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THE ECHINODERMS OF PORTO RICO.

BY

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The following account of the echinoderms of Porto Rico is based primarily on the extensive collections made by the U. S. Fish Commission steamer *Fish Hawk* in January and February, 1899, comprising considerably over 1,000 specimens and representing 85 species. The collection of crinoids is very small, but whether this is due to the difficulty of dredging in those waters or to the comparative scarcity of that group of echinoderms around Porto Rico it is impossible for me to say. The collection of holothurians is also small, but in this case there is little doubt that the difficulty of dredging is responsible. The collections of starfishes and sea-urchins, though not very extensive, probably represent with a fair degree of completeness the littoral fauna of Porto Rico in those groups. The collection of brittle-stars is large, comprising more specimens and more species than all the other groups combined, and it is doubtless very representative, at least of the littoral fauna.

I have also had the privilege of examining the echinoderms collected in the winter of 1900 near San Juan by Mr. George R. Gray. Though this collection embraces only 22 species, it includes 1 holothurian and 1 brittle-star not in the *Fish Hawk* collections. The number of species in the following list is therefore 87, of which 3 are crinoids, 11 asteroids (starfishes), 49 ophiuroids (brittle-stars), 13 echinoids (sea-urchins), and 11 holothurians. Of these, 8 seem to have been heretofore undescribed and 14 others have their previously known range extended considerably, so that the collections add not a little to our knowledge of West Indian echinoderms. About 50 of the 87 species may be classed as "littoral" forms; that is, they may be looked for in water of less than 2 fathoms depth, and nearly all of them occur in much shallower water than that, often just below low-water mark. Judged by these collections, the echinoderm fauna of Porto Rico is essentially like that of the other West Indian islands, although some of the new forms may prove to be confined to Porto Rico alone. At present we know too little of the fauna of any of the islands to draw any far-reaching conclusions.

In preparing this report two very different objects have been kept in view, but it is hoped that the attempt to combine them in one paper will not detract from the value of the work. Primarily, it is intended to present a complete report of the collections made by the *Fish Hawk*, describing and figuring the new species, and giving a full list of the echinoderms of Porto Rico. But the attempt is also made to give a brief description and account of each species, sufficient to enable anyone acquainted with zoölogy to identify them. The echinoderms are among the most

noticeable and characteristic animals of the West Indies, and any visitor to the islands at all interested in natural history is sure to find specimens which it would be of interest, if not of importance, to identify. At present there is no single work, nor indeed any popular book of any kind, by means of which this could be done. The Porto Rican collections have afforded the opportunity to prepare such a paper, since they include many of the common littoral echinoderms of the West Indies. It is hoped that these very artificial "keys" may be of use, not only to travelers and to residents in Porto Rico and the other islands who are interested in marine life, but especially to students or specialists in other fields of zoölogy who may visit the West Indies and wish to know the names and history of the echinoderms with which they meet. The "keys" may also be of use in Florida and along the Gulf coast.

It must be borne in mind that our knowledge of West Indian echinoderms is far from complete, and there are doubtless many of the less common "littoral" species not included in these "keys." Specimens of such forms may or may not fit by accident into the key, but the brief account given under the name of each species will assist in preventing mistakes. There are quite a number of species which were not taken in Porto Rico, but which will very possibly be found there. Such forms have been included in paragraphs following the lists of species, with brief statements of their distinguishing characteristics, to assist in their identification if found. It is of great importance that specimens which do not answer to the descriptions here given should be preserved in spirits and if possible forwarded to the Fish Commission or the National Museum at Washington for identification. In this way the present list will be extended until it includes all of the littoral echinoderms of the West Indies.

In presenting this report I desire to express my deep appreciation of the courtesies I have received from the Hon. George M. Bowers, U. S. Commissioner of Fish and Fisheries; and also from Dr. Hugh M. Smith, of the U. S. Fish Commission.

## CRINOIDEA.

## SEA LILIES.

The crinoids comprise a very insignificant part of the *Fish Hawk* collections, and there are no stalked forms among them. There are not a half dozen specimens all together, although there are fragments of many arms. They represent three common West Indian species of *Comatulæ*, collected at five different stations, and may be distinguished from each other by the following characters:

- A. Mouth approximately in center of disk. Oral pinnules without a "comb" near tip ..... *Antedon hagenii*  
 B. Mouth at side of disk. Oral pinnules with a "comb" of coarse teeth on inner side near tip.  
 1. Color pale. Pinnules without minute spines or hooks on each joint. .... *Actinometra meridionalis*  
 2. Color red-brown, with a longitudinal black stripe on aboral side of arms. Pinnules with minute spines or hooks on each joint ..... *Actinometra rubiginosa*

***Antedon hagenii* (Pourtales).**

This has been called the commonest crinoid of the West Indies. It was first collected by Pourtales in the Straits of Florida, and has since been found widely distributed in the Caribbean Sea. The calyx is about 20 mm. across; arms 100 mm. long. There is one calyx and fragments of many arms from station 6067, where they were dredged on a coral bottom at over 100 fathoms depth. Pourtales says the color is "pale-greenish, turning white in alcohol." The fragments of arms before me are almost white, but are banded with pale brown, and near the base is a longitudinal pale-brown stripe on the aboral side.

***Actinometra meridionalis* (Pourtales).**

Originally described by Pourtales from specimens collected in Florida Straits, but now known as a common and widely distributed form in the western Atlantic. Somewhat larger than the preceding.

There are 4 calyces of this species, with portions of arms attached, from station 6063. The longest arm measured 125 mm. There are also fragments from station 6066. This specimen was collected with a trawl on a rocky sand bottom at a depth of from 75 to 172 fathoms.

***Actinometra rubiginosa* (Pourtales).**

First described from south of Florida, its range eastward being greatly extended by its collection at the eastern end of Porto Rico. About the size of the preceding and more handsomely colored. Fragments of arms collected with a tangle on a coral bottom at stations 6088 and 6090, at depths of 16 to 23 fathoms, seem to be referable to this species. They are dark reddish-brown, with a longitudinal black stripe on the aboral side.

Numerous other species of crinoids have been collected in the Caribbean Sea, but it is impossible to say what forms may be expected to occur in the Porto Rican waters. It is worth noting, however, that the three species collected by the *Fish Hawk* are not only all *Comatulæ* (crinoids without stalks, not attached when adults), but belong to the 10-armed series of that group. Several *Comatulæ*, having 15 to 20 or more arms, may be looked for, while other 10-armed species undoubtedly occur. Of the stalked crinoids, *Pentacrinus decorus* W. Thomson has been recorded from the "south side of Porto Rico" (Fewkes, Bull. Mus. Comp. Zool., vol. x, p. 181) and three other species of the same genus are also known from the West Indies, all collected in water of over 70 fathoms depth. The curious little *Holopus*, which has been recorded from the north side of Cuba and from Barbados, may be looked for attached to rocks in comparatively shallow water.

## ASTEROIDEA.

## STARFISHES.

The *Fish Hawk's* collection of starfishes is of considerable interest, although no new species were found. There are 103 specimens, representing 11 species, but one-third of these belong to a single species of *Astropecten*. With one exception the species are common West Indian forms, and the list is almost a duplicate of one published in 1898 as "The Asteroids of Jamaica" (Johns Hopkins Univ. Circ., Nov., 1898). These starfishes are readily distinguished from each other, as they represent no less than 7 families, and the following artificial key will make their determination easy, although it is worthless for any other species.

- A. Rays shorter than diameter of disk, the general shape of animal pentagonal.
- I. Size large, disk high ..... *Pentaceros reticulatus*. (7)
  - II. Size very small, disk flat ..... *Asterina folium*. (8)
- B. Rays much longer than diameter of disk.
- I. Rays more or less flattened, and spiny, at least on the sides.
    - a. Disk large; general form star-shaped; marginal plates of rays on upper side very prominent.
      - 1. Marginal plates without spines..... *Astropecten antillensis*. (1)
      - 2. Marginal plates with erect, conical spines..... *Astropecten duplicatus*. (2)
    - b. Disk smaller, rays longer, marginal plates not prominent.
      - 1. Rays 9, flat and long ..... *Luidia senegalensis*. (5)
      - 2. Rays 5, flat and long, not spiny above..... *Luidia clathrata*. (4)
      - 3. Rays 5, banded alternately with green or purple and yellow, somewhat flattened, long, and covered with small spines..... *Luidia alternata*. (3)
      - 4. Rays 5, not much flattened, short, blunt, and bearing a few (30 to 60) coarse spines... *Echinaster crassispina*. (11)
  - II. Disk very small, rays very slender, and almost cylindrical.
    - a. Rays rather blunt and quite smooth.
      - 1. Groups of openings through skeleton arranged in regular longitudinal rows on rays... *Ophidiaster guildingii*. (9)
      - 2. Groups of openings through skeleton, without any definite arrangement ..... *Linckia guildingii*. (10)
    - b. Rays tapering, and more or less spiny, at least on sides ..... *Zoroaster fulgens*. (6)

1. *Astropecten antillensis* Lütken.

This common starfish occurs throughout the West Indies, on sandy bottoms. It is generally very light colored, whitish or pale brown, and reaches a diameter of about 175 mm. There are thirty-six specimens in the *Fish Hawk* collection, ranging from 6 to 185 mm. across. The smallest has the paxillæ with 6 or more spinelets, 4 marginal plates on each side of ray, and a  $\Lambda$ -shaped plate at tip; infero-marginal plates with one lateral spine, the second just beginning to appear. Specimens 12 to 15 mm. across have the second lateral spine nearly as large as the first, except on the 2 infero-marginal plates at angle of the rays; the paxillæ spinelets are more graniform. In specimens 24 mm. across the paxillæ spinelets are nearly granular. Small specimens are easily distinguished from small specimens of the next species by their flatness, breadth of rays, the paxillæ, and bluntness of lateral spines.

Collected at Arroyo, Mayaguez, and Puerto Real.

2. *Astropecten duplicatus* (Gray).

This species seems to occur in deeper water than the preceding around Porto Rico, but may be found with it. There are several differences between them, but the spines on the marginal plates sufficiently distinguish *duplicatus*. It reaches the same size and has the same distribution as *antillensis*, but varies more in color, being sometimes bright reddish brown.

There are 11 specimens before me, varying in size from 18 to 178 mm. across and in color from almost white to brownish orange, with feet red, green, or pale brown. The smallest has only 4 or 5 spinelets on each paxilla and no spines on supero-marginal plates.

Collected at stations 6058, 6072, 6084, 6085, 6091, and 6096; none taken in less than 6 fathoms.

3. *Luidia alternata* (Say).

One of the handsomest starfishes of the West Indies, often found with the two preceding. It reaches a large size, 250 mm. across, and its striking colors make it very conspicuous. There is only one small specimen in the *Fish Hawk* collection (65 mm. across), from station 6097, in 10 fathoms. The colors are purplish and yellowish.

**4. *Luidia clathrata* (Say).**

Common on sandy bottoms along the southeastern coast of the United States and throughout the West Indies, also occurring in Bermuda. It reaches a diameter of 200 mm. Color usually grayish blue above, light yellowish beneath.

Collected at stations 6054 and 6084; 7 specimens, the largest 200 mm. across.

**5. *Luidia senegalensis* (Lamarck).**

This curious and interesting starfish occurs on sandy bottoms throughout the West Indies. It reaches a diameter of over 350 mm. Upper surface grayish blue; lower pale yellow. There are 3 specimens, all with 9 rays. The largest is 365 mm. across. Collected at Cataño, Mayaguez, and Puerto Real.

**6. *Zoroaster fulgens* W. Thomson.**

A large and handsome starfish, 225 mm. across, found in deep water throughout the North Atlantic. Its occurrence in shallow water at San Juan seems quite exceptional. There are 2 very fine specimens labeled simply "San Juan," which I have referred to this species, though not without hesitation. They answer very satisfactorily to Sladen's description (Challenger Report, vol. xxx), but not so well to his figures, which, however, differ somewhat from the description, especially in proportions. The specimens before me have the rays 110 mm. long, while the radius of the disc is only 8 mm., therefore  $R = 14 r$ . Perrier, in his description of *Z. ackleyi*, speaks of superficial resemblances, aborally to *Ophidiaster*, orally to *Luidia*, and in these the Porto Rican specimens agree with *ackleyi*; but they differ from that species in having only 11 longitudinal rows of plates on the rays, agreeing in that respect with *fulgens*. They also agree with the latter species in the granulation of the plates and in several other minor points, but they are not nearly as spiny as Sladen's figures. All the differences together, however, do not seem to me to warrant the separation of the Porto Rican species as new. It is unfortunate that there are no data to show at what depth these specimens were collected; it hardly seems possible that they could have been collected along shore or in very shallow water.

**7. *Pentaceros reticulatus* (Linnæus).**

This is perhaps the best known of the West Indian starfishes, being commonly brought back by sailors and travelers as a curio. It reaches a large size, up to nearly 0.5 meter in diameter. In life the color is usually yellowish or reddish-orange, but when dried it is more often brown. It occurs on sandy or muddy bottoms, in shallow water, throughout the West Indies. The *Fish Hawk* collection contains 12 small specimens, measuring from 72 to 200 mm. across. They were collected at Mayaguez, Ponce, and San Juan. Mr. Gray brought back about 50 specimens of medium size, of which 2 have 6 rays and 2 have only 4. The ambulacral furrows of the latter form a perfect cross. Mr. Gray called my attention to the fact that there are 2 well-marked varieties of this starfish, so different from each other that, were connecting links wanting, they would easily pass for distinct species. One has the rays acuminate, the disc very high, the skeleton comparatively light, and the oral surface quite spiny, while the other has the rays shorter and more rounded, the disc lower, the skeleton very solid, and covered with large tubercles; oral surface more granular and less spiny.

**8. *Asterina folium* Lütken.**

A very pretty little starfish, rarely 20 mm. in diameter, found clinging to the under side of rocks, in shallow water. The color varies greatly, blue being the prevalent shade, but red, yellow, green, and white specimens often occur. Found from Bermuda southward throughout the West Indies. One small specimen, 13 mm. across, from the reefs at Ponce, is the only representative in the *Fish Hawk* collection.

**9. *Ophidiaster guildingii* (Gray).**

Found among corals and broken rocks throughout the West Indies, but does not seem to be as common as the following, which it superficially resembles. It rarely reaches a large size, 50 to 60 mm. across being a good average. The color varies from red and yellow to purplish, brown, and white. Three average-sized specimens of this species were collected at Ponce.

**10. *Linckia guildingii* (Gray).**

A very common starfish from Bermuda southward, occurring among corals and broken rocks. It reaches a much larger size than the preceding, a big specimen measuring 200 mm. across; but it is

generally much less than 100 mm. in diameter. Color very variable; some are light brown with dark blotches, some chocolate brown, some purplish brown, and some almost black. Rays very variable in size and number, a specimen with 5 equal rays being a rarity. It is not uncommon to find a single ray creeping about by itself, and sooner or later such a ray reproduces a new disk and 4 or 5 new rays. This remarkably variable species is represented by 16 specimens in the *Fish Hawk* collection and 2 in Mr. Gray's collection. Of these, 9 have 6 rays, 6 have 5 rays, 1 has 4 rays, and 2 consist of only 1 ray each. Very few have the rays even approximately equal, and in no less than 6 specimens 1 ray is so much larger than the others that it is clearly reproducing a new disk with the rays. In these the madreporic plate is usually lacking, but in one of them there are 3. Of the other 12 specimens, 9 have 2 madreporic plates, 1 has 1, and the 2 single rays have none.

Collected at Ensenada Honda (Culebra), San Juan, and Ponce.

#### 11. *Echinaster crassispina* Verrill.

This starfish belongs to an entirely different order from the preceding. It is seldom 100 mm. across, and is reddish brown or yellowish brown in color. Its exact range is not known, but it is considered by some writers as identical with *E. spinosus*, which occurs on muddy bottoms and among mangroves throughout the West Indies. Eleven specimens from Cataño, San Juan Harbor, and Puerto Real and stations 6059, 6072, and 6091 vary much in color, from bright yellow brown to dark red brown, but agree very well in general form and appearance. The largest has  $R=48$ ,  $r=11$ ,  $R=4\frac{1}{2}r$ ; the smallest has  $R=18$ ,  $r=4$ ,  $R=4\frac{1}{2}r$ . In others,  $R=3r$ ,  $R=4r$ , and  $R=5r$ . They are all clearly representatives of Verrill's species *crassispina*. Sladen gives *crassispina* as a synonym of *spinosus* Retzius, but these Porto Rican specimens are so easily distinguished from Jamaican specimens of *spinosus*, that it seems better to use Verrill's name. The short, blunt arms, with the rather few, very coarse spines, are quite characteristic, and none of the specimens before me have the bright-red color of the Jamaican *spinosus*.

Several other starfishes may be looked for on the shores of Porto Rico, as they are common in other parts of the West Indies. They are closely related to those already listed, and may be found in similar situations. *Astropecten articulatus* (Say) may be distinguished from either of the *Astropectens* given above by the presence of a small, blunt tubercle on the marginal plates near the tip of the ray, but there are no spines on these plates. In color and general appearance this species approaches *antillensis* very closely. *Asterina minuta* (Gray) is smaller and less pentagonal than *folium*, and the color is pretty uniformly white. The plates along the edges of the furrows in which the feet lie carry 2 or 3 spines on their free margin (not 4 or 5, as in *folium*), and the plates in the interradial spaces of the upper surface carry only 1 spine (rarely 2) instead of 3 or 4, as in *folium*.

Another starfish allied to *Asterina* is *Stegnaster wesseli* Perrier. This form is somewhat larger—20 to 35 mm. across and having the disc rather high (4 to 7 mm.). The whole animal is covered with a thick, granular skin, which conceals the underlying plates. The color is whitish. It occurs under rocks with *Asterina* and *Linckia*.

If *Echinaster spinosus* is a different species from *E. crassispina*, probably it also occurs in Porto Rico. It may be recognized by rather long, tapering arms,  $R > 5r$ , numerous small, sharp spines, and its deep but bright red color. It is a handsome starfish, and should be easily recognized. Possibly *Asterias tenuispina*, which occurs in the Bermudas, or some other *Asterias*, may occur in Porto Rico. The genus may be recognized by the absence of marginal plates, by the irregular meshwork of the skeleton on the upper side, and the numerous spines of various sizes. *A. tenuispina* has a variable number of arms, 4 to 9, but usually 7. The color is reddish yellow, with more or less violet marking.



## OPHIUROIDEA.

## BRITTLE-STARS, SAND-STARS, SERPENT-STARS, ETC.

The brittle-stars make up by far the largest and most interesting part of the collection of echinoderms made by the *Fish Hawk*. There are about 550 specimens, representing 49 species, of which no less than 7 seem to be new to science. In spite of the fact that the ophiurans of the West Indies have been long and carefully studied by some of the best systematists in the world, so great is their number and so extraordinary their variety that almost every collection of any size adds something new to the list. This is especially true when collecting with a tangle, for a dredge or trawl is of little use on a bottom covered with coral, while a tangle quickly gathers up any objects as rough as the ordinary brittle-star. Of course, on sandy or muddy bottoms, where the ophiurans are buried, a dredge or trawl is better. Half of the specially interesting forms collected by the *Fish Hawk* were taken with the tangle; all but one or two of the remainder were taken with the dredge or 7-foot trawl. Aside from those which are new, there are several species of very great interest on account of the considerable extension of their range or the discovery of their presence in shallow water when previously known only from considerable depths. There are 17 species which were collected along shore, the remaining 31 having been taken at depths of from 4 to 231 fathoms. In the study of this collection Professor Verrill's recent papers on West Indian Ophiurans (Trans. Conn. Acad., vol. x, pt. 2) have been of the greatest value, and his classification and nomenclature have been adopted in the following list except in one or two instances.

The following very artificial key to the brittle-stars of Porto Rico (on pp. 240-241) is rendered more or less technical on account of the large number of species and the close relationship between many of them. Consequently it has been necessary to make use of certain terms that may not be readily understood by one not familiar with the group. These terms are herewith briefly defined in order to make the key thoroughly intelligible:

- Adoral plates*.—A pair of small plates at the base of the jaws, proximally close to the oral shields.  
*Arm-comb*.—A series of very small teeth-like projections or papillæ bordering the plates of the disk at the base of the arm in the genus *Ophioglypha*.  
*Arm-spines*.—The spines borne on the side of the arms; the number of arm-spines is the number in a single vertical row.  
*Disk*.—The body, as distinguished from the arms, especially the upper side of the body.  
*Distal*.—Away from the mouth; toward the tip of the arm.  
*Jaws*.—The five triangular bodies which surround the mouth, each one made up of several plates and bearing the oral papillæ and tooth papillæ.  
*Oral papillæ*.—The teeth-like projections on the sides of the jaws.  
*Oral shields*.—The large plates lying one in each interradius between the bases of the arms, on the under side, just outside the bases of the jaws.  
*Proximal*.—Toward the mouth or base of the arms.  
*Radial shields*.—Large plates on the surface of the disk, arranged in pairs at the base of the arms; they may be very large, or small, or entirely concealed; the two shields of a pair may lie close together or widely separated.  
*Tentacle pores*.—Openings on under side of arm, through which tentacles project in the living animal.  
*Tentacle scales*.—Small scales, just outside the under-arm plates and close beside the tentacle pores.  
*Tooth papillæ*.—The teeth-like projections at apex of jaw.  
*Under-arm plates*.—The longitudinal row of plates covering the lower surface of the arms.  
*Upper-arm plates*.—The longitudinal row of plates covering the upper surface of the arms; usually they form a single continuous series, but sometimes they are widely separated from each other, and occasionally there are additional rows composed of supplementary plates on each side.

## Key to the Brittle-Stars of Porto Rico.

A. Arms not capable of being vertically coiled; disk sharply set off from arms.

- I. Arm-spines short, smooth, on distal edge of side arm-plates, closely appressed to arm.
- a. Disk covered with fine granules.
- a1. Arm-spines 8 to 10, short, broad, equal; arms comparatively short, about 3 times diameter of disk; radial shields covered; adoral plates covered by granules. . . . . *Ophiura brevicauda*. (2)
- a2. Arm-spines 7 to 8, slender, equal; arms more than 3 times the diameter of disk; radial shields covered; adoral plates naked . . . . . *Ophiura brevispina*. (3)
- a3. Arm-spines 8 to 9, the lowest the longest; radial shields covered. . . . . *Ophiura appressa*. (1)
- a4. Arm-spines 6 to 8, the lowest the longest; radial shields naked; color ashy gray . . . . . *Ophiura cinerea*. (4)
- a5. Arm-spines 8 to 9, the lowest the longest; radial shields naked; color purplish red . . . . . *Ophiura rubicunda*. (5)
- b. Disk covered with scales or plates.
- b1. Upper arm-plates with supplementary plates on each side; arm spines 4 to 6. . . . . *Ophiolepis elegans*. (6)
- b2. Upper arm-plates, without supplementary plates.
- c. Radial shields separated from genital plates by a pair of plates, which bear on their proximal edge a row of bead-like papillæ, similar to those on distal edge of radial shield. This makes the radial shields appear as though eracked transversely, each side of the crack bearing a row of little papillæ. . . . . *Ophiothyrcus goesii*. (10)
- cc. Radial shields not as above.
- d. No tentacle-pores beyond the basal arm joints.
- e. Disk-scales rough and swollen; an erect spine on each of several basal arm-plates; arm-spines 2. . . . . *Ophiomusium sculptum*. (14)
- ee. Disk-scales smooth; under-arm plates persisting nearly to end of arm; arm-spines 3. . . . . *Ophiomusium eburneum elegans*. (13)
- eee. Disk-scales smooth, rather few; no under-arm plates beyond third or fourth; arm-spines 4 to 5. . . . . *Ophiomusium validum*. (15)
- dd. Tentacle pores to end of arm.
- f. Not more than 2 tentacle-scales.
- g. Small separated radial shields; 4 to 5 arm-spines, lowest longest. . . . . *Ophiozona impressa*. (7)
- gg. Radial shields large, slightly separated; arm-spines 3 (rarely 4) subequal. . . . . *Ophiozona nivea compta*. (8)
- ggg. Radial shields large, with a blunt spine on the outer end; arm-spines 3. . . . . *Ophiozona tessellata*. (9)
- ff. Tentacle-scales 3 or more.
- h. Papillæ of arm-comb small, almost bead-like. . . . . *Ophioglypha robusta*. (12)
- hh. Papillæ of arm-comb sharp and cylindrical. . . . . *Ophioglypha ljungmani*. (11)
- II. Arm-spines rather long, more or less at an angle to arm, and often rough or thorny.
- a. Disk covered with little granules.
- a1. Disk granules coarse and uneven; no tooth papillæ; basal oral papillæ very wide; arm-spines 3. . . . . *Ophiostigma isacanthum*. (40)
- a2. Disk granules even; numerous tooth-papillæ; arm-spines 4 to 6.
- b. Two tentacle-scales . . . . . *Ophiocoma chinata*. (19)
- bb. One tentacle-scale.
- c. Color almost black; under side and especially tentacles rusty red . . . . . *Ophiocoma riisci*. (21)
- cc. Color light brown; arms banded with darker . . . . . *Ophiocoma pumila*. (20)
- aa. Disk more or less covered with scattered spines, spinules or thorny stumps.
- b1. No oral papillæ; arm-spines 5 to 10, long, glassy, thorny.
- c. Disk beset with numerous trifid stumps, among which there are often a few slender spines. . . . . *Ophiothrix angulata*. (16)
- cc. Disk beset with slender spines . . . . . *Ophiothrix arstedii*. (17)
- ccc. Disk with a few long slender spines; arm-spines very long, slender, rough and glassy. . . . . *Ophiothrix suensonii*. (18)
- b2. Oral papillæ few, rarely more than 2 on a side; arm-spines 4 to 7, smooth to the naked eye.
- d. Size large, disk over 10 mm.; color very dark; arms 5, very long; arm-spines 7. . . . . *Ophiactis longibrachia*. (25)
- dd. Size small, disk not often over 7 mm.; colors green and white; arms usually 6, rather short; arm-spines 7. . . . . *Ophiactis krebsii*. (24)
- ddd. Size small; colors purple and white; 6 arms; arm-spines 4 . . . . . *Ophiactis loricata*. (26)
- b3. Oral papillæ numerous, 4 or more on each side.
- c. Oral shield touches the side arm-plate on each side.
- f. Radial shields long, narrow, and partly covered.
- g. Arms, 5. Rows of spines closely approximate dorsally. . . . . *Ophiacantha bidentata*. (41)
- gg. Arms, 6. Rows of spines not approximate dorsally . . . . . *Ophiacantha ophiactoides*. (42)
- ff. Radial shields broad and thin, one overlapping the other . . . . . *Ophioplathuca spinissima*. (45)
- cc. Oral shield separated from the side arm-plate by a corner of the adoral-plate. . . . . *Ophiopristis hirsuta*. (44)
- c. Disk covered with scales or smooth skin, without spines or thorny stumps.
- e1. Upper arm-plates with supplementary plates on each side.
- h. Color pale bluish, yellowish, or whitish; arms yellowish, banded with brown; usually a network of fine brown lines on disk . . . . . *Ophionereis rcticulata*. (39)
- hh. Color reddish-brown; arms banded with darker. . . . . *Ophionereis dubia*. (37)
- hhh. Color olive-green, spotted with yellowish . . . . . *Ophionereis olivacea*. (38)

- c 2. Upper arm-plates without supplementary plates.
- i. Arm-spines long, glassy, numerous (8); size large (disk over 10 mm. in diameter); color dark brown ..... *Ophiacera glabra*. (43)
  - ii. Arm-spines rather short, not glassy, numerous; size medium; color various, but disk usually speckled; scales very minute.
    - k. Disk reddish or gray, spotted with black; arm-spines 6 to 7..... *Ophiopsila riisci*. (23)
    - kk. Disk grayish, spotted with orange; arm-spines 6 to 11..... *Ophiopsila fulva*. (22)
  - iii. Arm-spines short, 3 to 7; size small; arms long; color of disk grayish, arms very light; scales very distinct.
    - l. Oral papillæ 2, one on each side at base of jaw and 1 at the tip; middle of jaw edge bare; arm-spines 4 or more.
      - m. Tentacle-scale 1; radial shields twice as long as broad; 4 to 5 short, blunt arm-spines ..... *Amphiura simpsoni*. (28)
      - mm. Tentacle-scales 2; radial shields three times as long as broad; 6 tapering arm-spines ..... *Amphiura fernosa*. (27)
      - mmm. Tentacle-scales 2, at base of arm; radial shields twice as long as broad; 6 to 7 short arm-spines, 2 next to the lowest with little hooks on the end. *Amphiura bihamula*. (29)
    - ll. Oral papillæ 3 on each side, the distal one very wide; arm-spines 3.
      - n. Arms very long and slender, more than 8 times diameter of disc..... *Amphipholis gorsii*. (30)
      - mm. Arms less than 8 times diameter of disk.
        - o. Radial shields short and joined ..... *Amphipholis limbata*. (31)
        - oo. Radial shields long and narrow ..... *Amphipholis subtilis*. (32)
    - lll. Oral papillæ 3 or 4, subequal or the distal one smallest; arm-spines 3, rarely 4.
      - p. Tentacle-scale 1..... *Amphiodia pulchella*. (34)
      - pp. Tentacle-scales 2.
        - r. Oral shield elongate; arm-spines more or less acute ..... *Amphiodia riisci*. (35)
        - rr. Oral shield ovate, broadest proximally; arm-spines flat and wide at tip. *Amphiodia planispina*. (33)
  - llll. Oral papillæ 5, unequal; radial shields widely separated; arm-spines 3. *Amphioplus stearnsii*. (36)
- c 3. Upper arm-plates altogether wanting or consisting of a number of small indistinct pieces.
- s. Upper-arm plates wanting; size small, disk 5 to 6 mm. in diameter. *Ophiocoloe serratus*. (46)
  - ss. Upper-arm plates indistinct, of several pieces on each side; size large, disk 15 to 25 mm. in diameter ..... *Ophiomyra flaccida*. (47)
- B. Arms slender, capable of being vertically coiled; disk very small, not sharply set off from arms.
- I. Color yellowish-brown; arms covered by a granulated skin..... *Astroscema oligactes*. (49)
  - II. Color brown and white; arms ringed by regular raised belts of close-set nodules..... *Astroporpa annulata*. (48)

The user of this key must be cautioned that it is of no value except for the species included. Moreover, in the case of large genera like *Ophioglypha*, *Ophiomusium*, *Amphiura*, and *Ophiacantha*, several species might answer to the very brief descriptions given to the Porto Rican forms, though the attempt has been made to have these descriptions reasonably exclusive. It is believed, however, that the ordinary littoral forms can be easily and accurately determined by means of this key. The characters show much more plainly in dry specimens than in fresh or alcoholic material, and this is particularly true of the covering of the disk and the upper and under arm-plates.

### 1. *Ophiura appressa* Say.

Very common from South Carolina and Bermuda to Brazil, found in similar situations with *O. brevispina*, which it closely resembles in size and color. Oral shields usually wider than long, but even this difference is not very constant. Small specimens of the two species are distinguishable with difficulty.

There are 27 specimens of this species in the *Fish Hawk* collection, varying greatly in size and color. Taken at Ponce, Ensenada Honda (Culebra), Caballo Blanco and Guanica, and at stations 6088 and 6093. Mr. Gray took this species at San Juan, also.

### 2. *Ophiura brevicauda* Lyman.

This handsome ophiuran is common in shallow water from Florida eastward throughout the West Indies, found under stones on sandy bottom. The disk may be 20 mm. in diameter. The color varies to an extraordinary degree from green or blue and white to pink and white, but most of the Porto Rican specimens are cobalt-blue and white.

*O. brevicauda* is represented by 25 specimens from Ponce, Ensenada Honda (Culebra), Caballo Blanco, Puerto Real, and station 6076. Mr. Gray took it at San Juan.

### 3. *Ophiura brevispina* Say.

This is also a variable and handsome species found with the preceding and not always easily distinguished from it. It does not reach quite such a large size and the prevailing colors are shades of green, gray, and red. The oral shields are usually ovoid in outline.

This species is widely distributed from Bermuda to Brazil. Twenty-seven specimens from Porto Rico vary in color from uniform grayish white to pink and white or green and light brown. They were collected at Ensenada Honda (Culebra,) Arroyo, Puerto Real, and stations 6079, 6080, 6086, and 6096.

### 4. *Ophiura cinerea* Lyman.

This rather somber-colored brittle-star is found throughout the West Indies from Florida to Brazil, occurring under rocks with the preceding forms. It reaches a large size (25 mm. in diameter), but the arms are comparatively short, not more than 4 times the diameter of disk. The color varies little, except in intensity. In large specimens the upper arm-plates are usually broken into several pieces.

Sixty-three specimens of *O. cinerea* were obtained, chiefly from Ensenada Honda (Culebra), 2 from Puerto Real. The largest has the disk 23 mm. in diameter and arms 67 mm. long. Mr. Gray found the species common at San Juan.

### 5. *Ophiura rubicunda* Lyman.

This large and handsome species seems to be the least common of the five members of the genus found in Porto Rico. It has been taken at the Tortugas, Cape Florida, St. Thomas, and Colon, and probably occurs throughout the West Indies, being found under or among stones and coral in shallow water. It reaches a diameter of 25 mm., and the arms are 5 to 6 times as long. The color varies somewhat, but is always more or less reddish.

Only 3 specimens were obtained by the *Fish Hawk*, but one of them is a very fine one, the disk 23 mm. in diameter, the arms 135 mm. long. It was taken at Ensenada Honda (Culebra), while the other 2 are from Ponce and station 6097.

### 6. *Ophiolepis elegans* Lutken.

A handsome species, reaching a diameter of 18 mm., though usually smaller; the arms are only 2 to 3 times as long. The upper surface is variegated brown, gray, and white; beneath it is pure white; the arms are banded.

*O. elegans* is found from South Carolina southward through the West Indies in water of from 2 to 30 fathoms depth. A single specimen was taken at station 6086. The disk is 8 mm. across and the arms are only 17 mm. long. There are 4 arm-spines on most of the joints, but 1 has 5, and a few have only 3.

**7. *Ophiozona impressa* (Lutken.)**

From Florida to St. Thomas and Jamaica, usually in shallow water along shore, under or among stones or coral. It reaches a diameter of 15 mm., the arms 4 to 5 times as long. Variegated dark brown and white above, pale yellowish brown beneath; arms regularly banded. Five specimens, all from Ponce.

**8. *Ophiozona nivea compta* Verrill.**

This species occurs throughout the West Indies in water of from 50 to 400 fathoms. It reaches a diameter of 16 mm., the arms 2 or 3 times as long. The color is whitish. In typical *nivea* the radial shields are not separated.

One specimen from station 6050.

**9. *Ophiozona tessellata* Lyman.**

This easily recognized species is found throughout the West Indies, but only in deep water, 60 to 300 fathoms. It is smaller than the preceding, but similar to it in color.

There is a single *Ophiozona* from station 6067, which is evidently this species.

**10. *Ophiothyreus goesii* Ljungman.**

This curious little ophiuran (under 10 mm. in diameter) is plain grayish-white in color. It has been taken at various stations in the West Indies, but only in water of over 80 fathoms depth.

One small specimen from station 6067.

**11. *Ophioglypha ljungmani* Lyman.**

Previously taken only off the coast of Brazil, where it was found on muddy bottom in 350 fathoms. The color is gray. The disk reaches a diameter of 8.5 mm.; the arms about 5 times as long. The Porto Rican specimens were taken on the north and west sides of the island on a bottom of sand and mud in 20 to 45 fathoms.

There are 5 specimens of an *Ophioglypha* from stations 6051, 6062, and 6064, which are probably this species. They differ from Lyman's description only in the shape of the under-arm plates and in the presence of but 4 oral papillæ (3 on each side). They are certainly nearer to this species than to *lepida*, which was taken by the *Challenger* off the Bermudas and in other parts of the western Atlantic, and which belongs to the same section of the genus. The type of *ljungmani* was taken in 350 fathoms, 9 degrees south of the equator, so that its presence in shallow water off Porto Rico is certainly noteworthy. The largest specimen before me has a disk 6.5 mm. in diameter and arms about 20 mm. long. The type of *ljungmani* had the disk 8.5 mm. in diameter and arms 45 mm. long.

**12. *Ophioglypha robusta* Ayres.**

This northern species is quite small, rarely 10 mm. in diameter; the arms about 4 times as long. The color in alcohol is grayish white but the living animal is said to be gray, reddish, or violet, with the arms barred. In the north it occurs from low-water mark to 18 fathoms, but the specimens from Porto Rico were all dredged in water nearly 100 fathoms deep.

A species of *Ophioglypha* was taken at stations 6050 and 6067, 1 specimen at the former and 14 at the latter. They seem to belong to this northern species, though differing slightly in the shape of the under-arm plates and radial shields. But all the specimens are small (3 to 5 mm. in diameter) and they vary more or less among themselves. It is possible they are the young of *O. acerrater*, a common West Indian species, of which no specimens were taken.

**13. *Ophiomusium eburneum elegans* Verrill.**

This species occurs on rocky bottoms in 75 to 500 fathoms, from Cuba to Porto Rico and southward. Color, whitish. It reaches a diameter of 12 mm.; the arms about 4 times as long.

There are 12 specimens of *Ophiomusium eburneum*, 11 from station 6070 and 1 from 6063, in the *Fish Hawk* collection, all belonging to the variety described by Verrill from "off Havana." They vary in size from 5 to 10 mm. in diameter.

#### 14. *Ophiomusium sculptum* Verrill.

This species has been taken previously only on coral bottom, in 100 fathoms of water, off Habana, Cuba. The color is very pale grayish white. It reaches a diameter of 9 mm., the arms not quite 3 times as long.

This *Ophiomusium* is represented in the collection by 4 specimens from station 6067. They agree perfectly with Verrill's description, except that there are accessory spines on the first 3 or 4 arm joints, of which he does not speak. The differences between this species and *acuferum* Lyman seem to me to be very unimportant.

#### 15. *Ophiomusium validum* Ljungman.

Taken at several West Indian stations in water varying from 60 to 1,500 fathoms. Koehler reports it also from the Indian Ocean "north of Lacquedives." Yellowish white in color and very stiff and hard in appearance. It is somewhat less than 10 mm. in diameter; the arms about 4 times as long.

There are 4 very fine specimens of an *Ophiomusium* from station 6070, which I have referred to this species after much hesitation. They differ from the description and figures of *validum* as given by Lyman (Challenger Report, vol. v) in several important particulars, but the differences are not such as to warrant the establishment of a new species. There are more plates on the upper surface, a few more on the oral surface, the radial shields are separated by a row of plates, and there are 5 arm-spines, of which the lowest is very small and close to the fourth, which is the longest. These specimens are thus intermediate between *validum* and *lymani*, but are clearly much nearer to the former.

#### 16. *Ophiothrix angulata* Ayres.

This small brittle star (7 to 10 mm. in diameter) is very common from Chesapeake Bay to Rio Janeiro, occurring chiefly among corals and seaweeds. The color is extraordinarily variable, usually some shade of purple or brown, with a very distinct longitudinal white stripe on the upper side of the arm; sometimes, however, this stripe is dark or even entirely wanting.

Eighty specimens of this widely distributed and very variable species were taken at Ponce, Boqueron Bay, Ensenada Honda (Culebra), San Juan, Mayaguez, Puerto Real, Guanica, and at stations 6064, 6065, 6067, 6072, 6075, 6079, 6080, 6087, 6096, and 6098. The variety of color is extraordinary. While nearly all have the white longitudinal stripe on the upper side of the arm, one has the stripe very dark, and in a few it is wholly wanting. The ground color is usually deep purple or pale violet, but some are pale brown or yellowish white. A number have only prickly stumps on the disk and no longer spines. The smallest specimen is only 2 mm. in diameter and has arms 8 mm. long. In it the primary plates are very distinct, the radial shields are large and wholly bare, and there are only a few trifid stumps on the disk, and these are raised on little knobs. The most striking variety was taken at station 6063, where 2 medium-sized specimens were found in 75 fathoms. They are uniform pale brown and the arm-spines are very long, but there seem to be no other characters by which to distinguish them from *angulata*.

#### 17. *Ophiothrix oerstedii* Lutken.

Common throughout the West Indies, in the same situations as the preceding. It is a little larger, 10 to 12 mm. in diameter, and the arms are more slender. Color, usually rich green or blue, the arms transversely striped with white on the upper side. A well-preserved specimen is a handsome object. Specimens in this collection from Puerto Real and from station 6096 have the ground color dark purple, like *angulata*, instead of the usual dark blue or green.

Fifteen specimens were collected at Ponce, Arroyo, Ensenada Honda (Culebra), Caballo Blanco, Mayaguez, and Puerto Real, and stations 6065 and 6096.

#### 18. *Ophiothrix suonsonii* Lutken.

One of the handsomest and most notable of West Indian brittle stars, collected at various points southward as far as Brazil, but apparently not so common as the two preceding species. It reaches a large size, up to 14 mm. in diameter, and the arms may be 5 to 6 times as long. Color, pale lavender or bright rose-purple, marked with purple and with a broad longitudinal stripe of purple on the upper side of the arms. The whole structure is very delicate and glassy. Five specimens were obtained, 1 from Boqueron Bay being the most beautiful object in the whole collection. The disk is 14 mm. in

diameter, and the arms are 75 mm. long with spines 7.5 mm. The whole structure is very delicate, and the dark longitudinal stripe on the arm is very conspicuous. Of the other specimens 2 are from station 6067 and 2 from station 6079.

#### 19. *Ophiocoma echinata* L. Agassiz.

This large brittle-star is very common from Bermuda and Florida southward to Brazil, occurring under and among rocks and coral along shore and on the reefs. It reaches a diameter of 32 mm., with arms 4 to 5 times as long. The color varies considerably; the disk may be uniform brown or black, or it may be more or less blotched and spotted with gray or white; the arms are usually black. There is also much variation in the size of the arm-spines.

One-fifth of the collection is made up of specimens of this large and very common species. Of the 109, more than half were collected at Ponce and the remainder are from Fajardo, Ensenada Honda (Culebra), Caballo Blanco, and station 6096. Mr. Gray collected a large number of this species at San Juan.

#### 20. *Ophiocoma pumila* Lutken.

Smaller than the preceding, the disk seldom exceeding 15 mm., but found in similar situations throughout the same range. The colors vary somewhat, but the banded arms are very characteristic.

Sixteen small specimens of this species were collected at Ponce and Ensenada Honda (Culebra), and at stations 6076, 6077, 6080, 6095, and 6098. Mr. Gray took one specimen at San Juan.

#### 21. *Ophiocoma riisei* Lutken.

Found with *O. echinata*, from which it is easily distinguished by the rusty-red appearance of the under side of the arms. It is less variable in color, the disk being uniformly black or brown. It has been taken in deeper water, even up to 200 fathoms.

No specimens of this common West Indian species were taken by the *Fish Hawk*, but Mr. Gray collected 4 fine specimens at San Juan.

#### 22. *Ophiopsila fulva* Lyman.

Recorded from various parts of the West Indies in water of from 13 to 175 fathoms depth. Tentacle scales similar to those of the following species. There are 3 specimens of an *Ophiopsila* from station 6067 and 1 from 6080 which are apparently this species, although no one of them agrees perfectly with Lyman's description. The best specimen has the disk gray, with orange spots, as in the type, and 4 oral papillae and 9 tooth papillae, but there are only 6 arm-spines, which are flat and narrow, but not acute. The other 3 specimens have 8 or 9 similar but sharper arm-spines, but the tooth-papillae vary from 5 to 9 and the oral papillae from 4 to 6; the upper surface of the disk is wanting in all. The upper-arm plates vary from square, with rounded corners, to long, narrow, and rounded in front. Verrill proposes to separate this species from *Ophiopsila* and place it as the type of a new genus, *Amphipsila*, in the family *Ophiacanthidae*, because of certain differences in the covering of the disk and the arrangement of the tooth papillae. My specimens of *fulva*, however, agree essentially in these respects with *Ophiopsila riisei*, and the very characteristic appearance and arrangement of the tentacle scales, in which the two species also agree, seem to me too important to be ignored. Judged by the specimens before me, *Ophiopsila fulva* is much more nearly allied to *O. riisei* than to *Amphipsila maculata* Verrill. The latter is clearly not an *Ophiopsila*, and should be considered the type of the new genus. On this point Verrill's papers conflict. In his report on the *Ophiuroidea* of the Bahama expedition (Bull. Univ. Iowa, vol. 1, No. 6, Sept., 1899, p. 55) he says: "*Amphipsila*, gen. nov. Type *A. fulva* (Lym.)." Then follows a characterization of the new genus which will not apply at all to *O. fulva* Lyman. In his other paper (Tran. Conn. Acad., vol. x, pt. 2, Oct., 1899, p. 348) he says: "*Amphipsila* Verrill, 1899a, p. 55. Type *A. maculata* Ver." Then follows a copy of his original description of the genus, to which is added the following statement:

"I have separated this genus from *Ophiopsila*, as understood by Lyman, for he included in the latter *A. fulva* (Lym.), which is closely allied to our type species."

This latter statement does not seem to me justifiable, as I have carefully examined Lyman's original description (with which one of my specimens agrees admirably, except in the number of arm-spines), and it does not seem to me that *fulva* Lym. is at all closely allied to *A. maculata* Ver.

All of the 6 specimens of *Ophiopsila* before me agree in having 2 tentacle scales, of which the outer is from one-fourth to one-half the length of the inner. The latter is as long or longer than the arm joint and is generally spatula-shaped, but in 2 specimens is narrower and more pointed. The shape of the upper-arm plates varies greatly, as already mentioned, and the under-arm plates also vary in shape and distinctness. The oral shields also vary from long diamond-shape, longer than broad, to broad shield-shape, much broader than long. There is some slight variation in the number and size of the oral papillæ and tooth papillæ, but in general the specimens agree fairly well.

### 23. *Ophiopsila riisei* Lutken.

This species occurs throughout the West Indies and south to Brazil in shallow water among rocks or coral. There are 2 tentacle scales, of which the inner is very long and spatula-shaped. One very good specimen of this form from station 6079, and another, much smaller and broken, from 6080. The latter has the disk gray, with black spots, and the upper-arm plates, instead of being almost square, are twice as long as wide and the outer end rounded.

### 24. *Ophiactis krebsii* Lutken.

This is a common little ophiuran from Bermuda and South Carolina to Rio Janeiro, among corals in shallow water. There are generally 6 arms, 5 to 6 times the diameter of the disk. Oral papillæ usually 2 on a side. There are 6 small ophiurans in the collection, which I have referred to this species. Of these, 4 from Mayaguez reefs and 1 from Playa de Ponce have 6 rays each and the usual green and white coloring; but 1 from station 6080 has only 5 rays, and the colors are pale yellow and brown. In all other respects it agrees with the others. All are small, with disks from  $1\frac{1}{2}$  to 4 mm. in diameter.

### 25. *Ophiactis longibrachia*, nov. sp. (Pl. 14, figs. 1 to 5.)

Rays 5, long and slender. Disk 13 mm. in diameter; arms 100 mm. long;  $r=7\frac{1}{2}d$ . Arms 2 mm. wide at base. Disk almost circular, hiding the bases of the arms, covered with small but thickish scales, which are evident only when dry. Over the whole surface of the disk are scattered numerous very small, almost smooth, blunt spines, and these also cover the interbrachial spaces below. Radial shields long and rather narrow, separated at the inner ends, but touching at the outer extremities, smooth and naked. Upper-arm plates granular, wide and short, 3 or 4 times as wide as long, rounded at the sides. Arm-spines 7 (figs. 3 to 5) except on the first few joints the next to the uppermost generally longest, the others regularly shorter to the lowest, which is a little longer than the single large short and blunt tentacle scale. Under-arm plates almost square, with lateral edges markedly raised. Oral shields small, much broader than long, with a blunt angle inward. Adoral plates large, somewhat longer than wide, outer end the wider, meeting each other within. Oral papillæ 1 or 2, at the distal end of mouth slit, above the oral tentacle, separated, somewhat bluntly conical. Genital slits 2 in each interbrachial space. Color above, disk almost black, with outer ends of radial shields and the little spines whitish (under a lens), arms brown, tinged with purple; beneath, disk black, mouth parts and under side of arms at base pale yellowish; outwardly the under side of arms gradually becomes darker, until it is the same shade as above.

The only known specimen of this species was taken at station 6096, off Vieques Island, in 6 fathoms of water, on a coral bottom. It comes near to *O. dispar* of Verrill, which it resembles in some important particulars. It differs from that species in its much larger size, greater length of arms, markedly different color, and size and shape of the adoral plates, while there are slight differences in the arm-spines and oral papillæ and in the scaling of the disk.

The West Indian species of *Ophiactis* need careful revision from a large series of specimens, and when that is done this, as well as *dispar*, may prove to be the adult form of some one of the previously known species. The name given has been selected because of the unusually long arms.

### 26. *Ophiactis loricata* Lyman.

This uncommon species was originally described from Florida, where it was taken in water from 10 to 110 fathoms deep. The oral papillæ are 2 on each side. There is a single small *Ophiactis* from Mayaguez, which is clearly not *krebsii* and is probably this species. It is very small, with no disk spines, 6 arms with 4 arm-spines, and 2 mouth papillæ. The color is purple and white variegated.



**27. *Amphiura flexuosa* Lyman.**

This species was previously known only from Brazil. The Porto Rican specimen was taken at station 6066, on sand and mud, in Mayaguez harbor, at a depth of 162 to 171 fathoms. It answers well to the description, except that the next to the lowest arm-spine is bent.

**28. *Amphiura stimpsoni* Lutken.**

This species was known from the West Indies and Brazil in water of 10 to 35 fathoms. The Porto Rican specimen was collected on the reefs at Mayaguez.

**29. *Amphiura bihamula*, nov. sp. (Pl. 14, figs. 6 to 9.)**

Arms 5, very long and slender. Disk 5 mm. in diameter, clearly indented in the interbrachial arcs; arms about 60 mm. long;  $\therefore R=12d$ . Arms scarcely 1 mm. wide at base. Disk covered with rather large smooth scales. Radial shields short and broad, about twice as long as wide, completely separated. Upper-arm plates very broadly oval, rounded in front and wider there than behind; about twice as wide as long. Arm-spines 6 or 7 (figs. 8 to 9), the uppermost shortest; the fourth and fifth, or fifth and sixth, are longest (about equal to the joint) and have 2 prominent little hooks at the tip; all somewhat flattened and minutely spiny. As the distal end of the arm is approached, the upper-arm plates become smaller and the spines fewer, until at the tips the plates are very small, almost circular, and widely separated by the side-arm plates, and there are only 3 spines, subequal and shorter than the joint. Under-arm plates almost square, slightly concave in front, more or less convex behind, becoming longer and narrower as the tip of arm is approached. Tentacle scales, 2 at base of arm, quite small; 1 on the proximal, and 1 on the inner side of tentacle. Beyond the first third of arm there is only 1 scale, the one on inner side of tentacle having disappeared. Oral shields longer than broad, suddenly widened at the proximal end. Adoral plates large, almost triangular, meeting within but not without. Oral papillae as in typical *Amphiura*, a pair at the tip of the jaw and one rather large one at the distal end. Above and in front of the latter is a small sharp-pointed oral tentacle scale. Genital slits, 2 in each interbrachial space. Color of disk above very light gray; arms and mouth parts very pale cream color.

There is a single very good specimen of this interesting form from station 6050, at entrance to San Juan Harbor, on sand and mud in 91 fathoms. Its nearest allies seem to be *verticillata* Ljn. from Galapagos Islands and *divaricata* Ljn. from the East Indies. Its nearest West Indian ally is apparently *A. otteri* Ljn., but it differs decidedly from that species in the radial shields and in the arm-spines. The name *bihamula* refers to the two little hooks on the lower arm-spines.

**30. *Amphipholis goesii* Ljungman.**

Previously known from Cape Hatteras southward to Brazil, in water from 14 to 280 fathoms deep. The Porto Rican specimens were taken on sandy or, more usually, muddy bottom, in comparatively shallow water ( $4\frac{1}{2}$  to 25 fathoms), but twice at greater depths. It seems to be very common at the west end of Porto Rico. Sixty specimens of this species from stations 6054, 6056, 6057, 6058, 6059, 6060, 6061, 6062, and 6063. The largest has the disk missing, but the arm measures 160 mm. The smallest has the disk only  $2\frac{1}{2}$  mm.; the radial shields are scarcely visible, and the oral papillae are of nearly equal size.

**31. *Amphipholis limbata* (Grube).**

This species was previously known only from Rio Janeiro. The Porto Rican specimen, which is a very good one, was taken at station 6053, in 4 to  $7\frac{1}{2}$  fathoms of water, on fine sand, in San Juan Harbor.

**32. *Amphipholis subtilis* Ljungman.**

This, like the preceding, has been previously known only from Rio Janeiro. The Porto Rican specimens, which are small and badly damaged, were taken at Mayaguez, 2 in shallow water and 1 in 75 fathoms.

**33. ? *Amphiodia planispina* (von Martens).**

A single specimen of an amphiuran from station 6065, near Mayaguez, may represent this species, but as the disk is wanting, it is impossible to identify it positively. It is clearly an *Amphiodia*, and has 3 very broad and blunt arm-spines; the color is reddish, while the tentacles are dark brown, making them very conspicuous.

**34. *Amphiodia pulchella* (Lyman).**

There is a somewhat damaged specimen, probably of this species, which was collected at San Antonio Bridge, San Juan. It agrees with the description of *pulchella*, except that the arm-plates (either dorsal or ventral) are not separated from each other. The species has hitherto been known only from the coast of Florida, in 18 to 39 fathoms.

**35. *Amphiodia riisei* (Lutken).**

Reported from the West Indies and Brazil, in shallow water. The three Porto Rican specimens were taken in 170 fathoms at station 6066, near Mayaguez.

**36. *Amphioplus stearnsii* (Ives).**

Previously known only from the Bahamas, in shallow water. The single Porto Rican specimen, which is in good condition, was taken in 97 to 120 fathoms at station 6067, near Mayaguez. The disk is 5 mm. in diameter, the rays 50 mm. long.

**37. *Ophionereis dubia* Lyman.**

This species is about the same size as *O. reticulata* and is chiefly distinguished by its color. It is found in the Mediterranean and eastern Atlantic. There is one very good specimen of an *Ophionereis* and the ray of another from station 6090, which I have referred, after long hesitation, to this European species. The disk is 6 mm. and the ray 42 mm.; the single arm belonged to an individual nearly twice that size. The color is reddish-brown, the arms banded with darker. The scaling of the disk is very fine. The difference in color between these individuals and *O. reticulata* is very striking, but I could find no difference by which to separate them from *dubia*, though the latter has not been recorded from the West Indies hitherto.

**38. *Ophionereis olivacea*, nov. sp. (Pl. 14, figs. 10 to 13.)**

Arms 5, rather slender and tapering. Disk about 6 mm. in diameter, almost pentagonal; arms about 33 mm. long;  $R=5\frac{1}{2}d$ . Arms abruptly narrowed where they join disk, but 5 mm. from disk they are 1 mm. wide. Disk covered with numerous small scales, one at the center and a few near the margins being larger than the others. Radial shields narrow, exposed for about one-half millimeter, very widely separated. Upper-arm plates near base of arm small, imperfectly triangular, with rounded corners; farther out they become more diamond-shaped and are longer than broad; at the middle of arm they are broader than long, somewhat 5-sided, with the distal end narrower and rounded; near the tip they become small and almost perfectly hexagonal. Accessory upper-arm plates large and prominent; the first few joints have 2 or more such plates on each side, but farther out there is only 1. Arm-spines 3 (figs. 12, 13), of which the uppermost is blunt and equals the joint; the middle one is nearly twice as long, at least at the middle of arm, and is broadened and rounded at the tip; the lowest is acute and equals the uppermost. Under-arm plates at first almost square, but soon become longer than broad, slightly rounded in front. Tentacle scale 1, very large. Oral shields small, oval, the madreporic plate obviously larger than the others. Adoral plates small, irregularly triangular, pointed and not meeting within; blunt and not meeting without; separating the oral shields from the side-arm plates. Oral papillae 4 on each side, the outermost decidedly the widest. Above, and largely concealed by the latter, is the pointed oral tentacle scale. Genital slits 2 in each interbrachial space. Color above olive green, spotted on the disk with yellow; arms banded with a darker shade of green; below the color is very light, the interbrachial spaces being pale yellowish marked with olive, while the mouth parts and under side of arms are almost white; outside of oral shield is a patch of dark brown, as in *reticulata*.

The single specimen of this interesting species (from station 6096) differs very markedly from *O. reticulata*, not only in the color (and in this respect *reticulata* is very constant) but in the coarser scaling of the disk, the shape of the upper-arm plates, and in the size and shape of the second arm-spines. The same characters serve to distinguish it from the preceding species, which was taken at a neighboring station. The name selected has been chosen on account of the striking color.

**39. *Ophionereis reticulata* (Say).**

This handsome ophiuran is very abundant in clean sand in shallow water, especially under stones, from Bermuda and Florida to Rio Janeiro. It reaches a diameter of 12 mm., the arms about 7 times as long. Twenty-one specimens, all small, collected at Ensenada Honda (Culebra), Caballo Blanco, Puerto Real, and Guanica Bay, and at stations 6079, 6080, and 6088.

**40. *Ophiostigma isacanthum* (Say).**

This small ophiuran (disk 5 to 6 mm., arms 20 to 30 mm.) occurs sparingly from Bermuda to the southern West Indies along shore and in water up to 100 fathoms deep. Its color varies from white to brown, more or less variegated, but is usually very light. The arms are usually 5 but sometimes 6 in number; the latter specimens may be young. There are 4 small specimens, all from station 6079. The smallest has 6 arms and a very small disk.

**41. *Ophiacantha bidentata* (Retzius.)**

A medium-sized ophiuran, light brown in color, previously known from the North Atlantic. A single small specimen from station 6070 seems to belong to this species.

**42. *Ophiacantha ophiactoides*, nov. sp. (Pl. 15, figs. 5 to 8.)**

Arms 6, rather short and thick. Disk hexagonal, about 2 mm. in diameter; arms about 8 mm. long;  $R=4d$ . Arms about one-half millimeter wide at base. Disk covered with rather coarse scales and bearing a number of small, thorny spinules. Radial shields widely separated and only exposed at the tips. Upper-arm plates broadly oval, becoming triangular at the tip of arm, rounded in front and sharply pointed behind, completely separated by the side-arm plates. Arm-spines 4 (figs. 7, 8), approximately equal and smooth to the eye, but very spiny under a lens, about equaling a joint. Under-arm plates somewhat pentagonal, with rounded corners and an angle directed inward. Tentacle scale 1, small. Oral shields very large, rounded without, bluntly pointed within, much wider than long. Adoral plates long and narrow, wider at the outer end, not meeting without or within. Oral papillæ not very large, smooth, 3 on each side and 2 at tip of jaw, and a large oral tentacle scale at distal end. Genital slits 2 in each interbrachial space. Color, very pale yellowish-green, the arms banded with brown, each band about twice as wide as the intervening space.

One specimen of this curious little ophiuran was taken at station 6076, on coral sand, in 10 fathoms, at Gallardo Bank, Porto Rico. It does not seem to be very nearly allied to any previously known species, but as it is probably immature, it may prove to be the young of some other form. It resembles *Ophiactis krebsii* superficially, especially on the upper surface, and for that reason I have called it *ophiactoides*.

**43. *Ophialcæa glabra*, nov. sp. (Pl. 15, figs. 1 to 4.)**

Arms 5, rather stout. Disk pentagonal, about 12 mm. in diameter. Arms all broken, 2½ mm. wide at base. Disk covered with a thick, rather rough skin, which covers a very fine scaling visible only when the specimen is very dry. Radial shields wholly covered, but showing indistinctly through the skin, large and separated. Upper-arm plates broadly in contact, much wider than long, somewhat narrowed proximally, with rather acute outer angles; on one arm they are divided into 2 by an irregular line, perhaps due to an accident. Arm-spines 8 (figs. 3, 4), glassy, flattened, blunt, and slightly rough; approximately equal, about half as long again as the joint. Under-arm plates almost square, slightly convex distally. Tentacle scales 2, very large, about equaling the under-arm plate. Oral shield large, elliptical, much broader than long, touching the first side-arm plate. Adoral plates long and narrow, touching within, wider and widely separated without. Oral papillæ 6 or 7 in a single row, with 1 median tooth papilla; all long, acute, and rather narrow. On the face of the jaw is a little cluster of very small, round knobs. Genital slits prominent, 2 in each interbrachial space. Color, uniform dark brown above; on the interbrachial spaces below are a few scattered spots and blotches of yellowish white; under side of arm and mouth parts whitish.

There is a single specimen of this curious species from Playa de Ponce. Although in the arrangement of the oral papillæ it is a typical *Ophiacantha*, it differs sharply from that genus in the arrangement of the upper-arm plates, the arm-spines, and the covering of the disk. Verrill has recently divided the genus into a dozen sections (Trans. Conn. Acad., vol. x, pt. 2, Oct., 1899) and of these

*Ophialcea* comes the nearest to the present species; but even from that genus it differs in the covering of the disk. For the present, however, it may remain in that group, characterized especially by the upper-arm plates being broadly in contact, the rows of arm-spines not approximating dorsally, mouth parts as in typical *Ophiacantha*. This Porto Rican species is nearest to *O. rufescens* Koehl., which was collected in 470 fathoms off the Azores. It differs from that form in the number of arm-spines and in the covering of the disk and radial shields. The name *glabra* is suggested by the very smooth disk, the scales of which are very indistinct.

#### 44. *Ophiopristis hirsuta* (Lyman).

This species occurs throughout the West Indies in water from 80 to 1,000 fathoms deep. It is light chocolate brown above, nearly white beneath, and reaches a diameter of 11 mm. One specimen from station 6070.

#### 45. *Ophioplinthaca spinissima*, nov. sp. (Pl. 15, figs. 9-12.)

Arms 5, stout and very spiny. Disk almost circular, slightly indented in the interbrachial spaces, 7 mm. in diameter. Arms about 30 mm. long;  $\therefore R=4\frac{1}{2}d$ . Arm  $1\frac{1}{2}$  mm. wide at base. Disk covered by the radial shields and coarse scales; near the center it is depressed and carries numerous thorny stumps; these also occur elsewhere on the disk, in the interbrachial spaces below and at the distal ends of the radial shields. The latter are very large, about twice as long as wide, and are not simply in contact, but one actually overlaps the other. Upper-arm plates are very widely separated, broadly triangular in outline, slightly curved distally, and 2 or 3 times as wide as long. Arm-spines 9 (figs. 11 and 12), slender, somewhat glassy, very thorny, the fourth longest and about equal to 2 joints; the rows approximate closely dorsally. First under-arm plate almost pentagonal, the point inward; farther out they become hexagonal, the distal side very short, and concave both distally and proximally. Tentacle scale 1, large; sometimes the first one or more are divided into 2. Oral shields wide, much broader than long, narrowest without, wide and rounded within, the madreporic plate much the largest. Adoral plates large, quite broad, four-sided. Tooth papilla 1. Oral papillæ 5 to 7, in a nearly simple row, the most distal ones widest; there may be 1 or 2 narrow papillæ placed distally above these wide ones. Oral tentacle scale conspicuous. Genital slits very prominent, 2 in each interbrachial space. Color very light brown, variegated on disk with darker.

Two specimens of this species were taken at station 6067, in Mayaguez Harbor, on coral bottom, in 97 to 120 fathoms. One is badly broken and much smaller than the one described above. They clearly belong to genus *Ophiomitra* as defined by Lyman, and in some respects resemble the common West Indian species *O. valida*; but the arrangement of the oral papillæ seems to indicate their relationship to Verrill's genus *Ophioplinthaca*, though in some other respects they differ markedly from that genus. They differ from *Ophiomitra* sens. str. in the simple row of oral papillæ and in the close dorsal approximation of the rows of arm-spines, while they differ from *Ophioplinthaca* in the absence of special marginal scales. Were it not for the very close approximation of the rows of arm-spines, they might be considered young individuals of *O. valida*; but considering all their characters, it seems better to regard them as a new species of *Ophioplinthaca*. The name given was suggested by the very spiny arms.

#### 46. *Ophioscolex serratus*, nov. sp. (Pl. 14, figs. 14-17).

Arms 5, flat, slender, and very tapering. Disk almost pentagonal, the sides somewhat concave, 6 mm. in diameter. Arms about 39 mm. long,  $\therefore R=6\frac{1}{2}r$ . Arms about  $1\frac{1}{4}$  mm. in width at base. Disk covered by a peculiar flaky skin, which extends out on the arms; the surface is roughened by little flakes of a chalky material, between which it appears to be finely granular. Radial shields small, widely separated, showing through this skin, somewhat triangular, the apex pointing outward. Upper-arm plates wanting, the side-arm plates showing through the skin and giving a superficial appearance of upper-arm plates. Arm-spines 3 (figs. 16, 17), flat, very acute, and sharply serrate, the upper one longest, about equal to a joint and lying flat against the arm. Under-arm plates squarish, with truncated corners, slightly concave distally. Tentacle scales wanting. Oral shields twice as wide as long, the outer side almost straight, the inner widely curved. Adoral plates narrow, about equally wide at the two ends, meeting within, but not without. Oral papillæ 9, of which 1 is at the apex of the jaw; they are flat, thin, and abruptly pointed. Teeth large, rounded, prominent. Genital slits prominent, 2 in each interbrachial space. Color of disk (speckled with the whitish flakes above) greenish-yellow; upper side of arms bright yellow; beneath very pale, almost white.

There is a single specimen of this new species, collected at station 6050, at the entrance to San Juan Harbor, in 91 fathoms. In the number of oral papillae and the absence of tentacle scales it approaches *O. glacialis* Müller & Troschel, but it differs from that form in the shape of the oral papillae, and from all previously known members of the genus in the serrate arm-spines and the large rounded teeth. The name *serratus* has been selected on account of the arm-spines.

#### 47. *Ophiomyxa flaccida* Lutken.

This large, handsome, and very active species is known from Bermuda to Brazil. It is found under and among rocks and coral in shallow water. The color varies greatly, from uniform tawny or reddish yellow to green marked with white. A single large specimen in the *Fish Hawk* collection is from Ensenada Honda (Culebra), and Mr. Gray has a large specimen in his collection from San Juan.

#### 48. *Astroporpa annulata* Oerstedt & Lutken.

This very handsome and curious ophiuran is known from many West Indian stations, where it occurs at depths of from 20 to 163 fathoms, and it has also been taken off Cape Hatteras and Chesapeake Bay. The arms measure upward of 100 mm. in length. There is a single specimen in the Porto Rican collection from station 6063.

#### 49. *Astroschema oligactes* Lutken.

Known from various stations in the West Indies at depths of 69 to 288 fathoms, among corals. The arms are from 100 to 150 mm. in length. There is a single specimen before me from station 6067.

While there are more than 100 other species of brittle-stars known from the West Indies, most of them are deep-water forms and very few are likely to be met with in shallow water. There are, however, a few species not given in the above list which will probably be found along shore in Porto Rico, as they have been in other islands of the West Indies. One is a species of *Ophiura* (*guttata* Lyman), allied to *brevicauda* and found in similar situations. In it the upper-arm plates are broken into numerous pieces; the disk is about 15 mm. in diameter; above dark brown, beneath bright yellow. Another species found in similar situations is *Ophiolepis paucispina* Müller & Troschel, allied to *O. elegans*, but easily distinguished by having only 2 arm-spines. Other species of *Ophiactis* may occur, but their identification is a matter of great difficulty and can only be accomplished with the aid of figures or elaborate descriptions. *Amphipholis gracillima* (Stimpson) may occur and is easily distinguished from other members of the genus by having 4 to 5 arm-spines.

Over 40 years ago *Ophioblenna antillensis* was described by Lutken from 2 specimens labeled simply "West Indies" and presumably taken in shallow water. The species has not been met with since, and its rediscovery would be of great interest. It is characterized by the disk being covered with a naked skin, numerous close-set, spine-like oral papillae, and 6 to 7 flat, pointed, glassy, slightly thorny arm-spines.

It is not a little strange that the *Fish Hawk* did not collect a single specimen of the ophiurans known as "basket-fish," as several species belonging to the genera *Astrophyton* and *Gorgonocephalus* are known from the shallow water of the West Indies, though seldom near low-water mark. They are characterized by the arms being dichotomously branched into numerous branchlets, capable of being vertically coiled. When taken from the water, the arms bend and curl inward toward the mouth and become more or less interwoven, thus giving rise to the curious shape from which the name "basket-fish" has arisen. They reach a large size, the disk 50 mm. or more across, and the whole "basket" being often over a foot in diameter. The color is usually yellowish or reddish brown.

## ECHINOIDEA.

## SEA-URCHINS, SEA-EGGS, SAND-DOLLARS, SEA-MOONS, ETC.

The collections made by the *Fish Hawk* contain over 300 specimens of echinoids, but about two-thirds of these represent two species, and half of the remainder are supplied by two other common forms. There are 13 species altogether, and all of them are well known from the West Indies. Nine of the 13 are distinctly littoral forms, but 3 of the others occur only at depths of over 60 fathoms. The remaining species, *Brissopsis lyrifera*, is given by Agassiz (Revision of the Echini, p. 369) as occurring at depths of from 55 to 115 fathoms, so that it is worthy of special note that the *Fish Hawk* collected three adult specimens in Mayaguez Harbor in only 7 fathoms of water.

The following artificial key will enable anyone to distinguish these species from each other, but is liable to prove untrustworthy for young or very small specimens and worse than useless where other species are concerned.

- A. Test hard, hemispherical, elliptical, or more or less globular, the height equaling or exceeding one-half the diameter. Mouth at center of lower surface. (Sea-urchins proper.)
- I. Test approximately as wide as long.
- a. Spines stout and more or less club-shaped, longer than one-half the diameter of test.
1. Spines not more than equaling diameter of test ..... *Cidaris tribuloides*. (1)
2. Spines usually much exceeding diameter of test, often nearly or quite twice as much. *Dorocidaris papillata*. (2)
- b. Spines very long and slender (2 or 3 times the diameter of test) with needle-like points. . . . *Diadema setosum*. (4)
- c. Spines short, rather slender and pointed, not nearly equaling diameter of test.
1. Spines all white or whitish; test brownish or purplish ..... *Hipponoe esculenta*. (8)
2. Some of the spines green or greenish, and often with more or less red or violet; test usually with a decidedly greenish tinge ..... *Toxopneustes variegatus*. (7)
- II. Test not as wide as long; usually the difference in the two diameters is very marked.
- a. Apex of test, around anus, covered with numerous small spines. . . . . *Echinometra subangularis*. (5)
- b. Test about anus almost wholly free from spines. . . . . *Echinometra viridis*. (6)
- B. Test soft and leathery; more or less globular in life; very flat in dead specimens. Deep-water forms. (Flexible sea-urchins.)
- I. Color purple above; light yellowish about the mouth. . . . . *Asthenosoma hystrix*. (3)
- C. Test hard, much flattened, circular or elliptical, the height not one-half of diameter; mouth at center of lower surface; spines very short and numerous. (Sand-dollars, key-hole urchins, sea-moons, etc.)
- I. Oral surface very concave; test accordingly highly arched. . . . . *Echinanthus rosaceus*. (9)
- II. Oral surface flat; test not arched, very thin.
- a. Test with six slits (lunules) through it. . . . . *Mellita saxiforis*. (10)
- b. Test with only five lunules . . . . . *Mellita testudinata*. (11)
- D. Test hard, oval or elliptical; mouth near anterior end on the flattened oral surface; spines comparatively short and numerous with or without scattered, long ones. (Spatangoids.)
- I. Size large (over 100 mm.); color deep reddish-purple. . . . . *Palaeopneustes hystrix*. (13)
- II. Size small (60 mm. or less); color light brown . . . . . *Brissopsis lyrifera*. (12)

1. *Cidaris tribuloides* (Lamarck).

This urchin is marbled light brown and white, often with some red, especially on the spines. The large spines are comparatively few in number. The test of full-grown specimens is about 60 mm. in diameter. This species occurs abundantly in shallow water from South Carolina to Brazil, especially about reefs. A large number of specimens were collected at Arroyo and Mayaguez, and at stations 6075, 6087, and 6096. The largest was 58 mm. in diameter, with spines 45 mm. long.

2. *Dorocidaris papillata* (Leske).

This species resembles the preceding in size and color, but is usually lighter and the spines are often almost white; they are also more slender and tapering than in *Cidaris*. It occurs only in water of considerable depth, and is found on both sides of the North Atlantic, from Norway to the Mediterranean, and throughout the West Indies. Two specimens, one from station 6067, 23 mm. in diameter, with spines 53 mm. long, and one from station 6070, 45 mm. in diameter, with spines 83 mm. long.

**3. *Asthenosoma hystrix* (W. Thomson).**

As this urchin occurs only in deep water, it is not likely to be met with by the ordinary collector. It reaches a large size (140 mm. in diameter), but the test is always soft and flexible. The spines are short but very sharp, and scattered rather sparsely over the test. The feet are in three vertical rows in each poriferous zone in the adult.

There are two large specimens of this very curious flexible urchin, both as flat as can be. They measure 135 and 140 mm. in diameter, but are only 7 mm. thick. The abactinal surface is purple and the actinal very pale yellow. These specimens were collected at station 6070, and from the same place there are two very small flexible urchins, 10 mm. in diameter, which I refer with some hesitation to this species. Their coloration is precisely like that of the large ones, but the feet are in only a single row in each poriferous zone instead of in three rows, as in the adult.

**4. *Diadema setosum* Gray.**

One of the most characteristic urchins of the Tropics; of world-wide distribution from Cuba eastward to the Fiji Islands. Almost black, but the spines are often banded with white in the young. The adults are sometimes 100 mm. in diameter, with spines 300 or 400 mm. long. Very common about coral reefs.

The *Fish Hawk* collection contains twenty specimens of this species, varying from 17 to 75 mm. in diameter, and collected at Ponce, Mayaguez, and Arroyo. The smallest (those less than 40 mm. in diameter) usually have the spines banded light and dark, whitish or yellowish, alternating with purplish or brownish. One large specimen has all the spines on the actinal surface white. A large specimen from Ponce differs markedly from all the others in that a number of the spines, especially on the actinal surface, have prominent swollen "rings," 6 to 10 mm. wide and 2 to 3 mm. in diameter, about 25 mm. from the base. As all the spines are broken, I am not sure whether this swelling is always at the tip of the spine or not, but it appears as though it was. The spines are horizontally ringed, but these swellings are longitudinally ridged.

**5. *Echinometra subangularis* (Leske).**

This species is often called the "rock-boring" urchin, because of its habit of living in cavities in the reefs and ledges in shallow water. In size it is rather small, not often 50 mm. long, the spines about 20 mm. It varies greatly in form and proportions, but especially in color. All stages from very pale reddish brown to nearly black are common, while the spines are often green with more or less violet. It is found from Bermuda to Rio Janeiro. The collection contains 105 examples, exhibiting a most extraordinary range in color and shape. Indeed, the extremes are so different one might easily believe there are at least two distinct species in the series. The more common form was collected at Ponce, Arroyo, Boqueron Bay, Fajardo, San Juan, and Aguadilla. The largest measures 42 mm. long by 38 wide by 22 high. The spines are slender, 20 mm. long, and less than 2 mm. in diameter. The color varies from bright light green with violet-tipped spines to very light reddish brown and thence through varying shades of red-brown to almost black. The other form was collected at Ensenada Honda and on the light-house reef at Playa de Ponce. The difference in size is not notable, but the test is somewhat more flattened. The spines, however, are very different. They measure from 15 to 20 mm. in length and from 2 to 3½ mm. in diameter. They are much stouter, therefore, and are also somewhat flattened and abruptly pointed. Their color varies from pale, dull pink, through reddish brown to dark green, the spines having violet tips; in some more than half the spine is violet.

**6. *Echinometra viridis* A. Agassiz.**

This species closely resembles the preceding in size, shape, color, and habits, and seems to be distinguished only by the bare apical system. It is recorded from Florida, Cuba, and Haiti. Two specimens from the reefs at Playa de Ponce seem to be referable to this species. They are of about average size and color. The test is brownish; spines light green, almost yellow at base, violet tipped. There are no spines within the anal area, and only about 12 to 15 in the whole abactinal system.

**7. *Toxopneustes variegatus* (Lamarek).**

The common sea-urchin of the tropical western Atlantic, abundant from Bermuda and North Carolina to Rio Janeiro. It varies greatly in color from rich violet (Bermuda) to bright green and

white (Jamaica). Like the following species, it is usually found on sandy bottom and often covers itself with bits of seaweed and other débris. The collection contains 28 specimens, the smallest of which is only 4 mm. in diameter. They were collected at Ponce, Arroyo, Boqueron Bay, San Juan, Cataño, and Hucares. The color varies considerably, but is usually green and white. The spines are often tipped with reddish, and the specimen from Hucares has the spines rose pink.

#### 8. *Hipponoë esculenta* (Leske).

A very large urchin, sometimes 150 mm. in diameter. Adults are easily recognized by their white color and great size, but the young are not readily distinguished from those of the preceding species. Occurs from Bermuda to Surinam. The eggs are sometimes used for food. From Porto Rico there are fifteen of these large urchins, besides several fragments. Several of them measure 140 mm. in diameter and 95 mm. high, while the smallest is only 19 mm. in diameter. They were collected at Ponce, Arroyo, Aguadilla, and Guanica Bay.

#### 9. *Echinanthus rosaceus* (Linnaeus).

In life this species is reddish, yellowish, or greenish brown in color. It reaches a length of 140 mm., and the height is from one-third to nearly one-half the length. It occurs in the sand, often under stones and in very shallow water, and is found from South Carolina to Guadeloupe. Only one example of this species in the collection, a fair-sized specimen from Fajardo.

#### 10. *Mellita sexforis* (Lamarek).

This very flat and thin "keyhole urchin" is usually light olive-green (rarely brown) when alive. It reaches a diameter of 70 or 80 mm., and is found on sandy bottoms in shallow water, from South Carolina and Bermuda southward throughout the West Indies. One large specimen, 74 by 72 mm., from Arroyo, and four smaller ones from station 6085. The color of all these is pale olive-green.

#### 11. *Mellita testudinata* Klein.

This "keyhole urchin" is slightly larger and thicker than the preceding, but of the same color and habits. It has a wider range, having been found from Nantucket to Brazil. The *Fish Hawk* collection contains 10 specimens, varying in size from one 3 mm. in diameter to one 80 mm. broad by 70 mm. long. The color varies from light to dark green. The specimens less than 12 mm. in diameter show very nicely the formation of the lunules. In the smallest specimen no lunules are visible from above, but on the oral surface, in the posterior interambulacrum, there is a little depression which marks the position of the first lunule. The specimen 12 mm. in diameter has this lunule fully formed, while the other four lunules appear simply as notches in the edge of the test. Found at Ponce, Arroyo, Mayaguez, Puerto Real, and station 6053.

#### 12. *Brissopsis lyrifera* Agassiz.

This spatangoid is usually found only in deep water, rarely in less than 10 fathoms. It can not be confused with the following. It is found not only throughout the West Indies, but in the eastern Atlantic also, from Norway to the Mediterranean. There are 3 specimens of this form from station 6059, the largest of which measures 40 by 33 mm. The color is light yellowish brown. The fasciole connecting the subanal with the peripetalous fasciole is not complete and is only distinct close to the subanal. These specimens thus resemble European examples of the species more closely than they do those from Florida.

#### 13. *Palæopneustes hystrix* A. Agassiz.

This rare form, occurring only in deep water, is not likely to be met with. Its size (125 by 90 mm.) and color are sufficient to distinguish it from the preceding species, but an additional character is to be found in the broad, spatulate ends of the long spines. It is known only from the Caribbean Sea.

Of this remarkable spatangoid the collection contains one whole specimen, half of a second, and fragments of others, all from station 6070. The specimens measure about 125 mm. long by 90 broad by 55 high; color dark purplish red; spines somewhat lighter.



Besides the foregoing thirteen species, several other common West Indian echinoids may be expected to occur along the shores of Porto Rico. These are *Clypeaster subdepressus* (Gray), *Encope emarginata* (Gmelin), *Encope michelini* Agassiz, *Echinoneus semilunaris* (Gmelin), *Brissus unicolor* Klein, *Meoma ventricosa* (Lamarck), *Metalia pectoralis* (Lamarck), and *Moira atropos* (Lamarck). The first four will fall under the heading C in the key on page 252, the last four under the heading D. *Clypeaster* resembles *Echinanthus*, but may be easily distinguished by its larger, much flatter test. It occurs from South Carolina to Brazil and eastward across the Atlantic. The two *Encopes* resemble *Mellita*, but are larger (up to 140 mm. in diameter), and the lunules are different. Those in the radii differ from the one in the posterior interradius and are inclined to be elliptical or even oval. The two species of *Encope* may be distinguished from each other by the fact that in *emarginata* the posterior lunule is longer than any of the others, while in *michelini* it is generally smaller than the others. In the latter species, moreover, the anterior lunules often disappear with the growth of the animal, so that the test has only one or three lunules left. *Encope emarginata* occurs from South Carolina to Brazil, while *michelini* is found throughout the Gulf of Mexico.

*Echinoneus* is quite different from any of the others. Although properly a spatangoid, the mouth is central, so that in the key on p. 252 it would come under C rather than D. The test is a somewhat flattened ellipse, from 15 to 40 mm. long, covered with short, light-brown spines, and with the bright-red feet (in living animal) arranged in five double rows, radiating from the center of the aboral side. It lives in the sand in shallow water, often under stones, and occurs throughout the West Indies. It has been recorded in the past from Porto Rico.

*Brissus unicolor* resembles *Brissopsis lyrifera*, but may be distinguished from that species by the position of the center of the ambulacral system. In *Brissopsis* this point is near the center of the test; in *Brissus* it is far forward. Moreover, *Brissopsis* is a deep-water form occurring only occasionally in a few fathoms, while *Brissus* is found in very shallow water, in the sand, often under stones, in company with *Echinoneus*. *Brissus* has a wide distribution, being found all through the West Indies and eastward across the Atlantic into the Mediterranean.

*Meoma* and *Metalia* are both very large spatangoids (up to 200 mm. or more in length) and occur in comparatively shallow water, 1 or 2 fathoms. *Metalia* is much more flattened; the ambulacra are very slightly sunken, and the spines, especially on the upper side, are very coarse. *Metalia* is brown; *Meoma* varies from light-yellowish to deep-reddish brown. Both occur throughout the West Indies.

*Moira atropos* is easily distinguished from all the preceding by the very deeply sunken ambulacra, which give the test almost a deformed appearance. It reaches a length of 50 mm., and the color is yellowish brown. It occurs southward from South Carolina into the West Indies and Gulf of Mexico.

Owing to the firm structure of the test, all echinoids (except the flexible sea-urchins) can stand the wearing of water for some time after the death of the animal. In such cases the spines drop off and the organic matter is washed out, leaving the tests as delicate white or dull-colored shells, more or less granular, according to the size of the spines with which they were covered. These shells are sometimes called "sea eggs." Such tests are often of value to the zoologist, and should be preserved. Usually they are sufficient for the determination of the species to which they belonged.

## HOLOTHURIOIDEA.

## HOLOTHURIANS, SEA-CUCUMBERS, SEA-SQUIRTS, ETC.

The holothurians of the West Indies are not nearly so well known as the sea-urchins, so that every new collection is likely to contain undescribed species, or at least to extend the range of those previously known. About 35 species have been described from the West Indian region, or are known to occur there, and of these less than half a dozen are exclusively deep-water forms. It appears, therefore, that the great majority of the holothurians of this region are littoral forms, and many of them are apparently quite limited in their range. But as yet we know too little of their natural history, or of what constitute good specific characters in the group, to draw any important conclusions. Species have been made on form, color, size, number of tentacles, and other inconstant characters to such an extent that the whole subject of West Indian holothurians needs a thorough overhauling, especially since they constitute one of the most characteristic groups of the shallow-water fauna.

The *Fish Hawk* collection contains 85 specimens of sea-cucumbers, representing 10 species, all but one of which are littoral forms. Curiously enough, all these littoral forms belong to the single family *Aspidochirota*, so that probably only a small part of the holothurian fauna of Porto Rico appears in the collection.

The following artificial key will help to distinguish adult specimens of the above given species, and also includes one other species collected by Mr. Gray. It is hard to give distinguishing characters among holothurians, except by means of the microscopic calcareous particles in the skin. As far as possible the characters used below can be easily seen without the aid of a microscope; but it must be remembered that the number and arrangement of the tentacles, pedicels, and papillæ are often very different in the young from what they are in the adult. They are usually fewer in number and show a more orderly and definite arrangement.

- A. Tentacles long, slender, unbranched. Body-wall firm and spiny. Color white. Deep-sea form. *Echinocucumberis asperriana*. (1)
- B. Tentacles (normally 20) comparatively short, with numerous branches, crowded into a flat disk at the end. Body-covering soft. Shallow-water forms.
- I. Size large, up to a foot or more in length. Found on sandy or muddy bottom.
- a. Brown or black above; yellowish, reddish, or almost white below, and more or less on sides. Body-wall tough and leathery. Pedicels numerous on ventral side, not arranged in rows ..... *Holothuria mexicana*. (8)
- b. Color extremely variable; the extremes are uniform blackish-brown, without markings, and uniform light buff with a few small spots of dark brown. Between these two extremes all possible combinations of light and dark occur, but the commonest form is buff, considerably blotched with large patches of dark brown. Body-wall, though thick, soft and slimy. Pedicels numerous, arranged distinctly in three broad longitudinal rows on ventral surface..... *Stichopus uibii*. (2)
- II. Size small, rarely 8 inches long. Usually found among rocks, often buried in sand under loose slabs.
- a. Body covered with more or less wart-like conical papillæ. Pedicels few, irregularly scattered, or none ..... *Holothuria impatientis*. (7)
- b. Pedicels arranged in 3 longitudinal series on ventral surface. Cuvier's organs very noticeable, pure white in living animal ..... *Holothuria captiva*. (3)
- c. Pedicels thickly crowded ventrally, less numerous dorsally; few papillæ, if any..... *Holothuria glaberrima*. (5)
- d. Body very thickly covered with pedicels ventrally and with papillæ and pedicels dorsally. *Holothuria densipedes*. (4)
- e. Body elongated, with scattered and rather few papillæ on dorsal surface, and irregularly scattered pedicels on ventral.
1. Blackish and whitish or light gray, mottled with darker; sometimes more or less tinged with yellow..... *Holothuria grisea*. (6)
2. Grayish, but more or less decidedly yellow, with fine purple markings and blotches of the same color..... *Holothuria rathbuni*. (9)
3. Brownish or purplish, more or less indistinctly marked with darker blotches..... *Holothuria surinamensis*. (10)
- C. Tentacles 15, pinnate. Body long and slender, without pedicels ..... *Synapta lappa*. (11)

1. *Echinocucumis asperrima* Theél. (Pl. 16, figs. 1-7.)

This extraordinary holothurian is 1 or 2 inches long, including the long neck and slender, tapering tail. It has been recorded from only the Caribbean Sea, and there only in deep water.

There is one specimen of this species dredged at station 6066, in 170 fathoms of water. It is just 24 mm. long, and the delicacy and glassiness of its appearance make it an object of unusual interest. The species was first described by Theél, in 1886, from specimens collected in the vicinity of Jamaica and Cuba, at depths of 150 fathoms or over. As he published no figures of the species, it seems worth while to give with this report some illustrations of such a noteworthy form. The tentacles (fig. 4) are apparently only eight in number, and differ from the tentacles of all other pedate holothurians in being perfectly simple, without branches of any kind. The calcareous ring (fig. 2) is very small; no stone canal or Polian vessel found. Genital filaments few, but thick. Respiratory trees very delicate. No Cuvier's organs. Respiratory trees and intestine with numerous brownish spherical bodies in their walls, possibly waste matter. Intestine very long and much coiled. Pedicels very scarce, almost wanting, except near head and tail. Body-wall (fig. 3) very hard and firm, as though mailed, pure white. It is composed of more or less regular polygonal plates, each of which bears a single, long, stout and sharp spine. Calcareous bodies (figs. 6 and 7) consisting of irregular plates with numerous holes, very abundant, especially in and near the tentacles.

2. *Stichopus mœbii* Semper.

A common species and very interesting on account of the great variety in the color, shape, appearance, and number of tentacles. It reaches a length of 300 mm. or so. The body-wall contains numerous tables and C-shaped bodies; the former with well-developed disk and numerous teeth at top. Known from Bermuda and the West Indies. There are 8 specimens of *Stichopus* in the *Fish Hawk* collection, varying in size from 90 to 220 mm. Though differing somewhat in color, they all show the light background with large dark spots and blotches. The number of tentacles varies from 16 to 20, there being 1 with 16, 1 with 17, 2 with 18, 1 with 19, and 3 with 20. It is worthy of note that the two largest specimens have 20 tentacles and the two smallest have 18 and 16, respectively. This species was collected at Boqueron Bay, San Juan, and Mayaguez, and these specimens agree in all essentials with those from Jamaica and Bermuda.

3. *Holothuria captiva* Ludwig.

This little holothurian rarely reaches a length of 100 mm. It is rich brown in color, somewhat paler below. On the back are rather numerous papillæ. The body-wall contains numerous tables, with many teeth at the apex, and buttons with 3 pairs of holes. The species is known only from Bermuda and the West Indies. There are only two specimens from Porto Rico, and both are very small, 12 and 15 mm. in length. They were collected at Hucares. The skin is very delicate, almost without pigment, but the deposits are numerous, full size, and perfectly formed. Color in alcohol dirty-brown. Cuvier's organs very noticeable; in one specimen their bulk is fully one-tenth of the whole animal.

The arrangement of pedicels, papillæ, and tentacles is of interest.

Specimens.	Pedicels.	Papillæ.	Tentacles.
Smaller specimen .....	15 in a row; a single row on each side, a double row in middle of ventral surface.	Six longitudinal rows with 6 papillæ in a row.	10
Larger specimen .....	18 in a row; rows as above.....	Six rows with 10 in a row ..	14

4. *Holothuria densipedes*, nov. sp. (Pl. 17, fig. 1.)

There is a single specimen, from the light-house reef at Playa de Ponce, of a holothurian unlike any yet described. On account of the very numerous and crowded pedicels, I have given to it the name *densipedes*. It is 88 mm. long and about 20 mm. in diameter. The color is brown, with a few scattered dull purple or blackish blotches. The papillæ have a reddish tinge, while the pedicels are much lighter, with a touch of yellow. The pedicels are crowded on the ventral surface, and are

numerous, though somewhat smaller, dorsally. The papillæ are numerous and confined to the dorsal surface. There is no sign of arrangement in rows of either the pedicels or papillæ. Tentacles very small and pale, apparently 20. Polian vessel 1. Stone canal 1. Water-ring with many small bead-like bodies on it. Cuvier's organs present; small, greenish. Genital glands with numerous infrequently branched filaments. The calcareous deposits consist of tables and smooth buttons, with numerous supporting rods in pedicels, papillæ, and tentacles. The buttons usually have three pairs of holes, but not infrequently there are only 3 or 4 holes. The tables have the disk with 4 large central holes or a single deeply 4-lobed hole, surrounded by a circle of smaller holes, 4 larger alternating with 4 smaller, to complete the circle. The spire is comparatively low, with only 1 crossbeam and few (not more than 10 or 12) teeth. The tables of the pedicels are usually much reduced.

The supporting rods of the tentacles are simple, slightly rough or knobbed at ends. Those from the pedicels are usually broader and pierced by holes more or less symmetrically arranged. There are often 7 or 8 pairs of these holes. The calcareous ring is composed of 5 large radial pieces and 5 small, narrow, pointed interradial plates. The calcareous ring and the various calcareous deposits are exactly like those of *H. rathbuni* Lampert, from which species this form is otherwise radically different. (See pl. 17.) It differs from its nearest allies in the crowded papillæ on the dorsal surface, as well as in the detailed structure of the tables, while it differs markedly from *H. glaberrima* in the large size of the pedicels and papillæ, and in their crowded arrangement. It is known as yet only from Porto Rico.

#### 5. *Holothuria glaberrima* Selenka.

Especially common in cavities in coral rocks on the reefs and along shore. It is rather short and stout, seldom more than 100 mm. long. The color varies greatly from pale yellowish brown to almost black, but is generally uniform over the body. The body-wall contains only scattered branching rods. It is found throughout the Caribbean Sea and Gulf of Mexico. Six specimens from Hucares vary in length from 65 to 110 mm. In five the color is blackish brown, the tentacles black; the sixth is light yellowish brown, with light tentacles.

#### 6. *Holothuria grisea* Selenka.

This species reaches a length of 150 to 200 mm. The body-wall contains tables and small forked rods, the latter gathered in little circles or spots, often visible to the naked eye. It has been recorded from the West Indies, Surinam, and Brazil. Two specimens from Arroyo, 50 and 110 mm. long, and one from Hucares 70 mm.

#### 7. *Holothuria impatiens* Forskal.

This is one of the most widely distributed of holothurians, being known from the warmer seas of all parts of the world. It reaches a length of 150 to 200 mm., and is grayish purple in color, sometimes blotched with darker. Tentacles often very light colored. The body-wall contains tables and buttons with 3 pairs of holes. From Culebra there is one typical specimen 85 mm. long, and from Ponce there are two specimens (110 to 125 mm.) which are dark gray in color with no trace of purple.

#### 8. *Holothuria mexicana* Ludwig.

This is one of the largest West Indian holothurians, often reaching a length of 450 mm. or more. The color varies greatly; some specimens, usually small ones, are light brown above and pink or flesh-color beneath, the pedicels brown; others are almost jet-black with scarcely any light below. Between these two extremes all sorts of intergradations occur. The thick, leathery body-wall, which contains simple tables and numerous perforated plates of two kinds, helps greatly to distinguish this species. Described first from the Gulf of Mexico, and known only from the West Indian region.

Of this very common species, there are some 20 specimens in the collection, from 110 to 300 mm. in length. There is great diversity in the number of tentacles and Polian vessels. Four individuals have 18 tentacles; six have 19; nine have 20; one has 21. Two individuals have 1 Polian vessel each; two have 2; five have 3; two have 4; three have 7; one has 8; one has 9. These specimens were collected at Culebra, Fajardo, Boqueron Bay, Guanica, Puerto Real, Mayaguez, and San Juan.

9. *Holothuria rathbuni* Lampert. (Pl. 17, figs. 2 to 10.)

This species reaches a length of 200 mm. The body-wall contains tables and buttons with three pairs of holes. Occurs from Bermuda to Brazil.

There is a small holothurian in the collection from Culebrá, which I have finally decided to consider a young specimen of this species. *H. rathbuni* was first described by Mr. Richard Rathbun from specimens collected at Rio Janeiro, but he gave no name to it. In 1885 Lampert, without any further information, gave the species the name *rathbuni*. Among holothurians which I collected in Jamaica in 1896 and 1897, there are numerous specimens which may be referred without doubt to Mr. Rathbun's species. In 1899 the New York University party collected similar specimens on the south shore of the Bermuda Islands. These specimens all agree in coloration, size, and calcareous parts, as well as in habits, with the specimens from Brazil, as described by Mr. Rathbun. The Porto Rican specimen before me is only 50 mm. long, and is rather spindle-shaped, tapering towards both ends. The pedicels are confined to the ambulacra, where they form five double rows, which are very distinct near the two ends, but rather indistinct at the middle. Tentacles 20 in number, small and pale. Color light gray with a decidedly yellow tinge ventrally, more or less distinctly marked on the interambulacra with purplish black. Cuvier's organs are present, dirty green in color. There is no genital gland, which adds strength to the opinion that this is a young individual. It differs from adults in the arrangement of the pedicels, which are in them irregularly scattered. As no figures have ever been published of the calcareous parts of *H. rathbuni*, it seems wise to give them in connection with this individual.

10. *Holothuria surinamensis* Ludwig.

This very common species reaches a length of about 150 mm. The body-wall is often very thin. It contains a few irregular rods and numerous imperfect tables which lack the disk. Occurs from Bermuda southward to Surinam and into the Gulf of Mexico. About half of the holothurians collected by the *Fish Hawk* consist of this species, of which there are 40 specimens, 30 to 140 mm. in length, from Ponce, Boqueron Bay, San Juan, Puerto Real, and Guanica. In some the "bars" in the skin are numerous and very noticeable and the tables are heavy, while in others the "bars" are rather infrequent and the tables more delicate.

11. *Synapta lappa* Müller.

This large synapta reaches a length of 600 mm., or even more. The color varies considerably, from light gray to dark brown. The body-wall is thin and contains numerous "anchors and plates" (characteristic of the genus) and great quantities of miliary granules. It is found under rocks on sandy bottom in shallow water throughout the West Indies. Mr. Gray's collection contains a single specimen, found under a rock near San Juan.

Besides the species with the "shield-shaped" tentacles, there will doubtless be found along the shores of Porto Rico representatives of another family of holothurians, the *Dendrochirota*. Of this family *Cucumaria punctata* Ludwig and species of *Thyone* are almost sure to occur. Of the *Synaptida*, besides *Synapta lappa* Müller, *Synapta vivipara* (Erstedt) and *Chiridota rotifera* Pourtales will very probably be collected. Moreover, another genus of the *Aspidochirota* (of which *Holothuria* is a typical genus), *Mülleria*, may occur. This latter genus can be easily recognized by the five prominent calcareous teeth in the anus. It is brown, mottled with darker and lighter shades, and reaches a length of 300 mm., or thereabouts. *M. agassizii* Selenka, with 25 to 30 tentacles, has been collected in Florida, Haiti, the Tortugas, Bimini, and Jamaica. *Cucumaria punctata*, which reaches a length of 70 or 80 mm., may be recognized by the 10 much-branched dendriform tentacles, the bluish-gray color, and the yellowish pedicels, which occur in double rows along the ambulacra but are also somewhat scattered on the rest of the body. It occurs in cavities within and underneath broken rocks, from Bermuda to Barbados. *Thyone*

is a genus similar to *Cucumaria*, but has the pedicels much more numerous and crowded irregularly all over the body.

The members of the *Synaptidae* may be easily distinguished from all other holothurians by the absence of pedicels, papillæ, and respiratory "trees." The tentacles are pinnate and the body is more or less translucent. *Synapta vivipara* is a small species, 20 to 100 mm. long, reddish or greenish brown in color with more or fewer white spots. It is found living in seaweeds from Bermuda to Brazil. *Chiridota rotifera* is also a small species, rarely 100 mm. long, flesh-colored with little white spots, found under stones in the sand. The body-wall contains characteristic wheel-shaped bodies. It has been collected from Bermuda, Florida, Jamaica, and Brazil.

#### DISTRIBUTION OF SPECIES.

Of the 50 stations where the *Fish Hawk* dredged, trawled, or used the tangle, 36 yielded echinoderms. Their distribution is shown in the following tables and statements. The first table treats of the west end of the island, the stations being given as nearly as possible in their geographical order. The Crinoidea and Holothurioidea are given outside of the tables for typographical convenience.

Only two representatives of Crinoidea were found in this part of the island:

*Actinometra meridionalis*, at station 6063, depth 75 to 76 fathoms; bottom of rocks, sand and coral; obtained with 11-foot trawl.

*Antedon hageni*, at station 6067, depth 97 to 120 fathoms, coral bottom; obtained with dredge.

Specimens of the Holothurioidea were found as follows:

*Holothuria mexicana*, at Mayaguez, Puerto Real, and Boqueron Bay.

*Holothuria surinamensis*, at Puerto Real and Boqueron Bay.

*Stichopus mobii*, at Mayaguez and Boqueron Bay.

*Echinocucumis asperrima*, at station 6066, 97 to 120 fms., coral bottom, a dredge being used.

*Asteroidea*, *Ophiuroidea*, and *Echinoidea* collected by the *Fish Hawk* at the western end of Porto Rico.

Station.	Depth, bottom, and apparatus.	Asteroidea.	Ophiuroidea.	Echinoidea.
Aguadilla .....	.....	.....	.....	<i>Echinometra subangularis</i> , <i>Hipponoë esculenta</i> .
Station 6055.....	137 fms.; sand, mud, and shells; dredge.	.....	<i>Amphipholis goesii</i> .	.....
Mayaguez .....	.....	<i>Astropecten antillensis</i> , <i>Luidia senegalensis</i> , <i>Pentaceros reticulatus</i> .	<i>Amphipholis subtilis</i> , <i>Amphitrua stimpsoni</i> , <i>Ophiactis krebsii</i> , <i>loricata?</i> , <i>Ophiothrix angulata</i> , <i>ørstedii</i> .	<i>Cidaris tribuloides</i> , <i>Diadema setosum</i> , <i>Hipponoë esculenta</i> , <i>Melitta testudinata</i> .
Station 6057.....	4½ fms.; sticky mud; dredge.	.....	<i>Amphipholis goesii</i> .	.....
Station 6058.....	7½ fms.; sticky mud; 7-foot trawl.	<i>Astropecten duplicatus</i> .	<i>Amphipholis goesii</i> .	.....
Station 6059.....	7 fms.; sticky mud; 7-foot trawl.	<i>Echinaster crassispina</i> .	<i>Amphipholis goesii</i> .	<i>Brissopsis lyrifera</i> .
Station 6060 .....	12 fms.; sticky mud; dredge.	.....	<i>Amphipholis goesii</i> .	.....
Station 6061 .....	12 to 18 fms.; mud and sand; 11 ft. trawl.	.....	<i>Amphipholis goesii</i> .	.....
Station 6062 .....	25 to 30 fms.; sand, mud, and shells; dredge.	.....	<i>Amphipholis goesii</i> , <i>Ophioglypha Ijungmani</i> .	.....
Station 6063 .....	75 to 76 fms.; rocks, sand, and coral; 11 ft. trawl.	.....	<i>Amphipholis goesii</i> , <i>subtilis</i> , <i>Astroporpa annulata</i> , <i>Ophiomusium eburneum</i> , <i>elegans</i> .	.....

*Asteroidea, Ophiuroidea, and Echinoidea collected by the Fish Hawk at western end of Porto Rico—Cont'd.*

Station.	Depth, bottom, and apparatus.	Asteroidea.	Ophiuroidea.	Echinoidea.
Station 6064	22 to 23 fms.; sand and mud; dredge.		Ophioglypha ljunghmani	
Station 6065	4 to 6 fms.; coral; dredge.		Ophiothrix angulata. Amphiodia planispina? Ophiothrix angulata.	
Station 6066	161 to 172 fms.; sand, mud; 11 ft. trawl.		oerstedii. Amphiodia riisei. Amphiura flexuosa.	
Station 6067	97 to 120 fms.; coral; dredge.		Amphioplus stearnsii.... Astroschema oligactes. Ophioglypha robusta. Ophiomusium sculptum. Ophioplithaca spinissima. Ophiopsila fulva. Ophiothrix angulata. suensonii.	Doricoidaris papillata.
Station 6070	220 to 225 fms.; rocks; 9 ft. trawl.		Ophiothyreus goesli. Ophiozona tessellata. Ophiacantha bidentata.. Ophiomusium eburneum elegans. Ophiomusium validum. Ophiopristis hirsuta. Ophionereis reticulata..	Asthenosoma hystrix. Doricoidaris papillata. Palaeopneustes hystrix.
Puerto Real		Astropecten antillensis. Echinaster crassispina. Luidia senegalensis.	Ophiureis reticulata.. Ophiothrix angulata. oerstedii. Ophiura brevicauda. brevispina.	Mellita testudinata.
Station 6072	7½ fms.; coral, sand, and shells; tangle.	Astropecten duplicatus. Echinaster crassispina.	Ophiothrix angulata.	
Station 6075	8½ fms.; sand and coral; tangle.		Ophiothrix angulata .. Ophiura brevicauda.	Cidaris tribuloides.
Boqueron Bay			Ophiothrix angulata .. suensonii.	Echinometra subangularis. Toxopneustes variegatus.
Station 6076	10 fms.; coral and sand; tangle.		Ophiacantha ophiac-toides. Ophiocoma pumila.	
Station 6077	10½ fms.; coral and sand; tangle.		Ophiocoma pumila.	

On the southern side of the island the only echinoderms collected were in shallow water at the three following places:

Station.	Asteroidea.	Ophiuroidea.	Echinoidea.	Holothurioidea.
Guanica		Ophionereis reticulata.. Ophiothrix angulata. Ophiura appressa.	Hipponoë esculenta ..	Holothuria mexicana. surinamensis.
Ponce <i>a</i>	Asterina folium .. Linckia guildingii. Ophidiaster guildingii. Pentaceros reticulatus.	Ophiactis krebssii .. Ophialcea glabra. Ophiocoma echinata. pumila. Ophiothrix angulata. oerstedii. Ophiura appressa. cinerea. brevicauda. rubicunda.	Diadema setosum .. Echinometra subangularis. Echinometra viridis. Hipponoë esculenta. Mellita testudinata. Toxopneustes variegatus.	Holothuria densipedes. impatiens. surinamensis.
Arroyo	Astropecten antillensis.	Ophiozona impressa. Ophiothrix oerstedii.... Ophiura brevispina.	Cidaris tribuloides ... Diadema setosum. Echinometra subangularis. Hipponoë esculenta. Mellita sexforis. testudinata. Toxopneustes variegatus.	Holothuria grisea.

*a* Of the 24 species taken at Ponce, 7 were not taken at any other point, and 2 are new to science.

At the eastern end of the island the collecting was extended to within a few miles of St. Thomas, and included both Vieques and Culebra islands. This region proved rich in brittle-stars, 21 species being taken, of which 6 were not taken elsewhere, and 2 are apparently new to science.

Of the Crinoidea, *Actinometra rubiginosa* was taken with the tangle, from coral bottom, at station 6088, in 23 fathoms, and station 6090, in 16 fathoms.

Of the Holothurioidea, *Holothuria captiva*, *H. glaberrima*, and *H. grisea* were obtained at Hucares; *H. impatiens*, *H. mexicana*, and *H. rathbuni* at Ensenada Honda (Culebra), and *H. mexicana* at Fajardo.

Table showing the Asteroidea, Ophiuroidea, and Echinoidea obtained by the steamer Fish Hawk at the eastern end of the island of Porto Rico.

Station.	Depth, bottom, and apparatus.	Asteroidea.	Ophiuroidea.	Echinoidea.
Hucares .....	.....	.....	.....	Toxopneustes variegatus.
Stations 6097, 6098, and 6099.	9½ to 12½ fms.; coral; tangle.	<i>Luidia alternata</i> .....	<i>Ophiocoma pumila</i> ..... <i>Ophiothrix angulata</i> . <i>Ophiura rubicunda</i> . <i>Ophionereis reticulata</i> . <i>Ophiopsila riisei</i> . <i>Ophiostigma isacanthum</i> . <i>Ophiothrix angulata</i> . <i>suensonii</i> . <i>Ophiura brevispina</i> . <i>Ophiactis krebsii</i> . <i>Ophiocoma pumila</i> . <i>Ophionereis reticulata</i> . <i>Ophiopsila fulva</i> . <i>riisei</i> . <i>Ophiothrix angulata</i> . <i>Ophiura brevispina</i> . <i>Ophiocoma echinata</i> . <i>Ophionereis reticulata</i> . <i>Ophiothrix cerstedii</i> . <i>Ophiura appressa</i> . <i>brevicauda</i> .	Toxopneustes variegatus.
Station 6079 .....	20 to 23 fms.; coral; tangle.	.....	.....	.....
Station 6080 .....	20 to 23 fms.; coral; dredge.	.....	.....	.....
Caballo Blanco .....	.....	.....	.....	.....
Station 6084 .....	11 fms.; coral, sand, and shells; tangle.	<i>Astropecten duplicatus</i> . <i>Luidia clathrata</i> . <i>Astropecten duplicatus</i> .	.....	.....
Station 6085 .....	14 fms.; coral, sand, shells; 7 ft. trawl.	.....	.....	<i>Mellita sexforis</i> .
Station 6086 .....	14½ fms.; coral and sand; dredge.	.....	<i>Ophioplepis elegans</i> . <i>Ophiura brevispina</i> . <i>Ophiocoma echinata</i> ..... <i>pumila</i> . <i>Ophiomyxa flaccida</i> . <i>Ophionereis reticulata</i> . <i>Ophiothrix angulata</i> . <i>cerstedii</i> . <i>Ophiura appressa</i> . <i>brevicauda</i> . <i>brevispina</i> . <i>cinerea</i> . <i>rubicunda</i> .	<i>Echinometra subangularis</i> .
Ensenada Honda (Culebra).	.....	<i>Linckia guildingii</i> .....	.....	.....
Station 6087 .....	14½ fms.; coral and sand; tangle.	.....	<i>Ophiothrix angulata</i> .....	<i>Cidaris tribuloides</i> .
Station 6088 .....	23 fms.; coral; tangle.	.....	<i>Ophionereis reticulata</i> . <i>Ophiura appressa</i> . <i>Ophionereis dubia</i> .	.....
Station 6090 .....	16 fms.; coral; tangle.	.....	.....	.....
Station 6091 .....	15 fms.; coral; tangle.	<i>Astropecten duplicatus</i> . <i>Echinaster crassispina</i> .	.....	.....
Station 6093 .....	15 fms.; coral; tangle.	.....	<i>Ophiura appressa</i> . <i>Ophiocoma pumila</i> . <i>Ophiactis longibrachia</i> . <i>Ophiocoma echinata</i> . <i>Ophionereis olivacea</i> . <i>Ophiothrix angulata</i> . <i>cerstedii</i> .	.....
Station 6095 .....	12½ fms.; coral; tangle.	.....	.....	.....
Station 6096 .....	6 fms.; coral; tangle.	<i>Astropecten duplicatus</i> .	.....	.....
Fajardo .....	.....	.....	<i>Ophiura brevispina</i> . <i>Ophiocoma echinata</i> .....	<i>Echinometra subangularis</i> . <i>Echinanthus rosaceus</i> .



On the north shore the collecting was all done in the neighborhood of San Juan, and brought to light a number of species not taken elsewhere. The Asteroidea obtained were *Echinaster crassispina*, *Linckia guildingii*, *Luidia senegalensis* and *elathrata*. *Pentaceros reticulatus*, *Zoroaster fulgens*. The following table shows the distribution of Ophiuroidea, Echinoidea, and Holothurioidea in this region:

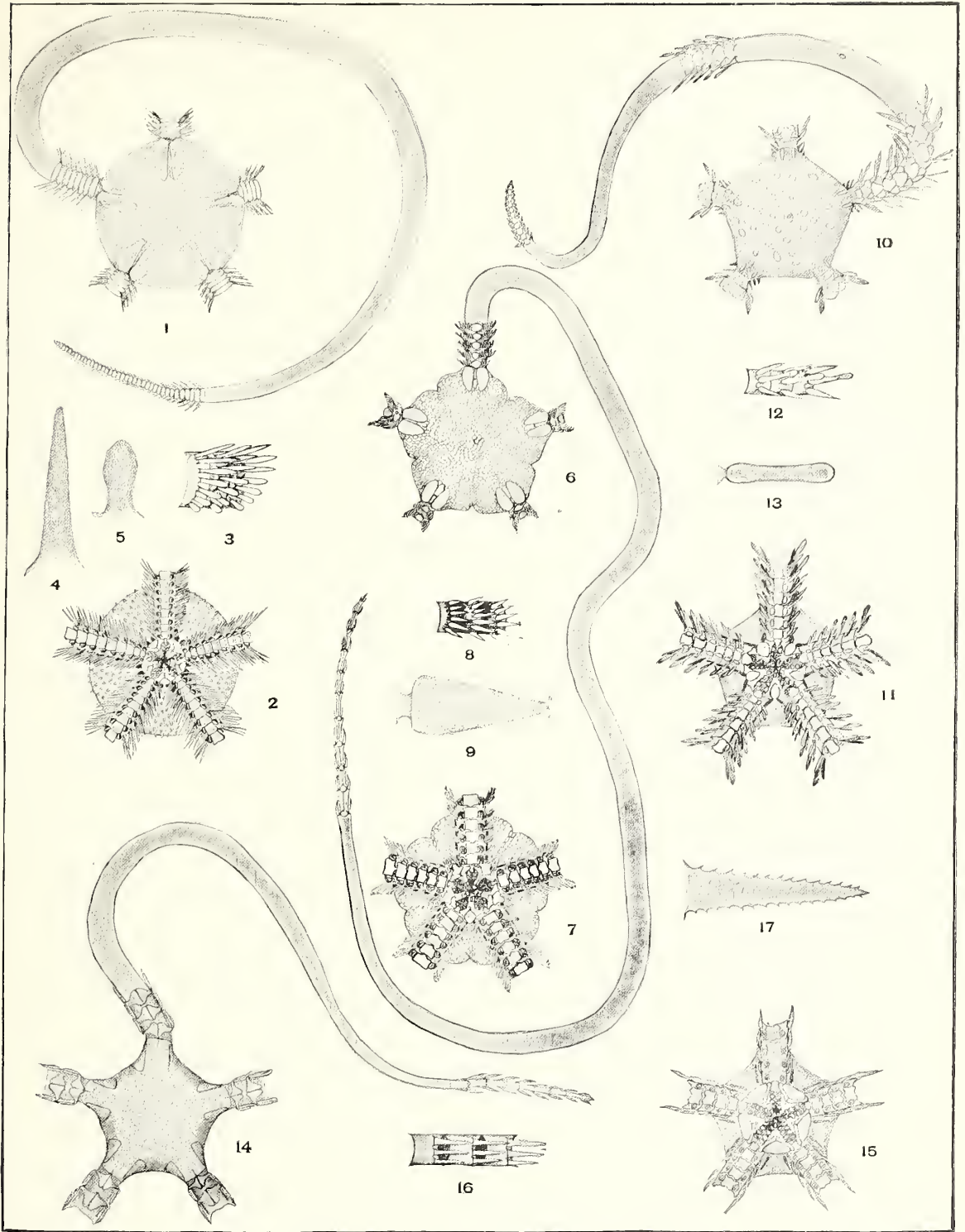
Station.	Depth, bottom and apparatus.	Ophiuroidea.	Echinoidea.	Holothurioidea.
San Juan .....	.....	<i>Amphiodia pulchella</i> . <i>Ophiothrix angulata</i> .	<i>Echinometra subangularis</i> . <i>Toxopneustes variegatus</i> .	<i>Holothuria mexicana</i> . <i>Holothuria surinamensis</i> . <i>Stichopus möbii</i> .
Collected by Mr. Gray from vicinity of San Juan.	.....	<i>Ophiocoma echinata</i> . <i>Ophiocoma pumila</i> . <i>Ophiocoma riisei</i> . <i>Ophiomyxa flaccida</i> . <i>Ophiura appressa</i> . <i>Ophiura brevicauda</i> . <i>Ophiura cinerea</i> . <i>Amphiura bihamula</i> . <i>Ophioglypha robusta</i> . <i>Ophiocolex serratus</i> . <i>Ophiözona nivea compta</i> . <i>Ophioglypha ljunghani</i> .	<i>Cidaris tribuloides</i> . <i>Diadema setosum</i> . <i>Hipponoë esculenta</i> .	<i>Holothuria glaber-rima</i> . <i>Holothuria grisea</i> . <i>Holothuria impatiens</i> . <i>Synapta lappa</i> .
Station 6050 .....	91 fms.; sand and mud; 7 ft. trawl.			
Station 6051 .....	45 fms.; sand and mud; tangle.			
Station 6053 .....	4 to 7½ fms.; fine sand; dredge.	<i>Amphipholis limbata</i> .	<i>Mellita testudinata</i> .	
Station 6054 .....	½ to 5½ fms.; sand and mud; dredge and tangle.	<i>Amphipholis goesii</i> .		

## SUMMARY.

An examination of the collections made at the various stations as given above shows that Mayaguez and its vicinity proved to be the best locality for the collecting of echinoderms, although the vicinity of Culebra Island and that of San Juan Harbor, each offers a very good field. At Mayaguez, within a radius of 9 miles, 43 species were collected (2 crinoids, 5 asteroids, 25 ophiuroids, 8 echinoids, and 3 holothurians), of which 24 were not taken elsewhere and 1 is new to science. In the vicinity of Culebra about 40 species were taken (1 crinoid, 5 asteroids, 21 ophiuroids, 5 echinoids, and 8 holothurians), of which 11 were not taken elsewhere and 2 are new. At San Juan, within a radius of 1¼ miles, 35 species have been collected (6 asteroids, 16 ophiuroids, 6 echinoids, and 7 holothurians), of which 8 were not taken elsewhere and 2 are new. The littoral collecting at San Juan proved the best, perhaps because more thoroughly done, but Ponce is a close second, and nearly a third of the species taken at the latter place were not found elsewhere. San Juan proved to be the best place for starfishes, Ponce or Culebra for littoral brittle-stars, Arroyo or Ponce for littoral echinoids, and San Juan for holothurians. Of littoral forms, the commonest starfish is apparently *Pentaceros reticulatus*, the commonest brittle-star *Ophiocoma echinata* or *Ophiothrix angulata*, the commonest sea-urchin *Toxopneustes variegatus* or *Echinometra subangularis*, and *Stichopus möbii* is probably the commonest holothurian.

OLIVET COLLEGE, September 15, 1900.





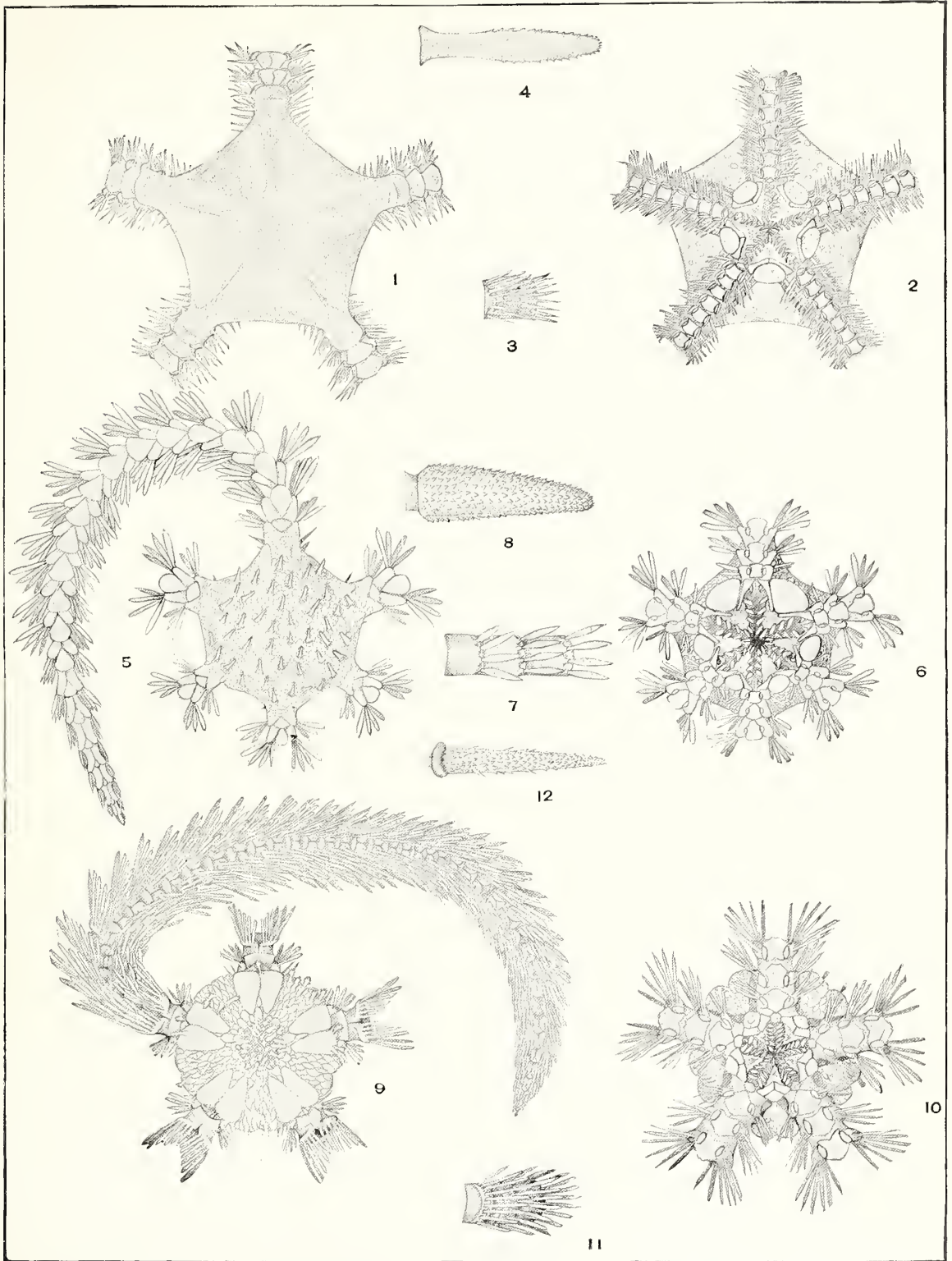
Figs. 1-5. *Ophiactis longibrachia*.—Fig. 1, upper surface,  $\times 1.5$ . Fig. 2, under surface,  $\times 1.5$ . Fig. 3, side view of 3 joints of arm, showing the number and proportions of the arm-spines,  $\times 5$ . Fig. 4, one of the upper spines,  $\times 20$ . Fig. 5, one of the lower spines,  $\times 20$ .

Figs. 6-9. *Amphitura bihamula*.—Fig. 6, upper surface,  $\times 4$ . Fig. 7, under surface,  $\times 4$ . Fig. 8, side view of 3 joints of arm, showing the number and proportions of the arm-spines,  $\times 10$ . Fig. 9, one of the lower spines, showing the little hooks at the end,  $\times 30$ .

Figs. 10-13. *Ophiocolea olivacea*.—Fig. 10, upper surface,  $\times 3$ . Fig. 11, under surface,  $\times 3$ . Fig. 12, side view of 3 joints of arm, showing the number and proportions of the arm-spines,  $\times 4$ . Fig. 13, one of the middle arm-spines,  $\times 10$ .

Figs. 14-17. *Ophiocolea serratus*.—Fig. 14, upper surface,  $\times 3$ . Fig. 15, under surface,  $\times 3$ . Fig. 16, side view of 3 joints from near middle of arm, showing the number and proportions of the arm-spines,  $\times 5$ . Fig. 17, one of the upper arm-spines,  $\times 20$ .





Figs. 1-4. *Ophiacantha glabra*.—Fig. 1, upper surface,  $\times 2$ . Fig. 2, under surface,  $\times 2$ . Fig. 3, side view of 3 joints from near middle of arm, showing the number of arm-spines,  $\times 2$ . Fig. 4, one spine from near middle of arm,  $\times 15$ .  
 Figs. 5-8. *Ophiacantha ophiactoides*.—Fig. 5, upper surface,  $\times 10$ . Fig. 6, under surface,  $\times 10$ . Fig. 7, side view of 3 joints from near middle of arm, showing the number of arm-spines,  $\times 10$ . Fig. 8, one spine from near middle of arm,  $\times 65$ .  
 Figs. 9-12. *Ophioplithaca spinissima*.—Fig. 9, upper surface,  $\times 3$ . Fig. 10, under surface,  $\times 3$ . Fig. 11, side view of 3 joints from near middle of arm, showing the number and proportions of the arm-spines,  $\times 3$ . Fig. 12, one spine from near middle of arm,  $\times 10$ .



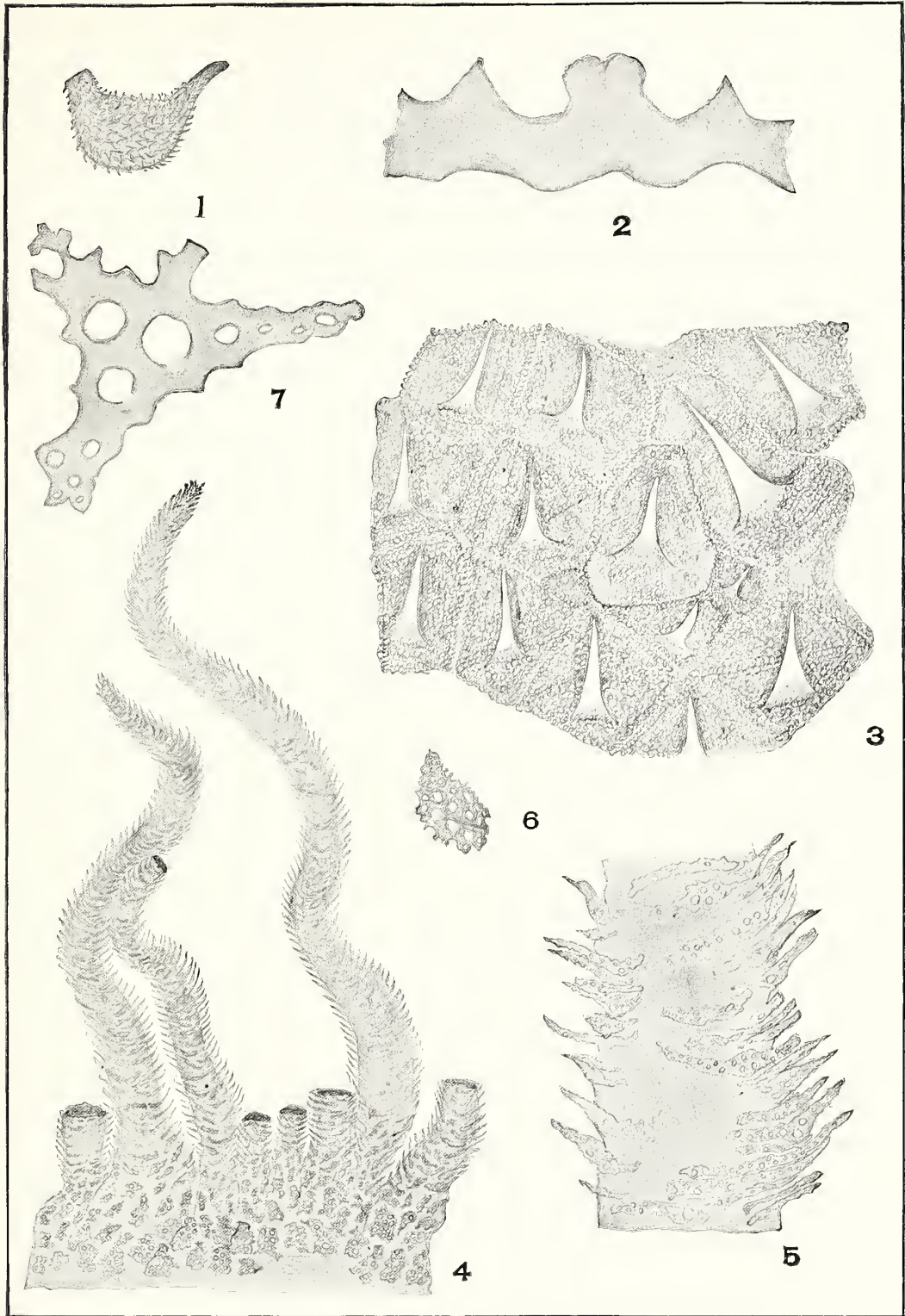


Fig. 1. *Echinocucumis asperima* Thcel, natural size.

2. Part of the calcareous ring,  $\times 45$ .

3. Part of the body wall from the outside,  $\times 20$ .

4. The circle of tentacles (some are broken and some may be wanting),  $\times 20$ .

Fig. 5. Part of a tentacle, to show the way in which the calcareous rods project,  $\times 90$ .

6. A plate from the body wall near the circle of tentacles,  $\times 90$ .

7. A plate from the base of a tentacle,  $\times 45$ .





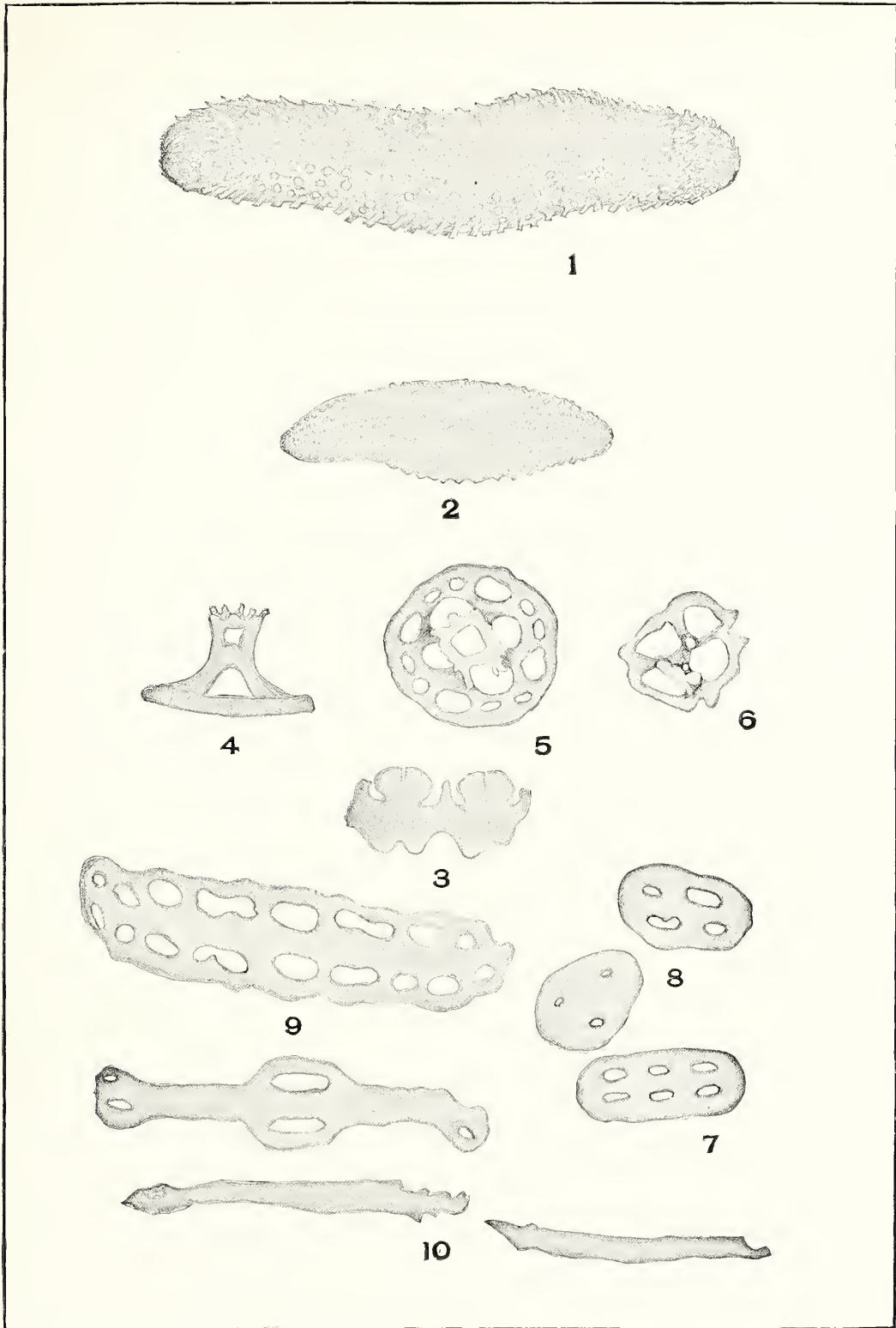


Fig. 1. *Holothuria densipedes*, n. sp., natural size.  
 2. ? *Holothuria rathbuni* Lamp., young, natural size.  
 3. Part of the calcareous ring of *H. rathbuni*, - 5.  
 4. Calcareous table from the skin of *H. rathbuni*, seen from the side,  $\times 450$ .  
 5. Table seen from above,  $\times 450$ .

Fig. 6. Incomplete table from pedicel,  $\times 450$ .  
 7. Normal button of *H. rathbuni*,  $\times 450$ .  
 8. Incomplete buttons, - 450.  
 9. Supporting rods from pedicels,  $\times 450$ .  
 10. Supporting rods from tentacles,  $\times 450$ .

Figs. 3-10 would answer equally well for *Holothuria densipedes*.