophagus rather long and muscular, joined by two narrow ceca that extend well toward posterior end of body. A number of cephalic glands near intestinal bifurcation with ducts opening into oral atrium. Primordia of reproductive system usually well developed. Most conspicuous feature of cercarial body is a pair of long tubular thin-walled excretory vesicles extending well anterior to mid-level, narrowing posteriorly, with separate sphincters, and usually filled with refractile concretions. Excretory vesicles continuous, with right and left caudal tubules that extend posteriorly without fusing and diverge to pass through furcae to pores at their tips. Caudal excretory tubules difficult to trace except in developmental stages, being obscured in emerging cercariae by the vacuolated parenchyma of tail. From anterior end of each excretory vesicle, a ciliated recurrent tubule extends posteriorly median to vesicle, crosses it at about mid-level, and receives an anterior and a posterior collecting tubule, both of which may be ciliated to the point that the first flame cell group is received. Anterior tubule with 2 groups of flame cells, posterior with 3, of which one is in the tail with half its flame cells in the vesicle and half in the proximal regions of the tail stem. Develop in rediae with a bifurcated posterior end; excretory pores of rediae at the tips of the blunt processes. Redial excretory pattern basically the same as in the cercaria. Hosts: marine prosobranch gastropods.

### Cercaria caribbea XLIII (FIGURE 105)

Specific diagnosis: with the characters of the group. Body in caudal vesicle oval, 0.135 to 0.145 by 0.115; vesicle with narrow invaginated anterior protuberance and 0.278 to 0.287 in total length; increases to a maximum width of 0.281 to 0.308 posteriorly just before turning under to join tail stem, the attachment of which is hidden by posterior edge of vesicle. Yellowish pigment especially prominent near anterior end of vesicle, fading out posteriorly where there is a light area having the appearance of a cavity. Tail stem measured along lateral margin from attachment to base of furcae 0.410 to 0.425 in length; width from dorsal or ventral aspect 0.056 to 0.063. Furcae about 0.150 to 0.165 long and 0.030 to 0.040 wide. Tail stem and furcae without noticeable pigment. Pharynx 0.028 long and 0.034 wide when body is in caudal vesicle.

Host: *Cerithium variabile.*

Localities: Punta Arenas, Isla de Ratones, and La Gata, off Parguera.

This species swims tail first by flexing the tail stem, resting occasionally body downward with furcae spread. It is strongly photopositive, and the larvae soon concentrate in the most strongly illuminated part of the dish.

### Cercaria caribbea XLIV (FIGURES 106 to 107)

Specific diagnosis: with the characters of the group. Anterior part of caudal vesicle with dense longitudinal striae, probably muscles, followed by a pigmented zone shading from yellow to orange with a reticulum of purplish-black pigment conspicuous at posterior edge of vesicle. Tail stem with nonpigmented basal portion followed by a wide zone of purplish-black pigment. Caudal vesicle 0.192 long and 0.144 in maximum width at about middle. Body 0.110 in diameter when in caudal vesicle, 0.275 long and 0.116 in maximum width in heat-killed detached bodies. Tail stem 0.48 to 0.49 long and 0.080 to 0.085 in maximum width; furcae 0.192 to 0.233 long and 0.018 wide at base from dorsal aspect, 0.034 to 0.042 in lateral. Pharynx 0.022 to 0.025 long and 0.030 to 0.032 wide. Eyespots about 0.010 by 0.014.

Host: *Cerithium algicola.*

Locality: Boquerón Bay.

This species has essentially the same behavior as the preceding one. It is decidedly less common.

### Cercaria caribbea XLV (FIGURES 108 and 109)

Specific diagnosis: with characters of the group. Distinctively pigmented. Caudal vesicle with golden-brown pigment near inner end of passage for body and with very conspicuous paired lateral and dorsoventral black pigment masses having the appearance of eyespots anterior to body capsule, with lines extending posteriorly from them and blending into a thin layer of black pigment enclosing the retracted body. Dorsal and ventral edges of tail stem with golden-brown pigment, furcae with a marginal reticulum of purplish-black pigment. Caudal vesicle bell-shaped and expanded posteriorly in living specimens, more contracted and with a distinct posterior flange in heat-killed ones. Vesicle 0.308 to 0.320 long and 0.178 in maximum width. Tail stem 0.575 long and about 0.130 in maximum width from lateral aspect, furcae 0.38 to 0.39 long and about 0.130 in maximum width from lateral aspect. Body within caudal vesicle 0.137 to 0.150 in diameter, pharynx 0.030 to 0.032 in diameter, eye spots about 0.011 to 0.014. Excretory formula $2[(4 + 4) + (4 + 4 + 4)]$ with the last group on each side in the tail, 2 flame cells in the vesicle, and 2 in the tail stem. Excretory formula of redia $2[(4 + 3) + (3 + 3 + 4)]$.

Host: *Cerithium algicola.*

Locality: Boquerón Bay.

This species is large and immediately recognized by the black pigment masses in the caudal vesicle. It swims tail-first toward the light with furcae spread and tail stem vibrating. It rests on the bottom with the tail extended and furcae together (FIGURE 109). A number of cercariae resting in this manner, all parallel and with tails toward the light, is a striking sight.

### Cercaria caribbea XLVI (FIGURE 110)

Specific diagnosis: the largest species of its type and with a deep red caudal vesicle almost black by reflected light. Tail stem and furcae usually colorless, but sometimes with very light pink pigmentation. Caudal vesicle 0.38 to 0.39 long and 0.322 in maximum width at about mid-level; posterior end with a prominent flange in both living and heat-killed specimens. Body retracted 0.178 in diameter; free, 0.355 long, and 0.144 in maximum width. Tail stem 0.60 to 0.65 long and 0.13 in maximum width from lateral aspect; furcae 0.377 to 0.410 long and 0.103 wide. Pharynx 0.032 long and 0.036 wide, eye spots 0.009 to 0.011 by 0.014 to 0.015. Flame-cell formula $2[(4 + 4) + (4 + 4 + 4)]$ with the last group on each side in the tail, 2 flame cells in the vesicle, and 2 in the tail stem.

Host: *Cerithium algicola.*

Locality: Boquerón Bay.

The large size and deep red pigmentation of the caudal vesicle distinguish this species from others of its type. In swimming activity and behavior, it is much like *Cercaria caribbea* XLV but swims rather more energetically. When killed in hot water, the shape and size of the caudal vesicle is much less altered than in that species, but the red color escapes into the water, whereas the black pigment of the preceding cercaria is unaffected and is distinct in specimens prepared as stained whole mounts.

### Cercaria caribbea XLVII (FIGURES 111 and 112)

Specific diagnosis: the smallest species of its type. Caudal vesicle bright pink-red in color, tail stem with pigment less concentrated and light pink in appearance. Shape considerably altered when heat-killed. Body within caudal vesicle 0.071 to 0.073 in diameter. Caudal vesicle 0.17 to 0.18 long and 0.115 to 0.120 wide. Tail stem about 0.20 long and with a maximum width of 0.062 in lateral aspect, 0.041 to 0.047 in the horizontal plane. Furcae 0.085 to 0.088 long and 0.028 wide at base in vertical plane, 0.020 in horizontal.

Host: *Cerithium muscarum.* (corrected identifiction).

Locality: Sucia Bay near tip of Cabo Rojo.

### Cercaria caribbea XLVIII (FIGURE 113)

Specific diagnosis: species of moderate size and with greatly inflated caudal vesicle which may remain so when heat-killed. Length of body within caudal vesicle, 0.140 to 0.145; width 0.118 to 0.120; outside but attached to tail, body is about 0.350 long. Tail without noticeable pigmentation, vesicle 0.510 to 0.514 long and 0.286 to 0.290 in maximum width; stem 0.490 to 0.496 long and with a maximum width of 0.082 in horizontal plane, 0.118 from lateral aspect. Furcae about 0.22 long and with a maximum width of 0.023 in horizontal plane, 0.048 from lateral aspect. Pharynx 0.025 long and 0.028 wide. Eyespots with a maximum dimension of about 0.01.

Host: *Cerithium muscarum.* (corrected identification).

Locality: Salinas Bay near Punta Jagüey, Cabo Rojo.

This species is distinguished by the greatly inflated caudal vesicle and absence of pigment. The larvae swim tail first toward the light and congregate near the surface.

## SCHISTOSOMATOID CERCARIA

A general diagnosis of this well-known type is unnecessary, as only a single species was found.

### Cercaria caribbea XLIX (FIGURE 114)

Specific diagnosis: distome, furcocercous, apharyngeate cercaria with a long tail stem and short furcae. Body and entire tail spinose, spines coarser on tail; eyespots present. Body 0.233 to 0.260 long and 0.072 to 0.098 in maximum width posterior to mid-level. Tail attached to extreme posterior end of body, stem 0.192 long to base of furcae measured on lateral surface and 0.035 in maximum width at bulge just posterior to base. Furcae 0.08 to 0.094 in length and 0.015 to 0.016 wide at base, devoid of fins. Penetration organ pyriform in shape, narrowest posteriorly, 0.076 to 0.078 long and 0.055 to 0.060 in maximum width; anterodorsally in it is a lobed glandular mass which may be a compound gland. Ventral sucker 0.032 to 0.035 in diameter, with puckered opening, and situated posterior to mid-level of body. Cephalic glands of 2 types: (1) 4 pairs of large granular glands more or less in a row from a level somewhat anterior to ventral sucker to posterior end of body, ducts in a single bundle on each side extending anteriorly between eyespots, piercing and extending through the anterior organ to open through hollow spines at anterior end of body; (2) numerous poorly defined glands, lateral in position, with almost invisible ducts extending anteriorly lateral to eyespots. Some of these ducts appear to open to dorsal surface before reaching anterior end of body. Right and left halves of excretory system fused only in tail stem, so that an Island of Cort is absent. Excretory pores at tips of furcae. Main excretory tubule on each side short, and receiving an anterior and a posterior collecting tubule, each joined by capillaries of flame cells. Excretory formula $2[(1 + 1 + 1) + (1 + 1 + 1)]$ with posterior flame cell on each side in base of tail. Develop in rather short, thick sporocysts with broadly rounded or truncate ends, one apparently bearing a birth pore.

Host: *Cerithidea costata.*

Locality: Mud flat, head of Sucia Bay, Cabo Rojo.

This species swims tail first with tail stem vibrating rapidly, and may come to rest at the surface of the water. It is a typical schistosome cercaria, and its adult probably is an avian blood fluke. In view of recent observations on marine swimmer's itch, it would be desirable to determine whether this species can cause symptoms of dermatitis in man.

## CYATHOCOTYLID CERCARIAE

Two species of cyathocotylid larvae are reported here. Recent studies have made this group one of the better-understood ones so far as structure and life history are concerned. The group is characterized by the following general diagnosis:

Furcocercous larvae developing in elongate sporocysts in freshwater and marine gastropods. Oral sucker, pharynx, and intestinal ceca well developed; ventral sucker embryonic or lacking. Tail with long slender stem and furcae, stem with long setae, furcal fins present or absent. Tail attached dorsally near posterior end of body. The larva rests suspended in water, typically with tail stem bent near its middle. Body spinose, with sensory papillae and setae, concave ventrally. Eyespots absent. Excretory system diagnostic. From thin-walled vesicle at base of tail, 4 tubules extend anteriorly as a median and a lateral pair. The median pair converges and fuses to form a single tubule connected anteriorly with the lateral tubules by a cross-commissure. On each side, just posterior to that level, a recurrent collecting tubule joins each lateral tubule, extends posteriorly a short distance, and receives an anterior and a posterior collecting tubule, each typically with 3 groups of flame cells, although other patterns have been described. Posterior flame-cell group on each side, almost always in tail stem. Encyst in fishes or, rarely, in the molluscan host and develop into adults of the family Cyathocotylidae. Definitive hosts, birds; less often, mammals; and, rarely, fishes.

It seems probable that the two cercariae reported below have avian definitive hosts. A booby was found to harbor two species of adult cyathocotylids, several hundred of one species and very few of the other.

### Cercaria caribbea L (FIGURE 115)

Specific diagnosis: very large for its type; body 0.254 to 0.260 long and 0.117 to 0.120 in maximum width posterior to mid-level; tail stem 0.546 to 0.550 long and 0.09 in maximum width about two thirds its length from attachment, furcae 0.035 wide at base and 0.275 long with fin projecting an additional 0.04 beyond the tip. Furcal fin attains a maximum width of 0.042 and has fine striae or folds. Body spines extremely fine, indistinct posterior to mid-level.

Oral sucker 0.034 to 0.036 in diameter, contains a few glands. No prepharynx; pharynx 0.016 long and 0.021 wide. Esophagus about 0.024 long. Ceca wide, sinuous, and empty. Two primordia in a line just anterior to excretory vesicle, a smaller anterior mass probably the developing ventral sucker, a larger, more posterior one being the primordium of either the tribocytic organ or reproductive system. Cystogenous glands present, but not as conspicuous as in the next species. Excretory concretions absent, lateral excretory tubule on each side extends anterior to cross-commissure without branching. Recurrent collecting tubule ciliated. Excretory formula $2[(3 + 3 + 3) + (3 + 3 + 3)]$, the last group of 3 flame cells on each side in tail stem and well separated in their distribution along stem. Musculature of tail forms a hollow tube containing about 21 caudal bodies along the main excretory tubule, which bifurcates posteriorly, a tubule extending through each furca close to its posterior margin to open at excretory pore at the tip.

Host: *Cerithium algicola.*

Locality: Reef off Punta Arenas near Joyuda.

This species is typical of its group although, when resting, the tail stem is bent more than in most larvae of its type, being U-shaped. The cercaria swims tail-first in a jerky path for a short distance and then rests longer than most other species do. Also, its movements seem more ponderous, probably because of its size. *Cercaria caribbea* L was much less common than the following species.

### Cercaria caribbea LI (FIGURES 116 and 117)

Specific diagnosis: typical of its group. Body length 0.199 to 0.219, maximum width 0.082 to 0.092 well posterior to mid-level. Tail stem 0.302 to 0.315 long and 0.040 to 0.043 in maximum width toward posterior end. Caudal bodies absent. Furcae 0.192 to 0.205 long and 0.021 to 0.024 wide at base, with prominent fin on dorsal and ventral edges continuous around tip. Fin on each side begins close to base of furca and widens rapidly to about 0.015, maintaining this width until just before it passes around tip with a width of about 0.031. Oral sucker 0.032 in diameter, prepharynx absent, pharynx 0.012 to 0.015 in diameter, esophagus short, ceca prominent and with finely dimpled walls. Cystogenous glands especially abundant and prominent in lateral regions of body from end to end. Primordia of ventral sucker and tribocytic organ or reproductive system essentially as in preceding species. Median excretory tubules fuse posterior to primordium of ventral sucker. Anterior extension of lateral tubes beyond commissure bifurcate. Excretory formula as in preceding species, *i.e.*, $2[(3 + 3 + 3) + (3 + 3 + 3)]$, and pattern the same except that flame cells in the tail stem are close together in the basal third or fourth of the stem. Develop in elongate sporocysts in the branchial region of the host. Sporocysts up to 5.0 long, with prominent circular muscle bands giving the stage a segmented appearance. Anterior end more pointed and active, with a subterminal birth pore.

Hosts: *Cerithium literatum* and *Cerithium algicola.*

Localities: Parguera and Boquerón Bay.

This species is an energetic swimmer, moving in an erratic path that may begin and end with a spin during activity following a rest period. When not swimming, the larva is suspended diagonally, with the tail stem bent as in other cyathocotylid cercariae. Resting cercariae swim at the slightest disturbance and, although they show no concerted phototropic behavior and scatter at random through the water, the majority will swim when shadowed.

## Alphabetical Host List

**Astraea imbricata**
*Cercaria caribbea* XXI

**Batillaria minima**
*Cercariae caribbeae* XXXI and XXXIII

**Bittium varium**
*Cercariae caribbeae* XIII and XIV

**Cerithidea costata**
*Cercariae caribbeae* I, II, III, V, X, XI, XII, XV, XIX, XXXII, XXXIII, and XLIX.

**Cerithium algicola**
*Cercariae caribbeae* VIII, XVI, XVIII, XXX, XLIV, XLV, XLVI, L, and LI.

**Cerithium literatum**
*Cercaria caribbea* LI

**Cerithium muscarum**
*Cercariae caribbeae* VI, XLVII, and XLVIII

**Cerithium variabile**
*Cercariae caribbeae* IX, XV, XIX, XXVI, XXX, XXXVIII, and XLII.

**Crepidula convexa**
*Cercaria caribbea* XXXVII

**Diodora cayenensis**
*Cercaria caribbea* XX

**Donax denticulata**
*Cercaria caribbea* XLI

**Macoma cerina**
*Cercaria caribbea* XXXV

**Nerita tessellata**
*Cercaria caribbea* XXVII

**Neritina virginea**
*Cercaria caribbea* XXVIII

**Nitidella cribraria**
*Cercaria caribbea* XXIII

**Pyrene mercatoria**
*Cercaria caribbea* XXXIV

**Tegula fasciata**
*Cercariae caribbeae* VII and XXIV

**Tellina lintea**
*Cercaria caribbea* XLI

**Tellina martinicensis**
*Cercaria caribbea* XL

**Tellina pauperata**
*Cercaria caribbea* XXXIX

**Turbo castaneus**
*Cercaria caribbea* XXII

**Turritella exoleata**
*Cercariae caribbeae* IV and XVII

## Alphabetical List of Mollusks Examined Without Finding Larval Trematodes

*Acmaea* sp.
*Anachis* sp.
*Arca occidentalis*
*Arca umbonata*
*Bulla occidentalis*
*Cecum* sp.
*Conus pygmaeus*
*Corbula* sp.
*Cymphoma gibbosa*
*Engoniophos unicinctus*
*Leucozonia angulifera*
*Leucozonia ocellata*
*Lima scabra*
*Lima tenerea*
*Littorina angulifera*
*Littorina ziczac*
*Livona pica*
*Marginella avena*
*Melampus* sp.
*Modulus modulus*
*Nassarius vibex*
*Nerita fulgurans*
*Nerita peloronta*
*Neritina viridis*
*Nitidella laevigator*
*Nitidella nitidula*
*Parastarte triquetra*
*Planaxis lineatus*
*Pusiolina hanleyi*
*Sistrum nodulosum*
*Tectarius muricatus*
*Tegula excavata*
*Tegula graniosa*
*Tegula scalaris*
*Tellina lintea*
*Thais patula*
*Vermetus irregularis*

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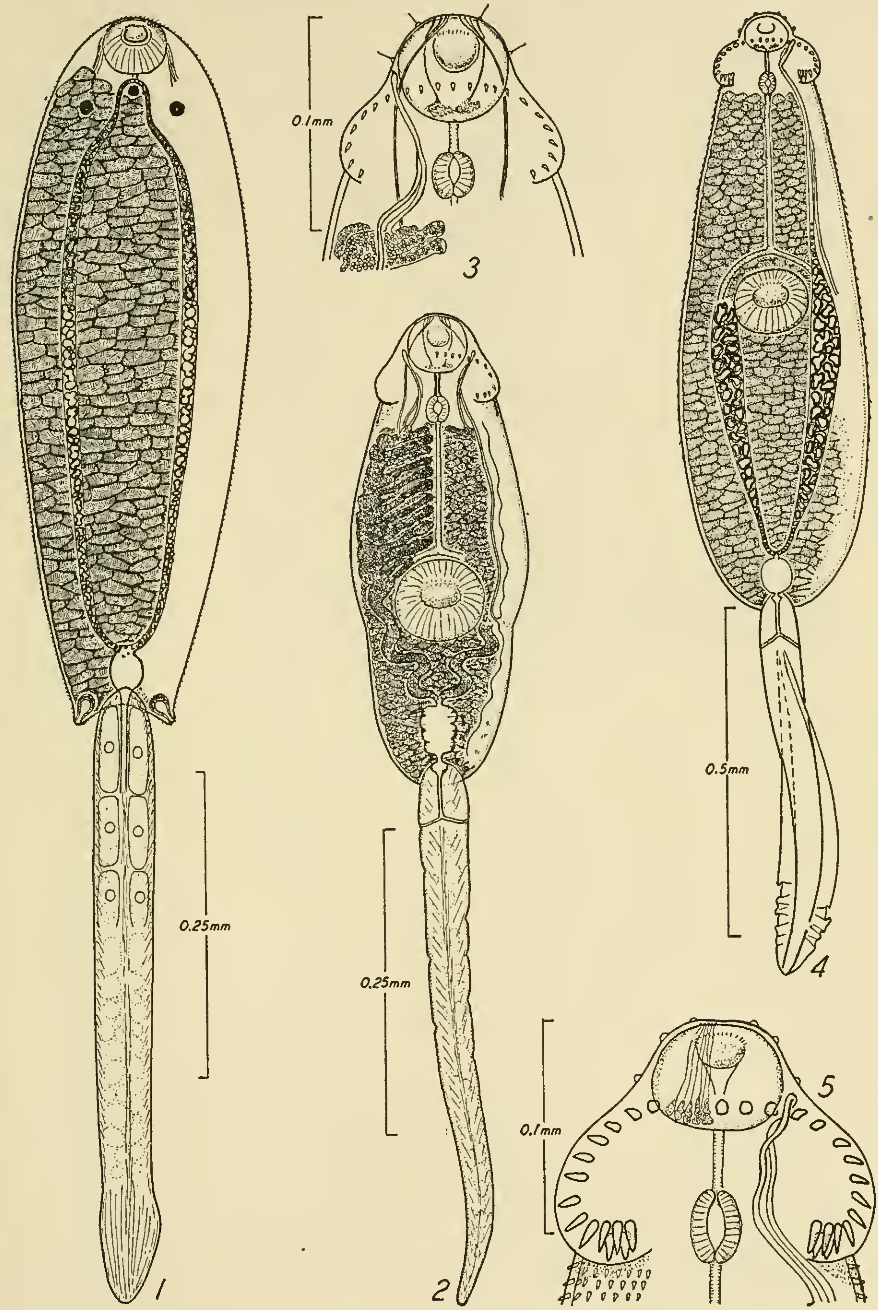
Plate I

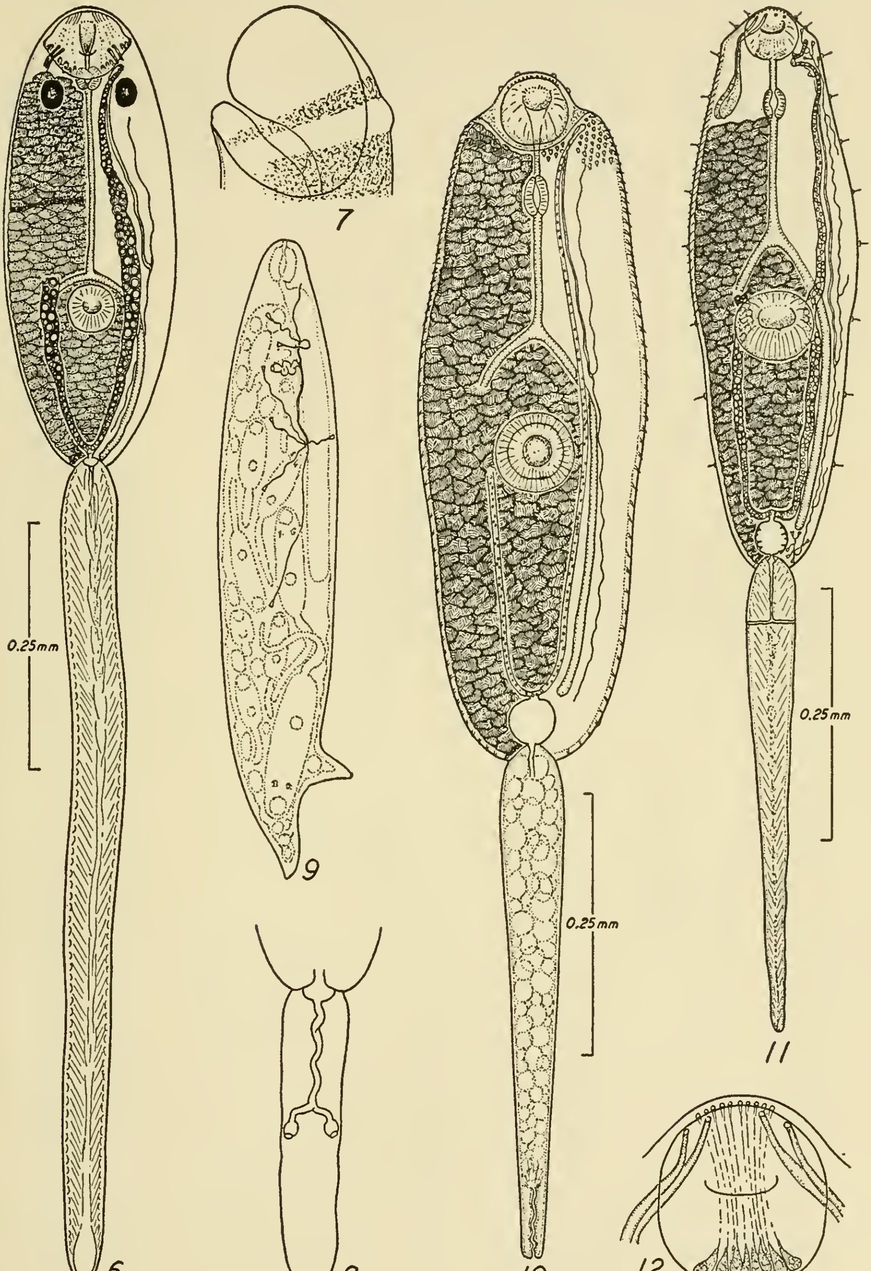
Figure 1. *Cercaria caribbea* I, ventral view.
Figure 2. *Cercaria caribbea* II, entire, ventral view.
Figure 3. Same, anterior end enlarged to show details of collar spines and cephalic gland ducts.
Figure 4. *Cercaria caribbea* III, entire, ventral view.
Figure 5. Same, anterior end enlarged.




CABLE: MARINE CERCARIAE OF PORTO RICO

PLATE II

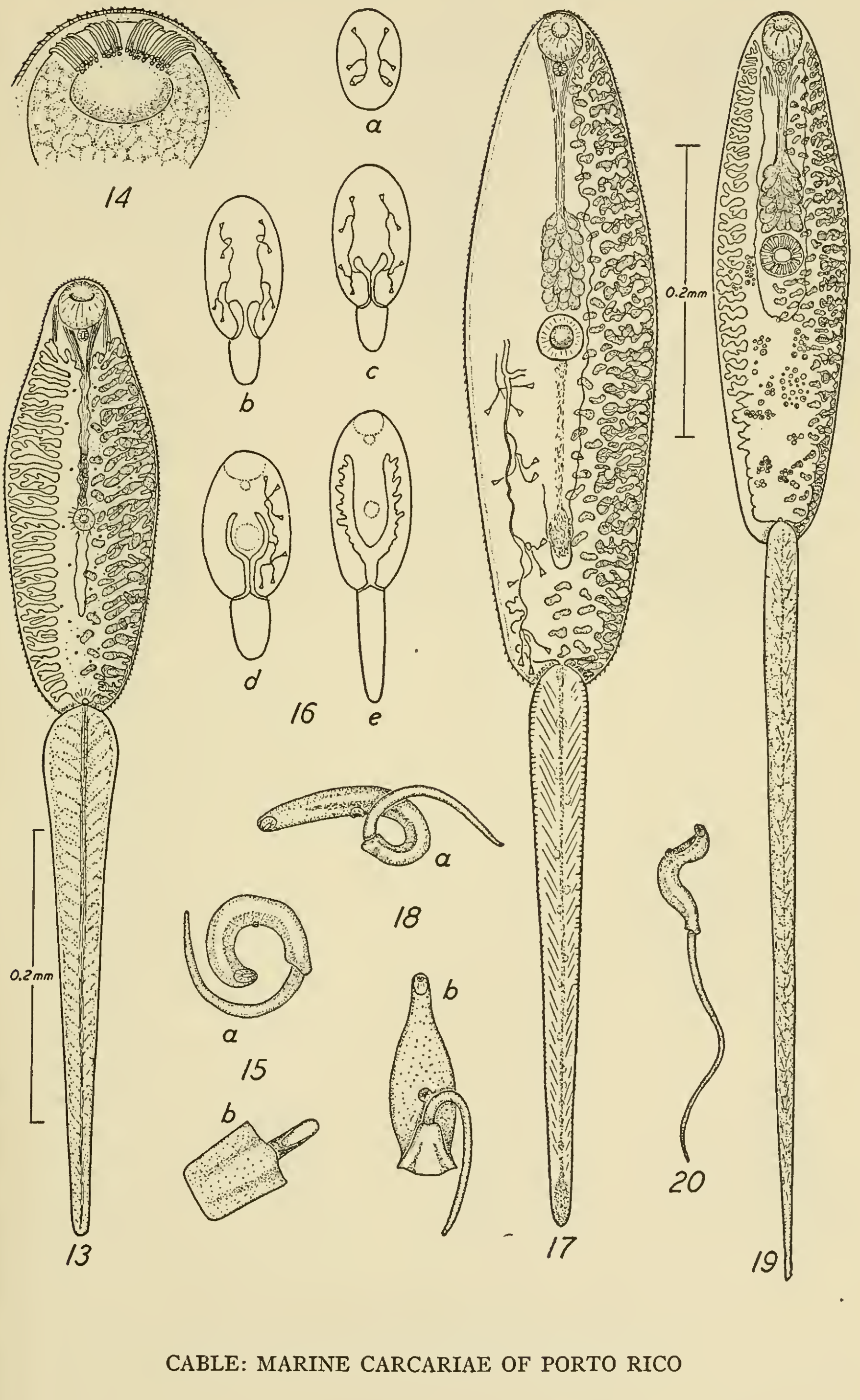
FIGURE 6. *Cercaria caribbea* IV, entire, ventral view.
FIGURE 7. Same, side view of anterior end showing distribution of pigment.
FIGURE 8. Same, excretory system in tail of embryo.
FIGURE 9. Same, redia drawn to show part of excretory system observed.
FIGURE 10. *Cercaria caribbea* V, entire, ventral view.
FIGURE 11. *Cercaria caribbea* VI, entire, ventral view.
FIGURE 12. Same, anterior end enlarged to show arrangement of gland ducts.




CABLE: MARINE CERCARIAE OF PORTO RICO

PLATE III

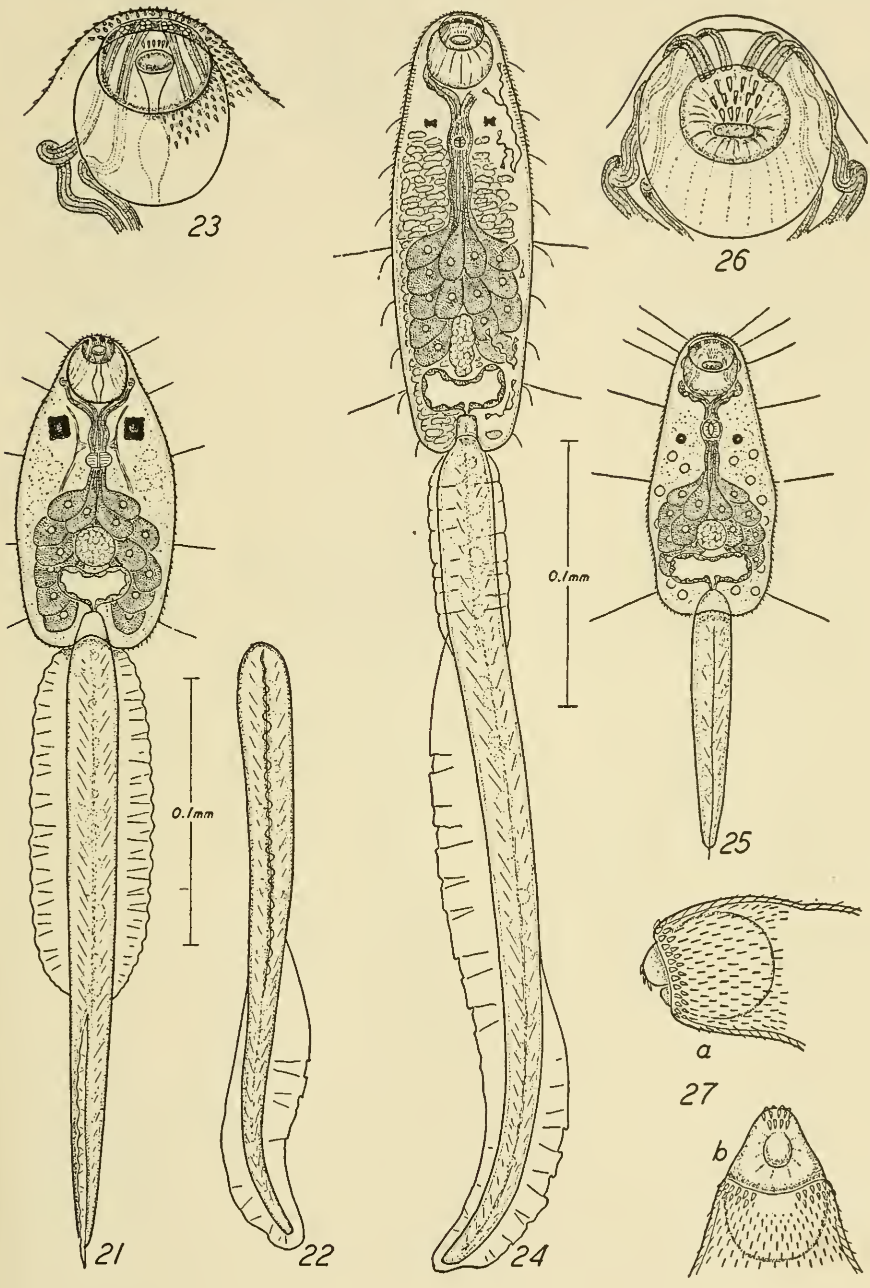
FIGURE 13. *Cercaria caribbea* VII, entire, ventral view.
FIGURE 14. Same, anterior end enlarged.
FIGURE 15. Same, resting position drawn free-hand from (a) lateral aspect and (b) from above.
FIGURE 16. Same, *a* to *e*, states in embryology of excretory system.
FIGURE 17. *Cercaria caribbea* VIII, entire, ventral view.
FIGURE 18. Same, resting position from (a) lateral aspect and (b) from above.
FIGURE 19. *Cercaria caribbea* IX, entire, ventral view.
FIGURE 20. Same, sketch of living cercaria from lateral aspect.




CABLE: MARINE CARCARIAE OF PORTO RICO

PLATE IV

FIGURE 21. *Cercaria caribbea* X, entire in ventral view.
FIGURE 22. Same, tail in side view to show extent of dorsoventral fin.
FIGURE 23. Same, anterior end enlarged to show details.
FIGURE 24. *Cercaria caribbea* XI, entire, in ventral view with tail drawn in lateral aspect to show extent of fin.
FIGURE 25. *Cercaria caribbea* XII, entire, from ventral aspect.
FIGURE 26. Same, enlarged view of anterior end with oral sucker retracted.
FIGURE 27. Same, spination of anterior end as seen (a) in side and (b) ventral view with oral sucker protruded.




CABLE: MARINE CERCARIAE OF PORTO RICO

Plate V*

Figure 28. *Cercaria caribbea* XIII, entire, in ventral view.

Figure 29. *Cercaria caribbea* XIV, entire, in ventral aspect.

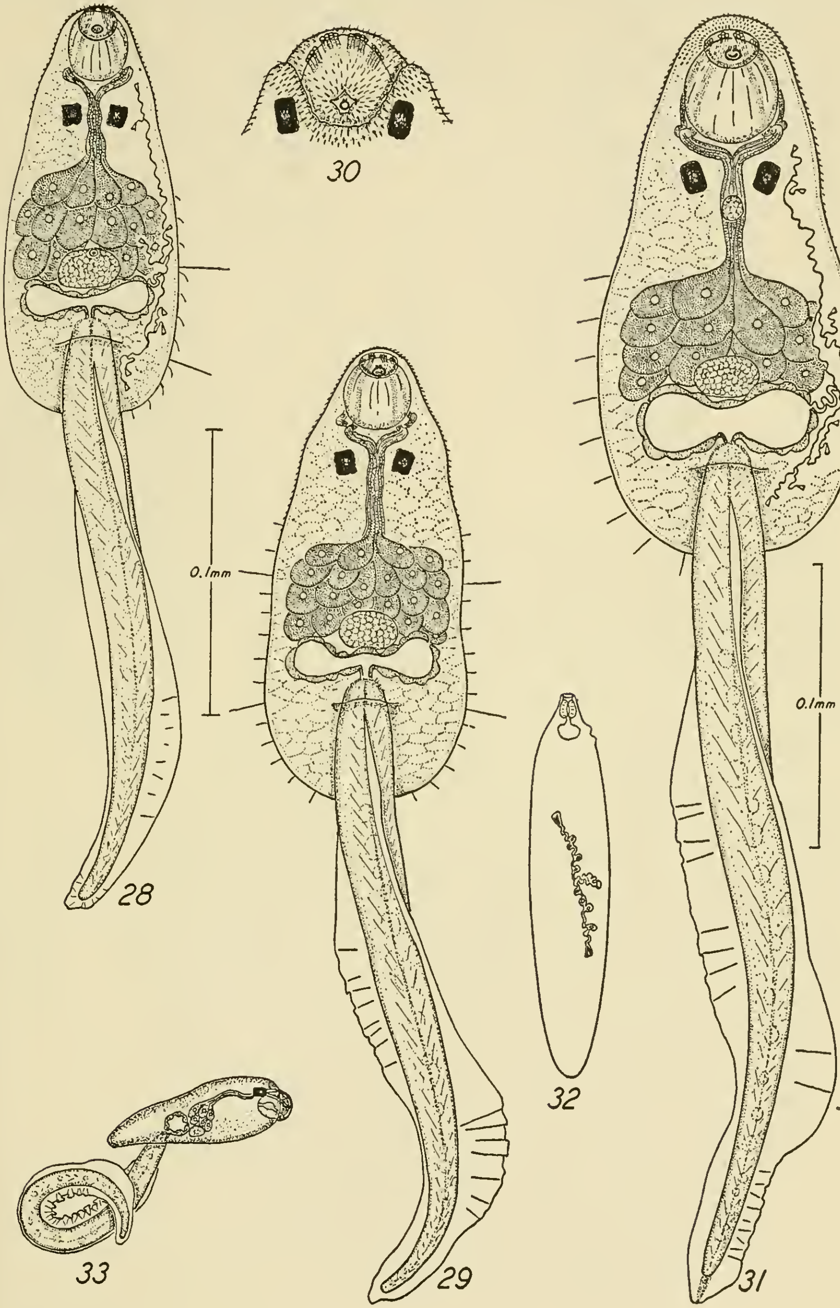
Figure 30. Same, enlarged view of anterior end to show secondary retraction.

Figure 31. *Cercaria caribbea* XV, entire, in lateral view. Retracted anterior end of living cercaria very similar to figure 30 except in number of gland ducts.

Figure 32. Same, redia drawn to show excretory system of one side.

Figure 33. Sketch showing the characteristic resting pose of *Cercariae caribbeae* XIII–XV.

* All tails with fins drawn in lateral aspect to show their extent.




CABLE: MARINE CERCARIAE OF PORTO RICO

PLATE VI

FIGURE 34. *Cercaria caribbea* XVI, freehand drawing of zygocercous (*Rattenkönig*) cluster. Bodies somewhat larger in comparison with tails than shown.

FIGURE 35. Same, isolated larva, entire.

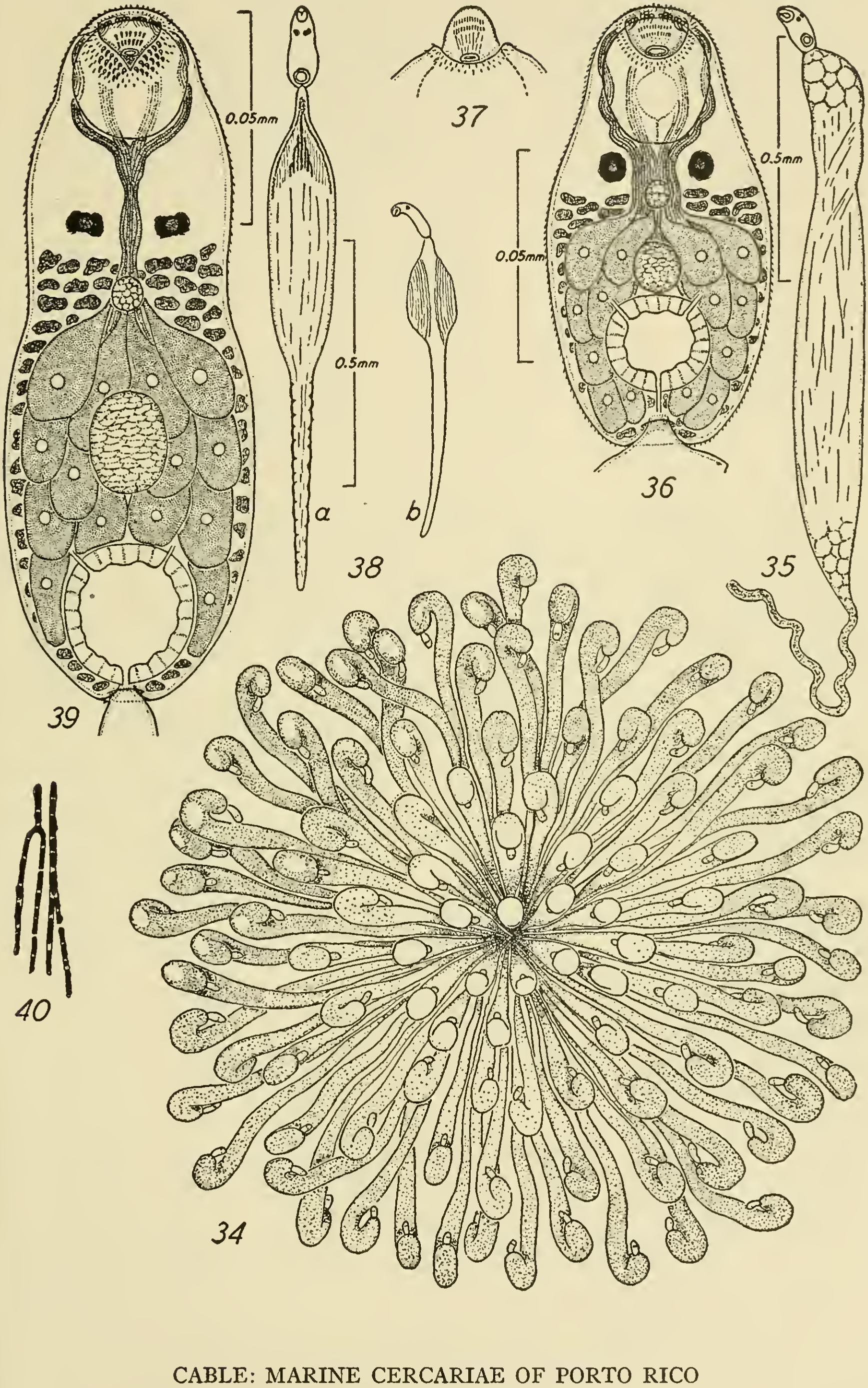
FIGURE 36. Same, body only to show details of morphology.

FIGURE 37. Same, appearance of anterior end with oral sucker protruded.

FIGURE 38. *Cercaria caribbea* XVII, entire; (a) heat-killed; (b) living and at rest with muscles of caudal enlargement contracted.

FIGURE 39. Same, body only to show details of morphology.

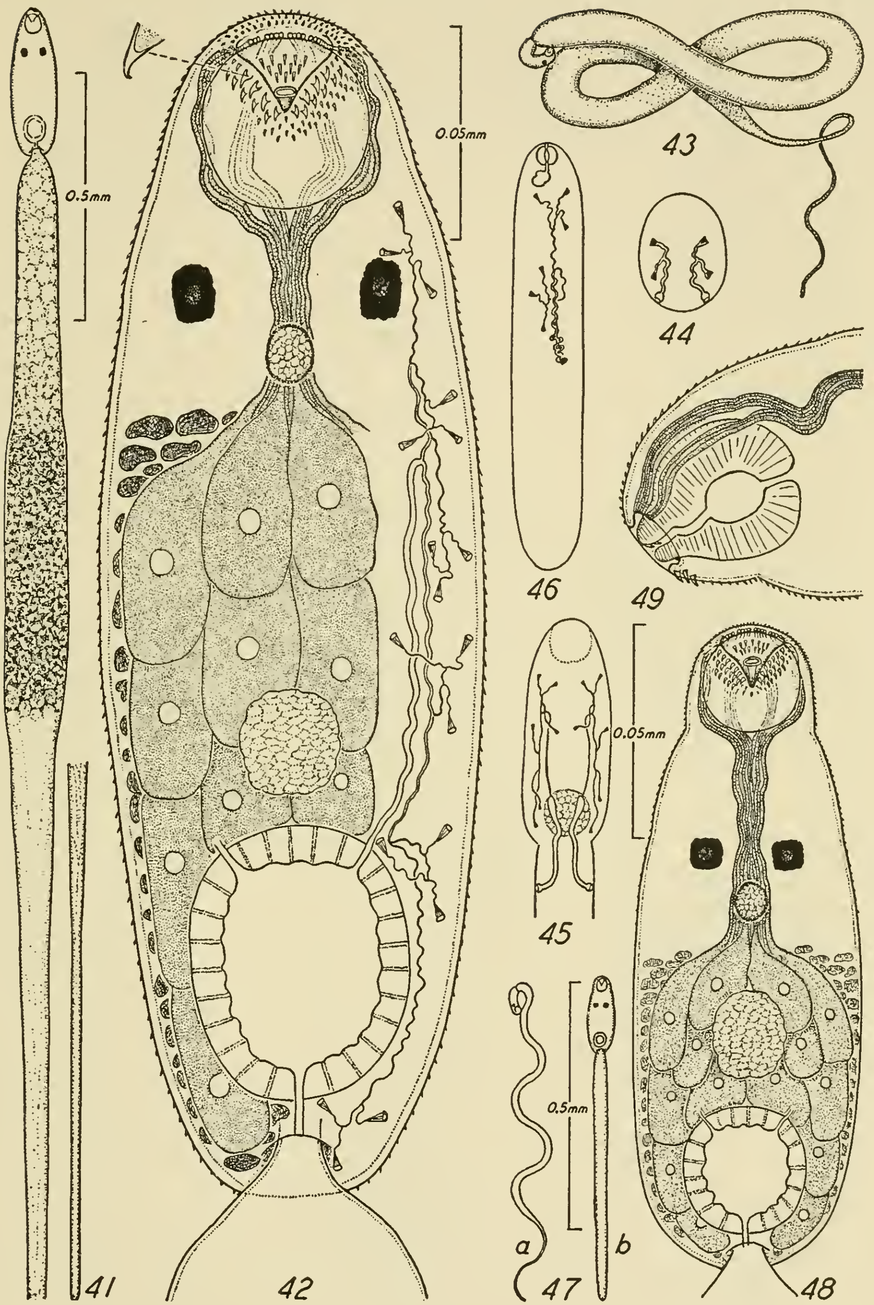
FIGURE 40. Same, form of pigment in anterior part of caudal enlargement.




CABLE: MARINE CERCARIAE OF PORTO RICO

PLATE VII

FIGURE 41. *Cercaria caribbea* XVIII, drawing of entire heat-killed larva with portion of tail shown separately.
FIGURE 42. Same, body only enlarged to show details of morphology.
FIGURE 43. Same, sketch of swimming larva.
FIGURES 44 and 45. Same, phases in development of excretory system in cercariae embryos.
FIGURE 46. Same, redia drawn to show excretory system of one side.
FIGURE 47. *Cercaria caribbea* XIX, showing appearance (a) while swimming and (b) heat killed.
FIGURE 48. Same, body enlarged to show details.
FIGURE 49. Same, enlarged drawing of anterior end in side view.

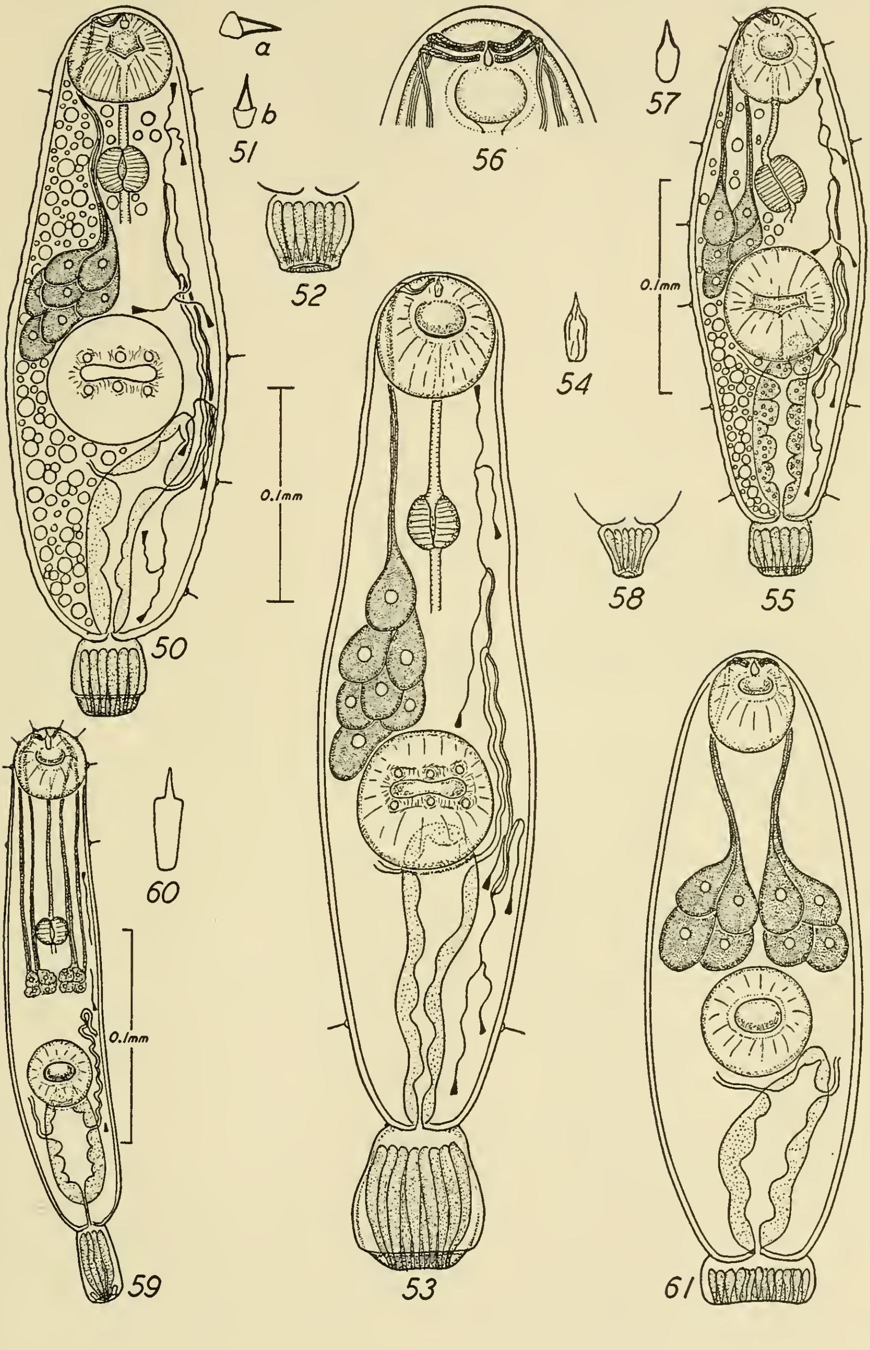



CABLE: MARINE CERCARIAE OF PORTO RICO

PLATE VIII*

FIGURE 50. *Cercaria caribbea* XX, entire, from ventral aspect.
FIGURE 51. Same, stylet in (a) lateral and (b) dorsal views.
FIGURE 52. Same, appearance of tail in living specimen.
FIGURE 53. *Cercaria caribbea* XXI, entire in ventral view.
FIGURE 54. Same, stylet.
FIGURE 55. *Cercaria caribbea* XXII, entire from ventral aspect.
FIGURE 56. Same, enlarged anterior end.
FIGURE 57. Same, stylet.
FIGURE 58. Same, appearance of tail in living specimen.
FIGURE 59. *Cercaria caribbea* XXIII, entire in ventral view.
FIGURE 60. Same, enlarged stylet.
FIGURE 61. *Cercaria caribbea* XXIV, freehand sketch from a single living specimen.

* All figures of entire cercariae except FIGURE 61 are to same scale as are all enlarged drawings of stylets.




CABLE: MARINE CERCARIAE OF PORTO RICO

PLATE IX*

FIGURE 62. *Cercaria caribbea* XXV.
FIGURE 63. *Cercaria caribbea* XXVI.
FIGURE 64. Same, side view of anterior end, enlarged.
FIGURE 65. *Cercaria caribbea* XXVII.
FIGURE 66. *Cercaria caribbea* XXVIII.
FIGURE 67. *Cercaria caribbea* XXIX.
FIGURE 68. *Cercaria caribbea* XXX.
FIGURE 69. *Cercaria caribbea* XXXI.

* All figures of entire cercariae are to same scale as are all enlarged drawings of stylets; (a) ventral view of entire cercaria; (b) side view of stylet; (c) dorsal view of stylet.

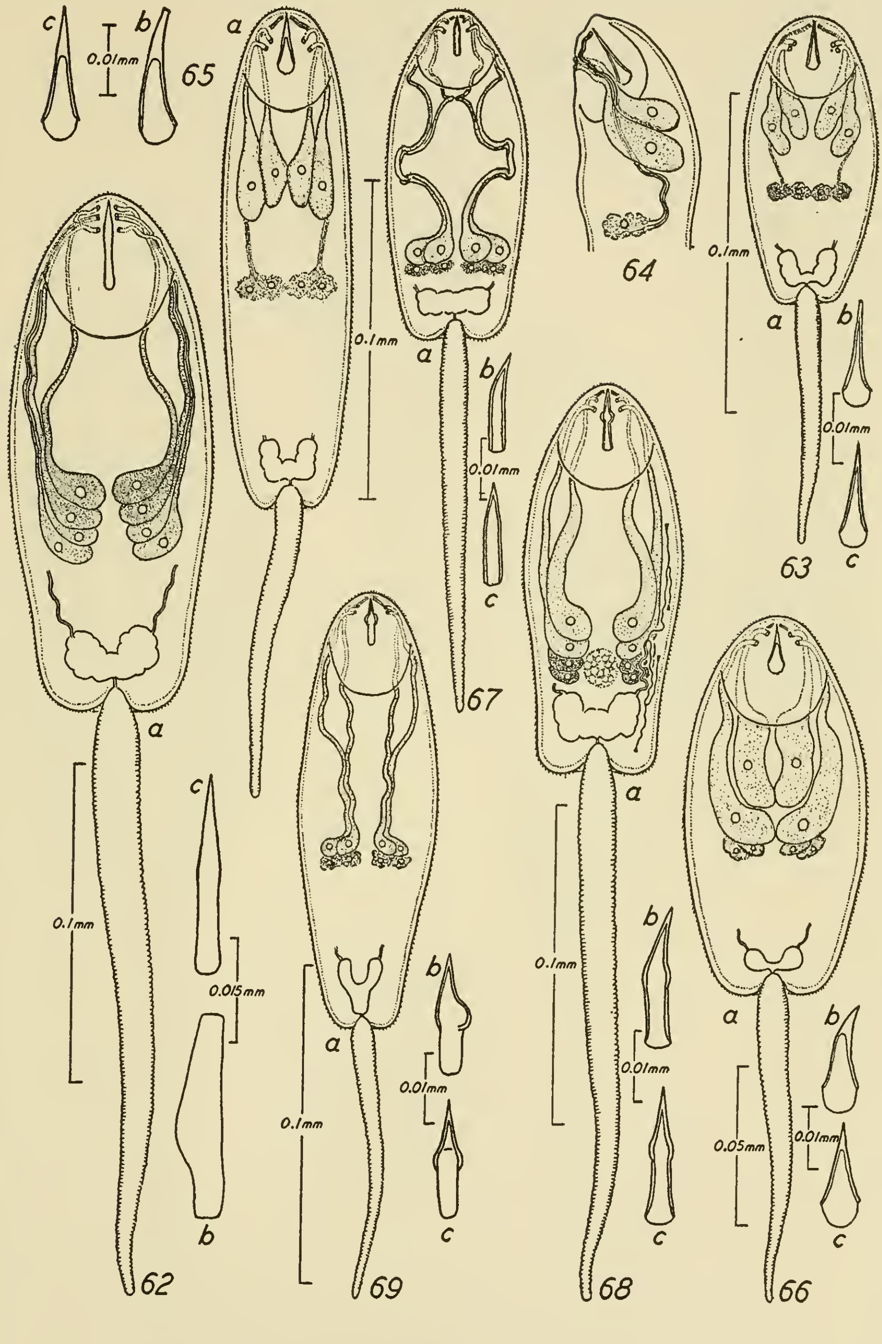



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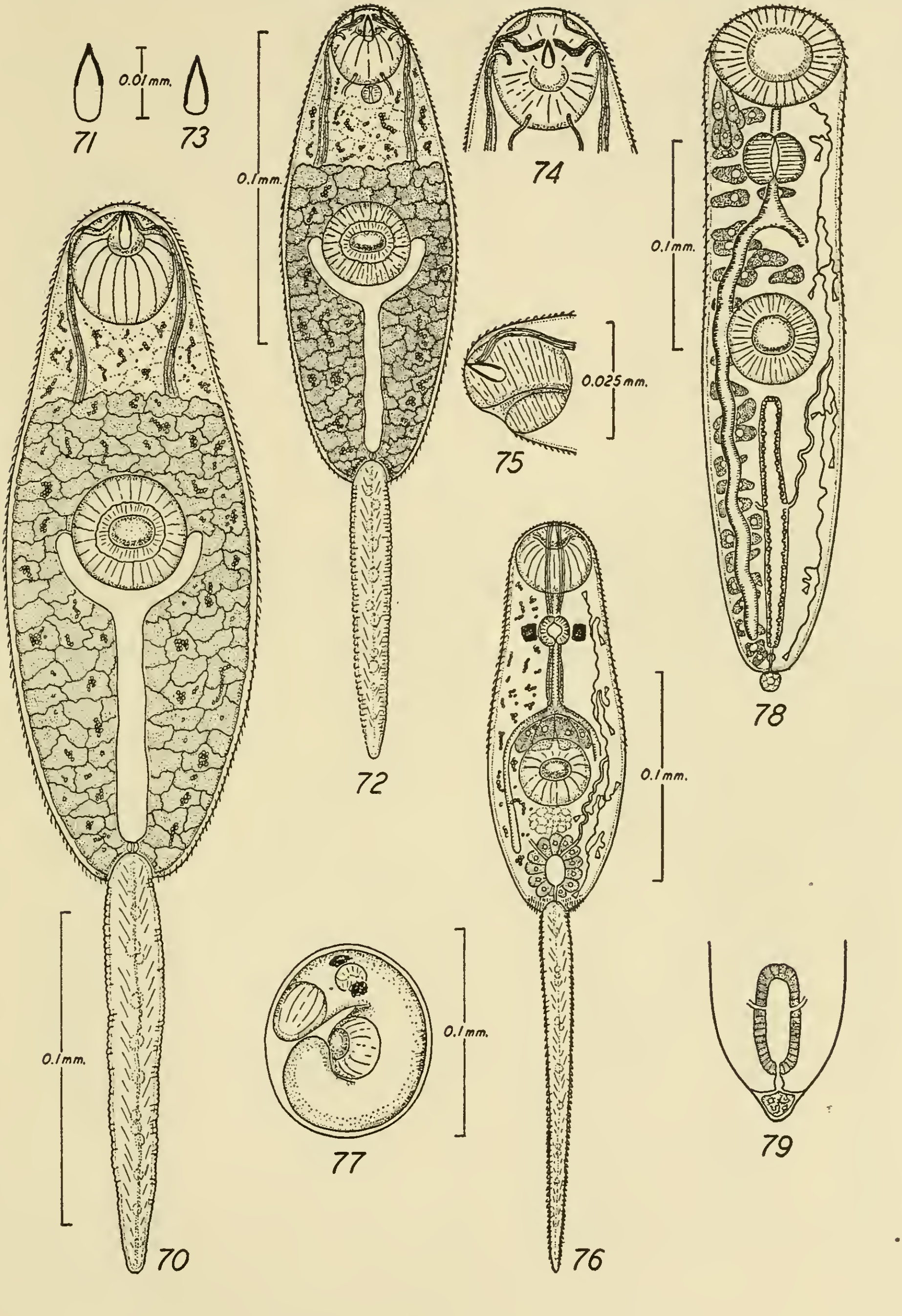
PLATE X

FIGURE 70. *Cercaria caribbea* XXXII, entire in ventral aspect.
FIGURE 71. Same, stylet enlarged.
FIGURE 72. *Cercaria caribbea* XXXIII, entire, ventral view.
FIGURE 73. Same, enlarged stylet.
FIGURE 74. Same, anterior end enlarged to show details of gland ducts.
FIGURE 75. Same, anterior end in side view.
FIGURE 76. *Cercaria caribbea* XXXV, entire, in ventral view.
FIGURE 77. Same, drawing of living metacercaria.
FIGURE 78. *Cercaria caribbea* XXXVI, entire, ventral aspect.
FIGURE 79. Same, posterior end of embryo drawn to show developing bladder and relationship of excretory openings to rudimentary tail.




CABLE: MARINE CERCARIAE OF PORTO RICO

PLATE XI*

FIGURE 80. Cercaria in side view.
FIGURE 81. Enlarged body of cercaria.
FIGURES 82 and 83. Early development of the excretory system.
FIGURES 84 to 86. Development of bladder and caudal excretory tubes.
FIGURE 87. Side view of advanced cercarial embryo showing beginning development of caudal bulb, flexion of remainder of tail, and relationship of excretory system to ventral appendage.
FIGURE 88. Redia drawn to show excretory system of one side.
FIGURE 89. A species of "*Torticaecum*" drawn to show main excretory passages; a portion of digestive system omitted for clarity.

* All figures except 89 concern *Cercaria caribbea* XXXIV.

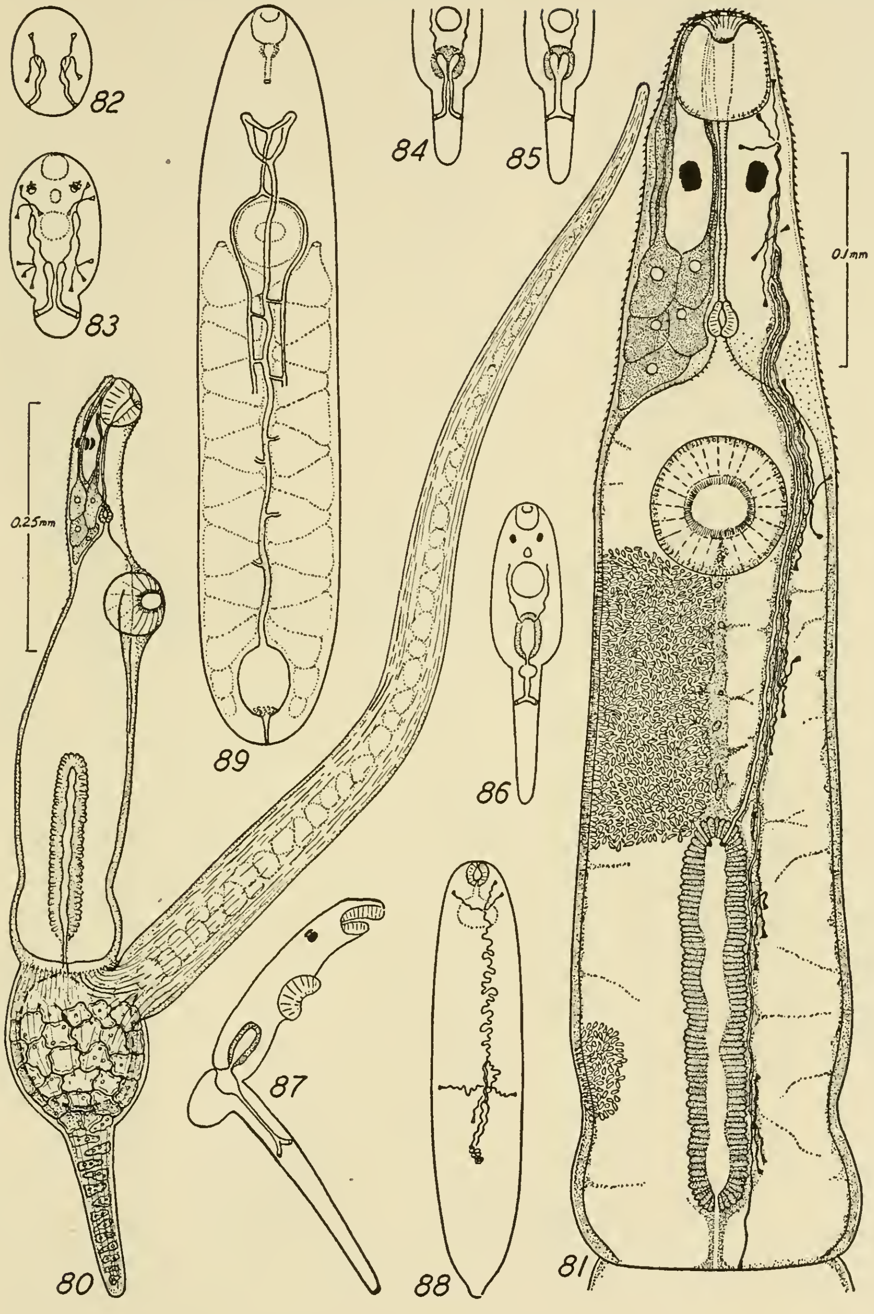



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PLATE XII*

FIGURE 90. *Cercaria caribbea* XXXVII, entire in ventral view.
FIGURE 91. Same, excretory system of one side from lateral aspect.
FIGURE 92. *Cercaria caribbea* XXXVIII, ventral view with caudal appendages of one side omitted.
FIGURE 93. Same, oral sucker (a) expanded and (b) contracted as observed in living specimens.
FIGURE 94. Same, embryo drawn to show relationship of excretory system to developing tail.

* FIGURES 90 and 91 from Cable, 1954a; FIGURES 92 to 94 from Cable, 1954b.

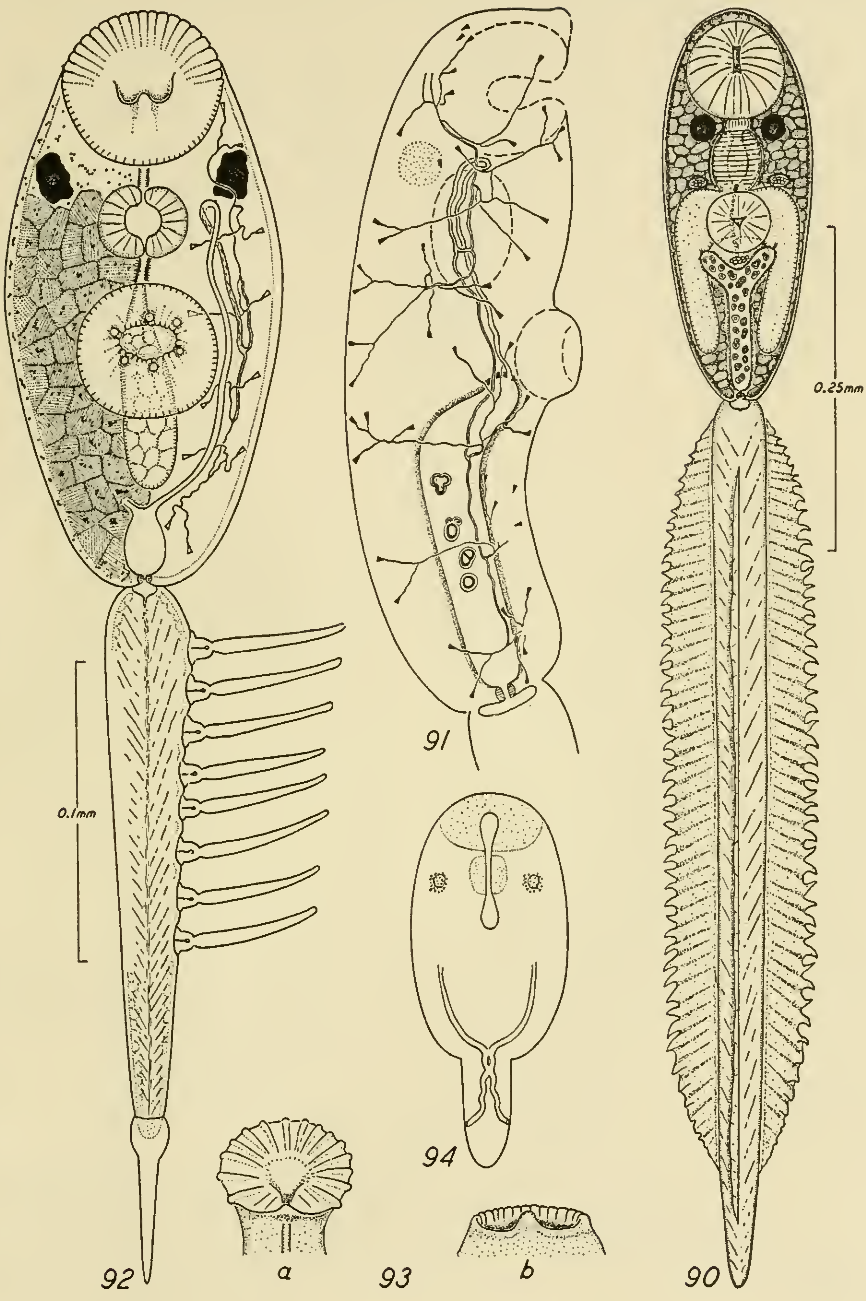


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PLATE XIII*

FIGURE 95. *Cercaria caribbea* XXXIX, ventral view with caudal finlets omitted from one side; (b) detail of caudal finlet in surface view.

FIGURE 96. *Cercaria caribbea* XL, ventral view with caudal setae omitted from one side.

FIGURE 97. Same, outline of one half of redial excretory system.

FIGURE 98. Same, a to c, development of triclad from rhabdocoele intestine in cercarial embryo.

FIGURE 99. Same, basal portion of multiple seta from tail stem.

FIGURE 100. *Cercaria caribbea* XLI (larva of *Parvatrema borinqueñae* Cable, 1953), drawn entire from ventral view.

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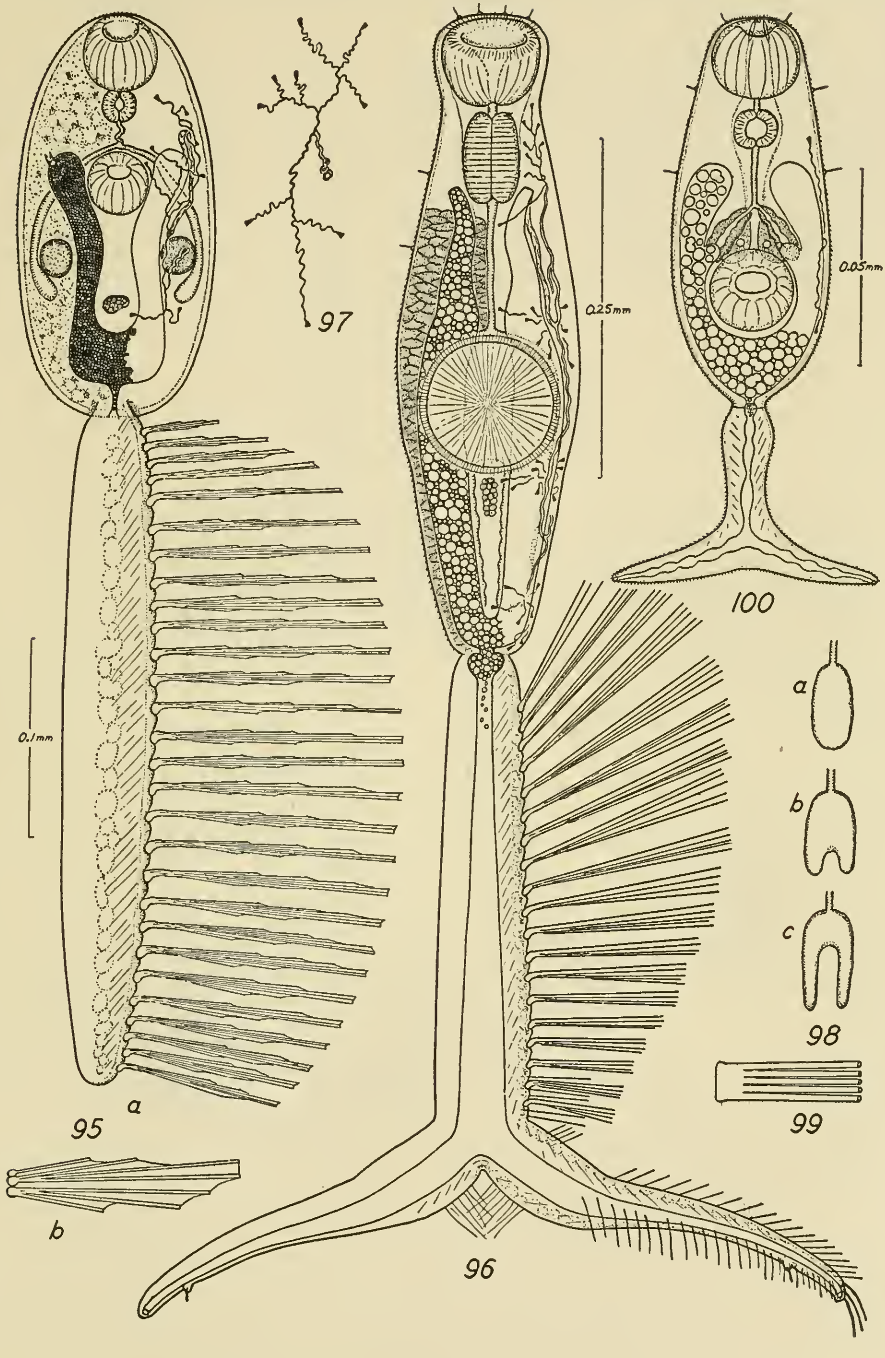
* Reproduced with change of figure numbers only from Cable (1953).




CABLE: MARINE CERCARIAE OF PORTO RICO

Plate XIV*

Figure 101. *Cercaria caribbea* XLII, scale outline of body and tail stem of heat-killed specimen.
Figure 102. Same, enlarged drawing of posterior part of body and adjacent tail region in a living specimen.
Figure 103. Same, anterior end enlarged to show structure.
Figure 104. Same, various shapes (a, b, and c) assumed by living specimens when suspended or on bottom.
Figure 105. *Cercaria caribbea* XLIII, entire.
Figure 106. *Cercaria caribbea* XLIV, entire, furcae in side view.
Figure 107. Same, with body not withdrawn into caudal vesicle.

* Figures 105 to 107 redrawn from original data and figures of Le Zotte, 1954.

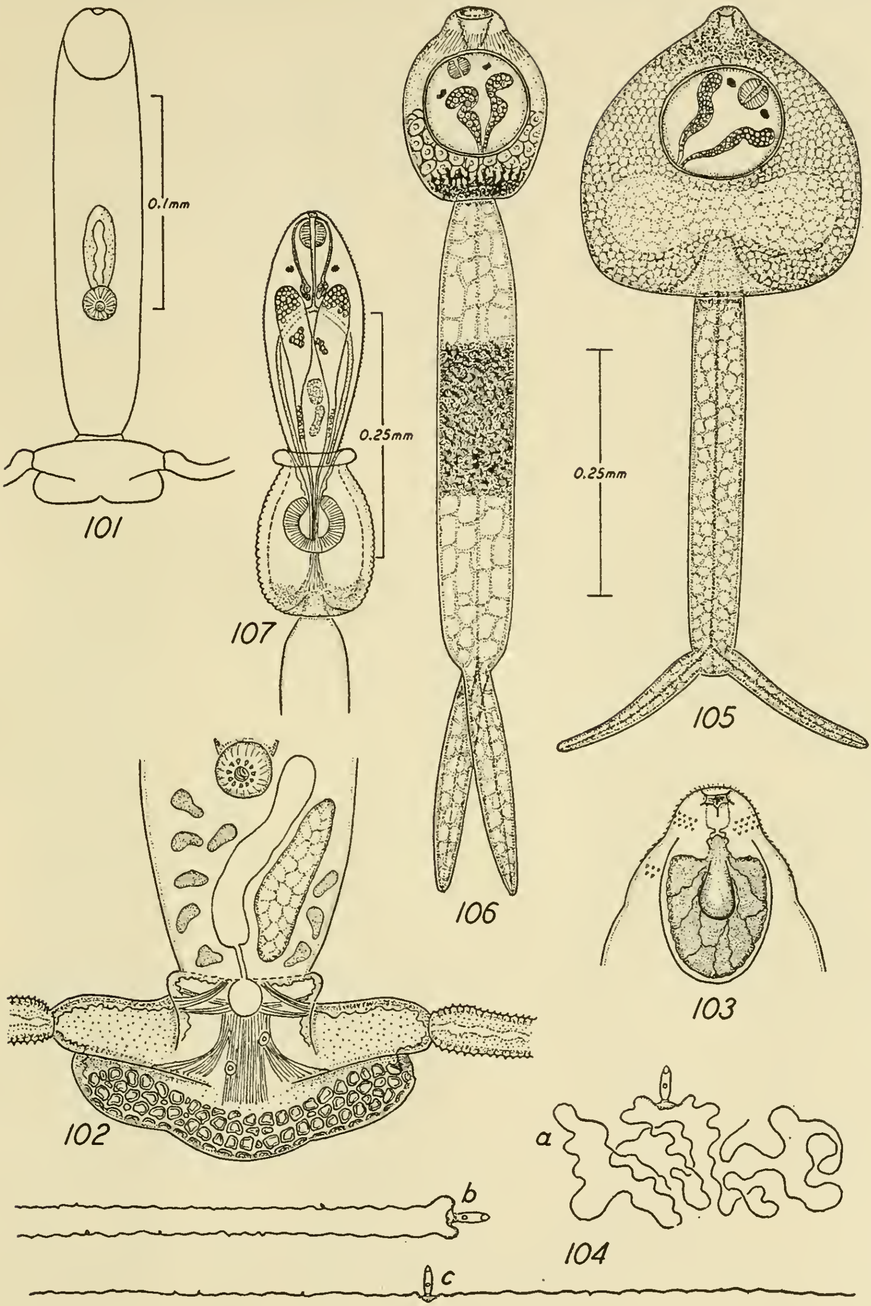



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PLATE XV*

FIGURE 108. *Cercaria caribbea* XLV, lateral view showing flattened tail-stem and furcae.
FIGURE 109. Same, but drawn to show shape of living specimen; tail-stem and furcae in edge view.
FIGURE 110. *Cercaria caribbea* XLVI, entire with tail in side view.
FIGURE 111. *Cercaria caribbea* XLVII, entire.
FIGURE 112. Same, drawn to show shape and proportions of living specimen.
FIGURE 113. *Cercaria caribbea* XLVIII, entire.

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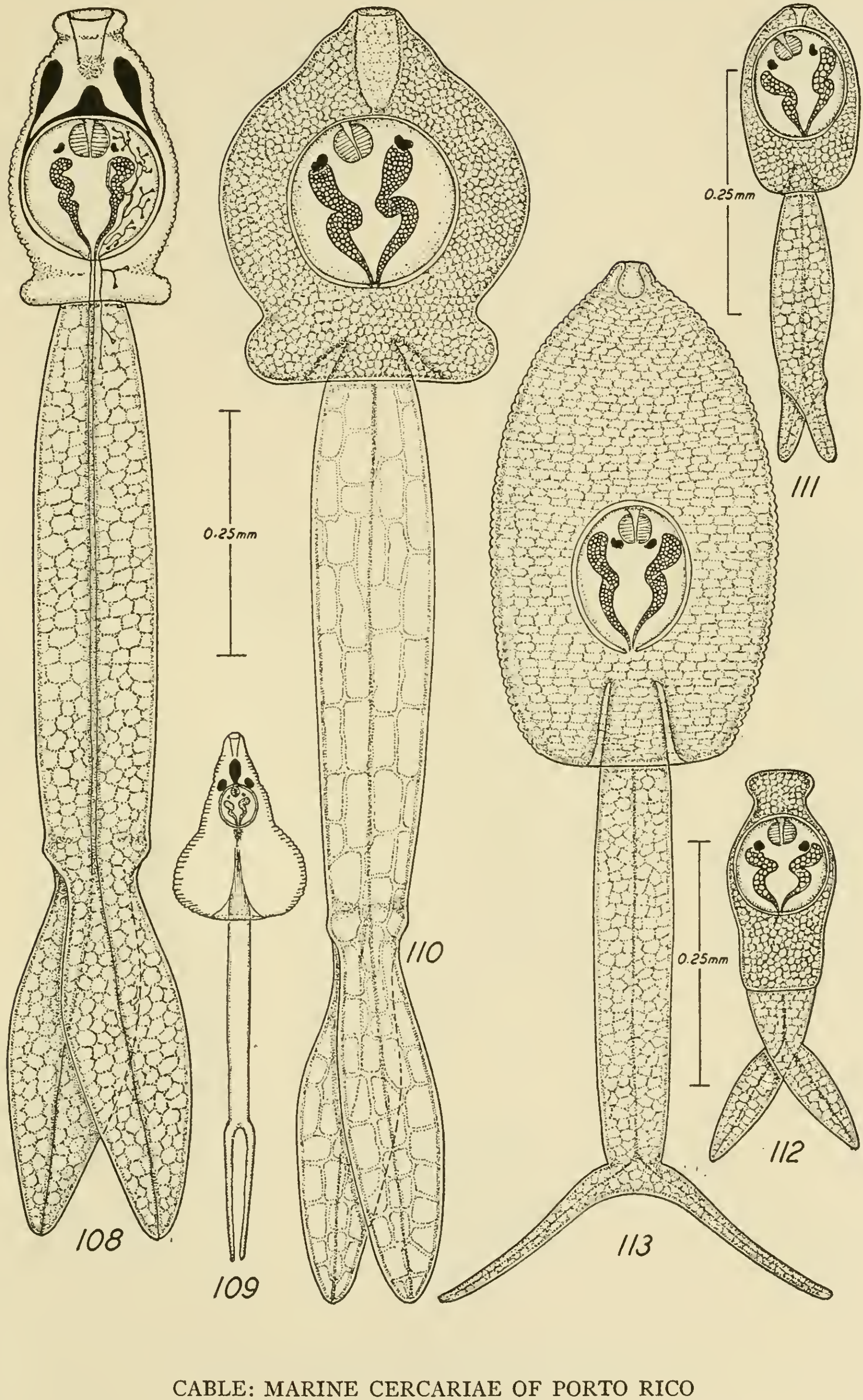
* All figures redrawn from original data and figures of Le Zotte, 1954.




CABLE: MARINE CERCARIAE OF PORTO RICO

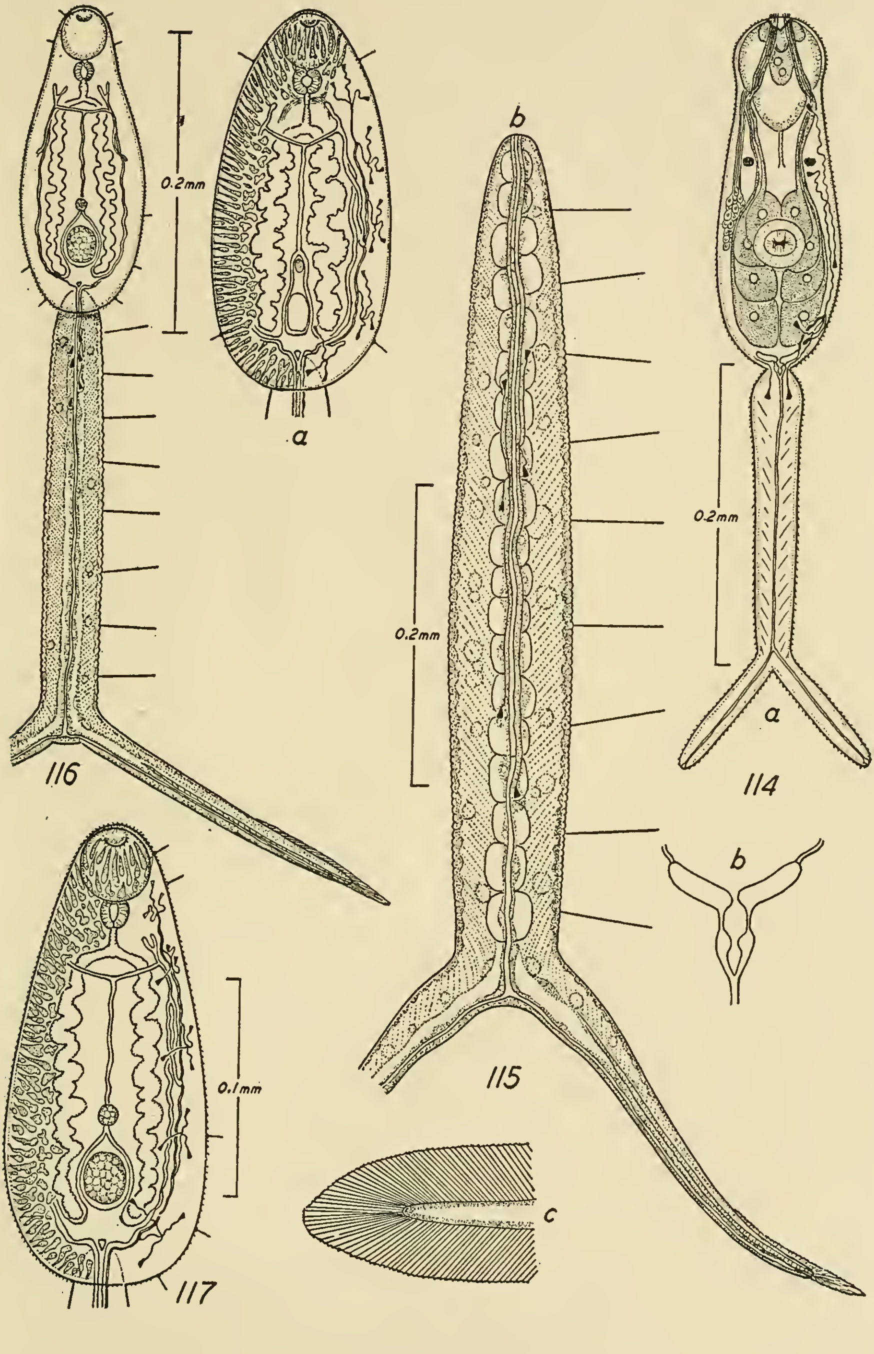
PLATE XVI

FIGURE 114. *Cercaria caribbea* LI, (a) entire, and (b) excretory vesicle showing absence of fusion within the body.

FIGURE 115. *Cercaria caribbea* L, (a) body, (b) tail with part of one furca omitted, and (c) enlarged furcal tip showing appearance of fin.

FIGURE 116. *Cercaria caribbea* XLIX, ventral view with one furca of tail omitted.

FIGURE 117. Same, enlarged body showing excretory system and other details.

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