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THE HOLOTHURIANS OF THE WESTERN PART OF THE ATLANTIC OCEAN

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WITH TWENTY-FOUR PLATES

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No. 3.— *The Holothurians of the Western Part of the Atlantic Ocean.*[1]

By Elisabeth Deichmann

Introduction

This paper is a monograph of the Holothurians of the western part of the Atlantic Ocean, from the coast of Brazil to Cape Cod, including Bermuda.

The Holothurian fauna of this region has never been worked out. The first paper about this group of Echinoderms we owe to Lesueur, 1823. Some of the species which he described from St. Bartholomew are still recognized. Subsequently a number of short notes were published, unfortunately without any figures but often with very characteristic descriptions (Stimpson, Ayres). In 1867 Selenka's classical monograph on the Holothurians of the world was published. His paper contains a number of West Indian species and most of his descriptions are accompanied by figures. Since then a number of small papers have been published, dealing with the local fauna of various places (Bermuda, Woods Hole, etc.), exclusively littoral forms. The deep-sea forms of the American waters were treated for the first time in 1885 when Verrill published his account of the deep-sea dredgings of the "Albatross," a paper which seems to have been entirely forgotten. The following year Théel's "Blake" and "Challenger" reports came out.

A study of the older literature shows clearly that the number of synonyms and wrong identifications has become very large, and only a very careful study of the collections could bring the Holothurians into such order that conclusions could be reached regarding the composition of the western Atlantic fauna.

The following paper is based entirely upon museum material, and includes practically all the material available from this region. It is primarily a revision of the unique collection in the Museum of Comparative Zoölogy, which contains most of Selenka's types, and an examination of the very large collections in the United States National Museum. Besides a very large number of littoral forms, the National Museum collections contain all the undetermined Holothurians from the deep-sea dredgings of the "Albatross" in 1884–85. The collections

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in the British and Copenhagen Museums have been studied and also the specimens at the University of Iowa, collected by the Barbados-Antigua Expedition. Only a few specimens of littoral forms in certain museums in Germany and Holland have not been examined.

From these studies it appears that the fauna of the region under consideration contains about 60 littoral species and about half as many deep-sea and continental forms. While only a few additions to the littoral fauna can be expected, it is probable that everything known from the deeper water of the eastern part of the Atlantic Ocean will be found to occur also in American waters, and the keys and references have therefore been made to include all Atlantic deep-sea Holothurians. The order Apoda has been treated rather briefly because the members of that group have recently been worked out by H. L. Clark, according to modern principles, with numerous figures, and therefore little had to be added. The Apoda are included in the present paper to make it complete, and because it is necessary to consider all orders, when we try to discuss the geographical distribution and the origin of the West Indian fauna.

The Holothurians of the region treated here include, besides the widespread deep-sea species, mostly tropical and subtropical forms; the latter reach very far north on account of the Gulf Stream, and it is difficult to draw a line between the two groups. A few arctic forms are included because they extend so far south that they enter the region which is otherwise occupied by subtropical forms; they are dealt with quite briefly, and in the discussion of the Holothurian fauna of this region as a whole, they are not included.

The present paper is primarily a taxonomic paper with descriptions of the anatomy, as far as the condition of the specimens has permitted, and a detailed study of the important spicules of the integument; these have in most cases been figured, except in the orders Elasipoda and Apoda. The spicules of the species in these groups have recently been figured by Hérouard, Perrier and Clark.

The often considerable changes which the spicules undergo during growth have been studied whenever it has been possible. Most of the material was, however, collected at a time when large specimens alone were preserved, and the growth series which have been available are therefore often very incomplete. It has nevertheless been possible in many cases to work out the course of development which the spicules probably take, either by becoming more complicated or more reduced, and many errors which have arisen from examination and description of immature or senile specimens have thus been corrected.

Except for the deep-sea order Elasipoda which Hérouard (1923) and Ekman (1925) recently have studied, and the order Apoda which H. L. Clark has treated (1908), it must be said that the detailed systematic arrangement of the remaining orders, the Aspidochirota, Dendrochirota and Molpadonia, is, as yet, very unsatisfactorily worked out.

The fauna which has been studied here is not rich enough to enable us to lay a foundation for a better systematic arrangement. But it contains so many different types that an idea may be gained as to what lines the systematic arrangement will probably follow, when equal value is given to the general anatomical features and the spicules. Keys have, therefore, been prepared, in most cases, so that species which seem to be nearly allied have been placed near each other, and consequently in some cases characters not absolutely necessary for the rapid determination of a species are mentioned in the keys.

In other Echinoderms the study of the larvae has proved to be of value in reaching a natural systematic arrangement (Mortensen, 1901). The larvae of the Holothurians, however, are apparently of a very uniform and simple type, so that it is probable they will prove of less help. They are at present very unsatisfactorily known; very few larvae have been reared and practically no comparison of the different types has been undertaken. A careful study of larval forms may therefore prove to be of some value, not only from a systematic point of view but also for understanding problems of distribution.

Very few biological notes have been included in the present paper, and these are mostly as given by W. K. Fisher and H. L. Clark. A further study of these animals in life will undoubtedly be of great interest, as it seems as if most of them are closely limited to certain habitats, and their choice of living places corresponds well with their anatomy and armature of spicules.

The results obtained may be briefly summarized as follows:

1. The West Indian Seas, including the eastern coast of the United States and the waters around Bermuda, have a rather rich fauna of littoral holothurians, namely about 20 tropical Aspidochirota, 20 Dendrochirota, partly tropical, partly subtropical, and a few Apoda. There is also a typical deep-sea fauna of Elasipoda, Aspidochirota (Synallactidae) and a few Molpadonia and Dendrochirota; about 30 species actually are known, but more are undoubtedly present.

2. A few arctic or boreal forms known also from the northern part of Europe and Greenland are intermingled with the subtropical fauna and reach as far south as does the cold water, or about to Cape Cod.

Records of boreal forms further south than this have proved to be incorrect.

3. Most of the Aspidochirota belonging to the littoral fauna are very uniformly spread over the tropical region (Gulf of Mexico, Caribbean Sea, Bermuda). They have apparently originated from the Pacific fauna. The relation to the eastern Atlantic fauna is very small. It may be that the few tropical forms which occur in both the western and eastern part of the Atlantic Ocean, as for instance *Holothuria mexicana*, were originally West Indian.

4. Many of the West Indian species show small but distinct differences from the Pacific forms; most of them have a parallel form in the Pacific Ocean.

5. The Dendrochirota and Apoda, which range from littoral to sublittoral, seem all to be endemic and have apparently no parallel forms in the Pacific Ocean. A few forms seem to be represented by closely related forms in the eastern Atlantic.

6. The west Atlantic deep-sea fauna of Holothurians is entirely Atlantic in its composition. It has nothing in common with the fauna of the Gulf of Panama (as one might naturally expect). The Gulf of Mexico and the Caribbean Sea are poor in regard to deep-sea forms and resemble thus a typical "Mediterranean Sea." The deep-sea forms are found most abundantly on the outer Atlantic side of the Antilles and along the coast of New England.

7. The deep-sea forms are generally found in lesser depth in the West Indies than in the eastern part of the Atlantic Ocean.

8. The distribution of the north Atlantic deep-sea forms seems to cover the area which is influenced by the Gulf Stream; the greater part of the Atlantic Ocean more than a few hundred miles from the mainland or the oceanic islands is apparently devoid of Holothurians (a few species have been collected on the Dolphin Ridge).

9. The distribution of the Atlantic deep-sea Holothurians, as we know it, from the explorations of the "Talisman," "Princess Alice," "Albatross," "Blake" and "Ingolf," argues against the theory of Théel (1882) that the deep-sea forms have direct development and spread over the sea bottom only by slowly creeping. Some of them apparently spread by means of swimming or drifting larvae, as has been observed in the case of *Scotoanassa translucida*, by Hérouard (1923, p. 88). Most likely many of them float at some depth, so that they never are taken in surface nets.

List of Holothurians at Present Known from the Western Part of the Atlantic Ocean

Order Aspidochirota
- Family Holothuriidae
  - Genus Holothuria
    - H. arenicola Semper
    - H. cubana Ludwig
    - H. densipedes Clark
    - H. floridana Pourtalès
    - H. glaberrima Selenka
    - H. grisea Selenka
    - H. impatiens (Forskål)
    - H. mexicana Ludwig
    - H. imperator sp. nov.
    - H. occidentalis Ludwig
    - H. parvula (Selenka)
    - H. princeps Selenka
    - H. pseudofossor sp. nov.
    - H. surinamensis Ludwig
  - Genus Actinopyga
    - A. agassizi (Selenka)
  - Genus Stichopus
    - S. badionotus Selenka
    - S. macroparenthesis Clark
  - Genus Astichopus
    - A. multifidus (Sluiter)
- Family Synallactidae
  - Genus Pseudostichopus
    - P. depressus Hérouard
    - P. atlanticus Perrier
    - P. occultatus v. Marenzeller
    - P. villosus Théel
  - Genus Mesothuria Théel
    - M. gargantua sp. nov.
    - M. intestinalis (Ascanius and Rathke)
    - M. maroccana Perrier
    - M. rugosa Hérouard
  - Genus Bathyplotes
    - B. natans (Sars)
    - B. pourtalesi (Théel)

Genus Pelopatides
Pelopatides gigantea (Verrill)
Genus Amphigymnas
A. bahamensis sp. nov.
Genus Zygothuria
Z. lactea Théel
Z. sp.

Order Elasipoda
Family Deimatidae
Genus Deima
Deima blakei Théel
Family Psychropotidae
Genus Benthodytes
B. kerhervei (Hérouard)
B. lingua Perrier
B. typica Théel
Genus Euphronides
E. auriculata Verrill
E. violacea Perrier
E. talismani Perrier

Order Dendrochirota
Genus Phyllophorus
P. dobsoni Bell
P. destichada sp. nov.
P. communis (Forbes)
P. conchilegum (Pourtalès)
P. occidentalis Ludwig
P. parvus (Ludwig)
P. pellucidum (Fleming)
P. seguroensis sp. nov.
P. tritus (Sluiter)
Genus Echinocucumis
E. hispida (Barrett)
E. hispida var. atypica var. nov.
Genus Cucumaria
C. argillacea (Sluiter)
C. calcigera (Stimpson)
C. frondosa (Gunnerus)
C. nina sp. nov.
C. parassimilis sp. nov.
C. pulcherrima (Ayres)

Genus Thyone
T. belli Ludwig
T. briareus (Lesueur)
T. cognita (Lampert)
T. fusus (O. F. Müller)
T. gemmata Pourtalès
T. micropunctata Sluiter
T. pervicax Théel
T. pseudofusus sp. nov.
T. sabanillensis sp. nov.
T. scabra Verrill
T. solida sp. nov.
T. surinamensis Semper
T. suspecta Ludwig
T. unisemita Stimpson
Genus Pentacta
P. pygmaeus Théel
Genus Psolus
P. complicatus sp. nov.
P. fabricii (Düben and Koren)
P. operculatus Pourtalès
P. phantapus (Strüssenfeldt)
P. pourtalèsi Théel
P. tuberculosus Théel
P. tuberculosus var. destituta var. nov.
Genus Thyonepsolus
T. braziliensis (Théel)

Order Molpadonia
Family Molpadiidae
Genus Molpadia
M. agassizi (Théel)
M. blakei (Théel)
M. musculus (Risso)
M. oölitica (Verrill)
M. parva (Théel)
Genus Caudina
C. albicans Théel
C. arenata Gould
C. obesacauda Clark
Genus Gephyrothuria
G. glauca (Clark)

Order Apoda
  Family Synaptidae
    Subfamily Synaptinae
      Genus Euapta
        E. lappa (J. Müller)
      Genus Synaptula
        S. hydriformis (Lesueur)
      Genus Leptosynapta
        L. acanthia Clark
        L. circopatina Clark
        L. crassipatina Clark
        L. inhaerens (O. F. Müller)
        L. multigranulata Clark
        L. multipora Clark
        L. parvipatina Clark
      Genus Protankyra
        P. abyssicola Théel
        P. benedeni Ludwig
        P. brychia Verrill
    Subfamily Chiridotinae
      Genus Chiridota
        C. laevis (Fabricius)
        C. pelorica sp. nov.
        C. rotifera Pourtalès

HOLOTHURIOIDEA

Key to the Orders

1. Without pedicels or papillae, not even anal papillae Order V. Apoda, p. 203
1. With either pedicels or papillae, or both, usually in great numbers, but in some cases only small anal papillae 2
2. Tentacles dendroid; retractors present; respiratory trees present; no tentacle ampullae; no rete mirabile; genital organs in two tufts.
Order III. Dendrochirota, p. 138
2. Tentacles peltate or peltato-digitate 3
3. Respiratory trees absent; no retractors; no tentacle ampullae; no rete mirabile; genital organs in two tufts; deep sea forms.
Order II. Elasipoda, p. 113
3. Respiratory trees present 4
4. Appendages numerous; tentacles peltate..Order I. Aspidochirota, p. 51
4. Appendages absent, except as anal papillae; tentacles digitate.
Order IV. Molpadonia, p. 193

ORDER I

ASPIDOCHIROTA Grube 1840

Diagnosis, after Ekman, 1925, p. 535.— Appendages present; tentacles peltate; no oral retractors present; respiratory trees developed; the mesentery belonging to the third loop of the intestine runs in the right ventral interradius. Deposits, when present, either derived from pointed rods, or from primary crosses, and in the latter case present as tables or derivatives of tables.

The order contains 3 families, namely, Holothuriidae Ludwig, Stichopodidae Haeckel and Synallactidae Ludwig.

Key to the Families

1. Tentacle ampullae absent; in most cases no rete mirabile is present; respiratory trees free ..... III. Fam. Synallactidae Ludwig
1. Tentacle ampullae present; rete mirabile well developed; left respiratory tree entangled in rete mirabile 2
2. Genital organs in two tufts ..... II. Fam. Stichopodidae Haeckel
2. Genital organs in one tuft on left side of dorsal mesentery.
I. Fam. Holothuriidae Ludwig

HOLOTHURIIDAE Ludwig 1894

Diagnosis, after Ekman, 1925, p. 586.— Aspidochirote Holothurians with tentacle ampullae; genital organs present only on left side of dorsal mesentery; head of madreporic canal separated from body wall.

Three genera are recognized at present, namely *Holothuria* Linnaeus, *Actinopyga* Bronn and *Labidodemas* Selenka. The last genus is known only from the Pacific Ocean, and will probably be united with the first which, on the other hand, will undoubtedly become divided into a number of smaller groups, with the rank of genera or subgenera.

Key to the Atlantic genera

1. Anus not surrounded by 5 large conspicuous calcified anal teeth; mesentery not with secondary attachments to the body wall; deposits of various kinds, as tables, buttons, grains, rosettes, rods..... *Holothuria* Linnaeus
1. Anus surrounded by 5 large conspicuous calcified anal teeth; mesentery with secondary attachments to the body wall; deposits as grains or rosettes or short rods, at least in full grown specimens.
Actinopyga Bronn

Holothuria Linnaeus 1758

Holothuria Linnaeus, Systema Naturae, 10th ed., 1758.

Diagnosis, after Théel, 1886, p. 202—Tentacles 20, exceptionally more or less; ambulacral appendages pedicels alone, papillae alone, or both pedicels and papillae, the papillae placed on the dorsal surface, the pedicels on the ventral. These ventral pedicels are seldom arranged in longitudinal series. Anus devoid of calcareous teeth, but sometimes stellate. C-shaped deposits absent.

Key to the species of the genus Holothuria occurring in the Western Atlantic

The species are, in the present key, arranged in as natural groups as possible. The calcareous deposits have, in most cases, been treated first, and the anatomical features which often are difficult or impossible to study have been placed in the second line.

1. Deposits, rosettes or perforated plates and tables.....Key III
1. Deposits, elongate buttons or rods, usually also tables.....2
2. Deposits knobbed buttons and tables.....Key I
2. Deposits smooth buttons, or rods, usually also tables.....Key II

Key I

Skin rigid, filled with deposits; relatively thin tentacles; small burrowing forms, often occurring in deeper water, below tide mark.

1. Buttons regular, complete.....2

1. Buttons irregular, often incomplete 3
2. Tables very complicated, developed as reticulated spheres; buttons strongly knobbed, middle bar of buttons not projecting beyond end of deposit. *H. cubana* Ludwig
2. Tables not complicated, with knobbed margin; buttons with undulated surface; middle bar of buttons often projecting beyond end of deposits. *H. pseudofossor* n. sp.
3. Gigantic tables with long, conical, solid spire, near end of appendages; other tables small with reduced spire ..... *H. princeps* Selenka
3. No gigantic tables with long, conical spire; tables relatively small; sometimes very reduced 4
4. Tables with robust spire ending in 4 blunt teeth; margin of disk with upwardly directed knobs ..... *H. occidentalis* Ludwig
4. Tables with reduced spire; margin dentate ..... *H. imperator* n. sp.

Key II

Skin not especially rigid, often soft; either burrowing or clinging to rocks (not an entirely natural group).

1. Elongated forms with small tentacles; no marked difference between dorsal and ventral sides 2
1. Stouter forms; large tentacles; dorsal and ventral sides different 4
2. Tables with few (8–12) spines on top of slender spire; disk reduced completely (except in very young specimens); also large flat rods with dentate margin or a series of holes; anterior end tapering; small yellow tentacles; appendages scattered, ventrally cylindrical, dorsally more papilliform without marked difference between the two sides. *H. surinamensis* Ludwig
2. Tables with numerous spines on top of spire; disk well developed with large central hole; oval buttons with 3 pairs of holes 3
3. Tables large with 8 marginal holes, almost as large as the central hole; disk large, squarish; spire with many spines on top; buttons with large holes; tentacles small; no difference between dorsal and ventral sides; appendages usually on warts; cylindrical on ventral side, more papilliform on dorsal; skin very rough to touch; color variable, mottled brown and gray. *H. impatiens* (Forskål)
3. Tables small with from 4 to a complete ring of small holes around the large central hole; delicate in structure; buttons with small to almost obliterated holes; normally 3 pairs; appendages cylindrical, scattered and not on distinct warts; very few seem to be developed as papillae; color grayish, generally more or less rust color, at least anteriorly, and either small stains of black irregularly spread or two rows of large dark patches along the dorsal side ..... *H. arenicola* Semper
4. No tables (except possibly in very young specimens); deposits branched rods often with curved ends, few and scattered; dark brown with dendritic almost black tentacles; integument soft, smooth . . *H. glaberrima* Selenka

4. Numerous tables with a variable number of marginal holes; disk squarish; numerous teeth on top of spire; numerous elliptic buttons, often obviously curved; small yellowish brown form, contains a green pigment, which is extracted in alcohol; anal papillae often calcified. . . *H. parvula* (Selenka)

Key III

Distinct difference between dorsal and ventral side; large ventrally directed tentacles; a natural group which seems to prefer quiet, very shallow water; they seem never to bury themselves nor to cling to rocks. Deposits small rosettes or plates; tables with small disk and high spire with 12 spines on top.

1. Plates with 2–4 larger holes; a few terminal ones which are small; margin of plates with blunt teeth; collected in heaps, visible to unaided eye; tables with spinous margin of disk; tentacles 20–25; stone canal single; color dark grey with yellow pedicels . . . . . *H. grisea* Selenka
1. Plates not with large holes and dentate margin; deposits mostly either rosettes or biscuit-shaped plates; tentacles 20; two tufts of stone canals. . . 2
2. Rosettes dominating in skin, distinctly in heaps; color variable, often with large dark spots, sand colored or dark reddish brown; maximum size about 25 cm., usually 15 cm.; skin not remarkably thick. . . *H. floridana* Pourtalès
2. Rosettes not present; numerous roundish, biscuit-shaped bodies with small holes in several rows; color, as a rule, dark brown above and pale yellowish to flesh-colored below; bases of ventral appendages dark bluish *H. mexicana* Ludwig

Holothuria cubana Ludwig

Plate **1**, figs. 1–8

Holothuria cubana Ludwig, 1875, p. 28, fig. 34.
Stichopus rigidus Selenka (partim), 1867, p. 317, pl. 18, fig. 30, 31.
Holothuria pleuripus (Haacke), Sluiter, 1910, p. 332.
Holothuria hypamma Clark (partim), 1921, p. 495.
Holothuria fossor Deichmann, 1926, p. 18, pl. 2, fig. 1, 1a-j.

The following is Ludwig's description translated.— "Twenty very small tentacles; the dirty white body of the single specimen is sausage-shaped; the entire surface is covered by appendages; anus is round; skin rough to touch on account of the numerous deposits; these are represented by a crowded layer of knobbed buttons which, as a rule, are perforated by 10 holes; beside these we find others which are irregular in their outline, smooth and perforated only by a few small holes, thus being transformed into plates. The tables are very clumsy; the spire is low and with many teeth; the disk is provided with knobbed thickenings as are the buttons. The shape of the calcareous ring is seen in

fig. 34c; Polian vesicle 1.5 cm. long; stone canal embedded in dorsal mesentery; the few times divided genital tubes, up to 6 cm. in length."

Maximum length of specimens examined about 15 cm. (from Bermuda), usually 6–8 cm., smallest specimen 3 cm.

A very characteristic form, flattened, with thin, rigid skin, except in very young specimens; mouth ventral with 20 very small tentacles; anus terminal. Appendages small, slightly tapering pedicels ventrally, rather scattered and, as a rule, completely retracted, visible only as small pits; dorsally they are small wart-like papillae, usually distinct along the sides and in scattered rows along the dorsal ambulacra. Color gray to whitish, dorsally often with 6 pairs of indistinct spots; ventral side lighter and often with a rusty stain at the bases of the appendages.

Internal anatomy.— A small, low and delicate, calcareous ring, with undulated posterior edge, of the same type as that of *H. pseudofossor;* tentacle ampullae small; Polian vesicle single; one small stone canal with small round head, placed to the right and partly attached to the mesentery. Course of intestine typical, that is, first loop is attached by mesentery along left side of right dorsal muscle band, second loop runs across left dorsal and ventral band and the midventral band, and the third loop runs along the right side of the midventral muscle band; rete mirabile is small; respiratory trees of almost equal size, running through the entire length of the body cavity. Longitudinal musculature thin. Genital organs as divided tubules, attached just behind the vascular ring; they are extremely long when ripe.

Selenka says that this species is provided with branched Cuvierian organs; a brown mass is present near the cloaca, but no distinct structure could be found in it.

Deposits.— An outer layer of densely placed large tables (diameter 0.05–0.08 mm.) resembling reticulated spheres, with a broad disk with large central hole and numerous smaller marginal ones; brim knobbed; spire low with numerous teeth on top, but these are often united with secondary outgrowths from the disk, in such a manner that the entire outer part of the table becomes covered by a reticulated meshwork. The tables are usually smaller and more simple ventrally, especially in the appendages, and here the different stages in the development may be observed. In very young specimens the skin is thin and we find here the primitive tables (fig. 5) as well as some typical, and these simple tables have a higher spire with a few, small spines on top, and the disk is almost smooth.

The inner layer of deposits is, in the adult, composed of a great number of regular knobbed buttons; dorsally they are, as a rule, provided

with 3 pairs of holes and are about 0.04 mm. long; ventrally they have 4–6 pairs of holes and are about twice as long; many are also less knobbed or even smooth.

In the pedicels a small but well-developed end plate and numerous plate-like rods, either developed as elongate smooth buttons (0.08–0.13 mm. long), or as more irregularly formed smooth plates with a few irregularly distributed holes and often a low longitudinal ridge; these latter are very typical for the full grown animal and have been figured by Ludwig, but one has to select a piece of skin which has one or more pedicels or else one will miss them. In the papillae apparently no end plate is present; there are curved rods alone, with broadened middle and some perforations. In the tentacles I have been unable to find any deposits.

In young specimens the inner layer of buttons is less developed; the buttons are furthermore smooth and of the large type, with 4–6 pairs of holes; the characteristic plates in the appendages are not present; we find only elongate rods with a few holes near their ends; probably the supporting plates arise from these rods. The tables are also generally of a simpler type, as mentioned above.

Remarks.— This species resembles in its outer form *H. pseudofossor*, which seems to have more cylindrical and larger pedicels on the ventral side, and besides the papillae a number of appendages developed as pedicels on the dorsal side; the appendages in *pseudofossor* are less apt to contract; because of some peculiarity of the skin we find that foreign particles also seem to cling better to the skin. The two forms are, however, so much alike that an examination of the spicules is necessary to make sure of the determination.

H. cubana differs distinctly from *H. pseudofossor* in the form of the spicules, as the figures clearly show; the latter species has more simple tables with few, regular holes in the margin of the disk and never the large supporting plates. *H. rigida* (Selenka) from the Society Islands, with which this species has been confused, has more simple tables and usually 5–8 pairs of holes in the knobbed buttons. *H. hypamma* Clark, also from the Pacific Ocean, differs by having more irregularly developed knobbed buttons and also just as in *rigida*, less complicated and smaller tables, and supporting rods of the common, slender type.

The reason why Ludwig's species, described in 1875, has escaped attention is simply because he described the smooth supporting plates from the feet, as buttons belonging to the body wall. Clark (1919) has pointed out that Selenka combined the description of two forms,

namely that of typical *H. rigida*, from the Society Islands, and that of the form from Florida, which Clark temporarily united with his *H. hypamma* from Mer, Torres Straits.

Sluiter says about his specimen of *H. pleuripus*, from Kingston: "corresponds exactly with the description which Théel gives of Haacke's specimen from Mauritius." Most likely Théel had *H. rigida* at hand; *pleuripus* and *rigida*, both Indo-Pacific forms, seem to be very closely related; our knowledge of all these forms with knobbed buttons and complicated tables is, however, still imperfect.

Type locality.— Off Cuba.

Type in Vienna Museum.

Also known from Florida (Selenka's type locality), Curaçao, Barbados and Bermuda. A burrowing form which hides itself in sand, under rock fragments.

Holothuria pseudofossor spc. nov.

Plate 1, figs. 9–14

Examined 10 specimens

Largest typical specimen seen, about 10 cm. in length; outer shape much like that of *H. cubana;* skin stiff from numerous deposits, tentacles small, ventrally directed; anus terminal, appendages mostly well expanded, apparently larger and more cylindrical on the ventral side, smallest near the midline; dorsally they seem to be mostly papillae and some of those placed near the dorsal radii are slightly larger. Color whitish; larger dorsal appendages often with a narrow dark ring around their base. Most specimens are covered with sand which clings firmly to the integument, and this peculiarity together with the large and usually well-expanded feet will in most cases serve to separate this species from *H. cubana.*

Internal anatomy like that of *cubana:* a very low and delicate calcareous ring, short tentacle ampullae; vascular ring about 1 cm. behind the calcareous ring; one Polian vesicle and one short, coiled stone canal with rounded head, embedded in the dorsal mesentery. Intestine short, its course as usual; mesentery narrow, forming a complete membrane; respiratory trees slender, with small lateral branches; rete mirabile small; muscle bands thin, with broad free margin; genital organs very long and slender tubules divided near their base, attached just behind the vascular ring.

Deposits.— Tables and regular, knobbed or smooth buttons. Tables of divers sizes, averaging about 0.07 mm. in diameter; rim smooth or

knobbed; central holes large and usually 8 regular marginal holes; spire low, solid, ending in numerous teeth; the tables seem never to develop into such complicated forms as is the case in *H. cubana*.

Buttons varying in size from 0.02–0.1 mm., with smooth to undulated or knobbed surface and with strongly undulated margin, and frequently with the middle bar projecting beyond the end of button, often provided with a few knobs; smaller and larger buttons are found intermingled, with 3 to 7 pairs of holes respectively.

In the pedicels which are covered to their ends by deposits, a well-developed end plate is found, and numerous very large supporting rods, almost straight, with perforated ends and widened out and perforated near their middle; in the papillae the end plate is lacking or very reduced; the end plates are mostly curved. The appendages also contain numerous tables and buttons, as in the other species of this group. The tentacles contain some heavy curved rods with pointed ends, sometimes with a few small perforations, as well as numerous small curved rods, which are smooth or with a few small spines.

Seems to be very closely related to *H. cubana* and probably has a similar distribution and biology.

Type locality.— Montego Bay, Jamaica.

Type in Museum of Comparative Zoölogy, cat. no. 917.

At present known only from the type locality.

Holothuria princeps Selenka

Plate **2**, figs. 1–8

Holothuria princeps Selenka, 1867, p. 332, pl. 18, fig. 67–69.

Type and half a dozen other specimens examined

The largest well-expanded specimen measured about 20 cm. in length, but, as a rule, the specimens are contracted to short, firm barrels. An almost cylindrical form with very little difference between ventral and dorsal side, excepting that the midventral appendages are slightly smaller. Mouth subterminal with very small tentacles, 20 in number; anus terminal. The body is covered with conical appendages, which in some cases end in a distinctly cylindrical pedicel with a large end plate; in others they are distinctly conical to their end with only a small vestige of an end plate; these two forms seem to be mixed irregularly with each other, and in many cases it is impossible to determine the kind. The integument is thin, flexible in spite of the numerous deposits, except when contracted. Color yellow with darker patches dorsally;

often the pigment is rubbed off. The appendages are usually somewhat paler in color; their bases are, however, often provided with a darker ring.

Internal anatomy not peculiar, except that the calcareous ring is very high and stout; each radial piece sends a short prolongation backwards, which often has a low notch, like the "tail" of the ring in a Cucumaria, as Selenka describes it; this notch may be filled out by a calcareous mass. One Polian vesicle; one stone canal unattached and with an oblong soft head.

Course of intestine as usual. Respiratory trees very strongly developed with wide stems and numerous short tufts; no Cuvierian organs have been observed; cloaca large; genital organs long divided tubules, fastened several cm. behind the vascular ring, in the examined large specimens.

Deposits.— Tables and buttons. Tables of two types: in the body wall small ones with irregular disk, large central hole and variable number of marginal holes which may be entirely wanting, and dentate to undulated margin (diameter about 0.04–0.06 mm.); spire low and on its way to becoming reduced; often one of the four rods is lacking; the top ends in few blunt teeth or none. In the terminal part of the appendages very large tables are present; they may be observed even with the unaided eye and the spire is simply gigantic, solid and ends in a smooth cone (height 0.3 mm.).

The buttons are irregular, as a rule incomplete, of the six-holed type, variable in size and with low knobs on the middle bar and sometimes also on the margin; their size varies from 0.04–0.05 mm.

In the appendages numerous supporting rods; relatively short (0.2 mm. long), with large holes near the expanded middle and at the ends, sometimes curved. In the pedicels a large end plate, in the papillae a mere vestige.

Remarks.— This species cannot at present be confused with any other form from the West Indies; no other species is known which has such large tack-like tables. A few closely related forms, belonging to the same group, are known from the Indo-Pacific Ocean. One is known from Taboga, Panama, but the spicules of these forms have not as yet been compared and measured. It seems as if the species with this kind of deposits form a special group within the genus Holothuria, and apparently quite distinct from the group in which, for example, *H. cubana* is placed, which also is a form with numerous deposits. The similarities are most probably due to a similar mode of life.

Type locality.— Florida.

Type in Museum of Comparative Zoölogy, cat. no. 685.

This species is represented by several specimens from Florida and a single one from San Domingo, in United States National Museum.

Holothuria occidentalis Ludwig

Plate 2, figs. 9–17

Holothuria occidentalis Ludwig, 1875, p. 28, fig. 35.
?Holothuria sulcata Ludwig, 1875, p. 25.

Ludwig's description.— Twenty tentacles. The present specimen is 13 cm. in length and covered with appendages all over the body; the ventral side is rather smooth, whereas the dorsal side makes a more warty impression. The color of the animal is brown on the back and much paler on the ventral side. A slight longitudinal furrow is present in the midline of the trivium. The skin is about 4 mm. in thickness. The following deposits are present: (1) buttons; these are perforated by 4–10 holes and provided with rounded knobs; (2) tables; these are rather small and clumsy; the crown is provided with 4 times 3 teeth; the basis also carries blunt teeth; (3) long, knobbed supporting rods and rather symmetrically developed supporting plates in the wall of the feet.

The calcareous ring has the form which is indicated by fig. 35e. The stone canals are present in two tufts, one on each side of the dorsal mesentery; the left tuft consists of 9, the right of 12 stone canals with the ends (heads) laterally compressed. The brownish colored Polian vesicles are 1–1.5 cm. in length and 3 in number. A bundle of genital organs is found on left side of the dorsal mesentery; average length of the tubules is $1\frac{1}{2}$–2 cm., divided near their ends."

With some doubt I have identified a Holothurian as *H. occidentalis* Ludwig, which was collected by Dr. Th. Mortensen, off Fredrikssted, St. Thomas, Virgin Islands, 200 fathoms depth.

The specimen examined is about 15 cm. in length, with ventrally placed mouth, surrounded by very small tentacles and with terminal anus. The body is slightly tapering and somewhat flattened with relatively few, conical appendages which are smallest dorsally and ventrally, and largest laterally; in its outer shape it reminds one somewhat of *H. martensii* Semper but, as a whole, it is more robust. The ends of the appendages are in most cases contracted, and they seem to lack end plates; most likely the majority will prove to be papillae and the others cylindrical pedicels as in *H. princeps*. Color dorsally brown-

ish, paler ventrally, and the appendages still paler. Skin rigid, thin, filled with deposits.

Calcareous ring relatively strong, stout; each radial with a short posterior prolongation, with deeply concave margin, same type but less pronounced as in *H. princeps;* tentacle ampullae very small; 4 large Polian vesicles and, between these, tufts of much smaller ones (which probably have been regarded as accessory stone canals by Ludwig). One large stone canal fastened to the dorsal mesentery, with large irregular head, free to the right. Intestine long, mud filled; course as usual; cloaca large; right respiratory tree as usual attached in right lateral interradius; left entangled in the very poorly developed rete mirabile; its basal part is completely hidden in the large, unbranched, yellowish white Cuvierian organs. Genital organs long and slender, few times branched, attached about 1 cm. behind the vascular ring.

Deposits.— Tables and buttons. Tables robust with large central hole and 8–12 small marginal holes, margin of disk undulated, often with blunt spines on the outer side (the side of the spire); diameter of disk about 0.06–0.08 mm.; the spire is low, with 1 or 2 cross beams, and ends in 4 blunt teeth; the tables are of very uniform size; they seem to increase slightly in size toward the end of the papillae. Buttons irregular, often incomplete and with few knobs; in many cases the holes are almost obliterated; when complete they have, as a rule, 6 holes; their length varies from 0.05–0.08 mm. In appendages numerous rods with laterally placed holes near the middle or for their entire length, thus resembling very large buttons; they seem to be most numerous in the dorsal appendages where they often are somewhat curved; no end plate has been found.

Remarks.— The only differences between the description given here and that of Ludwig is that the spire of the tables in his description is provided with 12 teeth whereas I have found only 4, but the tables in the group to which *H. occidentalis* belongs seem to change much, and the spire is often reduced, as for example in *H. princeps.* Neither has it been proved that his bundles of stone canals are identical with the small accessory Polian vesicles of the present species.

Nothing is known about the habits of this species; it is apparently a form which lives at greater depth than most of the members of the genus Holothuria and that accounts for the few specimens which have been collected.

Type locality.— West Indies.

Type in Hamburg Museum.

Holothuria imperator sp. nov.

Plate 3, figs. 1–11

Of this species 6 large specimens are at hand, about 25–30 cm. in length. A stout, cylindrical form with blunt ends; mouth ventrally directed, anus terminal. Twenty tentacles of medium size. Body almost uniformly covered by small, not too crowded papillae, not on distinct warts; a wart-like appearance is, however, artificially produced when the skin is strongly contracted; anus surrounded by five clusters of papillae. Skin thick, with numerous deposits, but in spite of this fact it is not rough to the touch as in *H. princeps*. Color of integument yellow, darker dorsally; each papilla being surrounded by a dark spot; these spots are largest dorsally.

Internally we find a high, well-developed calcareous ring; the radials provided with short posterior prolongations; the space between the prolongations seems to be filled out by a calcareous mass of a slightly different color. The tentacle ampullae are short, 1.5 cm. long in the largest specimens. The vascular ring is placed about 1 cm. behind the calcareous ring; Polian vesicle, ventrally placed, single; stone canal dorsal, free with a soft elongate head resembling a sack. The long sand-filled intestine has the normal course; the third loop is attached closely along the right side of the broad midventral muscle band. Respiratory trees large, provided with wide stems and extremely fine lateral tufts of branches; the right branch is attached in the right lateral interambulacrum; the left is as usual entangled in the rete mirabile. The muscle bands are broad. The genital organs are unripe in the specimens examined, but are present as a bundle of thin, thread-like tubules on left side of mesentery, only 1–2 cm. long, attached a few cm. behind the vascular ring.

Deposits.— The deposits are chiefly buttons (0.04–0.05 mm. long), of the six-holed type in most cases with very small holes; near the appendages we often find much larger buttons (0.08–0.09 mm. long), with several holes, irregular and often with secondary network.

Tables are present, but in the large specimens examined they are found only in the appendages and near these; they consist of a four-holed disk (diameter 0.05–0.08 mm.), with usually a circle of marginal holes and a dentate margin; spire much reduced. In younger specimens one would probably find more complete tables.

In the appendages no end plate seems to be present; a number of supporting rods are present of the normal type (0.2 mm. long), straight,

with a few perforations near the ends and one or two along the middle. In the tentacles, we find small simple rods.

Remarks.— I have been unable to identify this species with any other previously described. Although easily distinguished, it is undoubtedly related to *H. princeps*, the shape of the calcareous ring being almost identical. Most likely the two species have similar habits.

Type locality.— Yucatan.

Type in United States National Museum.

Holothuria surinamensis Ludwig

Plate 3, figs. 12–15, 19

Holothuria surinamensis Ludwig, 1875, p. 35, fig. 27; Deichmann, 1926, p. 12, pl. 1, figs. 1, 1a-g, 2a-b (list of references).
Holothuria languens Semper (partim), 1868, p. 87, 248.
Holothuria subditiva Selenka, 1867, p. 338, pl. 19, fig. 87 (partim).

About 100 specimens examined

Specimens from 3–20 cm. length have been examined. Body cylindrical, with terminal mouth and anus; tentacles 20, medium sized; no pronounced difference between dorsal and ventral sides; appendages scattered, rather uniformly distributed, present as cylindrical pedicels on ventral side, and as smaller, more conical appendages which form transitional stages to papillae; the specimens show some differences with regard to the development of pedicels or papillae; the dorsal appendages are often on low warts. Color, all shades from faded brown to dark purplish, with darker patches on the dorsal side and with tip of appendages paler; the ventral side is often paler. Skin thin, flexible, often rough to touch.

As the species multiplies by fission, complete animals are often difficult to get; the anatomy of quite intact, non-regenerating specimens, collected in Jamaica by Dr. H. L. Clark, has been studied here.

Calcareous ring low with broad radials and small interradials; posterior edge of ring somewhat undulated. Tentacle ampullae long: 1 or 2 slender Polian vesicles; one free stone canal with oblong head on left side of mesentery.

Intestine short; first loop running from left dorsal muscle band to right muscle band, second loop along lower side of left dorsal band, bending backwards a little anterior to the middle of the body cavity; the third loop running along right side of midventral muscle band. Respiratory trees long and slender. In none of the perfectly intact

specimens was any trace of Cuvierian organs observed, but the well-developed rete mirabile may perhaps in some cases look as if it were a bundle of Cuvierian organs (Ludwig mentions that they are present). Muscle bands broad, thin, without free margin. Genital organs attached a little anterior to the middle of the body cavity.

Deposits.— Tables and large flat rods with dentate edge. Except in very young specimens, where the disk is large and the spire high with several cross beams, the typical form of the tables (height 0.05 mm.) is absolutely devoid of disk; the inner end of the table is almost conical; the outer end provided with 4 vertical teeth and 8 horizontal double teeth (one has to use a large magnification to be sure of the fact that the teeth are double; in the feet the teeth are mostly simple; Ludwig has, however, noted this character in fig. 27). The outer end of the table is larger than the inner, and sometimes the top has been mistaken for the disk, as Théel has pointed out in his "Blake" report.

Long flattened rods (about 0.5 mm. long), with dentate margin are found in variable number; they are most numerous in the appendages where they are more or less curved and obviously function as supporting rods. End plate developed in accordance with the form of the appendage; in tentacles larger and smaller curved rods, usually with some spines.

Seems to be closely related to *H. languens* from Panama, which has hitherto been collected only in small numbers, not well suited for comparison; the tables are, as a rule, smaller in *languens*, more slender, provided with simple teeth on top of spire; inner end of spire not conical, but flattened (plate **3**, fig. 16).

Type locality.— Surinam.

Type in Würtzburg Museum.

A very common form usually occurring in great numbers. Known from Surinam, Barbados and probably also Florida. Selenka's *H. subdivita* from that locality is partly *H. surinamensis*, but I know of no other records from that well-explored locality, and I doubt the correctness of this very much. Common in Bermuda and Jamaica.

Holothuria impatiens (Forskål)

Plate **3**, figs. 17–18

Fistularia impatiens Forskål, 1775, pl. 39, fig. B.

Holothuria botellus Selenka, 1867, p. 335.

Holothuria impatiens Lampert, 1885, p. 65 (list of references). Théel, 1886, p. 233. Fisher, 1907, p. 666, pl. 69, fig. 4a. Clark, 1901b, p. 259; 1901c, p. 494; 1919, p. 63. Sluiter, 1910, p. 333. Deichmann, 1926, p. 11.

Maximum length about 15–20 cm. Form cylindrical with the anterior end sometimes extended as a long slender "neck"; mouth almost terminal with 20 medium-sized tentacles; anus terminal. Appendages few, uniformly scattered and, as a rule, placed on distinct warts, except in abnormally expanded specimens; ventrally they are developed as cylindrical pedicels; dorsally we find all stages between true pedicels and papillae. Skin thin, flexible, very rough to the touch. Color variable, different shades of grey mottled with larger and smaller patches of brown; sometimes small white spots are visible due to the deposits which may be collected in heaps.

Internal anatomy.— A low calcareous ring with broad square radials and small interradials; posterior edge undulated. Medium-sized tentacle ampullae; 1 or 2 Polian vesicles; normally one free stone canal, but in very large specimens I have observed 2 accessory canals. Intestine short, the course as in *H. surinamensis*. Muscle bands broad, well divided without any free margin. Cuvierian organs very large, white and transversely furrowed. Respiratory trees long and slender. Genital organs as long, thread-like tubules which originate far back near the middle of the body cavity, somewhat posterior to the bending between the second and third loop.

Deposits.— Tables and smooth, regular, six-holed buttons. Tables with large squarish disk (diameter 0.08–0.1 mm.), with 8 marginal holes and one central hole, about equal in size; accessory small outer holes may be found. Strong, robust spire ending in numerous small teeth, usually two cross beams, excepting in very young specimens, where the spire is higher and more tapering, and in the appendages, where the tables may show some irregularity. An inner layer of numerous, large (0.08 mm. long), regular, very smooth buttons, often collected in heaps. They are provided with 6 large holes and seem not to change during age.

Well-developed end plate in the pedicels, small in the papilliform appendages. Supporting rods, straight in the former and curved in the latter, with few holes in the ends, and strongly widened at the middle with some large perforations.

In tentacles, large and small curved rods with pointed ends and smooth surfaces.

Type locality.— Suez.

Type not preserved. In spite of all efforts it has been impossible to find any difference between the Indo-Pacific form and the West Indian; this fact has already been pointed out by Selenka. *H. impatiens* occurs also in the Mediterranean Sea, but seems not to be recorded from the West African islands.

Most likely this species occurs all over the West Indies; it is not yet recorded from Bermuda. Most collections contain but few specimens. A great number of specimens have been collected by H. L. Clark in Jamaica and Tobago (Museum of Comparative Zoölogy); a single specimen, brought home by the Antigua-Barbados expedition and 3 specimens from Porto Rico are all that are to be found in the United States National Museum, Washington.

Holothuria arenicola Semper

Plate 4, figs. 1–9

Holothuria maculata Brandt, 1835, p. 46, 47 (Sporadipus, subgenus Acolpos). Ludwig, 1881, p. 595; 1883, p. 156, 157, 167, 168. Lampert, 1885, p. 73. Sluiter, 1910, p. 332. Not *Holothuria maculata* Chamisso and Eysenhardt, 1821.

Holothuria arenicola Semper, 1868, p. 61, pls. 20, 30, fig. 13; pl. 13, fig. 4. Théel, 1886, p. 222.

Holothuria subditiva Selenka, 1867, p. 338, pl. 19, fig. 87 (partim).

Holothuria rathbuni Lampert, 1885, p. 73. Théel, 1886, p. 268. Clark, 1901a, p. 343; 1901b, p. 259, pl. 37, figs. 7–10; 1919, p. 63. Verrill, 1901, p. 37, figs. 6a, b; 1907, p. 145, fig. 37. Sluiter, 1910, p. 332. Deichmann, 1926, p. 13.

Holothuria sp. Rathbun, 1878–82, p. 141.

About 50 specimens examined

Largest specimens measured about 15 cm. long; young specimens few cm. long are however recognizable. Cylindrical, slender form, tapering, with almost terminal mouth and 20 very small tentacles; anus terminal. Appendages, exclusively pedicels, cylindrical and of almost the same size both dorsally and ventrally; arranged in five broad bands, with narrow naked stripes between, corresponding to the radii; they are not crowded and often strongly contracted; in some cases they may appear to be placed on low warts, but these are never so large and are always much more numerous than in the two other cylindrical forms, *H. impatiens* and *H. surinamensis*, and the skin is also much less rough to the touch than in those species. Color very variable, to some extent the coloration seems to depend on the locality in which the animal lives; it varies from gray, sand colored, with large dark patches in two series along the dorsal side, to gray with numerous small stains irregularly scattered over the entire surface; in some cases the specimens are almost rust color, as if they had been in contact with iron, and in others they are almost black; the two latter kinds of coloration

may be due to external conditions, but the small spotted and large spotted forms seem to be distinct varieties and I have never noticed that they both occur in the same locality. We are at present unable to distinguish between the forms which are found in the Pacific and Atlantic Oceans; if they, in spite of all, should prove to be different the name *rathbuni* must be applied to the Atlantic form.

Internal anatomy.— A low calcareous ring, the radial pieces often projecting a little beyond the posterior edge and slightly incised; tentacle ampullae small; vascular ring a remarkably long distance (1 to 2 cm. in large specimens) from the calcareous ring. As a rule, only one stone canal with small round head is found hanging free near the dorsal mesentery, but in a very large specimen I have found two at this place; 1 to 2 Polian vesicles. Course of intestine not remarkable; dorsally it changes from the left to the right dorsal muscle band, then it runs along the lower side of the left dorsal muscle band, proceeds forward for a longer distance than in *H. impatiens* and *H. surinamensis*, and in the third loop it runs near the midventral muscle band without touching it. Respiratory trees as usual; rete mirabile small; Cuvierian organs have been observed in all well preserved, intact animals, but always as very small tubes in an easily overlooked tuft; probably they are on the way to becoming atrophied. Genital organs as divided thread-like tubules; they originate about 1 cm. behind the vascular ring level with the anterior turn of the third intestinal loop.

Deposits.— Tables and buttons. Tables with relatively small delicate disk (diameter 0.05–0.06 mm.), with large central holes and, generally, 4 marginal holes, or a complete series of about 8. Spire low, tapering, with one or two cross beams, and ending in a variable number (usually 8–12) small teeth. In young specimens the disk is, as a rule, complete and the spire is higher with more cross beams; in old specimens some of these tables are retained in the terminal portion of the oral and anal appendages, but the holes in the disk are reduced and the spire is shorter. The buttons (length 0.04–0.06), which are missing in the smallest specimens, are regular, smooth, with 6 holes of variable size; the holes are apparently reduced with advancing age, but small holed buttons may be present even in relatively small specimens, 4–5 cm. long. In the pedicels a large end plate, composed of several small pieces, and also numerous straight supporting rods (0.15–0.17 mm. long), with a few holes near the ends and along the middle; some of them developed as buttons with a regular row of holes on each side.

The deposits show some range of variation in a single specimen, but, on the whole, they are very constant in the species, and a series of prepa-

rations, taken from specimens from all over the world, has failed to show any difference in size or form.

The type locality was Bonin Island, where Brandt found the small spotted form, which also occurs in Panama and at several places in the West Indies, as does the large spotted form which Semper described from Bohol; he also reports the large spotted form from Surinam.

Remarks.— Synonymous with this species are *H. humilis* Selenka from Hawaii and *H. subditiva* Selenka from Panama and Florida.

Brandt's species has latterly been listed as a synonym of Semper's *H. arenicola*, as the name *maculata* has to be used for a species of *Synapta*, but both Brandt's and Semper's names have been used indiscriminately.

The name *H. rathbuni* was introduced by Lampert, 1885, who thus named a species from Bahia, secured by Rathbun. From the description given by Rathbun it is quite evident that it is *H. arenicola* which is known from this locality; the only difference being that Rathbun describes a knobbed calcareous deposit, which probably came from one of the species of *Thyone* examined from the same locality.

The name *rathbuni* has been applied to the small spotted form as well as to the large spotted form. Sluiter seems to have used the name *rathbuni* only for the small spotted form; regarding the large spotted form, which he calls *maculata*, he says that he is unable to separate the West Indian form from the one which occurs in the Pacific Ocean.

Seems to be common all over the West Indies from Bahia to Bermuda; under rocks, uncovered by low tide; sluggish, and usually buried more or less deeply in the sand.

Holothuria densipedes Clark

Holothuria densipedes Clark, 1901, p. 257, p. 17, fig. 1.

Only one very small specimen, about 8.5 cm. in length, has ever been found of this peculiar form, which probably is an abnormal *H. arenicola* Semper. It suggests that species strongly, except for the feet which are more conical, soft, as if they were swollen and apparently more numerous, but to estimate about the number of appendages in a very contracted Holothurian is a difficult thing.

In the internal organization we find that the vascular ring is placed about one cm. behind the calcareous ring, where the well-developed genital organs also take their origin; this character we find also in *H. arenicola*. The Cuvierian organs are long and fine; in all the specimens of *H. arenicola* which I have seen they are fine but short. This is the

only difference which I have been able to detect, and it is not a very important character. The spicules cannot be separated from those found in *H. arenicola*.

Type locality.— Lighthouse Reef, Porto Rico (H. L. Clark).

Type in United States National Museum.

Holothuria glaberrima Selenka

Plate 4, figs. 10–13

Holothuria glaberrima Selenka, 1867, p. 328, p. 18, figs. 57, 58. Semper, 1868, p. 92. Lampert, 1885, p. 65; 1896, p. 58, 59. Clark, 1901b, p. 259; 1919, p. 63. Sluiter, 1910, p. 333. Deichmann, 1926, p. 17.
Holothuria lubrica var. *glaberrima* Mitsukuri, 1912, p. 96.

About 50 specimens examined.

Maximum length seems to be about 10 cm. A very characteristic form, soft-skinned, with a crown of large dendritic, black tentacles, which usually are ventrally directed in preserved specimens. Body relatively short, cylindrical; ventral side forming a distinct sole with numerous cylindrical feet; dorsally only small conical papillae or papilliform pedicels, not so numerous as the ventral appendages. Color varying from almost black to faded brown; a single almost white specimen has been found among several typical ones; never any patches or patterns on the dorsal side.

Internal anatomy.— A well-developed calcareous ring with high, squarish radials and much lower interradials. Long tentacle ampullae; Polian vesicle single, long and slender; stone canal free with elongate head on the right side of mesentery. Intestine runs parallel with the right side of right dorsal muscle band, closely along the lower side of the left dorsal muscle band and then parallel with the right side of the midventral muscle band. No Cuvierian organs; the type specimen has been examined, and what was supposed by Selenka to be Cuvierian organs are only some of the genital tubules which have become pressed through a rupture in the place where the Cuvierian organs normally occur. Genital organs originate behind the vascular ring and are several times divided, long tubules. Fleshy, distinctly divided muscle bands.

Deposits.— Rods alone have been found, even in the smallest (4–5 cm.) specimens, but it is likely that still smaller specimens will have tables also, as Mitsukuri has found in the case of *H. möbii* Semper. The deposits are straight or curved rods with branched ends; the

branches unite often and thus form series of holes along the edge (length 0.06–0.07 mm.); a few very small knobs may be found on the surface of the spicules near the end, but they are visible only with very high magnification. The spicules are never spinous as is the case with the spicules in *H. lubrica* Selenka, from the Pacific Ocean.

In pedicels a well-developed end plate, large in the ventral and small in the dorsal appendages. No supporting rods except the rods of the body wall which are found also in the tentacles.

Type locality.— Bahamas.

Type in Museum of Comparative Zoölogy.

Common in most parts of the West Indies. According to Selenka, it occurs also in Panama; these specimens are said to be in Göttingen, but I doubt the correctness of the determination; at least Dr. Mortensen and I have both failed to find the species there.

The habits of this species have been studied by Dr. W. K. Fisher, 1926, p. 17: "It clings to the outer side of the surf-washed rocks, usually where a tough kelp is growing."

Holothuria parvula (Selenka)

Plate **4**, figs. 14–22

Mulleria parvula Selenka, 1867, p. 314, pl. 38, fig. 17, 18. Semper, 1868, p. 77. Lampert, 1885, p. 76. Théel, 1886, p. 199. Sluiter, 1910, p. 333.

Holothuria captiva Ludwig, 1874, p. 32. Lampert, 1885, p. 68. Théel, 1886, p. 220. Verrill, 1907, p. 321. Crozier, 1917, p. 560. Clark, 1919, p. 63, 64.

Actinopyga parvula Clark, 1919, p. 63. Deichmann, 1921, p. 199–215, text-figs. 1–3, 5–7; 1926, p. 20.

About 100 specimens examined

A small form not known to exceed a length of about 6–7 cm., flattened, with cylindrical pedicels on the ventral side, forming a kind of sole; dorsally papillae or papilliform pedicels, situated on low warts. Mouth ventrally directed with 20 large yellow tentacles and a broad collar of papillae. Integument is thick, gelatinous in young specimens, of medium thickness and more tough in older. Color yellowish brown, paler below, without any pattern; the integument in all observed cases contains a very characteristic green pigment, which is known also in *H. surinamensis* and *Actinopyga agassizi* (see Crozier, 1917).

The species is able to multiply by means of fission, and incomplete specimens may be found, lacking either oral or anal end; this holds even of some of the type specimens, which are in the possession of the Museum of Göttingen.

Internal anatomy.— A low calcareous ring of the usual type; tentacle ampullae well developed; one or two Polian vesicles and a small stone canal, the latter embedded in the dorsal mesentery. Intestine relatively short, even in intact normal specimens, a feature which speaks in favor of transferring the species to the genus *Holothuria*, inasmuch as all true species of *Actinopyga* have a very complicated course for their enormously long intestine.

The intestine runs, in the dorsal interambulacrum, almost in the middle, then forward, along the lower side of left dorsal muscle band, and finally in right ventral interambulacrum at some distance from the midventral muscle band, except near the cloaca. Respiratory trees, as usual in the genus, slender, with short branches projecting in all directions; the right attached with very few strings to body wall; the left entangled in the relatively small rete mirabile. Large bundle of Cuvierian organs which are very effective when the animal is captured. Genital organs as dichotomously divided, long tubules, originating close behind the vascular ring.

Deposits.— Tables and smooth buttons. Tables resembling those of *H. impatiens*, but usually somewhat smaller (diameter 0.06–0.07) with 8 marginal, often many accessory holes, and a well-developed spire with 2 cross beams and numerous small teeth crowded on the top. In the pedicels the spire may be somewhat higher and more tapering. Buttons elliptical, smooth (length 0.09–0.11 mm.), often distinctly curved and with 6 or more holes, of variable size and never placed exactly in pairs but always alternating.

In pedicels a large end plate and numerous bilateral perforated plates in company with very large buttons, with the number of holes greater than 6. In papillae, slightly curved rods with perforated ends and middle; in tentacles strongly arched rods with pointed or branched ends and spines on the outer side of the curvature.

Remarks.— The presence of small calcified anal teeth in some specimens has caused the present species to be referred sometimes to *Actinopyga*, but it seems best to place it in *Holothuria* because of its anatomical structure and spicules. It is very closely related to *H. difficilis* Semper, from the Indo-Pacific, and Selenka identified specimens of *H. difficilis* as *H. parvula*. The differences are very slight. *H. difficilis* is apparently constantly twice as large as the West Indian form when full grown, and much more brown, with brown tentacles instead of yellow; the green pigment seems to be lacking too. The spicules are very similar; it seems as if the tables are generally larger than is the case with those

of *H. parvula*, but the deposits show some range of variation. It seems better to keep the two forms separate for the present.

Type locality.— Off Florida.

Type in Museum of Comparative Zoölogy.

Distribution.— Common over most of the West Indian region and also known from Bermuda. Occurs usually in some numbers. It prefers the underside of stones and rocks and is known only from very shallow water.

Holothuria floridana Pourtalès

Plate 5, figs. 5–9

Holothuria floridana Pourtalès, 1851, p. 8. Selenka, 1867, p. 324, pl. 18, figs. 47–49 (partim). Edwards, 1905, p. 383 (partim); 1908, p. 254–301, pl. 1–5 (partim). Clark, 1919, p. 63 (partim).

Holothuria nitida, silamensis, heilprini Ives, 1890, p. 319, 320, 322, pl. 8, 1–15.

About 100 specimens examined

Maximum length of specimens examined, about 15 cm. A relatively slender form, reminding one somewhat of *H. grisea*, especially when young. Mouth slightly ventrally bent; anus terminal. Ventral side with numerous cylindrical pedicels which are rarely retracted; somewhat more numerous than dorsal appendages; in very young specimens they may be arranged in series; dorsally papillae on low conical warts arranged without any definite order, and, besides, cylindrical feet, somewhat smaller than ventral; the warts only conspicuous in young specimens.

Tentacles 20, yellowish, not particular large. Skin of medium thickness, except in some young and contracted specimens, where it is thick and more gelatinous. Color very variable, from almost white, with darker tips of pedicels, to very dark brown; specimens from certain localities very irregularly spotted. It is a characteristic feature that the deposits of the inner layer of integument are arranged in heaps around the bases of the appendages and these heaps are visible to the unaided eye.

Internal anatomy.— Calcareous ring thin with undulated posterior edge; vascular ring placed about 1 cm. from the calcareous ring in a specimen 10 cm. long; number of Polian vesicles variable, 1 to 3; stone canals placed in tufts on each side of dorsal mesentery and increasing in number with advancing age. Course of intestine, first loop from about middle of body cavity along right dorsal muscle band; second loop closely along lower side of left dorsal muscle band; third loop which

is much coiled, runs along right side of midventral muscle band; cloaca large; no Cuvierian organs; muscle bands thin, with free margins; respiratory trees as usual in the genus; right one long and slender, attached in right lateral interambulacrum; left one short and bushy, entangled in rete mirabile. Genital organs well developed in most larger specimens, consisting of a tuft of long slender tubules, divided once or twice near base and originating a few cm. behind vascular ring.

Deposits.— An outer layer of tables, somewhat variable in height and form of spire (0.05–0.06 mm. in height), which may be composed of either almost parallel or converging pillars; disk always small, with large central hole and 4 small holes in margin; very rarely holes are incomplete; spire ends in 12 long teeth, 4 of which are vertical and 8 horizontal.

Inner layer of deposits small rosettes (0.02–0.03 mm. in diameter), arranged in heaps; a few developed as perforated buttons, or as plates with larger holes, but never biscuit-formed with minute holes; rosettes are retained as such during the animal's entire life. Pedicels contain a well-developed end plate and a few slender supporting rods with branched ends; in papillae a small vestige of an end plate may be present and numerous supporting rods; in tentacles no deposits seem to be present.

Type locality.— Florida Reef.

Type probably never preserved.

Ranges from Florida, where it is extremely common, to the north coast of Cuba, Swan Island and as far south as to Colon, Panama, but it has apparently never been taken in the waters of the Lesser Antilles or South America.

A shallow water form which always seems to be collected at low water mark, often in great numbers.

Remarks.— The species was established in 1851 by Pourtalès; later Selenka in 1867 united it with a form known from the tropical Pacific. Semper in 1868 regarded the Pacific form as typical *H. atra* Jaeger, including *H. floridana*, and he regarded Selenka's *atra* as a variety of Jaeger's species, namely *H. atra* var. *amboinensis*.

Typical *atra* from the Pacific Ocean, or what nowadays is regarded as *atra*, differs from *H. floridana* in the constantly darker color, the more smooth and slippery skin, which contains fewer deposits, and in that the arrangement of rosettes in heaps is not visible to the unaided eye. The rosettes (Plate 5, figs. 10–14) are more simple; the tables are slightly higher than they are in *H. floridana*, facts which Fisher pointed out in 1907.

Edwards (1908) united *H. floridana* with *H. mexicana*, but the two species are entirely different. *H. floridana* has thinner skin, more variable coloration and quite different spicules, which are rosette-shaped even in the oldest specimens and distinctly collected in heaps; furthermore, it has a very different geographical and bathymetrical range from that of *H. mexicana*.

It is evident from the figures and descriptions given by Selenka, that he also united *floridana* with specimens of *mexicana*, 38 cm. long.

Holothuria mexicana Ludwig

Plate 5, figs. 15–20

Holothuria mexicana Ludwig, 1875, p. 25. Théel, 1886, p. 215. Clark, 1901b, p. 258; 1919, p. 63. Sluiter, 1910, p. 333. Deichmann, 1926, p. 16.
Holothuria africana Théel, 1886, p. 174, pl. 8, fig. 7.
Holothuria floridana Edwards (partim), 1905, p. 383; 1908, p. 236–301. Clark, 1910, p. 63.

About 50 specimens examined

Largest specimen about 50 cm. in length; specimens 15–30 cm. long are usually captured, smaller ones being rare.

A subcylindrical form with blunt ends; mouth ventrally directed, anus terminal; skin very thick and smooth; ventrally numerous, soft, cylindrical feet, often completely retracted and hidden in the thick integument. Dorsally, smaller and more scattered cylindrical feet and a few papillae, which in preserved specimens seem to be placed on warts, except when very young. Tentacles 20, broad, peltate, not increasing much in size during growth, so that they appear to be relatively small in large specimens. The typical coloration of preserved specimens is very dark, almost black on dorsal side and a dirty yellowish on ventral side and flanks; the ventral feet are often bluish or brownish, as is the area around their bases; now and then a spotted form is found, usually with the ventral side provided with large dark patches, whereas the dorsal side is pale.

The outer appearance of the adult is entirely different from that of *H. floridana*, which is more warty, more slender and has conspicuous small spots, due to the arrangement of deposits around the base of the appendages. The few young specimens of *H. mexicana* examined are sand-colored, with small dark spots on dorsal side, and with distinct warts, but the skin is more tough and no accumulation of spicules in heaps is visible.

Internal anatomy.— Very much like that of *H. floridana*. The cal-

careous ring is, even in young specimens, thicker and more clumsy, without any distinct posterior notch in the radials; tentacle ampullae remarkably small in large specimens; a variable number of Polian vesicles, usually 2 or 3, and a very great number of small stone canals hanging in a tuft on each side of dorsal mesentery, increasing in number with advancing age. The course of intestine is exactly as it is in *floridana;* cloaca very large; muscle bands broad but not especially strong, with broad, free margin. Genital organs several times divided tubules, originating in the first third of body cavity.

Deposits.— An outer layer of scattered tables with small disk, with 4 small marginal holes, rarely 8; spire strong with 4 vertical and 8 horizontal spines; these tables cannot be distinguished from those found in *H. floridana.*

An inner layer of innumerable small buttons or plates of two kinds: a small elongate four-holed button with 2 lateral and 2 smaller terminal holes (sometimes a few accessory outer holes may be present) and also biscuit-shaped plates, slightly larger (0.04 mm. in diameter), with very small holes arranged in several rows; this latter kind of deposit is derived from the simple four-holed deposits; the holes during growth becoming divided into smaller holes by outgrowth from the margin, and the holes are then reduced in size by being filled in with calcareous matter. All intermediate stages are present; the biscuit-shaped deposits are very numerous, even in specimens only 5–6 cm. long.

In the pedicels we find a well-developed end plate and practically no supporting rods; in the dorsal papillae a mere vestige of an end plate and some curved supporting rods with bifurcate ends; in tentacles a few curved stout rods with perforated ends and a few spines along the sides.

Type locality.— Gulf of Mexico, probably near Cuba, as the species seems to range from northwest of Cuba to Porto Rico, Jamaica, Lesser Antilles and down to Curaçao, but does not enter the western region of the Caribbean Sea.

Type in Museum of Hamburg (a small, immature specimen).

This form has been taken with the dredge in 3–10 fathoms depth; it is probably never exposed during low tide, as is the case with *H. floridana.* From Marianos Beach, near Havana, I have a single large specimen from a 3-foot depth, and Dr. W. K. Fisher notes that the species is quite common in eel grass at low water in Barbados. It is not known why so few young specimens have been secured; probably they are able to hide themselves better than the adults, which never make any such attempt.

Remarks.— Reminds one somewhat of *H. edulis* Lesson from the Indo-Pacific Ocean, both in outer shape and coloration, but *H. edulis* has a thinner skin which contains but few deposits, and among these the tables are more slender, lacking disk and vertical spines on top; the plates are also smaller and seem never to form biscuit-shaped plates.

Holothuria grisea Selenka

Plate 5, figs. 1–4

Holothuria grisea Selenka, 1867, p. 328, p. 18, figs. 52–56. Semper, 1868, p. 92, 251. Greeff, 1882, p. 118. Ludwig, 1882, p. 26. Lampert, 1885, p. 85. Théel, 1886, p. 214. Clark, 1901b, p. 258; 1919, p. 63. Deichmann, 1926, p. 15.

Not *Holothuria grisea* Sluiter, 1910, p. 333.

?Holothuria unicolor Selenka, 1867, p. 329, pl. 18, figs. 63–64.

About 30 specimens examined.

A very characteristic form which may easily be recognized by its external characters, even if it is only 2 cm. long. Maximum size seems to be about 25 cm. Resembles somewhat *H. floridana*, but has a greater number of cylindrical feet on ventral side where the appendages form a regular sole; dorsal papillae arranged in series, 4 series in young specimens, 6 in very large ones and, generally, these papillae are placed on very distinct warts; small pedicels are placed in a circle around base of wart. Mouth directed slightly downward, with 20–25 yellow tentacles. Integument of medium thickness and of same texture as that of *H. floridana;* color in alcohol more or less dark grey, with minute white spots which are due to the accumulation of spicules in body wall. Tentacles and ventral feet honey yellow, sometimes the tip of pedicels may be darker brown. A few, very large specimens are very dark, like the young (which are rarely collected), and an occasional large individual may be pale, but, as a rule, this wide-ranging species is very constant in coloration, when alcoholic specimens are considered. (In life this species may be a complete harlequin with bright red and yellow colors (W. K. Fisher)).

The internal anatomy is very near that of *H. floridana* and *H. mexicana*, except that there is only one Polian vesicle and one stone canal, the latter is free with oblong head, dorsally placed, and contains very little calcareous matter.

Deposits.— Scattered tables, on an average shorter than those found in the above-mentioned species (height about 0.04–0.05 mm.), as a rule with about 12 spines on the margin of the small disk; the spire ends

in 12 teeth like those found in the two preceding species, but they are generally shorter; the tables seem not to change during growth, they are of exactly the same type in the smallest and largest specimens.

The inner spicules, which are collected in very distinct heaps, are regularly shaped plates with two or four central holes and sometimes smaller holes arranged at the ends and with a series of blunt teeth around the margin; a few plates are larger, more like rods, and some may be incomplete and thus resemble rosettes, but the deposits are absolutely larger than those of the two preceding species (diameter of plates about 0.05 mm.).

In the pedicels few, almost straight, supporting rods with a few holes in the spinous ends and a well-developed end plate; in papillae slightly curved, almost unbranched but spinous rods; in tentacles short, cylindrical rods, with unbranched or slightly branched ends and with spines along their sides.

Type locality.— Haiti.

Type in Museum of Comparative Zoölogy, cat. no. 620.

Ranges from Lesser Antilles (common) down to Curaçao, Colombia, and even as far west as Colon, Panama. Also known from southern Brazil. A single specimen has been reported from Florida; also known from Jamaica and Porto Rico. Also reported from Sao Thomé and Rolas, west coast of Africa, by Greeff, 1882.

It is very likely that this species is identical with *H. unicolor* Selenka, from Barbados; a few plates may resemble the figure which Selenka gives, and this holds also for the curved spinous rods, apparently from dorsal papillae, which Selenka describes as occurring in the dorsal integument.

The specimens which Sluiter has listed as *grisea* from the West Indies are, at least partly, *floridana*.

Actinopyga Bronn 1860

(*Actinopyga* Bronn, partim, and *Mülleria* Jaeger partim)

Diagnosis, after Pearson, 1914, p. 169.— Generally 20 tentacles, but occasionally more. Ambulacral appendages papillae on the bivium and pedicels on the trivium, the former being scattered and the latter being usually arranged in three more or less distinct rows. Anal teeth present. Calcareous ring has well-marked beveled ampullary notches, and the anterior border has no deep indentation between the radials and interradials. The radials extend almost as far forward as the interradials. Spicules small, generally taking the form of dichotomously

branched rods or spinous rods, or both. Tables and buttons never present.

(About rejection of the name *Mülleria*, see Fisher, 1907, p. 644, in the footnote.)

Only one species is known from the West Indian region, namely

Actinopyga agassizi (Selenka)

Plate 5, figs. 21–29

Mülleria agassizi Selenka, 1867, p. 311. Théel, 1886, p. 202. Lampert, 1885, p. 98.

Actinopyga agassizi Verrill, 1867–71, p. 347, Sluiter, 1910, p. 333. Crozier, 1917, p. 405.

About 15 specimens examined

Maximum size seems to be about 20 cm. A very robust form with thick leathery skin and numerous cylindrical appendages, arranged in 3 bands on ventral side, and small papillae or papilliform pedicels on dorsal side. Mouth ventrally directed with 25–29 broad tentacles; anus terminal with a round opening wherein are 5 large, white calcareous teeth, radial in position; the area around anus is devoid of other appendages. Skin very thick and firm. Color variable, from almost uniform brown to mottled yellow and different shades of brown in very diverse patterns. The pedicels seem invariably and the tentacles mostly to be yellow.

Internal anatomy.— A broad calcareous ring, of loosely united calcarious matter; radials and interradials of almost equal height and with more notches anteriorly than usual on account of the larger number of tentacles and tentacle ampullae; 1 or 2 Polian vesicles and one stone canal with rounded head, embedded in dorsal mesentery. Intestine unusually long; the course is not easy to make out, but apparently it follows along dorsal midline and then closely along right dorsal muscle band till it almost reaches the cloaca; then it turns forward and backwards in a secondary loop, and then in an oblique direction across the two left muscle bands, almost to anterior end of the animal, and then across the midventral muscle band and, after having formed a short arch toward the right ventral muscle band, it proceeds along the middle of right ventral interambulacrum. The intestine is very much convoluted in the posterior part of the first loop and in the third loop.[1] Respir-

[1] The course of the intestine is very much like that which Ekman, 1925, figures for *A. mauritiana*; apparently these secondary attachments form generic characters. The exact course is, however, difficult to make out, as the intestine in most captured specimens is often incomplete, and the internal layer of the body cavity easily tears off in flakes together with the mesentery.

atory trees very bushy, with wide stems and long much-branched secondary branches, the left one entangled in the large-meshed rete mirabile. A tuft of delicate, slender Cuvierian organs seems to be present at base of left tree. Genital organs present as tubules, 1 or 2 times divided, and attached in a tuft behind calcareous ring.

Deposits.— Only short rods and rosettes, usually rather simple and not very numerous. Dorsally the rods are relatively much branched, ventrally they are mostly present as simple rods, although rosettes may be present too. In pedicels a well-developed end plate and some elongate perforated rods near the end plate; also some few dentate rods and cross-shaped bodies and a few somewhat more complicated rosettes; in tentacles large, rough, simple rods and smaller, curved spinous rods.

Remarks.— It has been suggested by Théel that this form is identical with *A. mauritiana* (Quoy and Gaimard), from the Indo-Pacific Ocean. The forms are undoubtedly closely related, but it was evident even to Selenka that the spicules were distinctly different; in the West Indian form he found that they are much more simple than in any other known species, an observation which I have been able to confirm.

Type locality.— Florida.

Type in Museum of Comparative Zoölogy, cat. no. 795.

This species seems, as far as the collections give evidence, to occur only among the islands of the West Indies, from Barbados to Florida; a single specimen has been taken by Crozier in Bermuda, but it seems not to belong naturally to the fauna of that island, as it has never been recorded since.

STICHOPODIDAE Haeckel

Diagnosis.— Aspidochirote Holothurians, with tentacle ampullae, and genital organs in two tufts. Seem to have an intermediate position between the Holothuriidae and Synallactidae.

Clark, 1922, p. 47, 48 suggests the division of the family into 4 genera, namely *Thelenota*, *Astichopus*, *Stichopus* and *Parastichopus*. Only two genera are known from the western Atlantic.

Key to the genera from the Western Atlantic

1. Tables present, also C-shaped bodies; Polian vesicle simple.
Stichopus Brandt

1. No tables; granules in groups, accompanied by small S or C-shaped bodies.
Astichopus Clark

Stichopus Brandt 1835

Diagnosis, essentially from Clark, 1922, p. 44. Aspidochirote Holothurians with flattened ventral surface markedly distinct from dorsal, pedicels more or less fully covering ventral side; dorsal side with tubercles or papillae, at least along lateral margins; tentacles typically 20; gonads in a tuft on each side of dorsal mesentery; no Cuvierian organs; no anal teeth or noticeable papillae around cloacal opening. Numerous calcareous tables in epidermis; Polian vesicles few, unbranched; madreporic canal single.

Type species.— *Stichopus chloronotus* (Brandt).

Two species are definitely known from the West Indies; they are easily distinguished when the C-shaped bodies are examined.

Key to the two species

1. C-shaped bodies small, about as long as the tables are high (0.06 mm.), tables mostly with complete series of holes around four small central holes; skin thick; color very variable; size up to about 20 cm.
   S. badionotus Selenka
1. C-shaped bodies large, about twice as large as the tables are high (about 0.1–0.15 mm.); tables with four marginal holes around four large central holes; skin thin; color pale brownish; size up to 12 cm.
   S. macroparentheses Clark

Stichopus badionotus Selenka

Plate 5, figs. 30–36

Stichopus badionotus Selenka, 1867, p. 316, p. 18, fig. 26. Théel, 1886, p. 196. Clark, 1922, p. 55, pl. 2, fig. 11–18.
S. haytiensis Semper, 1868, p. 75, pl. 30, fig. 5.
S. möbii Semper, 1868, p. 246, pl. 7, fig. 11.
S. errans Ludwig, 1875, p. 97.
S. maculatus Greef, 1882, p. 158. Sluiter, 1910, p. 333.
S. diaboli Heilprin, 1888, p. 312.
S. xanthomela Heilprin, 1888, p. 313. (*S. acanthomela*, Zool. Rec., 1900, p. 78 (err. typ.)).

About 30 specimens examined

Maximum size about 20 cm., in life up to about 30 cm. A broad flattened form, with 3 rows of crowded cylindrical appendages on ventral side; the middle row being twice as broad as the lateral rows. Dorsally low warts. Mouth ventrally directed, with about 20 broad tentacles, and a large tentacle collar. Skin thick, especially laterally.

Color very variable, from buff to almost black, and all gradations of spotted specimens are found, often together. The ventral side is usually paler. Internally a broad calcareous ring, one Polian vesicle and one stone canal, attached to the dorsal mesentery. The tentacle ampullae are large. Intestine has the normal course; cloaca large; respiratory trees very bushy; the left being entangled in the richly developed rete mirabile. Genital organs typically developed, consisting of one long stem on each side of dorsal mesentery and with lateral, several times divided branches; the reproductive organs originate just behind the vascular ring.

Deposits.— A closely packed layer of small tables, with small disk, usually with a complete series of small marginal holes around 4 still smaller central holes; occasionally we may find some with 4 large central holes and 4 small marginal holes, but this type, predominant in very small specimens, is soon replaced by tables with complete series of outer holes. The spire is cylindrical, with two cross beams and a variable number of small teeth on the truncate top. In ventral appendages the spire is usually very low, although well developed.

A variable number of C-shaped bodies is usually found in the deeper layer of the skin, often near the dorsal appendages, but they are not always observed. Selenka missed them in his type specimen from Florida, although they are present in the specimen in question. The C-shaped bodies are a little longer than the tables are high or the disk is broad (about 0.06 mm.).

In pedicels we find a large end plate and numerous almost straight rods which in smaller specimens are simple, but in older become broadened out at the middle, with numerous perforations, so that they are ultimately transformed into broad, perforated plates.

In the tentacles we find large, curved rods with pointed ends and spines on their outer side.

Remarks.— This species is very closely related to *S. fuscus* from the Pacific Ocean, and Selenka mentions specimens from Acapulco, Mexico as belonging to *S. badionotus*. It differs only in very minute proportions of the spicules, which are slightly larger and heavier, with smaller disks in the tables and more plate-like supporting rods in the species from the Pacific Ocean. The color of *S. fuscus*, which is quite common in Panama, is more uniform, either reticulated brown or uniform brown. It is a remarkable fact that we have a form so closely related to the Caribbean form, which is known only from the west coast of tropical America; it is not likely that so large and conspicuous a species would have been overlooked in other parts of the Indo-Pacific Ocean.

The type locality for *S. fuscus* Ludwig (1875) is Patagonia, but I feel rather sure that this is an error. The very clear description which Ludwig gives applies in every respect to the specimens of *S. badionotus* from Acapulco, and to the numerous specimens which Dr. Mortensen has collected at Taboga, Panama. The occurrence of a typical species of *Stichopus* in Patagonia is highly improbable.

As is stated under *S. macroparentheses*, the latter form is also closely related to *badionotus*, only differing in its much larger C-shaped bodies and the more primitive form of the disk of the tables, as well as the more slender form of the spire.

Type locality.— Florida.

Type in Museum of Comparative Zoölogy; cat. no. 509.

Distributed over most of the West Indian Seas, from Bermuda to Panama, but according to H. L. Clark, not known from any locality south of Antigua, where it is quite common; very common in Bermuda.

It is usually regarded as a fact that it also occurs in the West African region; described by Greef as *S. maculatus*.

Occurs on soft, shady bottom, often in eel grass. The transparent young hide themselves among rocks; the larger specimens, from about 15 cm. long up, seem never to hide themselves and, according to Crozier, no animals will eat them. Their variable coloration seems to be merely an incidental feature, and is probably not protective.

A variety, *S. b. phoenius* Clark, is described (1922, p. 60) from Tobago; it seems to differ only in its beautiful red color, but it may be that it can be kept as a distinct variety, as this coloration is totally different from that of all other specimens.

Stichopus macroparentheses Clark

Plate 5, figs. 37–43

Stichopus macroparentheses Clark, 1922, p. 61, p. 1, fig. 1–7. Deichmann, 1926, p. 21.

Five specimens examined

This peculiar species is probably derived from the common form *S. badionotus*, and has been found in several localities in the West Indies. Hitherto only small specimens, about 12 cm. long at most, have been captured, but it might be that some of the large specimens of *badionotus*, upon more careful examination, would prove to be *macroparentheses*.

The species seems to agree in most outer features with *badionotus*,

but is, as far as the available collections show, uniformly pale brown and more thin walled. The inner organization seems to be quite identical.

Deposits.— Tables and large C-shaped bodies. The tables are characterized by having 4 large central holes and usually 4 outer smaller holes alternating with the inner, sometimes some still smaller, therefore accessory ones, but, as far as we know, never forming a complete outer circle of holes. The spire is cylindrical, but more slender than in *S. badionotus* and we find that the tables in the ventral feet also have a lower spire. The spire ends in a number of small spines and is flattened on the top.

The C-shaped bodies are about twice as large as they are in *badionotus*, varying from 0.1–0.15 mm. in length, thus being about twice as long as the tables are high, or the diameter of the disk is wide.

In the feet we find a well-developed end plate and numerous rods, mostly straight with pointed or branched ends and sometimes vertically projecting arms near the middle which may unite and give rise to holes. In the tentacles, curved spinous rods.

In very young specimens, 2–3 cm. long, the tables are more delicate, but the large C-shaped bodies are present. Even if these deposits are not found in the preparation, we can distinguish between young of *badionotus* and *macroparentheses*, as the spicules in the former are slightly larger, and some of the typical tables, with a complete circle of holes, are usually found.

Type locality.— Montego Bay, Jamaica (H. L. Clark).

Type in Museum of Comparative Zoölogy, cat. no. 921.

The species is also known from Antigua (W. K. Fisher) and Florida (H. L. Clark).

It seems to have a mode of life quite similar to that of *badionotus*. The types, 9 cm. long, were found among rocks; the specimens from Antigua, which were larger, were found in eel grass.

(Stichopus ecnomius Clark

Stichopus ecnomius Clark, 1922, p. 66, pl. 2, figs. 24–29.

The very remarkable small species, *Stichopus ecnomius* Clark, has, upon further study, proved to be devoid of normal tables, which probably had their origin from other preparations. The specimen contains only the very large deformed tables which H. L. Clark has figured, which bear some resemblance to the four-armed tables in the Synallactidae. There are, moreover, some X-shaped bodies, and, in the

pedicels, end plates. It is impossible to determine the generic position of this specimen, but it is interesting, because it is probably the smallest specimen of any aspidochirote Holothurian which has ever been described, and it may be that these "abnormal" tables are quite normal for young specimens belonging to this group.)

Astichopus Clark, 1922

Diagnosis.— As in Stichopus, except for the complicated, branched Polian vesicles, and entirely different spicules; only minute granules collected in heaps and accompanied by small C, S or O-shaped bodies. No supporting rods; dorsally only small appendages; no thickened marginal brim.

Type species.— *Astichopus multifidus* (Sluiter).

Astichopus multifidus (Sluiter)

Plate 5, figs. 44–47

Stichopus multifidus Sluiter, 1910, p. 334, fig. a-b.
Astichopus multifidus, Clark, 1922, p. 48.

One well-preserved specimen about 20 cm. in length examined, but fragments of another specimen are present in the Museum of Comparative Zoölogy, which indicate that this species may attain a length of at least 45 cm.

Outer aspect holothurian-like, with numerous, cylindrical, soft ventral feet and numerous smaller dorsal appendages, either papillae or papilliform pedicels. Twenty-one tentacles with rounded, knob-like disk are present, ventrally directed, surrounded by a very narrow tentacle collar; anus subdorsal. Color mottled brownish, with pale ventral side and tentacles.

Internally a loosely united calcareous ring, the exact shape of which could not be made out; tentacle ampullae very long and slender; 2 long, branched Polian vesicles, and others unbranched. A very small stone canal, embedded in dorsal mesentery. Intestine runs parallel to the right dorsal muscle band, almost reaching the large cloaca, then forward almost to the oral end along the lower side of the left dorsal muscle band, and then closely along the right side of the midventral muscle band. Respiratory trees relatively short, with wide stems and numerous short, finely divided branches; the left tree is as usual entangled in the very wide-meshed rete mirabile. Thin muscle bands with

free margin. No genital organs are developed in the specimen examined but according to Sluiter they are present as tufts, one on each side of the dorsal mesentery, of divided tubules.

Spicules.— Only small spherical grains, collected in heaps and small C, S or O-shaped bodies (length about 0.03–0.04 mm.). In pedicels an end plate, composed of several smaller plates, and numerous C-shaped bodies. In tentacles a few, straight, spinous rods, beside the C-shaped bodies.

Type locality.— Tortugas (Hartmeyer).

Type in Hamburg.

Known only from the type locality and from Port Antonio, Jamaica (H. L. Clark), but apparently very inconstant in its appearance, as Dr. Clark has sought it in vain on subsequent trips to the same locality.

SYNALLACTIDAE Ludwig 1894 [1]

Diagnosis.— Aspidochirote Holothurians without free tentacle ampullae; head of stone canal in most cases connected with the body wall.

Key to the genera which at present are known from the Atlantic Ocean

1. Deposits practically absent; genital organs in two tufts 2
1. Deposits present, usually quite numerous, developed as tables or derivates of these; genital organs in one or two tufts 4
2. Appendages very small; anus in a vertical furrow ..... *Pseudostichopus* Théel
2. Appendages easily observable, at least most of them; anus as a rule not in a vertical furrow 3
3. Large marginal appendages and a double row of small feet in midventral ambulacrum ..... *Benthothuria* Perrier [2]
3. Appendages distributed evenly over the back and sides, not especially enlarged along lateral margin; midventral ambulacrum and most of ventral interambulacra totally devoid of appendages ..... *Paroriza* Herouard
4. Single tuft of genital organs 5
4. Two tufts of genital organs 6
5. Feet cylindrical, thread-like, numerous and of very variable size; deposits tables with short arms on top of spire; supporting rods absent in appendages ..... *Mesothuria* Ludwig

[1] Herouard (1923, p. 30) places *Cephyrothuria* in this group, near to *Pseudostichopus*, because he thinks it contains numerous practically invisible feet. I have seen the type of *C. glauca* (Clark) and cannot confirm that observation. The genus seems to fit very well in the Molpadonia, where it was originally placed (see p. 193).

[2] Imperfectly known. It is unknown whether the absence of spicules is normal.

5. Feet wart-like, present only in the lateroventral ambulacra: deposits tables with very high and slender spire, with long arms on top of spire; supporting rods present in appendages ..... *Zygothuria* Perrier
6. Deposits four-armed bodies with high spire, composed of four rods and several cross beams; distinct ventral sole, with margin of numerous small appendages; odd ambulacrum usually naked or with a few irregularly distributed pedicels; often wart-like small appendages on the ventral interambulacra ..... *Bathyplotes* Oestergren
6. Deposits 3–4 armed rods with solid spire or no spire at all, or perforated plates with or without spire 7
7. Flat, broad forms, with double rows of small appendages on posterior part of unpaired ambulacrum; deposits three-armed, with a few holes in the ends of the arms, no supporting rods ..... *Pelopatides* Théel
7. Cylindrical forms without distinct sole, no separate row in unpaired ambulacrum; ventral appendages of various shapes; supporting rods present .. 8
8. Skin leathery to gelatinous, with relatively few deposits, developed as three- or four-armed bodies, sometimes the arms united, thus forming disks with a solid spire ..... *Synallactes* Ludwig
8. Skin thin, glass-like, filled with deposits, representing various stages of tables, with small to very large disks, perforated by numerous holes; spire usually composed of 3 rods with 1–3 cross beams; in the larger deposits it is entirely reduced ..... *Amphigymnas* Walsh

Pseudostichopus Théel, 1882

Diagnosis, from Hérouard, 1923, p. 230.— Sixteen to twenty tentacles; no tentacle ampullae hanging free into the body cavity; stone canal connected with body wall, sometimes perforating it; in other species apparently absent. Ambulacral appendages cylindrical, or conical, small and numerous especially on the back and side of body, often distributed in pairs which gives the aspect of a serial arrangement. Genital openings placed on the boundary between the first and second third of body; genital organs forming two symmetrical tufts, one on each side of dorsal mesentery. Anal retractors originating from paired ambulacra alone, permitting the longitudinal muscle of the odd ambulacrum to contract the anal region into a deep furrow. Deposits rare or completely lacking.

Type species.— *Pseudostichopus mollis* Théel.

Key to the species of Pseudostichopus, which at present are known from the Atlantic Ocean

1. Body distinctly flattened, with a cartilaginous brim; head of stone canal visible as a large, kidney-shaped depression on dorsal side. Feet small, uniformly distributed ..... *Ps. depressus* Hérouard

1. Body not distinctly flattened and with only a very faint indication of a brim near oral end, or none at all; head of stone canal not visible as a kidney-shaped depression on dorsal side 2
2. Body covered with Creseis shells and sponge spicules; occurs at relatively slight depth, namely 400–600 m. ..... *Ps. occultatus* v. Marenzeller
2. Body either covered with globigerinae, small stones or naked 3
3. Appendages small, very difficult to see; integument white, thick, no foreign particles adhering to it; an indistinctly thickened brim may be found around anterior end ..... *Ps. atlanticus* Perrier
3. Appendages relatively large, often of various sizes 4
4. Pedicels very few, arranged only along the ambulacra; dorsally 4 pairs of feet, placed along inner side of dorsal ambulacra anteriorly; laterally a series of feet, placed on each side of the ventrolateral ambulacra and most numerous on ventral side; posteriorly they are larger and united by a kind of webbing; in odd ambulacrum an incomplete row of very small pedicels ..... *Ps. lapidus* Hérouard
4. Pedicels numerous, distributed over almost the entire surface 5
5. Pedicels ventrally few, beside the lateral which are large and placed in an indistinct series, at some distance from the margin there are regularly distributed small appendages arranged in heaps, most numerous near oral end and in the posterior third of the ventral side; body covered with globigerinae ..... *Ps. marenzelleri* Hérouard
5. Pedicels ventrally numerous 6
6. Pedicels ventrally of unequal size, near osal end placed on low warts; dorsally numerous; anus placed on a small, conical prominence; body covered with globigerinae ..... *Ps. globigerinae* Hérouard
6. Pedicels numerous on ventral side of equal size; general aspect hairy. *Ps. villosus* Théel

Pseudostichopus atlanticus Perrier

Pseudostichopus atlanticus Perrier, 1901, p. 333, pl. 17, fig. 15–20.

One specimen, 9.5 cm. long, is at hand; body much flattened, like an empty sack, mouth ventral, surrounded by 20 tentacles; anus in a deep furrow. Appendages extremely difficult to observe, but I believe that they are mostly arranged along the ventrolateral ambulacra and below anus. The integument is opaque; around the oral end there is an indication of a marginal thickening. Color whitish; the ventral midline gray; tentacles dark brown.

Internally almost all organs are ejected. A well-developed calcareous ring deeply excavated and undulated. No stone canal could be traced; one well-developed respiratory tree with numerous small tufts of secondary branches; muscle bands narrow, of equal size, undivided, circular in cross section.

Spicules.— No spicules could be detected in any part of the body, but it is possible that the alcohol contained some acid; the specimen examined has been kept in alcohol since 1879.

Type locality.— Between Azores and France, depth 3614 m.

Type in Paris.

The specimen examined is from off Bequia, British West Indies; depth 2,920 m.; coll. Museum of Comparative Zoölogy

Remarks.— The specimen seems to agree best with Perrier's *Ps. atlanticus* in the total absence of adhering particles. The presence or absence of spicules in these forms is always a somewhat problematic character, as they may be variously developed in specimens of different ages.

Perrier thinks that Théel's specimens of *villosus* from between Bermuda and France are identical with *Ps. atlanticus;* I cannot agree with him, as the hairy aspect seems to be such an important character, and the appendages in *Ps. atlanticus*, according to the description, are very small, retracted and not hairlike. I am more inclined to think that Hérouard's *Ps. villosus* from off Morocco is identical with *Ps. atlanticus.* Hérouard gives a figure of a perfectly smooth animal, and the figure of the calcareous ring resembles very much that of the specimen which I have examined.

Pseudostichopus depressus Hérouard

Pseudostichopus depressus Hérouard, 1902, p. 15, p. 2, fig. 15–18. Perrier, 1901, p. 337.

Fourteen small specimens, up to 8 cm. in length, seem to belong to this species; they are very flat, with a broad, cartilaginous brim; mouth ventrally directed, anus in a very distinct furrow. The attachment of the stone canal is visible on outer side; appendages are visible in a broad band along midventral ambulacrum, where they are quite distinct; if appendages are present on other parts of the integument they are extremely small. Color white; integument cartilaginous, especially in the small specimens.

Internal anatomy quite typical, midventral muscle band broadest. No deposits have been detected in any part of the body.

Type locality.— Between Portugal and Azores; depth 4,360 m. The specimens described are from off the coast of South America, "Albatross" station 2,127. In United States National Museum.

Pseudostichopus villosus Théel

Pseudostichopus villosus Théel, 1886, p. 170. Hérouard, 1902, p. 11, pl. 2, fig. 1–3; pl. 7, fig. 3; 1923, p. 23.

Three specimens, from 2–3 cm. in length; after having been placed in fresh water for twenty-four hours the feet were distinctly expanded; these are laterally placed in bundles on distinct conical warts; ventrally the feet are uniformly distributed and dorsally they seem to be scarce and smaller. The tentacles are large and not much ventrally directed; anal furrow not very deep. Color golden brownish.

Internally a very delicate low calcareous ring; one ventrally directed Polian vesicle; no stone canal could be detected. Intestine partly lost; only one respiratory tree is left; muscle bands of equal breadth; genital organs as thick finger-like tubules divided once, and apparently placed near middle of body cavity, but that may be artificially.

No deposits could be detected.

Type locality.— Latitude 34° 53′ N.; longitude 56° 38′ W.; depth 2,652 m.

Type in British Museum.

Also from several stations in the Pacific Ocean.

The specimens here examined are all from off Guadeloupe, French West Indies; depth 896 m.

Remarks.— Seems to be identical with Théel's species, except for the absence of the mulberry-shaped deposits which Théel himself thought were artificial. The species is, as noted above, recorded from the Indo-Pacific Ocean; comparison of these specimens from different localities will probably give unsatisfactory results; most likely we have a case similar to that of *Cucumaria abyssorum* Théel, namely, one species which gradually changes into closely related forms or varieties.

Pseudostichopus occultatus v. Marenzeller

Pseudostichopus occultatus v. Marenzeller, 1893, p. 15, pl. 4, fig. 9.
Not *Pseudostichopus occultatus* v. Hérouard, 1902, p. 14, pl. 2, fig. 4–14.

A single specimen examined, hardly 2 cm. in length, completely covered with sponge spicules and Creseis shells, which gives it an aspect as if it were covered with silk-like spines; anal furrow seems to be present, but it is very difficult to make out; mouth ventral with very small, almost tubular tentacles, the exact number could not be determined. Body wall paper thin, soft, with long thread-like appendages along the ambulacra and smaller ones on interambulacra (only a small

part of the shell covering was removed). Internally a low, very fragile calcareous ring and two bundles of well-developed genital tubes, containing ripe eggs and originating near the oral end; musele bands simple, undivided. All other organs lost.

Deposits.— In tentacles, small curved supporting rods, most of them provided with a thickening at the middle; in appendages and body wall all deposits were missing; genital organs contain numerous delicate, much branched rods, much more complicated than in the type specimens.

Type locality.— Eastern Mediterranean Sea (Pola); depth 745–2,180 m., also reported from coast of Spain (l'Hirondelle).

The present specimen is from off Havana, Cuba, depth 232 m.

Remarks.— The reason why I think this specimen belongs to v. Marenzeller's species is the relatively slight depth at which it was taken; it seems, as Hérouard points out in 1923, quite constant that this species lives at a shallower depth than the other species of the genus; its choice of the material with which it covers itself very likely also depends upon the depth; Creseis shells and sponge spicules are not available at the very great depths where globigerinae serve as protective coverings.

Pseudostichopus lapidus Hérouard

Pseudostichopus lapidus Hérouard, 1923, p. 26, pl. 4, fig. 5.

Type locality.— Between Azores and North Africa; depth 3,676 m.
Not known from the western part of the Atlantic Ocean.

Pseudostichopus globigerinae Hérouard

Pseudostichopus globigerinae Hérouard, 1923, p. 23, pl. 4, fig. 6.

Type locality.— Bay of Biscay; depth 4,588 m.
Most probably identical with Théel's *Ps. villosus*.
Not known from the western part of the Atlantic Ocean.

Pseudostichopus marenzelleri Hérouard

Pseudostichopus marenzelleri Hérouard, 1923, p. 25.
Ps. occultatus Hérouard, 1902, p. 14, pl. 2, fig. 4–14.

Type locality.— Between Azores and Portugal; depth 4,423 m.
Not known from the western part of the Atlantic Ocean.

Benthothuria Perrier 1901

Diagnosis, translated from Perrier, 1901, p. 365.— Twenty tentacles; stone canal penetrating the body wall; body with well-defined sole, surrounded by a continuous series of conical papillae, which forms a very distinct border; on the ventral side, a double series of pedicels along the od f ambulacrum on the posterior two thirds of the body; besides these a double series of lateral pedicels placed on the posterior third part of the body in the ventral interambulacra. Dorsally irregularly distributed ambulacral and interambulacral papillae. Two tufts of genital organs. Deposits absent (dissolved or normally lacking?).

Type species.— *B. funebris* Perrier, 1901, p. 365.

Only the type species is known at present. It was taken off Sudan, Senegal, from a depth of 782–1,230 m. (Talisman). Perrier gives a very detailed description of this remarkable form which seems to be most closely related to *Pelopatides*.

It may possibly be found in the West Indian seas.

Mesothuria Ludwig 1894

Diagnosis, as modified by Perrier, 1901, p. 301.— Twenty, rarely 18–19 tentacles; no tentacle ampullae; stone canal attached to body wall without penetrating it; ventral side usually somewhat flattened; dorsal side more or less uniformly covered with numerous pedicels, which are small and of equal size, or much smaller dorsally, where they sometimes are hardly visible. Single genital tuft, placed to the left; anus ventral or subventral, without special arrangement; calcareous deposits present in body wall and pedicels (except in *M. expectans?*), developed as tables exclusively, either tri- or quadriradiate; no supporting rods in pedicels.

Type species.— *Mesothuria multipes* Ludwig.

Key to the species known from the Atlantic Ocean

1. Two series of large papillae in each ambulacrum, except in the odd; the remaining part of body covered with numerous small appendages which are smallest ventrally and larger dorsally and laterally. Deposits absent or dissolved ..... *M. expectans* Perrier
1. No series of large papillae; pedicels of equal or unequal size 2
2. Deposits quadriradiate tables 3
2. Deposits triradiate tables 5

3. Feet, thin, thread-like, of almost equal size, distributed over the entire surface except on anterior part of ventrum. Deposits as tables with irregular margin and relatively small rectangular holes, often with disk incompletely developed; spire low, ending in 4 simple teeth; in pedicels the tables are reduced to spires alone; end plate small, especially in dorsal appendages ..... *M. verrilli* Théel

3. Feet small dorsally, absent partly or entirely on ventral side 4

4. Deposits, tables with about 8 marginal holes of equal size, oval in outline, sometimes accessory holes in variable number; spire ending in a variable number of small teeth; in feet, tables with well-developed disk; large end plate in lateral feet, smaller in dorsal appendages; only rudimentary appendages present on ventrum .... *M. intestinalis* (Ascanius and Rathke)

4. Deposits, tables with enormous disk with numerous holes, in several circles, the innermost being the largest; spire ending in numerous teeth; end plate absent in most cases; sexes separate ..... *M. gargantua* n. sp.

5. Pedicels distinctly larger along the sides; ventrally rudimentary, dorsally quite good-sized; tables regular, triradiate, usually with 6 large holes; spire relatively low, with short diverging arms on top, ending in a few small teeth; tables smaller but usually well-developed in appendages. *M. maroccana* Perrier

5. Pedicels hair-like, very uniform in size, absent on interradialia; tables with irregular perforated disk; spire high, slender; arms almost parallel and often of unequal length, ending in a few teeth; in the feet, tables high without disk and often distinctly deformed as are some of the tables in body wall ..... *M. rugosa* Hérouard

Five species have been taken in the western part of the Atlantic Ocean.

Mesothuria expectans Perrier

Mesothuria expectans Perrier, 1901, p. 317.

Only one specimen 9.5 cm. in length has been recorded; from its anatomy it is a typical *Mesothuria*, but it is absolutely devoid of spicules. It is characterized by having slender papillae situated along the sides beside normal cylindrical feet, which are small ventrally and large dorsally and laterally.

The type had one tuft of small genital organs developed on the left side. Perrier is of the opinion that Hérouard's *Paroriza prouhoi* is possibly identical with *M. expectans*, but the genus *Paroriza* is characterized by its two tufts of genital organs; it may be that the genital organs are developed later and are feebler on the right side in *Paroriza;* if this is the case *M. expectans* will quite naturally be removed from the genus *Mesothuria* and placed in *Paroriza.*

Type locality.— Between Azores and France; depth 4,255 m.

It may be expected to occur in the West Indian seas.

Mesothuria verrilli (Théel)

Plate 6, figs. 1–8

Holothuria verrilli (partim), Théel, 1886a, p. 6. Marenzeller, 1893, p. 7, pl. 1, fig. 2; pl. 2, fig. 2. Oestergren, 1896, p. 345. Perrier, 1901, p. 307, pl. 15, figs. 22–31.

Mesothuria intestinalis Koehler, 1896, p. 106. Ludwig, 1901, p. 138.

Allantis intestinalis var. *verrilli* Hérouard, 1902, p. 18, pl. 1, figs. 3–6.

Not *Mesothuria verrilli* Deichmann, 1926, p. 22, pl. 1, fig. 2 (young Holothuria sp.).

Several specimens varying from 2–30 cm. were examined. The species is, when well expanded, a cylindrical form with relatively thick skin, the outer layer often much wrinkled as if it was an outer covering of silk; appendages very small, thread-like, and in large specimens very hard to observe, except near the ends, especially on the ventral side near anus; they are uniformly distributed, being absent only on the anterior part of ventrum. Mouth ventrally directed, with about 20 relatively small tentacles which usually are retracted; anus terminal.

Internal anatomy as in other species in this genus; the most striking feature being that the genital organs are different in male and female; in the former they are relatively long tubes resembling the genital tubes in *M. intestinalis;* in the latter they are very short, grapelike; they are quite numerous and of variable size; in dissected ripe specimens I found that the posterior part of the genital basis has small, partly absorbed genital tubes, whereas the anterior portion has small, unripe tufts, containing immature sexual products of the same kind as that of the large, ripe tufts.

The deposits are numerous tables with irregular or regular disk, according to the age of the specimen; the disk is partly resorbed during life; it has a large central hole and about 8 marginal holes, smaller alternating with larger, and almost squarish in outline; spire usually low with 4 simple teeth on top. In feet a small end plate is usually present and a number of small tables with the disk resorbed and often also a partly resorbed spire. (Diameter of disk about 0.08–0.09 mm.; height 0.06 mm.)

In some of the smaller specimens we find tables with much larger disk (diameter 0.11 mm.), larger holes and higher spire, often with a small thorn-like spine beside the typical simple teeth; in the feet we find tables with complete disk.

Type locality.—Off Ambergris Key, British Honduras; depth 1,200 m. Type in Museum of Comparative Zoölogy, cat. no. 448.

Also from off Barbados, Dominica, Grenada and other localities in the West Indies.

Also correctly recorded from the following localities: Mediterranean Sea and Azores (v. Marenzeller, Hérouard), several stations along coast of Sahara (Perrier).

Depth.— From 700 m. and downwards.

Remarks.— Three species were united by Théel under the name *M. verrilli*, namely *intestinalis*, *gargantua* and *verrilli;* Théel's description refers partly to the two last species and it has been most natural to select the name *M. verrilli* for the species which was recognized later under that name by v. Marenzeller, Perrier and others. The species has been united with *M. intestinalis* (Ludwig, Koehler, etc.) and it was v. Marenzeller who, in 1893, gave the distinguishing characters between *verrilli* and *intestinalis;* later Perrier (1901) added some other characters.

The distinguishing features are the small feet of equal size, with small end plates and small abortive tables, the form of the holes in the disk, the simple teeth on top of spire, and the sexes separate, with difference in the shape of the genital tubes.

Mesothuria intestinalis (Ascanius and Rathke)

Plate 6, figs. 9, 10

Holothuria intestinalis Ascanius and Rathke, 1867.

Mesothuria intestinalis Ludwig, 1901, p. 139 (complete list of references, partly obsolete). Perrier, 1901, p. 204, pl. 16, figs. 19–21, text figs. 1–2. Théel, 1902, p. 4–34, pl. 1, 2, figs. 1–19, and 12 text figures.

It is with much doubt that I include the typical north Atlantic form in the West Indian fauna, especially as a closely related form, *M. gargantua*, occurs in these waters, but I have compared specimens of the same size with each other, and I feel very sure that they are different.

Three specimens examined, ranging in size from 6–12 cm. and in outer shape quite identical with others from Norway which I had at my disposal. They have the peculiar semitransparent skin to which a few pebbles cling, the same arrangement of the appendages with large lateral feet, smaller dorsal ones and almost completely naked underside. It has sometimes been stated that the dorsal side is almost naked, whereas the ventral side is provided with appendages; in all the specimens which I have seen this is not the case, the dorsal side has feet and the ventrum is almost naked.

The internal anatomy is not peculiar, and has been described by several writers. A low simple ring of the common "holothurian-like

type," a single Polian vesicle and a dorsal stone canal attached to the integument; a relatively short muscle stomach, usually mud-filled intestine, the first loop attached in dorsal interambulacrum, the second below left dorsal muscle band, the third in right ventral interambulacrum, nearest the median muscle band; two large free respiratory trees with large lobes; muscle bands undivided, of equal width; genital organs attached near oral end, of the usual type, with several large duets ending in a number of divided tubes, the anterior tubes smaller and of a distinctly different color and containing the opposite kind of sexual products than the large tufts; posteriorly a well-developed genital basis with small brown spots, indicating the scars left by resorbed genital tubes; one specimen seems to be an almost ripe female; the large tubes are yellow and filled with eggs.

Deposits.— Exactly as in Norwegian specimens; well-developed tables with large central holes and about 8 marginal holes which are oval, usually with the outer end of the oval more pointed; accessory holes may also be present; the feet are filled with spicules of the same type and size, and there are also well-developed end plates with relatively dense network.

Type locality.— Coast of Norway.

Type not existing.

This species has to some extent been confused with *M. verrilli*, and it is at present impossible to give any exact account of its distribution. It seems to range from the coast of Norway to the Mediterranean Sea and coast of North Africa (Talisman). It is said to range from 18 to about 1,000 m. in vertical direction, and von Marenzeller is undoubtedly right when he regards it as the shallow water form, whereas *M. verrilli* is the deep water form, although it must be remembered that the latter also occurs in a few hundred fathoms depth.

From the western part of the Atlantic Ocean I have examined 3 specimens, one from Grenada, depth 748 m., and two from "Fish Hawk" station no, 7,514, off Florida in 200 fms.

Remarks.— The differences between this species and *M. verrilli* have been very carefully worked out by von Marenzeller and Perrier; they are also briefly mentioned above.

Mesothuria gargantua sp. nov.

Plate **7**, fig. 1

Holothuria verrilli Théel (partim), 1886a, p. 6.

Several specimen of this species are at hand, varying in size from 7 to 20 cm. in length. The species resembles a very robust form of

M. intestinalis. Mouth ventral, surrounded by about 20 tentacles, which in all cases are retracted; anus terminal; appendages absent on the foremost part of ventrum and otherwise uniformly distributed over the entire body; they are stout, cylindrical, and of almost equal size throughout, perhaps slightly smaller on dorsal side; integument in the older specimens firm, rough to the touch; color white or yellowish.

Anatomy almost exactly like that of *M. intestinalis* but the genital organs which are shorter in *intestinalis* seem to contain only one kind of sexual products; the posterior part of the genital basis shows scars of atrophied genital tubes, but the anterior tufts, although they are small, are of the same kind as the large tufts placed on the middle of the stolon. One of the specimens was peculiar in that it had "viscera inversa," the intestine being attached in the opposite interambulacra (except the dorsal loop), and the genital organs being attached on the right side of the mesentery.

Deposits.— Very large tables (diameter up to 0.25 mm.), most of them being 2–3 times as wide as the tables found in *M. intestinalis;* with about 8 inner holes which are oval in outline and become reduced in size in the larger tables; outside these we find a variable number of small holes arranged without any definite order; the spire is low, solid, with few to many blunt spines on top; a few tables with delicate meshwork and 8 large regular holes may be found; these are evidently juvenile tables which have not been resorbed yet.

The feet are covered with tables which are almost as large as those found in the body wall; I have in most cases failed to find any end plate; they seem to be few in the small specimens, and I believe that they are totally absent in the large specimens, where the end of the pedicel usually is contracted; in the tentacles a few large-meshed plates.

Type locality.— Off Barbados; depth 720 m.

Type in Museum of Comparative Zoölogy, cat. no. 449.

Also from off Dominica, and St. Vincent, 659 and 825 m. depth.

Remarks.— This large species differs from *M. intestinalis* in the much larger and more solid tables; the reduction of end plates, the presence of numerous large feet on the posterior part of ventrum, the larger size, and the fact that the sexes are separate (as far as the present material shows).

Mesothuria maroccana Perrier

Plate 7, figs. 2–7

Mesothuria maroccana Perrier, 1901, p. 312, p. 16, figs. 32–35. Hérouard, 1923, p. 17.
Holothuria murrayi ? Théel, 1886, p. 127.
Mesothuria verrilli Théel, 1886a, p. 6 (partim).
Mesothuria murrayi var. *grandipes* Hérouard, 1923, p. 15, pl. 4, figs. 7–9.
Not *Mesothuria murrayi* (Théel), 1886a, p. 6. Hérouard, 1902, p. 23.

The 7 specimens which I have examined are all 4–6 cm. in length, tapering, usually much contorted; mouth ventrally directed with about 20 small, violet tentacles; feet of unequal size, largest along the sides, where a zigzag or double row seems to be present; they are small but quite well developed on dorsal side, whereas they are quite vestigial on the ventrum.

Internal anatomy as in the rest of the group. Sexes separate.

Deposits.— Tables with 6 large marginal holes and quite large central hole; spire relatively low with 3 short rods, a single cross beam and greatly diverging arms at the top which ends in a few small teeth; in the feet a small end plate and several tables of the same type as in body wall and also some which are devoid of disk; these resemble those of *M. rugosa*, but are not so high.

Type locality.— Coast of Morocco; depth 2,105 m.

Type in Paris.

Distribution.— From vicinity of Gibraltar (Théel, Perrier) to the West Indian seas.

In the Museum of Comparative Zoölogy there is one specimen from southwest of Jamaica, 999 m. depth.

In the United States National Museum there are specimens from "Albatross" stations: 2,379, 2,381, Gulf of Mexico; 2,658, 2,659, Bahamas to Cape Fear, and 2,751, off Cape Florida.

Remarks.— The present species was first described from Gibraltar by Théel as *H. murrayi?;* later Perrier gave a very careful description of it, and I think he is right when he regards it as a distinct species. I have had the opportunity to compare his description and figures with Théel's specimens in the British Museum, and I feel quite sure about their identity.

Hérouard's *M. murrayi* var. *grandipes* is, as far as I can see, identical with Perrier's species; the differences which Hérouard points out (p. 17) are, first the arrangement of the lateral pedicels in two rows instead of one, a very doubtful character when the variation caused by con-

traction or age is considered; second, the serial arrangement of the dorsal appendages, also a very doubtful matter; and third, the fact that the deposits are much larger than in Théel's and Perrier's species, the disk having a diameter of 0.15–0.18 by 0.10–0.12 mm. With our present imperfect knowledge of the variation within a single species, this character is not of supreme importance. It may be that *M. murrayi* var. *grandipes* is a specimen which has retained some of its larger,

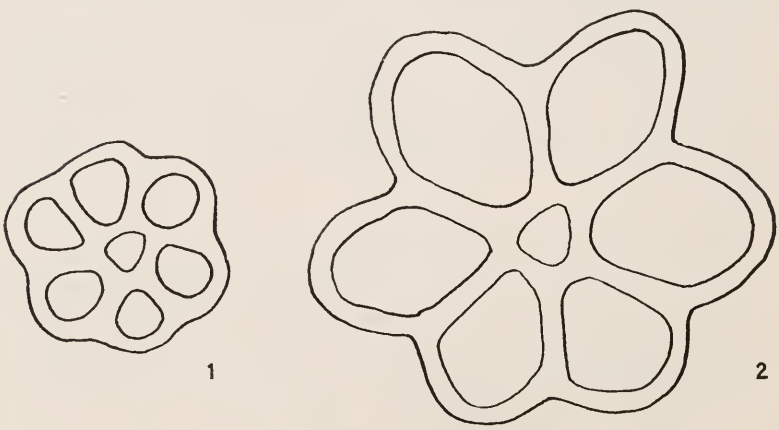


Fig. 1.— Outline of disk of table of Théel's *M. murrayi*, from Gibraltar.
Fig. 2.— Outline of disk of table of Théel's *M. murrayi* from the Pacific Ocean. (Same magnification.)

juvenile tables; it may be that it is really a distinct variety, but then it would be more correct to write *M. maroccana* var. *grandipes*. Hérouard does not mention what the deposits are in the feet, and he gives no figures of the deposits at all.

I have also had the opportunity to compare the Atlantic form with the Pacific form of this species; the tables in the latter species have another outline and are much larger, so I think it will be best to keep the two forms separate.

Mesothuria rugosa Hérouard

Plate 8, figs. 1–6

Mesothuria rugosa Hérouard, 1923, p. 19, pl. 1, figs. 11–21.
Holothuria murrayi Théel, 1886a, p. 6.
Mesothuria murrayi Hérouard, 1902, p. 23.

The 3 specimens examined are 4–6 cm. in length and their aspect is

hairy; the tapering body is almost uniformly covered with very thin pedicels; these are absent on some parts of midventral ambulacrum and according to Hérouard, who has examined one 16 cm. long, they are arranged in broad bands, being absent on the median part of the interambulacra, but this was not visible in the strongly contracted and contorted specimens which I had at my disposal.

The internal anatomy is not peculiar; the genital organs were ripe in the specimens examined; 3–4 large tufts, with short tubes, were present, placed on long ducts beside which there were also a number of unripe tufts.

Deposits.— Tables which in my specimens have a large disk with numerous triangular or rectangular holes; spire high, ending in 3 arms, often of equal size, parallel with the axis of the spire and with some small teeth on the ends; in the feet, typical small end plates, with a large perforation in the central part, and several small but high, deformed tables, usually without disk.

Type locality.— Near Cape Verde Islands; depth 3,890 m.

Type in Monaco.

In the West Indies, off Guadeloupe and St. Vincent (Théel).

Remarks.— The determination may be criticized in as much as several of the tables have a much larger and more complicated disk than those which Hérouard figures; but it is a well-known fact that the spicules vary very much in this genus and, as Hérouard's figures are from a specimen which is 16 cm. long, it is at least very likely that the species when young has much larger deposits; the general impression of the spicules, especially of those in the feet, is of something very deformed and irregularly developed.

A specimen from station 719 ("Princess Alice") is in the Museum of Comparative Zoölogy, listed as *M. murrayi*, but identical with the specimens of *M. rugosa*, which I have examined from the West Indian region. It has feet of almost equal size and very contorted, high tables, so there is no doubt about its identity. Hérouard undoubtedly overlooked this record of *M. murrayi* in his last paper, where he deals with *M. rugosa* and *M. murrayi* var. *grandipes*.

Bathyplotes Oestergren 1898

Diagnosis.— Synallactinae with 15–20 tentacles; mouth ventrally, anus dorsally; body with solelike ventral side, usually with marginal appendages; midventral ambulacrum naked or provided with a few feet; ventrolateral ambulacra with feet in a single row or more;

dorsally papillae, more or less distinctly in rows; musculature in most cases undivided; genital organs in two tufts; deposits, tables with cross-shaped disk and spire built up of four rods, usually with several cross beams; very closely related to *Synallactes*.

Type species.— *B. natans* (Sars).

The number of species known at present from the Atlantic Ocean is somewhat difficult to determine, as the specimens are often in very bad condition, and the descriptions of their outer shape are therefore somewhat diverse. The situation becomes especially difficult when the spicules have been dissolved, as has happened in some of the specimens from the West Indian region, and also in one of Perrier's specimens.

Key to the species of Bathyplotes at present known from the Atlantic Ocean

1. Calcareous deposits with relatively short arms; the ends perforated by several small holes; spire with parallel rods and usually strong spines on the sides; 3–4 cross beams which are distributed at almost equal distance from each other; fungiform papillae absent or, when present, very small. *B. natans* (Sars)

1. Calcareous deposits with relatively long, slender arms; ends perforated by few, large holes, often dichotomously branched; spire distinctly tapering, with small teeth or none on sides; cross beams only on upper part of spire; fungiform papillae large, in variable number (possibly sometimes absent?). *B. pourtalesi* (Théel)

Bathyplotes natans (M. Sars)

Plate 9, figs. 1, 2, 8

Holothuria natans M. Sars, 1868, p. 4.
Bathyplotes fallax Oestergren, 1896, p. 355.
Bathyplotes natans Ludwig, 1901, p. 137 (complete list of references).
Bathyplotes tizardi (Théel), Ludwig, 1901, p. 138, pl. 12, figs. 3–4; pl. 18, fig. 19.
Bathyplotes reptans Perrier, 1901, p. 352, pl. 12, figs. 3–4; pl. 18, figs. 1–9.
Bathyplotes natans Grieg, 1921, p. 7. Mortensen, 1924, p. 220, figs. 105, 106.
Not *Stichopus natans* Théel, 1886a, p. 5.

It is with some doubt that I include this Norwegian species among the West Indian forms, but specimens of this species seem to show so much variation that it is impossible, at present at least, to draw any sharp line between specimens from various localities, and the spicules seem to agree exactly.

The 5 West Indian specimens which have been examined are all

large, about 15–20 cm. in length, with a smooth vaulted dorsal side with small thread-like papillae scattered in indistinct longitudinal rows; the ventral sole is provided with a distinct fringe of small conical papillae. In all the specimens which I have had occasion to examine I have found a distinct midventral longitudinal furrow, provided with numerous small pores which resemble small contracted appendages, but examination of the inner side shows that there are no connections with the vascular system. In ventral interambulacra a number of small appendages are present which belong to the ventral side of the lateroventral vessels; they are few, arranged without order and almost devoid of deposits, but this may be due to age (in a much smaller specimen from Lofoten which I have used for comparison, the appendages form a distinct double row on each side and the appendages contain end plate and numerous supporting rods).

The color is pale yellowish or white; the contracted furrow is darker, dirty grayish. The skin is thick, opaque and finely rough from the deposits.

Internally there is a low calcareous ring, one slender Polian vesicle, a very small stone canal with indistinct head which attaches dorsally near the opening for the genital duct. The intestine is lost, its exact course could not be determined; respiratory trees are also lost. The muscle bands are broad and fleshy; the lateroventral ones are provided with a longitudinal furrow; the midventral band seems to be completely divided; the dorsal ones are simple and about twice as broad as the ventral bands. The genital organs are attached near oral end, about 1 cm. behind vascular ring; each tuft consists of a long duct which ends in a number of several short, divided tubes.

Deposits.— Of the same type as in the Norwegian form, with numerous small holes in the expanded ends of the arms, and a stout, not tapering spire with 3–4 cross beams and strong, blunt spines projecting from the sides; some of the spicules are much smaller than others, a normal condition in this genus. No C-shaped deposits were found. In feet a few supporting rods, no end plate; in tentacles numerous curved, simple rods.

Type locality.— Coast of Norway.

Type apparently not existing.

B. natans (with *B. tizardi* and *fallax*, both regarded as varieties, as they all occur in the same localities and gradually merge into each other, according to Dr. Th. Mortensen's observation) is the typical form from 60° to 69° latitude along the coast of Norway, at a depth of 183–1229 m., according to Ludwig (1901).

It may be that future investigations will prove that there really exist northern and southern subspecies and if that is true, it is very likely that the West Indian form will be placed in the latter subspecies.

When Perrier described his new species *B. reptans* from off Morocco, he figured the spicules of another specimen from off Senegal, and these spicules seem to agree with those found in *B. natans;* and I am inclined to think that *B. reptans* is identical with *B. natans*. Perrier mentions that the papillae are more numerous in his specimen of *reptans* than they are in *natans*, but it is very difficult to be sure of this character when the animals are much contracted, and in poorly preserved specimens of *natans* the dorsal appendages may look as if they were more conical in shape than in normal specimens. Perrier also mentions that small fungiform papillae are present on the ventral side beside the typical pedicels; in the Norwegian specimen at my disposal I found the same kind of small milk-white knobs along the ventral side; as far as I know, these appendages have never been noted before in the typical form, but they are very inconspicuous; they seem not to be present in the specimens from the West Indies.

From the West Indian region *B. natans* is represented from the following "Albatross" stations: station 2,396, 1 specimen; station 2,398, 5 specimens, all in United States National Museum.

As stated above, Théel's *natans* from St. Kitts is not *B. natans* but a poorly preserved specimen of *B. pourtalesi*.

Bathyplotes pourtalesi (Théel)

Plate 9, figs. 3–7

Stichopus pourtalesi Théel, 1886a, p. 4.

Stichopus natans Théel, 1886a, p. 5.

Bathyplotes bipartius Hérouard, 1912, p. 3, fig. 2; 1923, p. 34, pl. 5, fig. 8; pl. 9, figs. 17–20.

Most specimens hitherto collected are only strips of skin; in case the specimens come up with all their internal organs, they usually get rid of some part of the ventral integument upon which the large fungiform papillae are situated, and the result is that such individuals are naturally referred to another species. This is what happened with the specimens from St. Kitts which Théel examined; the only one which had retained most of its spicules, but lost parts of the ventral integument, was referred to *natans*, although the deposits were quite identical with those of *pourtalesi* from the same lot, and I have myself made the same mistake regarding some specimens from Albatross station 2,632.

The normal outer appearance of the species, which may attain a length of 15–20 cm., is, as Hérouard describes it for his *B. bipartius*, a vaulted dorsal side with huge, conical papillae, placed near the dorsal midline, arranged in two longitudinal zigzag rows and besides smaller papillae, hardly visible; a distinct ventral sole, with small papillae along the edge; mouth ventral, anus subdorsal; near the odd ambulacrum, which itself is devoid of appendages, we find a number of small cylindrical pedicels, which become very numerous toward anus; between these typical appendages and the marginal fringe of papillae there are normally a long band of very large, closely packed "fungiform papillae," most numerous near the anterior part of body and apparently variable in number; they end in a broad yellow disk but seem not to be connected with the vascular system, although some of them seem to contain a cavity. The skin is finely rough to the touch; on the flanks and middle of sole the integument is thick and gelatinous.

The typical fragments contain no trace of internal organs; the description of the anatomy is therefore taken from the only specimen in which these organs are present, collected from the same locality, containing the same kind of spicules, but lacking all trace of fungiform papillae, the sole being somewhat damaged in that part of it where they are situated in the typical specimens.

A very low calcareous ring, one long Polian vesicle, placed near the left ventral interambulacrum; stone canal attached to dorsal integument but without penetrating it; intestine relatively short, mesentery attached to dorsal interambulacrum, almost reaching the cloaca and turning forward across left dorsal and ventral ambulacra, and midventral muscle band, about one third body length from oral end and then proceeding backwards in the right ventral interambulacrum. Respiratory trees free, the right is the longest; stem wide, lateral branches short with few lobes. Musculature, dorsal bands broad and undivided, ventral bands, especially the odd one, are deeply furrowed. Genital organs are attached near oral end; the specimen examined is a female and the organs are filled with ripe eggs; each tuft consists of several slender ducts, each of these ending in a cluster of thick, short tubes, divided once; the clusters are of very variable size.

Deposits.— Quadriradiate bodies with ends branched, or perforated by few but relatively large holes; spire is distinctly tapering in its upper half, where the cross beams are found; small spines are usually present on the sides, but in some specimens they are almost absent (diameter of deposits about 0.1 mm.; height of spire, 0.05 mm.).

In pedicels I have missed end plates and found only a few supporting

rods of simple shape; in lateral papillae there are, on the contrary, numerous spinose rods, and similar deposits but larger are present in the stalk of the tentacles. No C-shaped bodies have been observed in any part of the body.

Type locality.— St. Kitts; depth 370 m.

Type in Museum of Comparative Zoölogy, cat. no. 435.

Also from Ambergris Cay, British Honduras, 1,080 m.; Barbados, 370 m.; Guadeloupe, French West Indies, 1,280 m. Albatross station 2,632 (16° 42′ N., 100° 11′ W., 838 fms.).

Described by Hérouard as *B. bipartius* from off the Canary Islands. One of his specimens in the Museum of Comparative Zoölogy has been compared with the types of Théel's species.

Pelopatides Théel 1886

Diagnosis, after Théel.— Tentacles 15–20, peltate, or subdigitate on margin of the crown; no tentacle ampullae; body more or less depressed, often with a conspicuous overhanging border, bearing a single series of numerous papillae; this border or brim obsolescent in some species except at fore and hind ends of the body; pedicels form a double row on hinder third or two thirds of midventral radius, and in some species also a single row along either ventrolateral radius, in addition to papillae; single series of papillae on dorsal ambulacra; gonads in two tufts, a right and left, mouth ventral; anus dorsal or subdorsal.

Deposits, when present, simple, triradiate or quadriradiate rods, either smooth or spinous; with slightly branched tips; deposits often entirely wanting. A rete mirabile is sometimes present.

Type species.— *P. confundens* Théel.

In spite of the fact that *Pelopatides* is a well-defined genus, the determination of the species is extremely difficult, as the animals are so injured by being hauled up in the dredge.

From the Atlantic Ocean only two species are known at present.

Pelopatides gigantea (Verrill)

Benthodytes gigantea Verrill, 1884, p. 216; 1885, p. 538, pl. 11, figs. 31a-b.
Pelopatides agassizi Théel, 1886a, p. 3.
Pelopatides grisea Perrier, 1901, p. 361.

The type as well as most of the numerous specimens in the United States National Museum are large specimens, the majority being about 20–25 cm. in length. Body flattened, broadly oval, with very

broad lateral brim. Mouth ventral, tentacles very small, retracted into small pockets, the exact number could not be determined; anus dorsal; ventral midline for two-thirds of its length provided with small appendages; dorsal side likewise, with a few small, inconspicuous appendages along the ambulacra. Integument thick, gelatinous; the deposits are very rarely dominating enough to give any roughness to the surface. Color varying from almost pure white with tentacles and the area around them as well as the ventral appendages, blackish violet, to speckled or uniformly violet, especially on the ventral side.

The body cavity of this species is remarkably small and narrow and does not extend into the lateral brim. No calcareous ring; one ventral Polian vesicle; one very small dorsally attached stone canal. Intestine seems to have been relatively short; it is attached in the dorsal interambulacrum, along the underside of the left dorsal muscle band and crosses the left and midventral muscle band about one-third of the body length behind the oral end, and runs finally backwards in the right ventral interambulacrum; the right respiratory tree is long, slender and attached to the lateral interambulacrum; the left is short, bushy, and has apparently been connected with the small rete mirabile which seems to be present (fragments are hanging to the intestine). Muscle bands well developed; the dorsal ones are wide, divided into equally broad parts; the lateroventral is divided into a narrow dorsal portion and a broad ventral part; the midventral is divided into equal halves. Genital organs in the largest specimens attached 5–6 cm. behind the oral opening as two tufts of long, divided threads.

Deposits.— Few, present only as large three-armed bodies with solid outer spire ending in a few teeth which are usually broken off; the arms are straight but slightly inward bent and provided with a few holes in their free end. No deposits are developed in the appendages; in tentacles there are several simple, pointed rods, smooth or with a few nodules.

Several specimens from various localities along the eastern coast of the United States have been examined.

If this species is identical with Perrier's *P. grisea*, then it also occurs near the Canary Islands and Azores ("Talisman").

Remarks.— This species has been united with *P. confundens* Théel, from the eastern tropical Pacific, by Ludwig, 1894. All the specimens of *P. confundens* which have hitherto been collected are much smaller, apparently more elongate, and according to the figures given by Théel squarish in outline. Perrier believes that the Atlantic form he has examined has the spicules with more inwardly bent arms than in typical

P. confundens, but the spicules are too few and variable in these species to allow such a distinction. The Atlantic and the Pacific forms are at present too little known to be united under one name.

Pelopatides atlantica Hérouard

P. atlantica Hérouard, 1902, p. 16, p. 1, fig. 15.

Type locality.— East of the Azores; depth 4,020 m.

No deposits. Description not quite clear; it appears as if the ventral appendages are partly situated on the odd ambulacrum, partly on the lateral ambulacra.

Synallactes Ludwig 1894

Rediagnosis, Perrier, 1901.— Body cylindrical or subcylindrical; (18–)20 tentacles; no tentacle ampullae; stone canal attached to integument; ventral side flattened but not limited by a marginal brim; ambulacral feet on ventral side and dorsally papillae arranged in rows, placed on the radials; on ventral especially distinctly in rows, forming 3 series, single or double. Genital organs in two tufts, anus not in a furrow and lacking anal teeth. Muscle bands divided.

Deposits present in skin and appendages, and often, but not always, as cross-shaped bodies with a simple spine, often bifid.

Type species.— *Synallactes alexandri* Ludwig.

In contrast to the Indo-Pacific Ocean where this genus is richly represented, there is at present only one species known from the Atlantic Ocean.

Synallactes crucifera Perrier

Synallactes crucifera Perrier, 1898, p. 1665; 1899, p. 247; 1901, p. 339, pl. 12, figs. 5, 6; pl. 17, figs. 21–35.

Type locality.— Coast of Morocco; depth 2,212 m.

Amphigymnas Walsh 1891

Rediagnosis — Closely related to *Synallactes*, but in its texture resembling a Deimatid. Skin thin, glass-like, filled with large deposits, derived from tables; spire 3–4 pillared with 1–2 cross beams and no teeth on top, often reduced or entirely absent, so the large plates resemble the plates found in the Deimatids; dorsally large, conical papillae, ventrally a lateral row of large and conical pedicels, and a midven-

tral row of smaller ones, filled with numerous supporting rods and a rudimentary end plate.

Type species.— *A. multipes* Walsh.

This genus was established by Walsh in 1891, but it seems as if he has placed some of the specimens of *A. multipes* in another genus as *Pannychia wood-masoni* Walsh. Koehler and Vaney have rejected *Amphigymnas* and regard *multipes* as a synonym of *Synallactes wood-masoni*.

I have had the opportunity to examine only one specimen, the type of *multipes*, so I cannot decide whether *wood-masoni* is identical with *multipes* or not, but it seems to me that *Amphigymnas* is as good a genus as *Synallactes* and *Bathyplotes;* it has neither the solid rod-like spire of the typical *Synallactes*, nor the long spire with the numerous cross beams of *Bathyplotes*. The deposits remind one so much of those found in certain Deimatidae that at first one would be inclined to place it in that group, and it is only when one notes the presence of respiratory trees as well as of smaller tables with more or less complete spire and the long Synallactid-like supporting rods that one realizes that the genus belongs in the Synallactidae.

From the Atlantic Ocean one species is known at present.

Amphigymnas bahamensis sp. nov.

Plate **9**, fig. 9; Plate **10**, figs. 1–6

Two specimens examined

The type is 17 cm. in length; form slender, not able to contract much; mouth ventral, anus terminal; tentacles 20, very lobate dorsally, long stiff papillae arranged in 4 rows, the anterior overhanging the oral opening as in Synallactes; ventrally a lateral row of conical pedicels, and a midventral double row of smaller conical pedicels; integument thin, stiff, glasslike, the tip of the oral papillae violet.

Internally a simple calcareous ring with squarish radials, deeply incised posteriorly and with notches anteriorly; interradials low, with the typical anterior tooth; one Polian vesicle; one dorsally attached stone canal. Intestine attached as usual, third loop runs on left side of midventral muscle band. Musculature narrow, undivided. Respiratory trees small with lateral lobes, hanging free into body cavity; no rete mirabile.

Deposits.— Very large tables with disks perforated by numerous holes; spire often broken and in many cases it appears as if it is quite normally reduced; spire, when present, is slender, composed of 3 rods

and united by some cross beams; it seems never to end in distinct teeth. In ventral feet, numerous long supporting rods with dentate edge, and small tables with 3–4 short rods in spire, ending in more or less distinct teeth; no end plate. In dorsal papillae, very slender dentate rods and tables of medium size, some of them resemble the three-armed rods in *Synallactes*.

Type locality.— "Albatross" station 2,666, between Bahamas and Cape Fear; depth 480 m.

Type in United States National Museum.

Also recorded from "Fish Hawk" station 7,281. Off Florida in 304 fms.

Zygothuria Perrier 1898

Diagnosis, translated from Perrier, 1901, p. 323.— Thirteen to twenty tentacles; stone canal placed close to body wall, without penetrating it; body ovoid, integument often wrinkled; not flattened but with a well-differentiated sole; a single series (rarely two series) of feet in each lateroventral ambulacrum, placed on the margin of the sole; these appendages are widely spread; dorsally, very small papillae, not numerous, irregularly distributed and sometimes totally absent. Calcareous deposits of integument exclusively in the form of tables, either tri- or quadriradiate.

Type species.— *Z. lactea* (Théel).

This genus has been rejected by Sluiter and Hérouard, but it seems to me quite convenient to have a separate genus for this almost footless form, and the shape of the tables seems to be characteristic. Perrier mentions supporting rods in the feet of *Zygothuria;* they are few and often difficult to find, when the appendages are completely contracted, but I think their presence will prove to be a general character in the genus.

No key has been given to the species which at present are said to occur in the Atlantic Ocean, as only one species is satisfactorily known. The two other species, from the eastern part, are very little known and may probably be identical. The Zygothuria sp. from the West Indian region is probably identical either with one or both of the eastern forms, or it is a new species, which is at present unsatisfactorily known.

Zygothuria lactea (Théel)

Plate 8, figs. 8, 9

Holothuria lactea Théel, 1886, p. 183; 1886a, p. 6.
Zygothuria lactea Perrier, 1901, p. 322, pl. 17, figs. 1–6.

Zygothuria lactea var. *oxysclera* Perrier, 1901, p. 323, pl. 17, figs. 7–10.
Mesothuria laetea Sluiter, 1910, p. 332. Hérouard, 1902, p. 21, pl. 1, figs. 17–19; 1923, p. 13, pl. 4, figs. 1–3.

About 20 specimens examined

The size most frequently met with is 6–15 cm., but larger specimens may occur; smaller specimens seem never to occur in collections. The outer shape is usually difficult to make out, except when the specimen has been treated very carefully; the usual impression one has is of a dirty whitish sack, much wrinkled and sandy to the touch, without any appendages whatever. A very fine figure is given by Hérouard in 1902. Oral opening ventral, the small tentacles with lobate margin are usually completely retracted; their number seems to be somewhat variable, varying from 15–20, but it may be that some of them have been overlooked; anus terminal; appendages are present only on a row along the outer side of the lateroventral muscle bands; color is as mentioned above, white, often dirty; the mud-filled intestine is often visible through the body wall.

Internal anatomy is often difficult to study, as it is usually badly preserved; in most cases the entire body cavity is filled with mud from the intestine which has been partly destroyed, and in this mud all organs are concealed. Calcareous ring is low, loosely built, much undulated; one small ventral Polian vesicle is present, and a dorsal stone canal which reaches the dorsal side; intestine comparatively short, of normal course; respiratory trees free with wide stem, with relatively few lateral lobes; muscle band narrow, often with a longitudinal furrow but not divided; genital organs placed near the oral end on left side of mesentery, of the typical shape: several tufts of short, divided tubes on the end of a long duct; anterior tubes being small and unripe, the posterior ones on their way to become absorbed and all containing the same kind of genital products.

Deposits.— Very fragile tables of the triradiate type, with 6 large holes around a small triangular central hole; spire high, usually with 3 long smooth arms on top. There is considerable variation as regards the diameter of the tables and the height of the spire; the disk is smallest, and most irregularly formed, with small accessory holes in the integument near appendages, and increasing in size in the dorsal integument. Hérouard gives the variation as being from 0.142–0.220 mm. in diameter, and I have found about the same sizes. Moreover, there are often several tables which have only one centrally placed strong spine or arm instead of 3, as Théel noted as early as 1886; it may be that this type of table, with a disk of the same diameter as the other

normal tables, becomes more numerous in older specimens. Perrier's var. *oxysclera* is based upon such very large specimens, in which all deposits were single pointed.

No end plate is present in the feet but a few supporting rods are present in the cylindrical part of the appendage; they are often difficult to detect, when the appendages are retracted; in tentacles we find quite a number of almost smooth, pointed, simple rods, strongly or slightly curved.

Type locality.— Off New Zealand ("Challenger").

Type in the British Museum.

Distribution in the Atlantic Ocean.— Recorded for the first time from the coast of the United States by Théel, who noted the characteristic difference between the type and the Atlantic specimen in the presence of the single-pointed tables.

Later, Perrier recorded several specimens from the coast of Morocco and off the Canaries, depth about 2,000 m., and he has furthermore described a new variety (*oxysclera*), based upon very large specimens, with single-pointed tables exclusively; apparently he overlooked Théel's record of the presence of such tables in specimens from the western part of the Atlantic Ocean.

Still later Hérouard found the species in the Bay of Biscay, and noted that the majority were the variety *oxysclera*, but the specimens contain also normal tables and he agreed with Sluiter (1901) that *oxysclera* cannot be maintained.

Examination of the specimens in the Museum of Comparative Zoölogy and United States National Museum shows that this species is extremely common along the coast of New England, and it occurs also in the West Indian region near the Antilles and in the Gulf of Mexico.

Depth.— As usual we find that the species occurs at a lesser depth in the western part of the Atlantic Ocean, about 800–1,200 m. being the common depth, whereas most of the eastern records are from a much greater depth, from 2,000 m. or more.

Remarks.— I have not been able to find any distinguishing characters between the type form and Atlantic specimens, so at present we must take it for granted that *Z. lactea* occurs in both oceans; the occurrence of single-pointed tables seems not in itself to be a very important distinguishing character, and the Pacific form probably has this type of table also, as will appear when more material is available.

Regarding the wide range of variation which the present species is said to exhibit, I cannot agree with most authors. It seems to me that the species does not vary much; its outer appearance is very constant

and the variation of spicules is within reasonable limits as far as my experience goes. We find some range of variation of the spicules in one individual and the single pointed type of tables seems to become more numerous in older specimens, but aside from these facts the species is very constant in its characters.

Zygothuria connectens Perrier

Zygothuria connectens Perrier, 1901, p. 327, pl. 17, figs. 11–14.

Three small specimens from off Sahara and the Canaries ("Talisman"), in bad condition, described in all details by Perrier.

The spicules seem typically to be larger than those of *Z. lactea*, although the largest among them are undoubtedly juvenile tables which cannot be regarded as typical; the disk is very irregular; the spire is high and ends usually in four long smooth arms, curving upwards.

Type locality.— Off the coast of Sahara and near the Canaries. Depth 1,975–2,518 m.

Type in Paris.

Zygothuria candelabri Hérouard

Mesothuria candelabri Hérouard, 1923, p. 17, pls. 1–10.

Of this form only fragments are known, and it is therefore doubtful whether it belongs to *Zygothuria* or *Mesothuria;* Hérouard, who rejects the genus *Zygothuria*, does not mention the presence or absence of appendages, but says that judging by the spicules, it seems to stand near to *Z. connectens* Perrier. I have chosen to place it in the genus *Zygothuria*, as I regard Hérouard's silence about the appendages as a sign that they are absent.

The tables are intermediate between tri- and quadriradiate type, often with 7 large irregular holes; the spire is high with very long arms, which are curved upward (not straight as in *lactea*) and provided with some small spines. If these spines were absent, I would not hesitate to regard the species as a synonym of *Z. connectens*.

Type locality.— Bay of Biscay ("Princess Alice"); depth 4,870 m.

Type in Monaco.

Zygothuria sp.

Plate 8, fig. 7

Only a single specimen is at hand, 10 cm. in length, of the typical shape with small tentacles, completely retracted and ventrally di-

rected; anus terminal; ventral side with a series of very small lateral papillae mostly recognized from inner side of body wall by their ampullae; dorsally some very small appendages which apparently are arranged along the ambulacra. Skin much thicker than in the typical specimens of *lactea*, with very distinct lateral thickening; color white; integument not transparent but opaque; more rough to the touch than that of *Z. lactea*.

Internal anatomy quite typical; a low, loosely united calcareous ring, a small ventral Polian vesicle; a dorsally attached stone canal which reaches the dorsal integument; short muscle stomach, and not very long, mud-filled intestine of normal course. Only one of the respiratory trees is left; it has a wide stem and several large lobes; muscle band narrow, the midventral furrowed; genital organs of the typical shape: numerous ducts ending in fertile tubes which in this form are very short, usually divided once.

As in *Mesothuria* we find that the posterior part of the genital basis has remnants of partly resorbed tubes, whereas the anterior part has smaller, unripe tubes; the specimen examined, a female, contained ripe eggs in the large tubes and unripe eggs in the small tubes

Deposits.— Tables, larger than in *lactea* and more irregular in the shape of the holes, very often the margin is incomplete; well-developed typical spire with three rods, ending in three long smooth teeth or arms. No rods in appendages or in tentacles.

This form is undoubtedly different from *lactea*, which is so richly represented in the waters along the coast of New England; it may be that it is identical with Perrier's *connectens;* the tables seem to be of the same size, but the disk is more complicated in Perrier's specimen, and a number of them have four rods in the spire, which I have never found in any preparation made from the specimen which I have examined. Perrier's example is, however, very small, so that it may be an immature character that the disk of the tables is different; I have therefore left the question unsettled until more material is available.

Specimen examined.— Museum of Comparative Zoölogy, cat. no. 429.

Locality.— Off St. Vincent, British West Indies, 573 fms.

Paroriza Hérouard 1902

Diagnosis, after Hérouard, 1902, p. 26.— Twenty tentacles; no free tentacle ampullae hanging into the body cavity; ventral side somewhat flattened, and without any feet on the ventrum; dorsally scattered,

straight or curved conical appendages, not numerous; mouth and anus ventral; two genital tufts; two respiratory trees. No deposits.

Type species.— *P. prouhoi* Hérouard.

Two species are at present known from the Atlantic Ocean, namely *P. prouhoi* Hérouard, 1902, p. 24, pl. 7, figs. 1, 2; pl. 8, fig. 30; 1923, p. 29, pl. 2, figs. 3, 4. Perrier, 1901, p. 323 and *P. pallens* (Koehler), 1896, p. 50–52, described as *Stichopus*.

Neither of these species have yet been recorded from the West Indian region or New England waters.

ELASIPODA Théel 1882

Diagnosis, from Ekman, 1925, p. 536.—Appendages present; tentacles built after the peltate type; oral retractors and respiratory trees absent. Mesentery of the third loop attached to right interradius and usually close to the dorsal muscle band. Among the deposits we find pointed rods or derivates from these. The outer shape of the body is distinctly bilateral.

The Elasipoda are divided into 4 families; in the present key the very aberrant genera *Pelagothuria*, *Enypniastes* and *Euriplastes*, which lack deposits, are included.

Key to the families and subfamilies

1. Deposits present 2
1. Deposits absent. V. Fam. (Cyclionidae) 7
2. Ventral radius with well-developed appendages; 15–20 tentacles 3
2. Ventral radius practically without appendages 4
3. No wheels among the deposits, which are either simple rods or four-armed deposits, often with outer projection ..... III. Fam. *Psycropotidae* Théel
3. Wheels numerous among deposits. II. Fam. *Laetmogonidae* Ekman (partim)
4. Deposits wheels ..... II. Fam. *Laetmogonidae* Ekman (partim)
4. Deposits no wheels (a few rudimentary ones may be present in some forms) 5
5. Deposits plates or large dichotomously divided rods or short stout rods. No wheels at all. Appendages uniformly distributed in rows along the paired ambulacra; 20 tentacles ..... I. Fam. *Deimatidae* Ekman
5. Deposits pointed rods, often with long vertically directed secondary spines, placed near the ends of the main rod, or derived from primary crosses, with four inner arms and 1–4 outer basal projections. Appendages usually unequally distributed in the respective ambulacra. 10 tentacles. (IV. Fam. *Elpidiidae* Théel) 6

6. The predominating spicules are rods with vertically placed spines placed near the end of the main rod; also C-shaped bodies and in some cases a few rudimentary wheels; cloacal caecum usually present.
VI. Subfam. *Elpidiinae* Ekman

6. The predominating deposits are derived from primary crosses with four inner arms and 1–4 outer projections. No cloacal caecum.
VII. Subfam. *Peniagoninae* Ekman

7. Lateral radii with a series of 8 feet on the posterior part and a double row of ordinary appendages on the anterior part, behind the nuchal crown; 12–20 tentacles ..... Group *Reptantia* Hérouard

7. Lateral radii devoid of appendages behind the collar; only with a few vestiges of papillae; 20 tentacles ..... Group *Natantia* Hérouard

DEIMATIDAE Théel (partim)

Diagnosis, from Ekman, 1925, p. 536.— Calcareous bodies large, mostly primary crosses, reticulated plates and dichotomously branched rods. Wheels absent. Marginal papillae strong; calcareous deposits placed parallel to the longitudinal axis of the papillae; the genital tubes are simple; the second loop of the intestine without a continuous mesentery; in the remaining loop the mesentery forms a complete membrane. Feet well developed in the lateroventral ambulacra; usually absent in the odd ambulacrum.

Four genera are usually recognized; a fifth, *Amphideima* Koehler and Vaney (1905) from the Indian Ocean is somewhat doubtful, and is therefore not included in the following key.

Key to the valid genera

1. Deposits, fenestrated plates; anus ventral 2
1. Deposits, not fenestrated plates; anus placed in various ways 3
2. Short forms; tentacles small, retractile, lateral feet in simple rows; dorsal papillae also in simple rows ..... *Deima*
2. Elongate forms, tentacles large, non-retractile; lateral feet in a zigzag row; dorsal papillae in simple or double rows ..... *Oneirophanta*
3. Deposits as long-armed, cross-shaped rods; lateral series of feet in zigzag to double rows; dorsal papillae in double rows. Anus ventral. (*Scotodeima*)[1]
3. Deposits short, robust, spinous rods; besides more slender, dichotomously branched rods. Lateral series of feet in a single row; dorsal papillae in double rows. Anus subdorsal ..... *Orphnurgus*

[1] *Scotodeima* is by some authors (Ohshima, Ekman) united with *Orphnurgus*.

Deima Théel 1882

Diagnosis.— Tentacles 18–20, small and capable of being retracted within the mouth. The lateral ambulacra of the ventral surface, with large pedicels disposed in a single row along each side of that surface, and another series of very elongated, conical, rigid, nonretractile processes, placed externally and above the pedicels, all along each side of the body and directed straight outwards. The odd ambulacrum naked and provided with a few abortive pedicels. The dorsal side with processes resembling those of the ventral lateral ambulacra, disposed in a single row along each ambulacrum. Integument with crowded irregularly rounded perforated plates, forming a rather hard "skeleton."

Type species.— *Deima validum* Théel.

Key to the species at present known from the Atlantic Ocean

1. Deposits composed of a single layer; 11 lateral feet; 6 lateral papillae and 6 dorsal papillae (in very large specimens 7) on each side. *Deima blakei* Théel
1. Deposits composed of two layers; 11 lateral feet; 5 lateral papillae, and 3 dorsal, on each side ..... *Deima atlanticum* Hérouard

Deima blakei Théel

Plate **10**, figs. 7–11; Plate **11**, figs. 1–3

Deima blakei Théel, 1886a, p. 1, figs. 1, 2. Hérouard, p. 40, pl. 5, fig. F; pl. 6, fig. 5. Koehler and Vaney, 1905, p. 55, pl. 11, figs. 13–15.

The average size for this species is about 10 cm.; a single specimen is 13 cm. long. The body is relatively short with flattened ventral side and vaulted dorsal side. The tentacles are completely retracted. The typical number for the appendages seem to be, on each half part of the body: 11 pedicels, 6 lateral and 6 dorsal papillae (the exceptionally large specimen has 7 dorsal papillae). On the midventral radius we find 2–3 abortive pedicels.

The present material seems to indicate that there is a difference in the outer characters corresponding to sex. Females have much stouter papillae than the males, but it may be merely accidental.

Internal anatomy seems to be very typical. A low calcareous ring, composed of 10 pieces; a small ventrally placed Polian vesicle, a short stone canal which opens dorsally. The intestine is very short, and is attached in the dorsal interambulacrum and in the right lateral interambulacrum; there is no mesentery to the second loop. The genital

organs are attached near the oral end in two tufts, and are simple tubes. In the material examined they were ripe and showed some difference in the male and the female; in the male they were cylindrical and white; in the female they were thickest at the middle and yellow; in both cases the wall of the tubes is glasslike, filled with spicules.

The deposits are very large plates with large central holes and several small marginal ones; all stages may be found from rods with dichotomously divided ends or with only a few large holes, to the complete plates. The deposits are never built up of more than one layer; the outer surface often carries some scattered spines.

In the feet we find delicate spectacle-shaped rods or simple, smooth to slightly spinous rods and elongate plates of the same type as in the integument. Apparently no end plate; in the tentacles similar rods.

Type locality.— Off St. Vincent; depth 573 fathoms.

Type in the Museum of Comparative Zoölogy.

Also from south of Jamaica, 610 fathoms depth and from near the Azores (2,779 m.).

According to Koehler and Vaney this species is also found in the Indian Ocean. This determination is doubted by Hérouard, but the figures which Koehler and Vaney give agree perfectly well with the deposits of *D. blakei*.[1]

Deima atlanticum Hérouard

D. atlanticum Hérouard, 1898, p. 88; 1902, p. 32, pl. 3, figs. 5–8.

Characterized by 11 lateral feet, 5 lateral and 3 dorsal papillae in each body half. Deposits composed of more than one layer.

Type locality.— Between Azores and Portugal. Depth 3,460 m.

Type in Monaco.

Not yet recorded from the western part of the Atlantic Ocean.

Orphnurgus Théel

Diagnosis.— Tentacles 15–20, rather large, nonretractile. Lateral ambulacra of ventral surface with very large pedicels, disposed in a single row all along each side of that surface, and with another series of slender flexible processes placed above the pedicels, all along each side of body. Odd ambulacrum naked. Dorsal surface with a more or less crowded series of numerous long papillae, disposed in one or two rows

[1] The deposits are composed of a single layer covered by a few secondary wide-meshed rods (perhaps an artefact). Both *validum* and *fastosum* have reticulated network in their deposits.

along each dorsal ambulacrum. Integument with deposits in the form of smooth or spiny rods, sometimes dichotomously branched, or rods transformed into solid, large ellipsoids.

Type.— *O. asper* Théel.

Orphnurgus asper Théel

Plate 11, figs. 4–8

O. asper Théel, 1882, p. 82, pl. 15; pl. 34, figs. 15, 16; pl. 38, fig. 10; pl. 41, fig. 3; pl. 44, fig. 3; 1886a, p. 2.

The single specimen at hand is poorly preserved but seems to agree in all respects with the type, and it is unnecessary to repeat Théel's description.

Type locality.— Sombrero Island, Lesser Antilles, from 810 m. depth. Type in British Museum.

Also off Guadeloupe, from 1,049 m. depth. According to Koehler and Vaney, *O. glaber* Walsh from Gulf of Bengal is merely a variety of *asper*.

Oneirophanta Théel 1882

Diagnosis.— Tentacles 20, large and not capable of being retracted within the mouth. The lateral ambulacra of the ventral surface with large pedicels disposed in a double row along each side of that surface, and with another series of very elongated, conical, more or less flexible, non-retractile processes, placed externally and above the pedicels all along each side of the body. The odd ambulacrum with a few more or less rudimentary pedicels. The dorsal surface with processes, resembling those of the ventral lateral ambulacra, disposed in a single row along each of its ambulacra. Integument with more or less crowded, irregularly rounded, perforated plates, sometimes forming a rather hard skeleton.

Type.— *O. mutabilis* Théel.

Key to the species of Oneirophanta known from the Atlantic Ocean

1. Dorsal appendages of almost equal size. Elongate rods present in dorsal integument ..... *O. mutabilis* Théel
1. Dorsal appendages in pairs of alternate size. No elongate rods in dorsal integument ..... *O. alternata* Perrier

Two species and a variety are recorded from the Atlantic Ocean, none of them has as yet been reported from the West Indian region.

Oneirophanta mutabilis Théel

O. mutabilis Théel, 1886, p. 62, pl. 21, fig. 2; pl. 22, figs. 1–3; pl. 36, figs. 1–2, 8–11; pl. 37, figs. 4, 13; pl. 38, figs. 11, 12; pl. 40, figs. 1–3; pl. 41, figs. 1, 2, 4; pl. 42, fig. 9; pl. 43, figs. 1, 6; pl. 45; pl. 46, figs. 6, 7. Perrier, 1901, p. 374, pl. 18, figs. 10–15. Hérouard, 1923, p. 39, pl. 4, figs. 1–10; pl. 5, figs. 2–3.

Type locality.— Pacific Ocean.

Type in British Museum.

Recorded from Gulf of Panama ("Albatross"), several localities in the Pacific Ocean, south of Australia, southeast of Africa ("Challenger"), also from Gulf of Bengal ("Investigator"). In the Atlantic Ocean reported by "Challenger" from off Montevideo, later taken in numbers from between Azores and Portugal ("Talisman").

Bathymetrical range, usually between 2,000–5,000 m. (from the Andamans reported from only 500 m. depth.

Oneirophanta alternata Perrier

O. alternata Perrier, 1901, p. 380, pl. 14, figs. 3–4; pl. 18, figs. 16–21.

Occurs in the same localities in the eastern Atlantic Ocean as *O. mutabilis*. Perrier also has recognized a variety *O. alternata* var. *talismani*. It is characterized by having the dorsal appendages arranged in pairs on each dorsal ambulacrum, a pair of large papillae alternating with a pair of small papillae. Perrier has, moreover, noted some differences in regard to the distribution of the spicules. No elongate rods are present in the dorsal integument.

It is possible that *O. alternata* and its variety are only varieties of the apparently very variable species *O. mutabilis*. It is also possible that we have a difference between the two sexes, as in *Deima blakei*, where we find some difference in the texture of the integument and the size of the papillae in female and male.

Scotodeima Ludwig 1894

Not represented in the Atlantic Ocean. The genus stands between *Oneirophanta* and *Orphnurgus* and is by some authors (Ohshima, Ekman) included in the latter genus.

LAETMOGONIDAE Ekman 1926

Diagnosis.— Deposits only as wheels and other small deposits. The papillae are usually flexible, without special armature. Genital organs

unbranched. Mesentery as a continuous membrane, present also in the second loop. Dorsal papillae uniformly developed in all parts of the ambulacra. Feet in the lateroventral ambulacra large, well developed; in the odd ambulacrum absent in most cases, or much smaller.

Most of the genera are Indo-Pacific forms. Only two genera, namely *Laetmogone* and *Benthogone,* are with certainty known from the eastern Atlantic. (Hérouard's *Pannychia glutinosa* is undoubtedly a young specimen of *Benthodytes lingua* Perrier. A poorly preserved specimen is designated as *Laetmophasma* sp.? by the same author, but I doubt very much the correctness of his statement.)

Key to the genera known from the Atlantic Ocean

1. Numerous small hair-like papillae scattered over the entire surface. Lateral feet large, cylindrical. Tentacles very much like the lateral feet in form and size ..... *Laetmophasma*
1. No hairlike papillae scattered over the surface 2
2. Pedicels retractile, dorsal appendages minute. Wheels extremely vaulted, cuplike ..... *Benthogone*
2. Pedicels nonretractile; dorsal appendages good sized. Wheels flat. *Laetmogone*

Laetmophasma Ludwig 1894

Diagnosis.— Sixteen to twenty tentacles, rather large, nonretractile; in each ventrolateral ambulacrum a single row of large feet; dorsal and ventral sides covered with numerous papillae. Wheels, similar to those found in *Pannychia.*

Type species.— *L. fecundum* Ludwig.

Hérouard describes, 1902, p. 35, a poorly preserved specimen from near the Azores which could possibly be referred to this genus. Aside from this specimen, the genus is known only by the type species from the eastern tropical Pacific.

Laetmogone Théel 1882

Diagnosis, from Théel, 1882, p. 73.— Tentacles fifteen, rather large, not retractile. The lateral ambulacra of the ventral surface with very large pedicels, disposed in a single row along each side of that surface. The odd ambulacrum naked. The dorsal surface with extremely elongated, flexible, cylindrical, nonretractile processes, disposed in a single row along each side of its ambulacra. Integument, with numerous wheels and, besides these deposits, spicules or cruciform bodies.

Type species.— *L. wyville-thomsoni* Théel.

The genus is represented in the eastern part of the Atlantic Ocean by two species, both of which are said to occur also in the Indo-Pacific. Both species may be expected along the coast of North America and in the West Indian waters.

Key to the two species

1. Slender form, several times longer than broad. Dorsal appendages few, long, slender and widely spaced; their number is much less than that of the ventral feet ..... *Laetmogone wyville-thomsoni* Théel
1. Short form, at most two and a half times as long as broad. Dorsal appendages short, slender and closely placed; their number is larger than that of the ventral feet ..... *Laetmogone violacea* Théel

It seems as if there were something uncertain about these two species. They have undoubtedly in many cases been confounded. It is usually stated that *L. wyville-thomsoni* lacks an outer layer of cross-shaped, hollow, spinous deposits, which characterizes *L. violacea*. It is undoubtedly a fact that this outer layer is often rubbed off, and specimens lacking these deposits have been referred to *L. wyville-thomsoni*, while those which possess them are referred to *L. violacea;* the miserable condition in which these animals are usually found makes it quite excusable to pay little attention to the dorsal appendages, which often stick to the gelatinous integument. A specimen from station 1450 ("Princess Alice") is labeled *L. violacea* and contains several cross-shaped deposits, but when the dorsal appendages are prepared they prove to be very long and slender and widely spaced; their number being 9 in each dorsal row, whereas the ventral feet are present to the number of 14 on each ambulacrum. The outer shape thus indicates that the animal is a specimen of *L. wyville-thomsoni*.

This fact explains, therefore, why Koehler regards *L. wyville-thomsoni* as the most common, eastern Atlantic species, whereas Perrier and Hérouard regard *L. violacea* as the most typical Atlantic form.

Laetmogone violacea Théel

L. violacea Théel, 1882, p. 78, pl. 13, figs. 1–3; pl. 36, figs. 20–24; pl. 42, fig. 2. Perrier, 1901, p. 390, pl. 19, figs. 1–7. Mortensen, 1912, p. 290. Grieg, 1921, p. 9. Hérouard, 1923, p. 37. Ohshima, 1915, p. 237 (complete list of literature).

Cryodora spongiosa Théel, 1879, p. 9.

Laetmogone spongiosa Théel, 1882, p. 78.

L. jourdaini Petit, 1885, p. 9.

L. brongniarti E. Perrier, 1886, p. 241.

Type locality.— South Pacific Ocean.

Distribution in the Atlantic Ocean.— West of Greenland, north of Scotland, Bay of Biscay, Gibraltar, off Morocco, Azores and Senegal.

Depth.— 893–1,490 m.

Should the Atlantic and Pacific specimens prove to be different, the name *L. spongiosa* is available for the Atlantic species.

Laetmogone wyville-thomsoni Théel

L. wyville-thomsoni Théel, 1882, p. 73. Koehler, 1895, p. 36; 1896, p. 117. Hérouard, 1902, p. 31, pl. 4, figs. 10–16.

Type locality.— South Indian Ocean.

Distribution.— Not well known at present.

Benthogone Koehler 1896

Diagnosis, modified from Perrier, 1901, p. 398.— Mouth ventral, surrounded by a circle of 15–20 tentacles, which are very little retractile; anus terminal, subdorsal; body flattened or almost cylindrical; ventrally on each side a series of marginal appendages which are rather large and contractile. Dorsally on each side of the median line and a short distance from it, a series of much smaller appendages, delicate and retractile; other papillae may be found, which are much scattered, but also arranged in a longitudinal, outer series. Deposits as wheels, resembling those of *Laetmogone* but more vaulted. The ambulacral appendages contain rods and a rudimentary end plate, as well as the wheels.

Type species.— *B. rosea* Koehler.

Benthogone rosea Koehler

B. rosea Koehler, 1896, p. 116, 1895, p. 53, text-fig. 16. Perrier, 1901, p. 339, pl. 14, figs. 1–2; pl. 19, figs. 8–14.

Perrier establishes the varieties *cylindrica* and *quatrolineata;* both seem to be merely stages of preservation or age.

Type locality.— Bay of Biscay, depth 1,300 m.

Also from off Morocco and Senegal ("Talisman"); south of Iceland ("Ingolf");[1] west of Ireland ("Helga"). Not yet taken in the western part of the Atlantic Ocean, but will probably be found there.

Psychropodidae Théel

Diagnosis, Ekman, 1925, p. 537.— Deposits exclusively derived from pointed primary rods which is some species form crosses or four-armed bodies with inwardly curved arms and often an outer central projection. Deposits never derived from primary crosses. Mesentery forming a continuous membrane, well developed also in the second loop. Feet are, as a rule, also present in the odd ambulacrum. Anteriorly the marginal brim contains several appendages which arise from the dorsal radial vascular canals.

Key to the genera

1. Odd ambulacrum devoid of appendages. Deposits cross-shaped rods with slightly inward bent arms and short conical outer projection. IV. *Psycheostrephes*

1. Odd ambulacrum with a double row of pedicels 2
2. Dorsal side posteriorly devoid of an unpaired appendage; only paired papillae, smaller or larger, are developed. Deposits, cross-shaped rods with more or less strongly bent, spinous arms with or without outer projection, or simple, spinous rods, which in some species are extremely scarce. I. *Benthodytes*
2. Dorsal side posteriorly, with a more or less broad, unpaired appendage. Deposits cross-shaped rods with more or less strongly bent, spinous arms and in most cases with outer projection 3
3. Unpaired appendage relatively short, situated anteriorly to the posterior third of the body. Lateral appendages small, relatively numerous and united by a web to form a swimming brim ..... II. *Euphronides*
3. Unpaired appendage very long, tail-like, placed near the posterior end of the body; lateral appendages relatively few, mostly large, conical, and not united by a web ..... III. *Psychropotes*

The first genus is not known from the Atlantic Ocean; the others are all represented in the eastern part, and several of the species are also known from the western part.

Benthodytes Théel

Diagnosis.— Body flattened or elevated, slender or short; mouth ventral, usually situated at some distance from the anterior margin; 12–20 tentacles; anus dorsal, sometimes almost terminal. Ventral ap-

[1] Not published.

pendages numerous in a double row of pedicels in the midventral radius; laterally they form a single series united by a web to a narrow or broad brim; dorsally papillae, either small and insignificant, easily overlooked, or large and prominent; their number seems to be somewhat variable within the species; they are either radial or placed in the lateral interambulacra.

Deposits, either simple pointed, spinous rods, which occur in very limited number, or large cross-shaped bodies with curved spinous arms and usually with a strong, spinous, simple or bifid outer projection.

Key to the species of Benthodytes, at present known from the Atlantic Ocean

1. 20 tentacles. Lateral brim of appendages broad; dorsal appendages very small. Deposits simple, spinous rods often few in number. . *B. typica* Théel
1. 14–15 tentacles; lateral brim of appendage forming a narrow limit round the ventral sole; dorsal appendages either thread-like or conical. Deposits cross-shaped, with or without outer projection 2
2. Deposits robust; outer projection stout, with numerous spines often divided into two or three stems. Elongate form, with slender dorsal appendages. *B. lingua* Perrier
2. Deposits not very robust; arms slender; outer projection slender or absent.
3. Dorsal appendages of unequal size; four pairs much longer than the remaining ones . . . . . *B. janthina* v. Marenzeller

Benthodytes typica Théel

B. typica Théel, 1882, p. 103; 1886a, p. 2. v. Marenzeller, 1893, p. 12 Perrier, 1901, p. 456, 466. Grieg, 1921, p. 10, pl. 3, figs. 6, 7. Hérouard, 1923, p. 102, pl. 6, fig. 4, 1896, p. 903.

B. glutinosa Perrier, 1901, p. 462, pl. 13, fig. 5; pl. 20, fig. 31. Grieg, 1921, p. 10, pl. 3, figs. 1, 2.

About 30 specimens examined

The maximum length of this species, so common in the West Indian region, seems to be 10–15 cm. Most examples are very poor, and present only a bundle of five fleshy muscle bands surrounded by some tissue which is colored dark reddish violet. When the animal is complete, it presents a short body with a very broad brim; ventrally directed mouth, surrounded by 20 tentacles; anus terminal. The midventral radius with a double row of pedicels, the dorsal side with a few scattered papillae. The lateral appendages are very easy to trace, as

their vascular portion is deep violet and the remnants of them are always visible as peculiar violet transverse bands. The dorsal appendages are usually overlooked, and examination of a very great number of specimens shows that the pedicels in the midventral radius are very often hard to trace; the specimens in which the ventral appendages seem to be scarce have often been referred to *B. glutinosa*.

The color is intensely reddish violet; the appendages are especially deeply colored as well as the lining of the body cavity, whereas the connective tissue of the integument is milky white, opaque.

Internally we find a long and narrow body cavity, the walls of which are practically covered by the very fleshy muscle bands. Calcareous ring in the usual low state of development; a long ventrally placed Polian vesicle and a short dorsal stone canal, which opens to the outer surface. The intestine is short, and by means of a fenestrated mesentery attached in the dorsal interambulacrum, in the left lateral interambulacrum and along the lower side of the right dorsal muscle band. Muscle bands fleshy, tapering toward the oral end, yellowish in color. Apparently only males have been examined; their genital organs consist of two slender ducts with numerous bundles of small slender fertile tubes. Females undoubtedly have genital organs of the usual type with a short duct, with thick globular fertile tubes.

Deposits.— A few scattered spinous rods, most numerous in the tentacles.

Type locality.— Off Gibraltar.

Type in British Museum.

Distribution.— From off the Azores; off Martinique; off Bequoia, Gulf of Mexico, west of Haiti and from Cape Hatteras to Nantucket.

Depth.— From 1,400–3,514 m. The lowest depths are as usual found in the western part of the Atlantic Ocean.

Remarks.— It is impossible to decide whether this species is identical with *B. glutinosa*, recorded by Koehler and Vaney from the Indian Ocean and by Clark from the eastern tropical Pacific.

Benthodytes lingua Perrier

B. lingua Perrier, 1896, p. 902; 1901, p. 466, pl. 12, figs. 1, 2; pl. 21, figs. 1–9.
B. sp. Théel, 1886a, p. 3.
Pannychia glutinosa Hérouard, 1902, p. 32, pl. 4, fig. 17.

About 10 specimens examined

The species seems to attain a length of about 25–30 cm. The specimens from the West Indian region agree perfectly with Perrier's de-

scription. Fifteen large tentacles, ventrally directed, surrounded by a circle of very small appendages; a distinct flattened sole with a double row of feet in the midventral radius and a narrow brim of small appendages united by a web, forming the border. Dorsally a few, whip-like papillae are present, but they are often inconspicuous. The color is either dark violet or more reddish, as noted also by Perrier. The integument is extremely rough, because of the enormous spicules which it contains; they seem usually to be best developed near the oral end, dorsally.

Internal anatomy quite normal, with a fragile semitransparent calcareous ring, a ventrally placed Polian vesicle, and a dorsal stone canal connected with the outer surface; the course of the intestine could not be made out in the present material. The longitudinal muscle bands are thin. The genital organs which are ripe present the typical difference between the female and the male; the organs in the former are short, resembling a corn cob, with few and short thick tubes, closely packed together; the latter are long with several slender tubes arranged in tufts along the main stem.

Deposits.— Very large deposits, several millimeters long, their entire shape visible to the unaided eye. They are developed as large crosses with stout inward bent arms, covered with strong spines, and with an outer central projection which likewise is covered with spines, and in most cases is divided into 2 or 3 equally large stems, a quite unique feature, by which these spicules are easily recognized. In the tentacles simple spinous rods.

Type locality.— Coast of Morocco.

Type in Paris.

Distribution.— From the type locality; several localities in the West Indies, off the Antilles and in the Gulf of Mexico and also along the coast of New England.

Depth.— 860–2,200 m.

Benthodytes kerhervei (Hérouard)

Psychropotes kerhervei Hérouard, 1902, p. 27, pl. 4, figs. 1–9; 1923, p. 104, pl. 3, figs. 4, 5.

With some doubt I refer a specimen from St. Croix to this species, which has hitherto been known only from off the Azores. The specimen is 5–6 cm. long, very short, with decidedly vaulted dorsal side with a few small appendages found near the middle of the back; the ventral side forms a distinct sole, limited by small papillae united to a narrow

brim and with a midventral row of pedicels; the tentacles are 15 in number and also ventrally directed; the anus is terminal. The color is dark violet; the integument is smooth to the touch.

The internal anatomy was not suitable for examination; the only organs well preserved are the genital organs, which contain large eggs and are of the typical form, short and compact with short, thick, fertile tubes. The deposits are few and of the same form as those figured by Hérouard, relatively small crosses with few, irregularly distributed spines, and a very small spinous outer projection or none at all.

Type locality.— Between Azores and Portugal.

Depth.— 3,825–5,005 m.

Type in Monaco.

Distribution.— From the type locality and off St. Croix, West Indies, in 2,376 fms.

Remarks.— The reason why I have placed this species in *Benthodytes* is because Hérouard's figures are not very convincing; the dorsal appendage is very short and little typical of *Psychropotes,* and the lateral appendages are small and united by a web, instead of being large and independent, as they normally are in the genus *Psychropotes;* finally the deposits are of the type which is characteristic of *Benthodytes* and not the kind which we find in *Psychropotes* and *Euphronides.*

Benthodytes janthina v. Marenzeller

B. janthina v. Marenzeller, 1893, p. 10, pl. 2, fig. 3. Grieg, 1921.

Incompletely known. Characterized by its dark color and four pairs of large dorsal appendages, beside some smaller pairs (their size can always be estimated when their ampullae are examined on the inner side of the body wall). Judged by its outer shape it seems to belong to the same group as *B. lingua* Perrier. The spicules were partly broken in the type, but besides the simple spinous rods, some were found which seemed to be fragments of cross-shaped bodies with outer projection.

Type locality.— Off the Azores.

Type.— Monaco.

Distribution.— Off coast of Morocco and Bay of Biscay (Grieg, 1921).

Depth.— 2,258–4,700 m.

Not yet reported from the western part of the Atlantic Ocean.

Euphronides Théel

Syn. *Triconus* Hérouard (partim).

Diagnosis.— Body more or less depressed, especially anteriorly. Skin gelatinous. Mouth and anus ventral. Tentacles increasing from 10–18

during growth. Dorsal side with 4–6 pairs of papillae, placed on the anterior third of the body; the hindmost of these papillae are usually much larger than the anterior. Dorsal unpaired appendage is usually placed at a considerable distance from the posterior end. Tube feet in a double row along the midventral ambulacrum; the lateral are small and numerous, united by a web to a narrow brim. Deposits dorsally, four-armed bodies with outer conical central projection and 4 large conical spines, placed at the bases of the long, inwardly curved arms; ventrally, the deposits are smaller, flatter and with the central projection usually absent or much reduced and the basal spines as mere vestiges.

Type species.— *E. depressa* Théel.

Key to the species known to occur in the Atlantic Ocean

1. Deposits with relative short arms; outer projection ending in four backwardly directed spines, resembling an anchor. Tentacles 15 (imperfectly known) ..... *E. anchora* Hérouard
1. Deposits with long slender arms, more or less strongly arcuated; outer projection conical, exceptionally divided into two outwardly directed spines, but never anchor-like. Tentacles increasing in number to 18 (or 20?) ... 2
2. Usually five pairs of dorsal appendages; the posterior pairs being very large, especially the hindmost. Dorsally, small and large four-armed bodies, 0.28–0.68 mm. in diameter, with large well-developed outer projection; and large basal spines besides other well-developed spines along the arms; ventrally, deposits much smaller, outer projection usually absent, and spines small. Color brownish ..... *E. cornuta* Verrill
2. Usually four pairs of dorsal appendages, of which the hindmost pair alone is large 3
3. Dorsal deposits very large, about 1 mm. in diameter; the spines along the arms relatively fine and small except the basal spine; ventral deposits small and very numerous, with many small spines along the arms, no outer projection. Color whitish to rose-colored .... *E. talismani* Perrier
3. Dorsal deposits intermediate in size between those of *E. cornuta* and *E. talismani*, about 0.55–0.95 mm. in diameter; the ventral deposits very scattered, almost smooth, and smaller than in any other species. Color dark violet ..... *E. violacea* Perrier

Euphronides cornuta Verrill

E. cornuta Verrill, 1884, p. 216; 1883, p. 538, pl. 10, fig. 32; pl. 12, figs. 33, 33a.
E. depressa Théel, partim, 1882, p. 94, pl. 26.
E. depressa var. minor Théel, 1886a, p. 2.

E. auriculata Perrier, 1895, p. 902; 1901, p. 434, pl. 13, figs. 1, 2; pl. 20, figs. 12, 13. Grieg, 1921, p. 8.

About 10 specimens examined

The type specimens from off Delaware and off Nantucket vary much in size; those from the first locality seem to be full grown and are about 19 cm. long, those from the latter are only 6–7 cm. long.

Most of the animals are well preserved, and show perfectly the typical characters of the genus; the flattened ventral side with the brim, which is large anteriorly and narrow along the sides and posteriorly; the ventral mouth is in no case surrounded by more than 18 broad tentacles; a double row of completely retracted feet is developed on the midventral ambulacrum and almost reaches the mouth. Dorsally, we find anteriorly 3 pairs of small papillae and behind these a pair of much larger and finally a pair of very large ones; more posteriorly we find the unpaired dorsal appendage which is very variable in form and size, according to its state of contraction. The color of the animals seems invariably to be a dull brown, darker on the appendages and the tentacles.

Internally we have the typical delicate calcareous ring composed of bundles of rods; a ventrally placed Polian vesicle, a very short, wide stone canal which opens dorsally, and a distinct muscle stomach; intestine partly lost in the specimens examined; musculature broad, peculiarly tapering toward the oral end; this holds especially for the ventrolateral muscle bands. The genital organs are developed as two long stems closely covered with short bundles of fertile tubes.

Deposits.— Dorsally smaller and larger four-armed deposits with strong outer projection and strong basal teeth; the other teeth are also well developed; ventrally much smaller but still spinous, cross-shaped rods, which usually lack the outer projection and have very small remnants of the basal spines. In the tentacles simple, strongly spinous rods.

Type locality.— Off Delaware, "Albatross" station 2,037; depth 1,731 fathoms.

Distribution.— Coast of New England; coast of Morocco and off the Canary Islands and Gibraltar. Depth 1,710–3,470 m.

Euphronides violacea Perrier

E. violacea Perrier, 1896, p. 102; 1901, p. 438, pl. 20, fig. 14.
E. depressa var. *minor* (partim), Théel, p. 2.
Benthodytes assimilis Théel, 1886a, p. 3.

The specimens are not well preserved, but it is evident that they very much resemble the preceding species, but have only 4 pairs of dorsal paired papillae, and the posterior pair of these is not remarkably large; the most striking feature is the reddish violet color. The deposits are very much like those found in *E. cornuta;* the best distinguishing character is the spicules in the ventral integument; they are very scarce, almost flat and smooth and only a little more than half as large as those found in *E. cornuta.*

Type locality.— Coast of Morocco and between Azores and Europe; also from Bequia and Gulf of Mexico.

Depth.— 1,180–4,060 m.

Euphronides talismani Perrier

E. talismani Perrier, 1901, p. 441, pl. 20, fig. 15.

At present not known from any locality in the western part of the Atlantic Ocean but it will probably be found there.

It is distinguished from the two other species by its delicate white to rose-colored integument and its much more spinous surface; its spicules are dorsally slightly larger and more slender and delicate than in the two other species; the spicules in the sole also seem to be larger and more spinous.

Type locality.— Off the Azores; depth 2,220 m.

Euphronides anchora Hérouard

E. anchora Hérouard, 1912, p. 6, fig. 5; 1923, p. 103, pl. 1, fig. 28; pl. 6, fig. 3.

Only the imperfect type specimen is known.

Type locality.— 31° 45′ 30″ N., 42° 42′ 30″ W. Depth 3,465 m. ("Princess Alice"). A locality remarkably far from the coast.

Psychropotes Théel 1882

Diagnosis.— Body more or less flattened anteriorly, where the mouth anteriorly is overhung by a broad brim, formed by numerous dorsal appendages, united by a web. Mouth and anus ventral. Tentacles 10–18. Ventral appendages: in midventral radius, numerous small pedicels, arranged in a double row; laterally few, large conical appendages, posteriorly a few small ones, indistinctly united by a web. Dorsally small insignificant papillae, and posteriorly a large unpaired appendage, tail-like, placed near the posterior part of the back. Deposits

strong, cross-shaped bodies with spines and large outer central projection and smaller cross-shaped bodies with central spine reduced, resembling those found in Euphronides.

Type species.— *P. longicauda* Théel.

At present 3 species have been collected in the eastern Atlantic Ocean, none of them, however, taken by the "Albatross" or "Blake"; they may all be expected in the western part of the Atlantic.

Key to the three Atlantic species

1. Midventral radius devoid of appendages (?).....*P. grimaldi* Hérouard
1. Midventral radius with a double row of small pedicels.....2
2. Deposits dorsally of two kinds; in the outer layer they are large, four-armed, with strong outer spinous projection with the basal spines on the arms almost as large as the central projection; inner layer, simple crosses, spinous, but without central projection and with relatively short arms. *P. buglossa* Perrier
2. Deposits dorsally only of one kind, relatively small four-armed bodies with spinous, arcuated arms and central projection and basal spines relatively short.....*P. fucata* Perrier

P. grimaldi Hérouard, 1896, p. 167, fig. 2; 1902, p. 25, pl. 3, figs. 1, 2.

Type locality.— Azores; depth 4,020 m.

P. buglossa Perrier, 1896, p. 902; 1901, p. 445, pl. 13, figs. 3, 4; pl. 20, figs. 16–28. Hérouard, 1923, p. 105, pl. 1, fig. 32; pl. 6, fig. 2.

Type locality.— Coast of Morocco; depth 2,210–5,005 m. ("Talisman").

Also from Bay of Biscay ("Princess Alice").

P. fucata Perrier, 1896, p. 901; 1901, p. 453, pl. 20, figs. 29–30.

Type locality.— Between Azores and France ("Talisman"); depth 4,165 m.

CYCLIONIDAE Hérouard 1923

Diagnosis, Hérouard, p. 85.—Elasipoda, characterized by at least 12 gigantic appendages which belong not only to the dorsal radial canals, but also to the lateroventral canals, and are arranged like a collar; in some cases this collar is united ventrally so that it forms a complete crown, which looks like a second crown of tentacles. The tentacles are 12–20 in number, peltate, with divided terminal ends. The integument is absolutely devoid of deposits.

The family is divided into two groups *Reptantia* with the two genera

Enypniastes and *Euryplastes*, both Indo-Pacific forms, and *Natantia*, with the single genus *Pelagothuria*, which is represented in both the Atlantic and Indo-Pacific Ocean, but not yet known from the western part of the Atlantic Ocean; only one species is known from the Atlantic Ocean.

Pelagothuria bouvieri Hérouard

P. bouvieri Hérouard, 1906, p. 1–6, fig. 1; 1923, p. 94, pl. 6, fig. 1.

Type locality.— 31° 38′ N.; 42° 38′ W. Between Azores and Africa. Surface.

For further information concerning these aberrant forms, see Hérouard 1923, and Ekman 1926, also Gilchrist, 1920, p. 373.

ELPIDIIDAE

Elpidiinae Ekman 1925

Diagnosis.— Most of the deposits are pointed rods or derivates of these. Four-armed rods are not present. Cloaca usually with caecal appendage.

Four of the genera recognized at present are Atlantic. None of them have as yet been reported from the western part of the Atlantic Ocean, but they are likely to occur there.

Key to the genera known from the Atlantic Ocean

1. Calcareous deposits in the shape of slender rods, slightly spinous with three long, straight, pointed arms in some distance from their ends. Arctic genus. *Elpidia* Théel (partim)
1. Calcareous deposits simple, straight or curved or three-armed.
2. Ten pairs of dorsal appendages ..... *Irpa* Danielssen and Koren
2. At most 3 pairs of dorsal appendages.
3. Three-armed rods; also wheels or C-shaped bodies, or both *Periamma* Perrier
3. No three-armed deposits.
4. Spinous rods and reticulated plates ..... *Kolga* Düben and Koren
4. Spinous rods and C-shaped bodies ..... *Ellipinion* Hérouard

Elpidia Théel

Diagnosis.— Ten tentacles; lateroventral ambulacra, with large pedicels; dorsal side with papillae arranged in pairs. Deposits, slender,

straight rods with 3 straight arms diverging from one point near each end; in some cases also small hat-like wheels.

Type species.— *E. glacialis* Théel.

According to Hérouard's rearrangement (1923) of the Elpidinae, this genus contains only one specimen. It is, however, a question whether it really is identical with the specimen which Théel mentions from the Southern Ocean which has somewhat deformed, partly dissolved spicules and lacks the small hat-like wheels. I feel almost sure that a revision will show that the two specimens belong to different species. The typical North Atlantic *E. glacialis* seems never to pass the ridge which separates the Arctic water from the North Atlantic area.

Irpa Danielssen and Koren 1877

Diagnosis (translated), with some additions.— Body almost cylindrical, bilateral. Mouth almost terminal; anus posterior; ten short fingerlike laciniated tentacles; along the sides of the body 9 pairs of stiff nonretractile feet, and 3 pairs of similar feet round the posterior part of the body. Two rows each, with 4 papillae, and between them a pair of papillae is found in the nuchal region on the dorsal side. Deposits, rods, straight or curved, simple or branched.

Type species.— *I. abyssicola* Danielssen and Koren

Exclusively Arctic. Only one species is known.

I. abyssicola Düben and Koren, 1878, p. 257, pl. 4. Ludwig, 1901, p. 141 (complete list of references). Hérouard, 1923, p. 82.

Kolga Düben and Koren 1879

Diagnosis, translated.— Body bilaterally developed. Oral disk with 10 tentacles and ventrally directed. Anus dorsal. A projecting collar on the anteriormost part of the back, provided with papillae; just in front of the collar we find two openings, one for the genital organs and one for the stone canal. Pedicels arranged laterally and posteriorly. The sexes are separate. No appendix to the intestine.

Type species.— *K. hyalina* Düben and Koren.

Arctic Sea. Also from between Iceland and Norway.

Key to the two known species

1. Dorsal appendages placed on a common, slightly curved ridge. Seven to nine pedicels on each side. Rosettes and plates beside the C-shaped bodies and straight rods. Five rods in each piece of the calcareous ring.

   K. hyalina Düben and Koren

1. Dorsal appendages arranged in two parallel series. Eight to nine pedicels on each side. No rosettes and reticulated plates. Ten rods in each piece of the calcareous ring ..... *K. nana* (Théel)

K. nana Théel, 1882, p. 39, pl. 2, figs. 3, 4; pl. 33, figs. 1, 2; pl. 34, fig. 5; pl. 36, fig. 25; pl. 42, figs. 5, 8. Ludwig, 1898, p. 12; 1901, p. 140.
Elpidia nana Théel, 1879, p. 15, pl. 2, figs. 20–22.

Type locality.— 42° N., 64° W. Probably also from the Antarctic part of the Indian Ocean (ab. 61° S., 80° E.).

K. hyalina Düben and Koren, 1879, p. 83–106, pls. 1, 2; 1882, p. 3–20, 80, pls. 1–3. Théel, 1882, p. 39. Ludwig, 1898, p. 12; 1901, p. 140. Hérouard, 1923, p. 82.

Ellipinion Hérouard 1923

Syn. *Scotoplanes* Théel (partim)

Diagnosis, from Hérouard.— Elpidids, with spicules of the 3-armed type, with 2 other kinds of deposits in the integument, namely straight rods with spinous ends and C-shaped bodies, simple or with a vestige of a third arm as a small apophysis on the convex side of the spicule. Body egg-shaped, the anterior end tapering. Nuchal group of dorsal appendages present, usually forming an asymmetrical deformation.

Type species.— *E. delagei* Hérouard.

Key to the species known from the Atlantic Ocean

1. Pedicels 8 in number on each lateral ambulacrum. Dorsal side with two pairs of small processes, united to a transversal ridge and behind these a pair of very small papillae ..... *E. papillosus* (Théel)
1. Pedicels more than 8 in each lateral ambulacrum.
2. Ten to eleven pedicels in each later ventral ambulacrum. Anteriorly some very small dorsal papillae ..... *E. albida* (Théel)
2. Twelve lateroventral pedicels. Dorsally 3 pairs of equally large papillae, placed in two rows parallel to the longitudinal axis of the body. *E. delagei* Hérouard

E. papillosus (Théel) (Scotoplanes).

Type locality.— 36° 44′ S., 36° 16′ W.; depth 4,823 m.

E. albida (Théel) (Scotoplanes).

Type locality.— 36° 48′ S., 19° 24′ E.; depth 3,473 m.

E. delagei Hérouard.

Type locality.— Off the Azores; depth 1,165–1,385 m.

None of the species have yet been taken in the western part of the Atlantic Ocean.

Perriamma Perrier 1901

Diagnosis, Perrier, 1901, p. 417.— Body slightly elongate or egg-shaped, at most two and a half times as long as broad; 10 tentacles. Dorsal side on its anterior part presenting a transversal row of 3–4 papillae sometimes distinct, sometimes adjoining, sometimes fused into a voluminous transverse four-lobed appendix.

Immediately behind these papillae a small number of isolated very small papillae are found on the dorsal ambulaera. Ventral sides each with a lateral row of pedicels which usually are developed behind the middle part of the body. Triradiate bodies, together with sigmaes.

Type species.— *P. roseum* Perrier.

Key to the species known from the Atlantic Ocean

1. Six posteriorly placed feet; 2 pairs of dorsally placed small papillae not united by a web; a smaller one is found posteriorly (only on one side in the type) *Perriamma ludwigi* (v. Marenzeller)
1. Nine feet placed in almost the entire length of the ventral side; dorsal papillae united to a veil.
2. Arms of triarmed rods about 93–174 μ in length; besides large spinous simple or dichotomously divided rods ..... *P. roseum* Perrier
2. Arms of triarmed rods about 31 μ in length; apparently no simple large rods present ..... *P. furcata* (Hérouard)

Perriamma ludwigi (Kolga) (v. Marenzeller), 1893, p. Hérouard, 1923, p. 83.

Type locality.— Eastern Mediterranean; depth 1,293 m.

Periamma furcatum (Kolga) Hérouard, 1899, p. 171, fig. 2; 1902, p. 40; 1923, p. 91, pl. 3, fig. 7; pl. 6, figs. 4–10; pl. 8, fig. 17.

Type locality.— Near the Azores; depth 1,846 m.

Periamma roseum Perrier, 1896, p. 901; 1901, p. 419, pl. 13, figs. 10–12; pl. 20, figs. 1–11. Hérouard, 1923, p. 91.

Type locality.— Between Azores and Europe; depth 4,060–5,005 m. Also from Bay of Biscay.

Peniagoninae Ekman 1925

Diagnosis.— The dominant type of calcareous deposits is 4-armed, with 1–4 outer projections, derived from primary crosses.

Six genera are recognized at present (see Hèrouard, 1923); only two of these are known from the Atlantic Ocean.

Key to the two genera

1. Dorsal appendages small or large, usually developed as a veil, but this is never forward projecting as if it was a prolongation of the body; body not especially flattened ..... *Peniagone* Théel
1. Dorsal appendages united to an enormous veil, which projects forward as a prolongation of the body; body extremely flattened .... *Scotanassa* Théel

Peniagone Théel (partim) 1882

Revised diagnosis, based upon Hérouard's results.— Lateral feet more or less numerous, sometimes absent on the part of the ambulacra which is nearest the mouth. Distinct nuchal thickening with 2 anterior pairs of papillae, which are either free or united by a larger or smaller web into a veil; 1 or 2 posterior pairs of atrophying papillae may be present behind the veil.

Deposits, derived from primary crosses with 4 more or less strongly inward bent arms and 4 outer, short to long projections; deposits smooth or covered with fine spines.

Type species.— *P. wyvilli* Théel.

Type in the British Museum.

The "Albatross" expeditions secured only 2 poorly preserved specimens of *Peniagone*, from the West Indian region, and I have been unable to identify them.

At present we know 9 species from the Atlantic Ocean, most of which may be expected from the West Indian region and off the coast of the United States, and a key has therefore been given, as well as references to the literature.

Key to the Atlantic species of Peniagone

1. Deposits in the body wall of two kinds; dorsally the usual type, with four inward bent arms and four slender outwardly directed projections, all completely smooth; ventrally, simple cross-shaped, robust, and very spinous rods. Dorsal veil large; number of ventral feet unknown. *P. vexillum* Perrier
1. Deposits in body wall all of the typical form, both dorsally and ventrally; a few simple cross-shaped bodies may also occur among the typical, usually located in the deeper layer of the integument. (Similar rods are often present in tentacles and in appendages.) 2
2. Short, almost ovoid forms, with appendages distributed in almost the entire length of the lateral ambulacra 3
2. More or less elongate forms, with a distinct diastema between the oral disk and the pedicels 6

3. Veil very small, only a basal web uniting the four small papillae; a third pair of very small papillae is placed behind the veil. In each lateral ambulacrum 9 appendages, slightly decreasing in size toward the anal end. Deposits of almost equal size dorsally and ventrally, large and robust, with relatively short outer projections, covered with numerous spines, especially toward the ends of the arms and the outer projections. In tentacles, simple spinous rods ..... *P. porcellus* Perrier

3. Veil well developed to very large 4

4. Veil well developed but not forming an enormous anterior hump, or overhanging brim; it is composed of two pairs of papillae which are almost completely united by the web, only the tips are free; the median are very closely placed; a single papilla is placed on each side at the base of the veil. Five pairs of large pedicels in each lateral ambulacrum, arranged in groups of two anterior and three posterior. Deposits small and delicate, with few spines; arms of deposits only slightly bent; in the deeper layer also simple cross-shaped rods ..... *P. obsoleta* (Hérouard)

4. Veil enormous, forming a large anterior hump-like portion or an overhanging brim 5

5. Veil deeply cleft into four parts, two pairs of small papillae placed behind the basis of the veil. Six large pedicels on each side, almost reaching the oral opening; 2–3 very small appendages are found near the posterior end. Deposits of the usual type, large and strongly spinous; many are developed as cross-shaped bodies, some are irregular with 5 arms, etc. In the tentacles and appendages, simple or cross-shaped rods . . *P. wyvilli* Théel

5. Veil flattened, overhanging the oral end as a large brim, laterally developed as a narrow brim, anteriorly not cleft. Seven pedicels along each side of the ventrum, the two hindmost rather small. Deposits with almost straight, smooth arms. Outer projections considerably longer than the arm itself ..... *P. foliacea* (Hérouard)

6. Veil large, forming a conical hump on the anterior part of the body, not incised; number of accessory papillae not known. Five to six pairs of pedicels, widely spaced, placed on the two posterior thirds of the body. Deposits of the usual type; arms slightly bent, with minute spines. Color dark ..... *P. lugubris* Théel

6. Veil small.

7. Veil divided into two parts to the basis, each part composed of two papillae. Nine pedicels on each side, of almost equal size, placed on the posterior two thirds of the body; also three small appendages, united by a web, are found round the posterior end. Deposits of the usual type, but the outer projections on the ventral deposits are distinctly much shorter than those on the dorsal deposits; finely spinous ..... *P. azorica* v. Marenzeller

7. Veil either undivided or divided into four parts 8

8. Veil deeply incised, divided into two parts; 2 pairs of posterior basal papillae are present. Five pairs of equally large pedicels present on the posterior half of the body, and also 2–3 very small ones beneath anus. Deposits

of the typical form, outer projections only slightly shorter than the arms; covered with spines ..... *P. ferruginea* Grieg

8. Veil not divided, margin only serrate, composed of 3 pairs of papillae, the basal pair also united to the web. Five pairs of large pedicels and 4 pairs of much smaller, posterior ones. Well-developed diastema. Deposits with outer projections as long as the arms and slightly stouter and more spinous; arms elegantly curved with very delicate spines, often almost smooth ..... *P. islandicus* sp. nov.

P. obsoleta Hérouard, 1899, p. 170, fig. 1; 1902, p. 41, pl. 6, figs. 11–15; pl. 8, fig. 16, 18; 1923, p. 80.

Between Azores and Portugal; depth 4,360 m.

P. wyvilli Théel, 1882, p. 42, pl. 10, figs. 3, 4. Perrier, 1901, p. 426. Hérouard, 1923, p. 80. Grieg, 1921, p. 8.

From "Challenger" station 271, 0° 33′ S., 151° 34′ W.; depth 2,425 m. Also taken by "Michael Sars" (Grieg, 1921).

P. foliacea Hérouard, 1912, p. 3, figs. 3, 4; 1923, p. 86, pl. 1, fig. 31; pl. 9, figs. 1, 2.

Off Madeira, depth 4,275 m.

P. lugubris Théel, 1882, p. 44, pl. 10, fig. 1. Hérouard, 1923, p. 80.

From "Challenger" station 104 (lat. 2° 25′ N., long. 20° 1′ W.; depth 2,500 fms.).

P. azorica v. Marenzeller, 1893, p. 12, pl. 1, fig. 4; pl. 2, fig. 5. Hérouard, 1902, p. 42, pl. 6, figs. 21–26; 1923, p. 80.

Near Azores (l'Hirondelle), depth 2,870 m.; also from south off Iceland ("Ingolf").

P. ferruginea Grieg, 1921, p. 7, pl. 1, figs. 4–6, text-fig. 3.

"Michael Sars," depth 2,800–3,000 m.

P. islandicus Deichmann.[1]

South off Iceland, "Ingolf" station 18, 61° 44′ N., 30° 29′ W.; depth 1,135 fms.

P. vexillum, Perrier, 1900, p. 118; 1901, p. 429, p. 13, fig. 6; pl. 19, figs. 24, 25. Hérouard, 1923, p. 80.

Locality unknown.

P. porcellus Perrier, 1896, p. 901; 1900, p. 118; 1901, p. 426, pl. 13, figs. 7–9; pl. 19, figs. 15–23. Hérouard, 1923, p. 80.

Between Azores and France; depth 4,060 m.

[1] [Description to be supplied later.]

Scotoanassa Théel 1882

Diagnosis, partly after Hérouard, 1923, p. 79.— Lateral feet restricted to the posterior part of the body, leaving a very large empty diastema between them and oral part. Two pairs of dorsal papillae are present united to a large veil, and directed forward, placed in the same plane as the rest of the body. Extremely flattened form in adult condition. Anus dorsal.

Deposits.— Four-armed with four outer projections.

Type species.— *S. diaphana* Théel.

Only one species is at present known from the Atlantic Ocean, as yet unreported from the western part.

Scotoanassa translucida Hérouard

S. translucida Hérouard, 1899, p. 172, fig. 3; 1902, p. 43, pl. 3, figs. 4–6; pl. 6, figs. 17–20; 1923, p. 88, pl. 3, figs. 7, 8; pl. 4, fig. 4.

Four pairs of conical pedicels or papillae, placed on the posterior rounded portion of the body. Deposits strong, of the typical form; the terminal part of the arms and projections are covered with fine spines.

Type locality.— Near the Azores; depth 4,000–5,000 m.

Also off the north coast of Spain and west of Ireland.

This form is interesting because Hérouard (1923) describes some 0.5 cm. long specimens which apparently are at the end of their larval period, resembling the "pentacta stage" described in the Dendrochirota and Synaptidae.

DENDROCHIROTA Grube 1840

Diagnosis.— Appendages present; tree-shaped tentacles; tentacle ampullae absent or small. Retractor muscles present. Respiratory trees present, sometimes connected with the alimentary canal through a rete mirabile. Stone canal hanging free into the body cavity. Mesentery of the posterior intestinal loop in left or right interradius. Genital organs in tufts on both sides of dorsal mesentery. No Cuvierian organs. Deposits of various kinds, as baskets, buttons, plates, tables and rods.

In the western part of the Atlantic Ocean occur the following genera: The very closely related and not well-separated genera *Cucumaria, Thyone, Pentacta, Pseudocolochirus* and the sharply defined *Echinocucumis* and *Sphaerothuria*, all belonging to the family *Cucumariidae;* further the well-defined genera *Psolus* and *Thyonepsolus*, belonging to the family *Psolidae;* and finally the heterogeneous group *Phyllophoridae,*

which probably will be divided into several genera; at present only the genus *Phyllophorus* is known from the western Atlantic.

Only a provisional diagnosis has been given for *Cucumaria* and *Thyone*, as the line between these two genera at present is not established. Specimens with few appendages are usually referred to *Cucumaria*, with many to *Thyone*. In the future they will become divided into several genera, with the calcareous deposits as well as the general anatomical features as the distinguishing characters.

In this paper is not included the Atlantic form of *Cucumaria abyssorum* Théel, taken in deep water off the Azores (Hérouard) and south of Iceland ("Ingolf" expedition, not published) (see Mortensen, 1927, p. 396, footnote 2). The species has not yet been taken in the western part of the Atlantic Ocean.

Key to the genera of Dendrochirota which are known from the western part of the Atlantic Ocean

1. Ventral side flattened into a distinct sole 2
1. Ventral side not flattened into a distinct sole 3
2. No appendages on the dorsal side except the papillae around anus and on the introvert; dorsal side covered by scales, naked or with grains. *Psolus*
2. Several appendages on the dorsal side, which is covered by scales and an outer thick layer of various deposits, partly concealing the scales. *Thyonepsolus*
3. Tentacles more than 10 ..... *Phyllophorus* 4
3. Tentacles not more than 10 5
4. Tentacles in 2 circles arranged in pairs; the pairs in the inner circle much smaller than the pairs in the outer circle ..... [*Thyonidium*]
4. Tentacles in 2 circles, not arranged in pairs; the inner circle contains 5 tentacles, somewhat smaller than those in the outer circle, which are unequal in size ..... [*Phyllophorus*]
5. Body globular, covered by scales, with large projecting spine 6
5. Body not globular, covered by scales 7
6. Spire mostly eccentrically placed; scales consist of perforated simple plates. *Echinocucumis*
6. Spire centrally placed; scales consists of plates with several layers of meshwork ..... *Sphaerothuria*
7. Appendages numerous all over the body ..... *Thyone*
7. Appendages not numerous all over the body 8
8. Dorsal appendages well developed, not few and papilliform ..... *Cucumaria*
8. Dorsal appendages and those around oral and anal opening few and papilliform 9
9. Skin soft with few deposits ..... *Pseudocolochirus* gen. nov.
9. Skin rigid with numerous deposits ..... *Pentacta*

Phyllophorus Grube 1840

Diagnosis.— Feet uniformly distributed; tentacles normally 20, arranged either in 5 outer larger pairs and 5 inner pairs, or in 2 indistinctly separated circles, with 15 tentacles in the outer circle and 5 slightly smaller ones in the inner.

Deposits, usually tables, with 4 or 2 rods in spire; in some species the deposits are reduced with advancing age; large end-plate in the feet, but no supporting rods; often rosettes in introvert; perforated plates on tables occur in some species.

The group might possibly be split into two: *Thyonidium*, with tentacles distinctly in alternating pairs, and *Phyllophorus* with 15 outer and 5 inner tentacles, but our knowledge about these animals is still so imperfect that such a division is not at present desirable.

Key to the species of Phyllophorus known from the west Atlantic region

1. Deposits: thick, discoidal bodies, with serrate margin and few (about 4) perforations, and a number of minute conical knobs. Short, stout radial projections on calcareous ring ..... *Ph. dobsoni* Bell
1. Deposits: tables or plates derived from tables 2
2. Table with 4 equally large central holes, and usually 4 distinct rods in spire, occasionally only 3, or spire entirely reduced 3
2. Tables with 2 equally large central holes; disk more or less elongate; 2 rods in spire, sometimes reduced to 4 knobs 6
3. Calcareous ring high; radials squarish, with short posterior prolongations; interradials overlapping the radials, posteriorly rounded, anteriorly tapering. Tables with squarish disk with about 12 holes in the margin. In the introvert more irregular table and rosettes. *Ph. seguroensis* sp. nov.
3. Calcareous ring, low, simple 4
4. Deposits: tables with regular disk, with about 8 holes in margin. Tentacles not in pairs ..... *Ph. conchilegum* Pourtalès
4. Deposits: tables with irregular disk; deposits often reduced, except in the introvert. Tentacles in pairs 5
5. Tables delicate, with high fragile spire with 3 or 4 rods, ending in few teeth. *Ph. communis* (Forbes)
5. Tables robust, with low spire ending in numerous teeth. *Ph. pellucidum* (Fleming)
6. Margin of tables dentate, spire often reduced to 4 low knobs. *Ph. occidentale* Ludwig
6. Margin of tables smooth 7
7. Long, well-developed tails on calcareous ring; usually 2 large and 6 slightly smaller holes in disk of tables ..... *Ph. destichadus* sp. nov.

7. Short tails on calcareous ring, interradials overlapping the radials 8
8. Smooth, oval outline of disk; 8 large holes and 2 small ones. Spire well developed . . . . . *Ph. parvum* Ludwig
8. Undulated outline of disk; 4 holes. Rudimentary spire . . *Ph. tritus* (Sluiter)

Phyllophorus dobsoni Bell

Phyllophorus dobsoni Bell, 1883, p. 60, p. 15, figs. 5, 5a, b. Lampert, 1885, p. 179. Théel, 1886, p. 151.

Redescription of the type.— A large specimen, about 8 cm. long, barrel-shaped; mouth and anus terminal, dorsally directed; feet conical, but with well-developed end plate, distributed over the entire body, more sparingly dorsally. Twenty slender tentacles, with 15 in the outer and 5 slightly smaller in the inner circle, not much branched. Color brownish; whitish where the pigment is rubbed off.

Calcareous ring high, very solid and with short, stout posterior prolongations on the radials; interradials with long anterior tooth and slightly excavated posteriorly. According to Bell, two Polian vesicles are present; they seem to have been torn off; one dorsally attached stone canal. Muscle stomach seems not to be well developed; intestine very long, collapsed, incomplete. Well-developed respiratory trees, laterally attached. Muscle bands strong, projecting like ridges into the body cavity. Two tufts of very numerous genital tubules, filled with eggs, are attached close behind the vascular ring.

Deposits very characteristic: rough, roundish buttons with 4 or more holes, apparently derived from rosettes. Besides these, only well-developed end plates; in introvert rosettes; in tentacles small rods.

At present only known from the Bay of Honduras (Dobson). The unique type is in the British Museum.

Remarks.— It is very likely that this form possesses tables in younger stages.

Phyllophorus seguroensis sp. nov.

Plate 17, figs. 10–13

The 10 specimens examined are 5–6 cm. in length. They resemble very much *Thyone suspecta* and *gemmata* in their outer shape, arrangement of appendages and coloration, but usually some of the feet will be sufficiently expanded to show that they are soft, collapsible, without any supporting rods. Tentacles 20 in alternating pairs; 5 small anal teeth hidden under 5 groups of slender papillae. Skin soft but finely rough to the touch; color brownish with paler appendages, the general effect of the animal is mottled.

Internally a high calcareous ring; radials almost rectangular with a broad, deeply furrowed anterior tooth and a small posterior incision, no true posterior prolongations; interradials overlapping the radials; posteriorly cut off in an almost straight line; anteriorly provided with a long, tapering tooth. Two to three Polian vesicles; a small stone canal; with roundish head, attached in the mesentery; muscle stomach not distinct in the specimen examined; intestine long; the mesentery runs in the dorsal interambulacra, crosses over the left dorsal muscle band just behind the attachment of the retractor, then over the left ventral retractor to the midventral muscle band and runs along its right side to the cloaea; respiratory trees richly branched, placed in lateral interambulacra; musculature fleshy; retractors attached a little anterior to the middle. Genital organs fastened at the same distance from the oral end; they are present as slender tubules in the immature specimen examined.

Deposits.— Regular tables with 4 central holes and about 12 marginal ones; margin often undulated to blunt dentate; spire built up of 4 rods with one cross beam and ends in numerous teeth. End plate large; only the bases of the feet covered with tables; the terminal part is devoid of deposits other than the end plate and therefore collapsible. In introvert tables of more irregular form and small rosettes; in tentacles no deposits in the main stem but several perforated rods in the smaller branches; besides numerous large rosettes.

Type locality.— Porto Seguro, Brazil; also collected by Dr. H. L. Clark from Port Antonio, Jamaica, and Tortugas, Florida, so we may conclude that it is quite a common species in the western part of the West Indian region.

Type in the Museum of Comparative Zoölogy, no. 856.

It occurs near low tide mark, in shallow water.

Phyllophorus conchilegum (Pourtalès)

Plate 17, figs. 14, 15

Thyonidium conchilegum Pourtalès, 1868, p. 128; 1869, p. 359, 361.

Specimens 3–4 cm. long have been examined, all in a very bad condition for more detailed anatomical study. Tentacles 20, of very unequal size, apparently arranged 15 in the outer and 5 in the inner circle. Feet relatively large and few, scattered without order; integument thin, wrinkled, resembling tissue paper; texture of skin finely rough to the touch; color whitish.

Calcareous ring simple; radials rectangular, high, with broad, deeply furrowed anterior tooth and low posterior prolongation; interradials low with long pointed anterior tooth, and deeply excavated posteriorly. Most other anatomical features not suitable for examination; the retractors are very long, attached near the middle of the body; the genital organs, which are ripe and filled with eggs (taken in May), form short, thick, fingerlike tubes, attached to the body wall, anterior to the middle of the animal.

Deposits.— Regular tables with 4 central holes and smooth thick disk with about 8 marginal holes; spire well developed with 4 rods and one cross bar and ending in numerous teeth. End plate well developed; the tables cover the feet completely and seem thereby to prevent the complete retraction of these. In the introvert, tables and perforated plates; in the tentacles, perforated plates.

Type in the Museum of Comparative Zoölogy, no. 259.

Type locality.— Off Sand Key, Florida, 100–120 fathoms; other specimens are labeled Florida Keys, 174–189 fathoms.

Phyllophorus communis (Forbes)

Plate **17**, figs. 16, 17

Cucumaria communis Forbes, 1841, p. 217, text-fig.
Thyone drummondi Forbes, 1841, p. 223, text-fig. *T. portlocki*, ibid., p. 238.
Thyone commune Düben and Koren, 1844, p. 214, p. 304, pl. 11, fig. 51.
Duodasmodactyla productum Ayres, 1854, p. 244. Stimpson, 1857, p. 17.
Orcula punctata Selenka, 1867, p. 353, fig. 112 (Agassiz, 1851, nomen nudum). Théel, 1886, p. 150.
Phyllophorus drummondi Ludwig (partim), 1901, p. 155.
Thyonidium dübeni Normann, 1868, p. 317.
Thyonidium productum Clark, 1901, p. 494.

Grows to a length of about 15 cm. Slender form; outer appearance varies much with the age of the animal.

Tentacles 20, distinctly arranged in 5 outer large pairs and 5 inner small pairs; tentacles in inner pairs mutually well separated. Feet of medium size, most densely distributed along ambulacra, more thinly scattered in interambulacra, still with a tendency to be absent on a narrow strip of the latter, and different stages of contraction make this character more or less obvious. Skin in young specimens thin, parchment-like, never transparent, and quite leathery in consistency, in old specimens very smooth, thick and fleshy. Color whitish or yellowish; usually the tentacles and some part of the oral end are violet.

Internal features.— A simple calcareous ring without any posterior prolongations; radials with very long squared anterior tooth and irregular incision in the posterior margin; interradials with a pointed anterior tooth, almost as long as the radial tooth. Polian vesicles 1–2 long; a very small stone canal coiled up in the mesentery. Apparently no muscle stomach; mesentery running in the dorsal interambulacra, almost reaching to the cloaca, then running forward to the bases of the retractors, across the two left muscle bands and finally running backward along the left side of the midventral muscle band. Respiratory trees with long, slender secondary branches, laterally placed and almost reaching the attachment of the retractors. Muscle bands relatively thin except in very large, senile specimens, where they are thick and fleshy; retractors almost reaching the middle of the body cavity. Genital organs attached near the middle along a 1 cm. long band (in specimen 10 cm. long); they appeared not quite ripe, and were only a few cm. in length, divided once, near the base.

Deposits.— Only in a very small specimen, tables were found in the body wall; usually they are restricted to the introvert; they have a delicate irregular disk with several holes and a high spire composed of 3–4 slender rods, united near base and top and ending in a few teeth. In old specimens the spire may be completely reduced or deposits may be entirely absent. The feet contain a well-developed end plate in young specimens, but it disappears in older ones, and the pedicles appear as soft, short threads. In the tentacles a few perforated plates or no deposits at all.

Type locality.— Coast of Ireland.

Type not existing.

Quite common along the coast of New England and Newfoundland. Its exact range in European waters cannot be made out at present.

Selenka's *Orcula punctata* is identical with this species, and was recorded from Charleston by mistake; his type specimen was from Eastport, Maine.

About its habits, Ayres says (of *Duodasmodactyla productum*): "This species is found in deep water, but occurs most frequently under stones or buried to a slight depth in gravel near low water mark. In fact, if distinct, it is at least very closely related to their (Düben and Koren's) *Thyonidium pellucidum*."

Remarks.— This species and the following have often been united, and it has for a long time been an open question whether we were dealing with several distinct species or one very variable form (see Ludwig, 1901 and Mortensen, 1910). The conclusion to which I have

finally arrived, after having had the opportunity of examining all the specimens of these forms represented in the United States National Museum, Washington; Museum of Comparative Zoölogy, Cambridge; British Museum, London, and the Zoölogical Museum of Copenhagen, is that Düben and Koren, in 1844, described these two species in a very clear manner and gave excellent figures of the spicules which better than words show the actual differences.

The name *Ph. communis* given by Forbes is to be preferred for *Ph. drummondi* Thompson, which is one year older, because it is evident that Forbes described *Ph. communis*, whereas it may be that Thompson's species was identical with *Ph. pellucidum;* his description is not clear. Forbes regarded as different species (*drummondi, portlocki*) the old and senile specimens of *Ph. communis*, which look very different.

Phyllophorus pellucidus (Fleming)

Holothuria pellucidum Fleming, 1828.
Cucumaria hyalinum Forbes, 1841.
Pentactes pentacta Oersted, 1833.
Orcula barthi Troschel, 1846. Lütken, 1857, p. 9. Duncan and Sladen, 1882, p. 8. Ludwig, 1901, p. 152 (complete list of lit.).
Thyonidium pellucidum Düben and Koren, 1844, p. 217, pl. 4, figs. 15–17; p. 303, pl. 11, fig. 57. Théel, 1886, p. 146.
Phyllophorus pellucidus Ludwig, partim, 1901, p. 153 (complete list of litt.).
Not *Thyonidium conchilegum* Pourtalès, as suggested by Théel (1886, p. 146) with some doubt.

Maximum length seems to be 10–15 cm. Outer aspect very variable, usually tapering, sometimes barrel-shaped; tentacles 20, in 5 outer large pairs and 5 inner small pairs; the 2 tentacles in each inner pair are so closely placed that they may be mistaken for a single, deeply cleft tentacle,[1] and such specimens have sometimes been referred to the genus *Orcula*, with 15 tentacles, which, as far as I can see, has no real existence.

The feet are large, almost uniformly distributed over the body; an indication of a serial arrangement along the ventral ambulacra may be observed in some specimens; skin, when expanded, semitransparent; in old contracted specimens it is thick, soft, opaque in section; color whitish to brownish.

Internal anatomy like that of *Ph. communis*, but the calcareous ring is, even in the oldest specimens, firm, showing no signs of degeneration.

[1] Ljungman 1879, p. 129, and Ludwig 1886, p. 276, have noted this peculiarity.

Deposits.— In young specimens the entire surface is covered with stout tables with large irregular disk and low, strong 3–4 pillared spire ending in numerous strong teeth; the deposits are reduced during age; sometimes they are retained in the introvert, in other cases they disappear completely; end plate large and well developed in young specimens, absent in old.

In young specimens the tables are characteristic enough to separate this species from *Ph. communis;* in old specimens the large feet and the solid, firm and elegantly shaped calcareous ring are the only reliable distinguishing characters.

Type.— Not preserved.

Common in Scandinavian waters, also around Great Britain, the Faeroes, Iceland and Greenland.

Recorded several times from the coast of Labrador; a few small specimens in United States National Museum are labeled "off Newfoundland," and the species may be expected also along the coast of New England.

Phyllophorus destichadus sp. nov.

Plate 18, fig. 3

Two well-preserved specimens, 4–6 cm. long with body slightly curved; a robust form with numerous strong feet almost uniformly scattered over the entire surface; tentacles apparently 17, but most likely some have been lost; they are arranged without order, small and large together. Skin solid, thick, soft to the touch; color brownish to violet; oral and anal ends paler.

Calcareous ring forms a high narrow tube with long rectangular radials with broad anterior tooth and short posterior prolongations; the interradials are slightly shorter, cut off at a straight line posteriorly, and constricted in front to a long tooth which proceeds forward to the same level as the radial teeth. One small Polian vesicle; one small, dorsally embedded stone canal; apparently no muscle stomach, but the intestinal tract was torn off just behind the vascular ring so it may have been present; course of intestine as usual, the third loop runs along the left side of the midventral muscle band. Respiratory trees richly branched, each divided into two large stems, spreading over and attached to the lateral interambulacra and lateroventral muscle band; musculature fleshy, forming narrow ridges in the body cavity; retractors short, attached distinctly in front of the middle of the animal; genital organs form two tufts of very numerous, thin,

closely packed tubules, which are attached near the middle of the dorsal midline. In one of the specimens examined the respiratory trees were deep violet in color.

Deposits.— Tables with oblong smooth disk with 2 large central holes and 3 slightly smaller in each end; spire composed of two rods, ending in 8–12 teeth. End plate well developed; no supporting rods, the tables covering the feet almost to the end plate; in introvert tables of almost the same type, and rosettes; in tentacles small rods.

Type in Museum of Comparative Zoölogy, cat. no. 1,201.

Type locality.— Tortugas, Florida (Clark). Collected in shallow water in eel grass at low tide.

Remarks.— This species belongs in the same section of the genus as *occidentale*, *parvum*, and *tritus* but is easily distinguished from Ludwig's two species by the tables, and from *tritus* by the calcareous ring being much better developed.

Phyllophorus tritus (Sluiter)

Plate 18, figs. 4–8

Thyone trita Sluiter, 1910, p. 339, text-fig. Ea, c. Deichmann, 1926, p. 24.

One specimen 3 cm. long was examined; 18 tentacles of unequal size could be counted, possibly 2 small ones have escaped my attention; they are very soft and very difficult to count. Feet numerous, not retracted, uniformly distributed over the entire surface; color grayish brown, skin soft to the touch. Internal anatomy as Sluiter describes it; calcareous ring with short, stout posterior prolongations on the radial pieces; interradial pieces slightly overlapping the radials, with broad anterior tooth, posteriorly slightly undulated, broadest at the middle.

Genital organs as divided tubules, 0.5 cm. long, attached near the middle of the body on a short genital basis. Other features as in the other members of the genus.

Deposits, in spite of the soft skin, rather numerous, developed as oval, four-holed tables with smooth to scalloped margin, often with 4 small accessory holes; spire two-pillared, very low, practically absent and with a few long teeth at the end of each of its 2 short pillars. In the feet a large end plate, no supporting rods at all, only a few typical tables. In the introvert, tables with smooth outline and usually 4 large and 4 small holes; spire somewhat higher and better developed; in tentacles rosettes and a few small delicate rods with a few perforations or a single hole in each end.

Type locality.— Tortugas, Florida.

Type in Berlin.

Also recorded from English Harbour, Antigua (W. K. Fisher).

Remarks.— I have not seen Sluiter's specimens, but my suspicion was awakened (after I had worked out all the West Indian species of *Phyllophorus* and *Thyone*), because Sluiter says nothing about supporting rods in the feet; their absence being a most unusual feature in *Thyone*. Through the kindness of Dr. Dayton Stoner of the University of Iowa, I have had the opportunity to reëxamine the specimen which I previously had determined as *Thyone trita*, and when the oral tract was opened my suspicions were confirmed by the presence of at least 18 tentacles.

Phyllophorus occidentalis Ludwig

Plate **18**, figs. 1, 2

Thyonidium occidentale Ludwig, 1885 (Nachtrag).
Thyone constituta Sluiter, 1910, p. 340, text-fig. E. Deichmann, 1926, p. 24.

Translation of Ludwig's description.— "The specimen is about 4 cm. in length and measures 2 cm. in diameter at the middle; the color is uniformly brown. A serial arrangement of the feet is indicated along the radii, and they are also spread uniformly over the entire body. The tentacles are arranged in a characteristic manner, namely 5 larger pairs 8–10 mm. long, alternating with 5 smaller pairs, only 1.5–3 mm. long. In the skin, which is rather soft to the touch, we find numerous deposits which are all of the same type; they are in the form of tables; the disk is well developed with scalloped margin (recalling those of *Ph. holothuroides*), whereas the spire is reduced to 4 low spines, united at their bases; the average length of the deposits is 0.045 mm., height 0.017 mm.

The calcareous ring is 7 mm. in height and composed of 10 pieces, 5 radials and 5 interradials; posteriorly a small piece is intercalated between radials and interradials; the latter are irregular, diamond-shaped; the radials are anteriorly provided with an incision and posteriorly prolonged into two short tails, composed of small calcareous plates. Two Polian vesicles are attached at left to the water vascular ring, one of these being 16 mm. long, the other 8 mm. The single stone canal is attached to the mesentery and ends in a globular head; the first part of it is coiled into several short loops; the head of the stone canal is 8.5 mm. away from the point of issue of the stone canal; the retractors are rather well developed and inserted between the first and second third of the body length, the introvert not being counted. The

long (about 24 mm.), delicate, unbranched genital organs are numerous and form a large tuft on each side of the mesentery; they are attached near the middle of the body."

Type locality.— Surinam.

In the Museum of Comparative Zoölogy several specimens are present which evidently belong to this species and are also identical with Sluiter's *Thyone constituta*, in which latter form the actual number of tentacles has been overlooked. It would be extraordinary to find a *Thyone* with deposits derived from tables but lacking supporting rods formed like elongate tables. Moreover, Sluiter's figure of the calcareous ring corresponds exactly with Ludwig's description.

Very little can be added. Examination of several specimens shows that the posterior accessory plates, belonging to the interradials, are not always well separated in all parts of the ring. Other anatomical features, as in other species of *Phyllophorus*, belonging to this group. The end plate is well developed and a few, very delicate rods may be found in some of the feet. In the introvert we find tables of the same type as those in the body wall; and, moreover, rosettes; in the tentacles tables; in the stem and in the remaining part, rosettes and very delicate rods.

Ranges from Porto Seguro, Brazil and Surinam to English Harbour, Antigua (Fisher) and the Tortugas, Florida (Sluiter, Clark). Apparently a shallow water form.

Phyllophorus parvus (Ludwig)

Thyonidium parvum Ludwig, 1881, p. 54, pl. 3, figs. 16–18. Théel, 1886, p. 147. Deichmann, 1826, p. 26.

Translation of Ludwig's description: "The unique specimen is 28 mm. long, more tapering toward the posterior end than toward the anterior; 8 mm. in diameter, measured across the middle of the body. The feet are scattered over the entire surface, being still more numerous in the radii where they form distinct double rows. Color pale reddish; 18 tentacles, 9 pairs alternating with 9 smaller. The calcareous deposits are closely packed in the entire outer layer of the integument, being all of the same type; they consist of an oblong disk, which most commonly is perforated by 8 larger and 2 smaller holes, and near the middle 2 rods vertical to the disk and united by a bridge parallel with the disk and ending in about 8 short spines. The calcareous deposits have a length of 0.098 mm. Quite similar deposits are also placed in the feet, but never reaching the large end plate which is composed of 5 pieces.

The calcareous ring consists of 10 narrow, slender calcareous pieces, among which the radials 3 mm. long proceed backwards into 2 prolongations 1.5 mm. long, composed of smaller fragments. Two Polian vesicles, 3.5 mm. long are attached to the water vascular ring; a quite short stone canal, only 2 mm. long with rounded head, is embedded in the dorsal mesentery; the point of attachment for the genital organs, several times divided, placed on each side of the dorsal mesentery, is 10 mm. behind the oral end, with tentacle crown withdrawn; the insertion for the strong retractors is 9 mm. behind the oral end; the cloaca is 6 mm. long."

Type locality.— Coast of Brazil.

A single specimen was subsequently collected, at low water mark, in English Harbour, Antigua (Fisher). University of Iowa.

Echinocucumis Sars 1859

Diagnosis.— Tentacles 10, unequal in size; 2 lateral being much larger than the 4 dorsal, which in their turn are slightly larger than the 4 ventral. Body spherical with mouth and anus placed at end of tubes which seem to be nonretractile. Few pedicels, arranged on the ambulacra, slender, thread-like. Body covered with very large scales, perforated by large regular holes, which become smaller toward the edge; these scales are never built up of several layers of reticulated network; but most of them are provided with a slender spire, usually placed near the margin; along the ambulacra some of the scales are provided with an incision for the passage of a pedicel.

Type.— *E. hispida* (Barrett).

Only one species is known with certainty. (*E. adversaria* Semper, 1868, incompletely known, seems to be a typical *Cucumaria*, related to the *calcigera* group, as far as I have been able to determine from the description and figure given by Semper.)

Echinocucumis hispida (Barrett)

Plate 18, fig. 9

Eupyrgus n. sp. Lütken, 1857, p. 24, 69.

Eupyrgus hispidus Barrett, 1856, p. 7, 46, pl. 4, figs. 1a–6.

Echinocucumis typica Sars, 1861, p. 102–110, pl. 10, figs. 11–20; p. 11, figs. 1–17. Pourtalès, 1869, pl. 151. Théel, 1886, p. 118, 119; 1886a, p. 9, 10, fig. 3. For other references see Ludwig, 1901, p. 232, under *Cucumaria typica* and Mortensen, 1924, p. 232.

Not *E. typica* Clark, 1923, p. 418.

A small form only few cm. in length; body spherical, tapering into

short anterior and posterior tubes, which, in the Norwegian form at least, seem unable to contract. Tentacles 10, simple, finger-shaped, the 4 dorsal and the 4 ventral very small, the remaining 2, one on each side, much longer. Feet few, very thin and slender, and present only on the ambulacra, absent near oral and anal ends and in the dorsal ambulacra.

Internal anatomy not peculiar. A low simple calcareous ring of 10 equally large pieces; one Polian vesicle, one small stone canal, dorsally attached. Distinct muscle stomach; very long and coiled intestine; course as usual, the third loop running in the left ventral interambulacrum; cloaca large. Respiratory trees quite abortive, with 1–2 small lobes. Musculature thin; retractors are attached a little anterior to the middle of the body cavity. Genital organs in 2 large tufts, with thick tubes, attached at almost the same level as the retractors.

Deposits.— Large circular plates more than 1 cm. in diameter in the full grown specimen, composed of a single layer of calcareous material, perforated by numerous large holes, which become smaller toward the margin; most plates are provided with an eccentric spire, composed of several pillars united with irregularly placed cross beams and with spines scattered over the sides. The scales along the ambulacra lack the spire in many cases and present often an incision for the passage of a pedicel. These have no end plate and contain only some small curved supporting rods, often with a knob-like vestige of a spire on the middle. The introvert contains tables and plates; the tentacles are crowded with perforated rods and plates, often with three arms and a few large holes.

Type locality.— Coast of Norway (Barrett).

Type probably not existing.

Quite common in the northeastern part of the Atlantic Ocean, ranging from North Cape to Bay of Biscay. In all cases where I have been able to go over the record of the depth it has been taken at 100–250 fathoms.

The description given here refers to material from Scandinavia. The material from the coast of America is too scanty to allow a more detailed examination.

A species which by its spicules belongs to the typical form, occurs near Florida, recorded by Pourtalès. Also from "Albatross" stations 2,644, 2,646.

Remarks.— Théel notes that specimens from the West Indian region are somewhat different from the typical form, and upon reëxamination

some of them have proved to be apparently young specimens of *Sph. asperrima*, whereas others differ so much that they may be regarded as a distinct form as follows.

Echinocucumis hispida (Barrett) forma atypica

Plate **18**, figs. 10, 11

Differs from the typical form by its often larger scales, sometimes with centrally placed spine which is longer and more slender than usual, and composed of one solid rod, with a few spines scattered along the sides. Only known from off St. Kitts, 116 fathoms depth, and off Havana, 100 fathoms depth.

Type in Museum of Comparative Zoölogy.

Sphaerothuria Ludwig 1894

Syn. *Ypsilothuria* Perrier, 1901

Diagnosis.— Eight to ten tentacles, finger-shaped, of different lengths, 1–2 on each side considerably longer than the remaining. Body spherical, with mouth and anus placed on long tubes, which may or may not be retractile, perhaps according to the age of the animal. Skin covered with very large scales, composed of reticulated network, at least in old specimens, and with a long spire built of several rods and covered with spines. Feet few, slender, confined to the ambulacra and almost absent dorsally; near the ends the feet pass through a small hole in the scale, often quite close to the spine. Other features as in *Echinocucumis*.

Type.— *Sphaerothuria bitentaculata* Ludwig.

Key to the West Atlantic species

Scales with coarse, reticulated network, which is developed relatively late; two long tentacles on each side; tentacles filled with plates, perforated by numerous small holes ..... *S. asperrima* (Théel)

Scales with finely reticulated network, developed relatively early; one long tentacle on each side; tentacles with strongly curved cylindrical rods with few spines and perforated ends ..... *S. talismani* (Perrier)

Sphaerothuria asperrima (Théel)

Plate **19**, figs. 1, 2

Echinocucumis asperrima Théel, 1886a, p. 10.
Echinocucumis typica Théel (partim), 1886, p. 118.

The type specimens are very large, the diameter of the spherical body, without oral and anal tubes, being about 2 cm., the tubes together measuring about 2 cm. They seem in these large specimens quite unable to retract; in some smaller specimens, which I with some doubt refer to this form, the oral and anal tubes which are very close together are completely retracted. The introvert with the tentacles is withdrawn, but a dissected specimen had two large tentacles on each side and apparently 4 small dorsal and 2 small ventral; the introvert had been cut out of the animal, so maybe it was 2 small dorsal and 4 small ventral. The scales are very large, more than 2 mm. in diameter; the feet are few, apparently present only in the ventral ambulacra, and they pass through the scales near the spine. They are often difficult to find. Color whitish, some specimens covered with a brownish stuff, most likely of foreign origin.

Internal anatomy almost like that of *Echinocucumis hispida*. A simple calcareous ring, distinctly composed of 10 pieces, with low anterior teeth and undulated posterior margin; one Polian vesicle and one small dorsal stone canal; muscle stomach short; intestine extremely long with large coils; the exact course of the mesentery could not be determined; two laterally placed respiratory trees with well-developed lateral branches. Musculature thin; the circular layer forming a thin film, the longitudinal bands thread-like; the retractors attached near the bases of the oral tube. Genital organs few, divided once near base, less than 1 cm. in length. They contained ripe eggs in the specimens examined, and were attached near the oral tube.

The deposits in the large type specimens consist of very large scales with numerous, relatively small holes in the thick primary disk and coarse reticulated network; the spire is strong, composed of several pillars and provided with spines; it is often almost centrally placed. Toward the terminal ends the scales become smaller. The feet seem to lack deposits; the introvert contains numerous scales with simple pointed spire. The tentacles are filled with curved plates with numerous holes and undulated edge.

In some of the smaller specimens, which Théel has labeled as *Echinocucumis typica* var. *globosa* (the name of the variety has never been published), I have found that in most cases only one layer, the primary disk of the scale, is present and the animals would therefore naturally be listed as belonging to *Echinocucumis*, but the fact that the feet penetrate the scales and that the size of the holes of the scales agree in size with those found in typical *S. asperrima* has convinced me that these specimens are identical with that species.

Type locality for Théel's large specimen.— Off Isle of Pines, Cuba, 158 fms.; also known from off Kingston, Jamaica, 150 fms.; off Fredrikstadt, Virgin Islands, 180 fms.

The small specimens, listed as *Ech. typica* (var. *globosa*), are from the following localities: off Morro Light, Havana, 240–400 fms.; off St. Lucie, Florida, 116 fms.; off Barbados, 209 fms.

All are in the Museum of Comparative Zoölogy.

Sphaerothuria talismani (Perrier)

Plate **19**, fig. 3

Ypsilothuria talismani Perrier.
Echinocucumis typica Clark, 1923, p. 418.

The specimens examined are all small, about 1 cm. in total length, and seem to agree with *Sph. asperrima*, except that there is only one large tentacle on each side of the oral opening, and the scales are even at this stage built up of reticulated network, which is much finer than in the preceding species. The tentacles are filled with quite different spicules, they are strongly curved, simple rods, cylindrical with a few spines, the ends being flattened and perforated by a few holes.

The specimens in the Museum of Comparative Zoölogy, which were designated as *E. typica* by Théel and *Sph. bitentaculata* by H. L. Clark, are from the following localities: north of Havana, 339 fms.; off St. Vincent, 464 fms.; off Grenada, 567 fms. In the United States National Museum one specimen is present from "Albatross" station 2,096.

Distribution.— Cape of Good Hope; west coast of Africa and Europe (coast of France), Caribbean Sea.

Remarks.— The specimens examined seem to be identical with the greater part of Perrier's *Sph. talismani*, perhaps also his *attenuata;* his descriptions are very short. It may be that some of his specimens are identical with *Sph. asperrima*, and one of his figures resembles very much a specimen of *Ech. typica*. I think that his specimen from the Bay of Biscay, from 600 m., is identical with that species.

This species is very closely related to Ludwig's *Sph. bitentaculata* but differs, first by its possession of 10 tentacles, a very slight distinguishing character, as it may be that the two ventral tentacles are occasionally completely aborted, or have been overlooked, and second, by the slightly different form of the supporting rods in the tentacles, which in Ludwig's form are flat rods or narrow perforated plates (pl. 19, figs. 4, 5), whereas in Perrier's species, as here interpreted (Perrier gives no figures of the spicules), the rods are cylindrical, with flattened ends.

Cucumaria Blainville 1834

Diagnosis.— Dendrochirote Holothurians with 10 tentacles of equal size, or the 2 ventral ones smaller. Ambulacral appendages chiefly in rows along the ambulacra, absent or more sparingly distributed in the interambulacra, and in that case mostly in the dorsal ones. Spicules of various kinds, sometimes almost lacking.

No type species is given as the group is entirely heterogeneous and several species at present included belong in *Thyone*. The group will undoubtedly be divided in the future into several genera.

Key to the species of Cucumaria known from the western part of the Atlantic Ocean

1. Tables among deposits 2
1. No tables among the deposits 3
2. Tables large, of very variable size and shape; a densely crowded layer of plates beneath the layer of tables. The calcareous ring has long posterior prolongations. Up to 10 cm. long. Arctic ..... *C. calcigera* (Stimpson)
2. Tables oval with four holes, occasionally some have more; spire two pillared and often reduced. About 5 cm. in length. Tropical form which may reach the coast of New England ..... *C. pulcherrima* (Ayres)
3. Plates and baskets 4
3. Plates alone 5
4. Irregularly perforated plates, generally of oblong shape and with a few flattened baskets with spines on the margin. Plates in the pedicels. Radials very high with small posterior prolongations; interradials short and triangular, the feet tend to become placed in single rows toward the ends. Only known specimen 1.3 cm. long. Tropical form ..... *C. vicaria* Sluiter
4. Irregular plates with larger and smaller holes; a few, flattened baskets, almost without spines on the margin. Very few supporting rods, mostly in dorsal appendages. Simple calcareous ring. Few cm. long. Coast of New England ..... *C. nina* nov. sp.
5. Plates regularly four-holed, with well developed knobs. Elongate tables in feet. Prolongations on the ring almost as long as the radials are high. Feet ambulacral alone. Small tropical form ..... *C. argillacea* Sluiter
5. Plates irregular with smooth to undulated surface; if knobs are present, they are few and scattered 6
6. Plates few except in very young specimens, and reduced during growth. Feet large, soft, completely retractile, scattered in dorsal interambulacra. Up to 50 cm. long. Arctic, subarctic form ..... *C. frondosa* (Gunnerus)
6. Feet confined to ambulacra, not soft, not completely retractile. Deposits numerous. Small form, few cm. in length. From coast of New England. *C. parassimilis*, nov. sp.

Cucumaria calcigera (Stimpson)

Plate **11**, figs. 9–12

Pentamera calcigera Stimpson, 1851, p. 67. Verrill, 1866, p. 352.
C. korenii Lütken, p. 4–7, 104.
C. kalcigera, Duncan and Sladen, 1881, p. 5–8, pl. 1, figs. 3–8. Norman, p. 206, 207. Ludwig, 1873, p. 277, p. 6, figs. 1–5. Clark, 1901c, p. 492. Mortensen, 1910, p. 290.

Maximum length of specimens from the coast of New England about 9 cm. Club-shaped, the anterior end more blunt than the tapering anal end. Often the animal is so strongly curved that the two ends almost meet. Oral end usually retracted, with 10 much branched tentacles, the 2 ventral being much smaller. Pedicel nonretractile, in 5 distinct bands, most numerous at the middle of the animal, where they are crowded into 4 or 5 rows; towards the ends they are more scattered and form zigzag rows. Color white, with dark introvert and tentacles.

Internal anatomy.— A very high calcareous ring with long tails on the deeply cleft radials; often the ring is composed of small pieces. Radials also high and very narrow. One Polian vesicle and one stone canal with flattened head. Short muscular stomach and intestine with the usual course, first along the dorsal midline, then in an oblique line across the left dorsal and ventral muscle bands and after having made a loop into the right ventral interambulacrum, it runs backward along the left side of the midventral muscle band. Cloaca long, as is usually the case in the forms with long tail-like end. The respiratory trees are well developed, with very large accessory branches, giving the impression that there are 4 trees in all. The musculature is strong. The retractors are set about one third the body length behind the oral end, when measured in the ventral midline, but they are placed anterior to the attachment of the mesentery of the intestine.

The genital organs are present as numerous, long tubules, which are attached to the body wall in the same region as are the retractors.

Deposits, numerous tables and plates; outermost a layer of irregular tables, with rounded to stellate disk, often with 4 arms; as a rule 4 large central holes are found, among which 2 again are larger, and outside these a variable number of smaller holes. The spire is usually composed of 2 rods, although 3 or 4 may occasionally be present; it ends in a variable number of teeth, arranged at different heights; 2 cross beams are often present.

The plates form a closely packed layer beneath the tables and are,

as a rule, elongate; in the simplest cases they have 4 central holes and 1 or 2 holes in the ends, but usually they have developed 2 rows of holes, or they may be rounded or even star-shaped.

In the feet we find a well-developed end plate, with a circle of larger radially placed holes, arranged around the central portion of smaller holes. In the sides of the feet numerous elongate tables are found, usually high, well-developed spire, composed of 2 rods. In the tentacles numerous, often symmetrically developed, perforated rods of almost equal size through the entire tentacle.

Type locality.— Coast of New England, thrown up on the coast after a storm; type not existing. Dredged from several localities off the coast of New England, and occurring also along the coast of Labrador. Known also from Barrow Strait and Wellington Channel. It is very abundant along the west coast of Greenland, but is not known east of Cape Farewell (except, perhaps, at Nova Zembla). A very closely related form, if distinct, occurs in Bering Sea, and it is probably this form which has been recorded from the west coast of Waigatsch, Nova Zembla (according to Ludwig). All the records of *calcigera* from south of Bering Sea, in the Pacific Ocean, are undoubtedly wrong (excepting possibly the records from a few localities in Alaska).

From the coast of New England it has been dredged only from a depth of 20–40 fms.

It is possible that the Pacific form of *C. calcigera* is identical with Brandt's *albida*, which was collected at Sitka.

Cucumaria pulcherrima (Ayres)

Plate **11**, figs. 13–16

Pentamera pulcherrima Ayres, 1854, p. 20. Verrill, 1873, p. 715. Théel, 1886, p. 139.

Thyone pulcherrima Semper, 1868, p. 66. Théel, 1886, p. 139.

Cucumaria pulcherrima Clark, 1902, p. 567, pl. 11, figs. 70, 81–85. Coe, 1912, p. 113.

C. quinquesemita Selenka, partim, 1867, p. 351.

Length of largest specimen measured about 5 cm. in contracted condition. Body form seems invariably to be short, almost ovoid, with the anterior and posterior portion dorsally directed. Five crowded rows of cylindrical, nonretractile pedicels, strictly confined to the ambulacra. Ten very bushy tentacles, the 2 ventral smaller. Skin thin, often transversely wrinkled and stiff, because of its great content of calca-

reous deposits. Color white or dirty brown, probably in relation to the kind of bottom upon which the animal lives. The tentacles are dotted with a dark brown pigment.

Internally a high, typically formed calcareous ring with long posterior prolongations deeply cleft on the radials; the interradials are high and narrow, only slightly incised posteriorly; often the ring appears to be composed of a mosaic of small pieces. One Polian vesicle and one long stone canal, embedded in the dorsal mesentery and with the head free. A short musele stomach and a very long intestine with the usual course. Respiratory organs unusually large and richly branched, some of the branches near the cloaca almost form independent trees. The longitudinal, as well as the musculature, is well developed; the retractors split off at about one third of the body length from the oral end. The genital organs form two clusters with numerous long unbranched tubules, fastened near the retractors' origin. The ampullae of the feet are visible internally as clear elliptical vesicles which are arranged along the sides of the longitudinal muscles.

Deposits.— A crowded layer of regular, oval tables with 4 holes and a low spire, composed of 2 rods and ending with 2–3 blunt teeth; often the spire is reduced. A few thin, elongate plates with 2 central holes, and a variable number of smaller holes near the ends may occasionally be found. A great number of irregular plates are crowded around anus. In the feet a well-developed end plate is present, and numerous elongate tables with more or less reduced spire. In the tentacles, irregular, perforated plates. Apparently no deposits in the introvert.

Type locality.— Charleston. Type not existing. This form is undoubtedly a tropical form which occasionally reaches the coast of New England. It has been recorded from Sabanilla, Colombia (United States National Museum, Washington) and from Beaufort, N. C., where it quite often is found in shallow water, buried in mud (Grave). Very inconstant in its occurrence on the coast of New England, where it apparently lives in deeper water and only is washed ashore after heavy storms; sometimes it is taken by dredge, but it is often abundant one year and not the following.

It is one of the few forms which has been reared from the egg (Grave) to adult, but unfortunately no adequate account of the development has ever been published.

Cucumaria vicaria Sluiter

C. vicaria Sluiter, 1910, p. 3, text-fig. C.

The following is translated from Sluiter: "13 mm. long and 4 mm. wide, tapering backwards more than forwards; near the middle the animal is pronouncedly five-edged, but not markedly so towards the ends. The anus lacks teeth, but is distinctly five-edged. The feet are arranged in double rows only near the middle of the body; towards the ends they are placed in single rows. There are 10 tentacles of equal length. The integument is rather thick, but firm and rigid, due to the numerous calcareous deposits, yet it is not quite stiff. The deposits are plates of irregular form, usually oblong. Beside these we find a few baskets with spinous rim; in the pedicels there are plates, not rods.

Calcareous ring.— "Radials high, with short posterior prolongations; interradials small, blunt, triangular; they only extend backward for a short distance, but in front they are at the same level as the radials. A rather large Polian vesicle is attached to the vascular ring, as well as a single stone canal.

"This west-Atlantic form is at least closely related to *C. pentactes* Linn. from the coast of Europe, but it differs in the form of the calcareous ring and the somewhat aberrant shape of the calcareous bodies."

Type locality.— Barbados.

Type in Museum of Berlin. Only known from the type locality.

Cucumaria nina sp. nov.

Plate **12**, figs. 1–5

Length of mature specimens about 1 cm.; body shaped like a lemon, with mouth and anus slightly elevated. Ventrally 3 rows of large, soft pedicels arranged in single series, 7–9 in each; dorsally we find double rows, also scattered pedicels in the dorsal interambulacra; these are much smaller than the ventral pedicels, and only visible as points. The tentacles are much branched and crowded with spicules; the two ventral ones are much smaller. The skin is thin and filled with spicules. Color whitish.

Internally we find a simple calcareous ring, the radial and interradial pieces are of almost uniform size, except that the radial pieces project a little more forwards than the interradial pieces. A single Polian vesicle, and a long stone canal with divided head, attached in the mesentery. Muscle-stomach short, well developed; intestine relatively

short. Respiratory trees short and feeble, with very small and few branches. The musculature is delicate; the retractors split off in the first third of the body length. The genital organs, which seem to be ripe, are attached at about the same distance from the oral end; they are remarkably short and thick, fingerlike and few in number.

Deposits.— Numerous large, thin plates, generally oblong in shape and perforated by several holes which become smaller toward one or both ends. A few, easily overlooked, very flat baskets are also present. No end plate in the ventral feet, which seem to lack all deposits; in the dorsal appendages we find a rudiment of end plate and a few elongated, supporting rods. Numerous perforated rods and plates in the tentacles.

The relationships of this small form are not easily determined. At present it occupies a quite isolated position.

Type locality.— East of Georges Bank, depth 101 fathoms. Collected in September, 1883.

Type in United States National Museum, Washington, cat. no. 18,222.

At present only known from off the coast of New England, from relatively deep water.

Cucumaria argillacea Sluiter

C. argillacea Sluiter, 1910, p. 336, text-fig. Ba-c.

The single specimen is 8 mm. long, pale gray and decidedly five-edged, only slightly tapering toward the ends and without anal teeth. Integument fragile and crisp, on account of the great amount of calcareous deposits. These are found in the shape of rather regular plates with 4 holes and 4–6 knobs, also as plates with a greater number of holes and knobs. We also find smooth plates with several holes.

In the wall of the pedicels are the usual kind of tables, with rod-shaped elongate disk. The calcareous ring consists of 10 pieces, the radials with long posterior prolongations which are nearly as long as the rest of the ring is high; the interradials are almost triangular and as high as the undivided part of the radials. One Polian vesicle and a single stone canal. The genital organs are only feebly developed, short and undivided.

Type locality.— Tortugas, Southwest Channel; depth 12 fms.

Type in Museum of Berlin.

The species has not been recorded since. It is impossible to say whether so young a specimen belongs to the genus *Cucumaria* or to *Thyone*, and hence it is useless to attempt to discuss its relationships.

Cucumaria frondosa (Gunnerus)

Plate 12, figs. 6–9

Holothuria frondosa Gunnerus, 1770, p. 121–125, pl. 4, figs. 1, 2.
Holothuria pentactes O. F. Muller, 1788, p. 36, pl. 31, fig. 8.
Botryodactyla grandis Ayres, 1851, p. 52.
Botryodactyla affinis Ayres, 1851, p. 145.
Cucumaria fusicola Forbes, 1841, p. 227.
Cucumaria frondosa Ludwig, 1901, p. 150 (with complete bibliography. All records from the Pacific Coast refer to closely related species). Clark, 1904, p. 564. Edwards, 1910, p. 333, pl. 13. (The literature since 1910 has not been given, as none of the papers deal with the occurrence of the species on the coast of North America.) Not *C. frondosa* Pourtalès, 1869, p. 359, 361 (from off Florida).

Maximum length about 50 cm. A soft-skinned form, usually barrel-shaped, with ten bushy tentacles of equal size, and soft, completely retractile large feet, which are arranged in rows along the interambulacra, and also occur more or less reduced in development in the dorsal interambulacra. Mouth and anus terminal. Skin soft, leathery. Color brown in preserved condition, paler in young specimens; occasionally pure white or yellowish specimens may be found.

Internally a very loosely united calcareous ring of simple form; the calcareous mass is reduced more or less with advancing age. One very long Polian vesicle, sometimes as long as the contracted animal itself. The stone canal is attached in the dorsal mesentery and has a large round head. A long and slender muscle stomach and a very long intestine with the usual course, first in the dorsal interambulacrum, then forwards across the left dorsal and ventral muscle bands, reaching so far forwards that the mesentery is perforated for the passage of the retractors, and finally the intestine runs along the left side of mid-ventral muscle band.

Respiratory trees large and very bushy, attached in the lateral interambulacra and partly also to the lateral ventral muscle band. The musculature is strong and fleshy, the retractors are attached near the middle of the body wall. The genital organs are, when well developed, very long and numerous tubules, attached near the middle of the body wall and almost entirely hiding the other organs.

The spicules are well developed only in very small specimens, a few cm. long. They consist of roundish plates, regularly perforated, and with a few knobs scattered here and there. Also more button-like plates with 4 holes are occasionally present. In the feet we find a

small vestige of an end plate and some elongate plates or rods. In the tentacles a few, long, perforated plates may be found.

This Arctic and subarctic form ranges from the coast of northern Europe (Scandinavia and Great Britain) to the Faeroes and South Iceland, coast of Greenland and down to the coast of New England. The record of its occurrence off Florida is due to a mistake, as Pourtalès' specimen is not *frondosa* but a species closely related to *Colochirus violaceus* Théel (see p. 182).

It is also due to errors in identification that it is recorded from the Pacific Ocean, where 3 closely related, but distinct species are found. It seems to be most closely related to *C. fallax* Ludwig which occurs in Bering Sea, but the latter species retains its somewhat differently formed spicules for a longer period.

The type locality is off the coast of Scandinavia but the type does not exist.

It usually occurs just below tide mark, but is also taken in deeper water (200 fms., according to Ludwig). It seems to prefer rocky shores where it clings to the rocks, usually without making any attempt to hide itself, and is often found in great numbers.

It has a free-swimming larva, the development of which has been studied by Runnström (1917–18).

Cucumaria parassimilis sp. nov.

Plate **13**, figs. 1, 2

Maximum length of apparently mature specimens, a little more than 1 cm. Form cylindrical, with 5 rows of feet which dorsally show some tendency to spread into the interambulacra; the feet are not crowded and are apparently nonretractile. Tentacles 10, the 2 ventral smaller; they are stiff, completely crowded with deposits; introvert very short. The skin is thin, crisp, filled with deposits. Color pale brownish.

Internally a low simple calcareous ring; other features quite normally developed; the retractors and genital organs being placed a little anterior to the middle of the body cavity; the genital organs consist of a few tubules, which in one specimen contained a few eggs.

Deposits.— Perforated plates of variable size, roundish or elongate, with few to many holes; surface with small knobs; in pedicels rods and plates, but apparently no end plate; in tentacles similar plates and rods; no special kind of deposits in the short introvert.

Type locality.— Georges Bank, "Albatross" station 2,523; also re-

corded from middle ground, Halifax; off Cape Cod and east of Georges Bank. Depth 80–121 fms.

Remarks.— This species may be identical with *C. assimilis* Danielsen and Koren from Norway; the authors compared their specimen with small *C. frondosa*, but the species has never been recorded since, and *C. assimilis* is usually listed as a synonym of *C. frondosa* (among others by Dr. Th. Mortensen, 1924).

The new species has been compared with typical small *frondosa;* their outer aspect is entirely different, *frondosa* being a soft-skinned animal with few large, soft and retractile feet, even when only 1 cm. long, whereas *C. parassimilis* is stiff, with tapering, nonretractile feet; the ventral feet are also distinctly smaller than the other in *C. parassimilis,* whereas they are all of the same size in *C. frondosa;* the spicules are also different, being usually more elongate in *C. parassimilis.*

Thyone Oken 1815

Diagnosis.— Dendrochirote Holothurians with 10 tentacles of equal size or the 2 ventral ones smaller. Ambulacral appendages even in young specimens numerous, also in the interambulacra, and usually most abundant ventrally. Arrangement in bands along the ambulacra more or less indistinct. Deposits of various kind, often reduced.

No type species is given as the group is quite heterogeneous, some species hitherto referred to this group belong undoubtedly to the genus *Cucumaria.* The group will in the future be divided into several genera.

Key to the species of the genus Thyone, at present known from the West Indian Seas and off New England

1. Deposits in body wall as tables (*Thyone sensu strictu*) 2
1. Deposits in body wall chiefly as knobbed buttons or plates 5
2. Spire composed of 4 rods, disk irregular with 7–8 holes. Calcareous ring very high but with relatively short posterior prolongations. *Thyone briareus* (Lesueur)
2. Spire composed of 2 rods 3
3. Disk irregular with numerous holes; tables large and very solid; in introvert more delicate tables and no rosettes. Solid rods in tentacles. Curved, tapering body form . . . . . *Thyone scabra* Verrill
3. Disk regular, oblong, usually with 4 holes (sometimes 4 outer accessory holes). In the introvert often tables and always rosettes; delicate rods in tentacles 5

4. Disk thin with 4 large holes, often 4 accessory ones; spire high, with delicate pillars, tapering, ending in few small teeth . . *Thyone fusus* (O. F. Müller)
4. Disk thick, with 4 small holes, no accessory holes; spire low with thick pillars and ending in numerous robust teeth. (In some cases the tables develop a handle on the other side of the disk.)
Thyone pseudofusus nov. sp.
5. Supporting rods as tables with distinct spire; posterior prolongations on radials; rosettes in introvert and tentacles; sometimes also tables in the introvert. Scattered irregular large plates 6
5. Supporting rods never as tables. Calcareous ring usually single, only occasionally with very short posterior prolongations. Strong rods in tentacles; in some cases rosettes in introvert 7
6. Buttons with thick smooth handle, strongly knobbed and short. Tables and rosettes in introvert; in tentacles rosette-like plates.
Thyone belli Ludwig
6. Buttons usually without handle, regularly knobbed and with a tendency to become elongate, especially in young specimens; a few of the small buttons may have a thin handle with small spines on the top, thus resembling a table. Large complicated rosette-like plates in introvert and tentacles; no tables in the former . . . . . *Thyone micropunctata* Sluiter
7. Deposits elongate, perforated plates, almost smooth.
Thyone cognita (Lampert)
7. Deposits mostly 4 holed knobbed buttons, regular or irregular 8
8. Among deposits no outer layer of baskets. Midventral series of feet usually distinctly separated from the remaining appendages which are uniformly distributed . . . . . *Thyone unisemita* (Stimpson)
8. Among deposits an outer layer of baskets 9
9. Baskets deep with a narrow opening fringed with numerous irregular small teeth both on the inner and the outer side. Buttons strongly knobbed, very regular and of very different sizes . . . . . *Thyone solida* nov. sp.
9. Baskets relatively flattened, widely open, either with few large distinct teeth or with some very blunt and indistinct ones 10
10. Feet cylindrical all over the body, with distinct end plate, simple or composed of smaller plates. Tentacles of equal size 11
10. Feet papilliform toward the ends; end plate often small or absent in several of the appendages. Ventral tentacles smaller 12
11. Deposits few, large-holed buttons; few, often incomplete baskets; large holes in the supporting rods; skin soft . . . . . *Thyone suspecta* Ludwig
11. Deposits numerous; partly large-holed, regularly knobbed and partly swollen, small-holed; baskets large, well developed; supporting rods with small holes; skin relatively stiff . . . . . *Thyone surinamensis* Semper
12. Feet uniformly spread, usually contracted to low warts.
Thyone pervicax Théel
12. Feet in distinct double rows along the ambulacra and also scattered in the interambulacra 13

13. Baskets very small, much smaller than the buttons are wide, and with blunt incomplete teeth. Buttons very irregular; regular smooth perforated plates are also present ..... *Thyone sabanillaensis* nov. sp.
13. Baskets large, about as broad as the buttons are wide and with about 8 large conical teeth. Buttons swollen, irregular; smooth regular plates are never found ..... *Thyone gemmata* (Pourtalès)

Thyone briareus (Lesueur)

Plate **13**, figs. 5–7

Holothuria briareus Lesueur, 1824, p. 161. Gould, 1841, p. 345.
Sclerodactyla briareus Ayres, 1851–54, p. 101. Pourtalès, 1851, p. 9.
Anaperus carolinus Troschel (partim), 1848, p. 62. Pourtalès.
Thyone briareus Selenka, 1867, p. 353. Coues and Yarrow, 1878, p. 305. Ludwig, 1882, p. 132. Lampert, 1885, p. 168. Théel, 1886, p. 133. Clark, 1901, p. 484; 1901b, p. 567, pl. 11, fig. 67; pl. 13, figs. 96–102; 1919, p. 63. Coe, 1912, p. 116, 133, text-figs. 21, 25, pl. 29, fig. 15; pl. 30, 31.
Thyone tenella Selenka, 1867, p. 354.
Not *Sclerodactyla braziliensis* Verrill, 1868, p. 370.

About 100 specimens examined

Grows to about 10–12 cm. in length; specimens less than 5 cm. long seem never to have been collected. It is a barrel-shaped form with numerous tapering appendages, which cover the animal like a coat of hair. Tentacles large, bushy, the 2 ventral smaller. Anus surrounded by a complete calcareous ring. Color variable, usually brownish or greenish. Skin soft with few deposits, which become scarce with advancing age. Internally a high, tubelike calcareous ring, the radials as well as the interradials being high, the former with relatively short but distinct posterior prolongations. One Polian vesicle and one stone canal, with large round head, attached to the mesentery. Distinct muscle stomach and a very long intestine, with the usual course. The respiratory trees are of almost equal length and attached in the lateral interambulacra. Musculature remarkably thick, fleshy and projecting into the body cavity almost as septa. The genital organs are present as very long and slender tubules attached in 2 bundles near the middle of the dorsal side, absent only in specimens a few cm. long.

The deposits are few, in some specimens almost absent. They consist of tables usually with 4 large ventral holes and 4 outer smaller ones and a spire built up of 4 rods — an unusual feature in this group — and ending in a variable number of teeth. The feet are provided with a large end plate and numerous elongate tables with complicated spire,

usually built up of 4 confluent rods, forming a network and ending in a few teeth; the deposits seem to be heavier near the anal end. In the introvert, numerous more delicate tables with more holes in the disk and lower, often incomplete spire, also with 4 rods. In the tentacles, numerous large, perforated rods.

Remarks.— Selenka's *Thyone tenella*, in the collection of the Museum of Comparative Zoölogy, is only a pale, swollen specimen of *T. briareus*, without any deposits.

The specimen which Pourtalès describes as *Anaperus carolinus* Troschel is undoubtedly identical with *Thyone briareus* (calcareous ring very long and strong, also a smaller calcareous ring around anus).

Troschel's *Anaperus carolinus*, which he records from both Peru and South Carolina, is undoubtedly in the first case one of the soft-skinned species of *Thyone* from the Pacific Ocean, in the other simply *Th. briareus*.

This species is, as far as can be determined, identical with *Holothuria briareus* Leseueur; the type locality is St. Bartholemew, West Indies; the type no longer exists.

It is a very common form, ranging from Woods Hole to Texas and has been taken from low tide mark to some fathoms depth, usually on muddy bottom, occasionally on sand. The development is not known, and small specimens are not represented in any of the collections to which I have had access.

Thyone scabra Verrill

Plate **13**, figs. 3, 4

Thyone scabra Verrill, 1873, p. 100. Théel, 1886a, p. 135; 1886b, p. 11. Clark, 1901, p. 568, pl. 11, fig. 71; pl. 13, figs. 91–94; 1901c, p. 494. Coe, 1912, p. 136, pl. 32, fig. 7.

About 20 specimens examined

A relatively small form, usually about 5 cm. in length when measured along the midventral radius; specimens 10 cm. long have been recorded. The body is usually strongly curved with tapering anal end. The tentacles are usually retracted, the 2 ventral are smaller; the feet are uniformly distributed; they are hairlike, tapering, and seem unable to retract. The color is whitish, often with a brownish tinge; the skin is stiff, filled with deposits.

Internal anatomy.— Calcareous ring with very long posterior prongations; the radials are deeply cleft; the interradials are high and

narrow. The other features are as usual. Very long secondary branches on the respiratory trees.

Deposits.— Irregular tables with 7–10 or more holes and a two-pillared spire ending in some indistinct teeth. In the feet a well-developed end plate and numerous elongated tables with a simple low spire, composed of 2 rods. In the introvert we find tables with larger, more circular and more delicate disk; spire low; the tentacles with numerous strong, perforated rods. No rosettes have been discovered.

Distribution.— Coast of New England down to Delaware; ranges from 10 to several hundred fathoms depth (according to Clark, 1901c).

Nothing is known about its habits.

Thyone fusus (O. F. Müller)?

Plate **14**, figs. 1–5

For literature concerning the typical form, see Ludwig, 1901, p. 150–152.

About its supposed occurrence in American waters, Verrill, 1875, p. 14, writes *T. fusus* Danielssen and Koren?, but later in the same paper he writes *T. scabra* (*T. fusus?* not of Koren). Théel, 1886, p. 135, writes *T. fusus?* Verrill, as synonym of *T. scabra*.

Clark, 1921, p. 63, mentions *T. fusus* (O. F. Müller) from Tobago, West Indies, but says: "It is quite improbable that they are really identical with the European '*fusus*.'"

The 4 small specimens collected at Tobago have been examined and it is impossible at present to find any character that distinguishes them from the Norwegian form, except that the radials are very deeply cleft, whereas in the typical *fusus* they are only cleft to the posterior edge of the interradials; the ring of the West Indian form resembles very much that of *Cucumaria aurantiaca* Costa from the Mediterranean Sea, but the latter has no supporting rods in the pedicels; apparently only large specimens of *C. aurantiaca* have been examined, and it may be that larger specimens of the West Indian form will prove to be identical with the Mediterranean species.

It is, therefore, only provisionally that the West Indian form has been listed under the name *Thyone fusus*.

The specimens examined are a few cm. long, of typical *Thyone* aspect, with numerous feet, indistinct in double rows along the ambulacra and also distributed over the interambulacra; 10 tentacles, the two ventral smaller. The feet are fine and tapering, hair-like as in all typical *Thyone*. Color dirty grayish brown, somewhat paler in an expanded specimen.

Internally a high tube-like calcareous ring with long posterior prolongations on the radials; these are cleft almost to the middle of the interradials; Polian vesicle large, single; one small stone canal with rounded head, attached in the mesentery; muscle stomach short; intestine running in dorsal interambulacra, making a long coil at the end of the loop and proceeding forward until it reaches the left ventral retractor, then forming an arch across the left interambulacrum and running backward along the midventral muscle band. Respiratory trees much branched and only attached by a few threads to the lateral interambulacra; retractors attached slightly forward of the middle of the body cavity. Genital organs quite well developed in the expanded specimen, which is 2 cm. long; they were relatively short and apparently undivided and attached near the middle of the body cavity.

Deposits.— Exactly like those found in the European form, with the same limits of variation in regard to size; only four-holed oval tables with tapering spire composed of 2 rods, with few teeth on the top; sometimes the disk has 4 outer marginal holes; these 8-holed tables seem to occur near the ambulacra; in the feet a small end plate, easily overlooked, and numerous elongated tables with well-developed spire. In the introvert and tentacles no other deposits than rosettes, most of them very complicated; in the smallest specimens they are present in all parts of the tentacles except in the finest terminal lobes

Type locality.— Faeroes. Type not existing.

Ranging from Lofoten to the Mediterranean Sea, but not recorded from any of the West African islands.

In the western Atlantic only known from Tobago, British West Indies. Museum of Comparative Zoölogy, cat. no. 1,167.

Thyone pseudofusus sp. nov.

Plate **14**, figs. 6–9

About 25 specimens examined

The largest specimen is about 2 cm. in length. A tapering form often with mouth and anus upward bent; pedicels in double rows and also scattered in the interambulacra, most numerous in the ventral interambulacra; a very small specimen, about 0.5 cm. in length, has only ambulacral feet; tentacles 10, the two ventral smaller; 5 small anal papillae were visible. Skin thin, pliable, except in strongly contracted specimens, and containing numerous deposits; color whitish.

Internally a calcareous ring with very long and deeply divided pro-

longations on the radials; other features as in *T. fusus* and the other species of this group.

Deposits.— Tables with unusually thick disk, with 4 small holes and smooth to slightly knobbed margin; sometimes an extra hole in each end of the disk; spire robust, low, with distinct teeth on the top; in some cases a handle may be present on the inner side of the disk; a very peculiar feature, which gives some of the tables a character between tables and buttons. In the pedicels a well-developed end plate and numerous elongated tables with a small spire with 2 rods. In introvert, tables with irregular disk and rosettes; in tentacles, delicate rods with few holes in the ends.

Type locality.— Yucatan, "Albatross" station 2,362 (18 specimens); depth 25 fathoms.

Types in United States National Museum.

Also from Tobago, British West Indies and Florida (Clark), Museum of Comparative Zoölogy, cat. no. 1,168.

Thyone cognita (Lampert)

Plate 15, figs. 1–4

Semperia cognita Lampert, 1885, p. 67.
Cucumaria cognita Théel, 1886, p. 266.

About 20 specimens examined

Maximum length of strongly curved animals about 12–14 cm. A decidedly tapering form, in most cases with the oral and anal ends bent upwards. Feet short, small, usually not completely contracted, in double rows along the radii, and scattered in the interambulacra near the middle of the body; toward the ends they are transformed into short conical, stiff papillae. Tentacles of equal size, and small compared to the entire length of the animal. Skin filled with spicules but still somewhat flexible, especially in smaller animals, and sandy to the touch. Color varying from almost white to mottled gray, with yellowish feet; tentacles dark grayish brown.

Internally a delicate calcareous ring more or less distinctly composed of smaller pieces, and with well-developed tails; the radials are deeply cleft, and the interradials are high and narrow with concave posterior margin; 1–2 Polian vesicles and one very small stone canal with round head, attached to the mesentery. Long muscle stomach, intestine attached almost in the dorsal midline, this goes across the left dorsal and ventral muscle bands, and finally runs along the left side of the

midventral muscle band. Cloaca large. Respiratory trees in lateral interambulacra. Retractors remarkably short, attached 2–5 cm. from the oral end in the largest specimen. Genital organs, unbranched, as long tubules in tufts on each side of the mesentery, almost at the middle of the body.

Deposits.— Even in the youngest specimens it has been impossible to find any other kind of deposits than perforated plates, which are, for the most part, elongate with 2 rows of holes, and rather thick, with uneven surface; also small button-like plates, usually with 4 holes. In the pedicels a rudimentary end plate, which is fairly well developed in small specimens and a variable number of slightly curved rods with perforations and often a short third arm from the middle of the rod, thus resembling the elongate tables with rod and two-pillared spire which are found in many *Cucumariidae*. In the papillae near the ends we find numerous large plates of very variable form. In the introvert, irregular rosettes; these are also present in the tentacles, where many heavy supporting rods with numerous terminal holes occur, and also in the finest branches very small delicate rods.

Type locality.— Fernando de Noronhas, Cuba.

Type in Museum of Berlin.

Small specimens from Yucatan, United States National Museum, and from Porto Seguro, Brazil, Museum of Comparative Zoölogy; in the latter collection there are a number of large, beautifully preserved specimens from the Tortugas, Florida (H. L. Clark coll.), so it appears as if the species had quite a wide distribution in the West Indian region.

About its habits, Dr. Clark informs me that it is found buried in soft bottom, in eel grass.

Thyone unisemita (Stimpson)

Plate **15**, figs. 5–10

Anaperus unisemita Stimpson, 1851–54, p. 8, 9.

Stereoderma unisemita Ayres, 1854, p. 46, 47. Selenka, 1867, p. 344, pl. 19, figs. 76, 77. Verrill, 1874b, p. 413. Lampert, 1885, p. 165. Théel, 1886a, p. 142.

Thyone unisemita Clark, 1901, p. 494; 1902 (1904), p. 569, pl. 11, 12. Coe, 1912, p. 135, pl. 32, fig. 1, text-fig. 26.

About 10 specimens examined

A small form, which rarely seems to attain a greater size than 5 cm. Both ends are usually dorsally directed, body cylindrical with blunt ends; the 2 ventral tentacles are smaller than the remaining 8; the feet

are numerous; in the midventral radius they form a distinct double row, separated from the rest of the feet by distinct naked stripes; laterally and dorsally the feet are uniformly distributed. The feet are conical with thickened bases, and are often retracted to low warts. The skin is stiff, filled with numerous deposits; the color of preserved specimens is pure white.

Internally a simple, low, calcareous ring with long anterior teeth and posteriorly undulated; one Polian vesicle, one small stone canal embedded in the mesentery. A short muscle stomach and a very long coiled intestine, running in the dorsal interambulacrum, across the left muscle bands without touching the retractors, and finally attached to the left side of the midventral muscle band. The respiratory trees are long with long secondary branches and laterally attached; the muscle bands are well developed, with distinct longitudinal furrow; the retractors are attached near the middle of the body cavity, where also the 1 cm. long genital tubes have their place.

Deposits.— Four-holed buttons of variable size with smooth to knobbed surface, often one part of the deposit is more knobbed than the rest; in the feet no end plate and no deposits in the terminal part which is shaped like a true pedicel, with distinct sucking disk; in the remaining part of the appendages numerous deposits, mostly buttons and a few supporting rods, which are usually short and dichotomously branched; in the introvert oblong rods and plates which in some cases recall rosettes; in the tentacles numerous elongate, perforated rods and plates.

Although this species bears a close resemblance to forms in which baskets normally occur, I have failed to find any, even in very small specimens.

Type locality.— Grand Banks.

Type apparently lost.

Ranges from Grand Banks, Newfoundland, to Narragansett Bay. According to Clark, its bathymetrical range is from 17–22 fathoms.

Thyone micropunctata Sluiter

Plate **14**, figs. 14–18

Thyone micropunctata Sluiter, 1910, p. 338, fig. D, a-c.

Sluiter's description: "Eighteen mm. long, 4 mm. wide, tapering toward both ends, but the body is still much wider than the distinctly pointed terminal end, which is tail like. Around the anus are 5 anal

teeth. In alcohol the animal is gray, the ventral side is much paler than the dorsal which is more densely dotted over with small dots (visible with a hand lens).

"All appendages are pedicels with well-developed end plate; the 2 ventral tentacles are much smaller than the remaining 8.

"The spicules are numerous and the skin is consequently stiff and fragile. The most common form of spicule is a knobbed plate with holes placed in a cross and on the middle two large knobs, which never unite in a bridge as in *Th. sacellus* (from the Pacific Ocean). Around the margin of the deposits we find usually 10 knobs; plates with 5–8 holes may also occur, and scattered X-shaped spicules. In the pedicels we find tables with elongate disk, curved or rod-shaped as they often are in the pedicels of the Dendrochirotae.

"The calcareous ring is composed of the normal 10 pieces, the radials being provided with posterior prolongations, almost as long as the rest of the piece is high.

"Although this West Indian form bears some resemblance to the European form *Th. raphanus* Düben and Koren, it cannot be united with that species, first because the deposits are entirely different, and second because of the arrangement of the pedicels; moreover, the calcareous ring and Polian vesicles differ. It seems to be a *Thyone*."

Type locality.— Tortugas, 12 fathoms depth, 3 specimens.

Type in Museum of Berlin.

I have referred one specimen from off Florida and several small ones from Tobago to this species; they seem to agree in all anatomical details. It must be remembered, however, that the small size of these closely related animals will never allow any very detailed study of anatomical differences. The deposits seem to agree exactly with Sluiter's description and figures.

Thyone solida sp. nov.

Plate **15**, figs. 11–17; Plate **16**, figs. 1, 2

The type specimen is about 6 cm. in length, strongly contracted; body barrel shaped with mouth and anus slightly turned dorsally; oral valves present as in the genus *Pentacta;* tentacles, 8 large, and probably 2 small ones which have been lost by previous examination. Appendages numerous, very uniformly distributed; they are more cylindrical ventrally and more papilliform dorsally, where they are placed on low warts; skin thick, firm and filled with deposits. Color yellowish.

From another locality several small specimens have been collected a little more than one cm. in length, and with more *Pentacta*-like aspect, most of the feet being arranged in rows, and only a few scattered in the interambulacra; the spicules resemble in every detail those of the larger specimen.

Calcareous ring low, without any trace of posterior prolongations; the radials with a broad, deeply cleft anterior tooth; the interradials with a blunt triangular tooth; one Polian vesicle and one very small stone canal. Intestine with distinct muscle stomach; most of the intestine is ejected, so its exact course could not be examined. Respiratory trees in the lateral interambulacra; muscle bands narrow, thin, with a longitudinal furrow; the retractors are attached a little anterior to the middle of the body; genital organs in the type were few cm. in length, unbranched and attached a little behind the retractors.

Deposits.— Strongly knobbed, regular buttons of variable size and an outer layer of baskets; the baskets are deep, with 4 thick spokes and numerous small teeth on the inner as well as the outer side of the brim. In the feet no regular end plate, but a number of branched rods act as an end plate; numerous thick, supporting rods, with small holes and often a short third arm; in the introvert, numerous, complicated rosettes and small buttons; in the tentacles strong, perforated rods.

Type locality.— "Albatross" station 2,369.

Type in United States National Museum, Washington.

Also recorded from "Albatross" station 2,405, 8 small specimens.

Thyone surinamensis Semper

Plate **16**, figs. 5–8

Thyone surinamensis Semper, 1868, p. 65, pl. 15, fig. 15. Lampert, 1885, p. 158. Théel, 1886, p. 133. Deichmann, 1926, p. 25, pl. 3, figs. 1a-e.

Cucumaria punctata Ludwig, 1874, p. 82. Sluiter, 1910, p. 335. Clark, 1919, p. 63.

Semperia punctata Lampert, 1885, p. 152.

The maximum length which this species seems to attain is about 10 cm. The shape of the body in well-extended specimens is cylindrical, tapering toward both ends which are bent slightly upward. The tentacles are of equal size, large and richly branched. In most cases we have the feet distributed in double rows along the ambulacra, with a tendency to spread in rows in the interambulacra; but the feet seem to be more abundant in the ventral interambulacra than in the dorsal and lateral areas. The feet are conical with distinct end plates and, as

a rule, expanded. The skin is thick, flexible, and contains an abundance of calcareous matter, which in contracted specimens may give some firmness to the integument. Around the anus we find 4–5 soft anal papillae, sometimes one or two of them are double, and below each a small scalelike anal tooth. The color is brownish; tentacles dark, feet usually whitish sprinkled with brown, and provided with brown or yellowish sucking disks.

Internally a well-developed calcareous ring with relatively short anterior teeth on both radials and interradials; the posterior margin is undulated; one Polian vesicle placed to the left ventrally; a small stone canal is attached to the mesentery, with the head free to the muscle stomach; intestine of normal course, making a large coil behind the genital organs, then running backwards, then forwards across the 2d left muscle bands, and finally backward along the midventral muscle band, partly attached to the band itself. The long respiratory trees are attached to the lateral interambulacra; the muscle bands are thin, narrow with indistinct longitudinal furrow. The retractors split off a little before the middle of the body cavity, and the genital organs are attached at the same distance from the oral end, perhaps nearer the middle of the body cavity; the tubes are short in a mature female; in a female with most of the eggs apparently spent, they are much longer, and similar conditions were found in the male genital organs.

Deposits.— Regular buttons and baskets, The buttons are of two kinds: a heavier, small-holed type, with large, slightly elevated knobs, and a more delicate type with large holes and small globular knobs, widely separated; the former type predominates; a few completely flat buttons with large holes may be present.

The baskets are large, only slightly smaller than the buttons are long; distinctly hollow, and with a variable number of 12–20 teeth in the margin; exceptionally the teeth may unite and form a secondary network across the cups.

In the feet we find a large end plate composed of 4–5 pieces and a number of almost straight supporting rods with slightly undulated edge and small holes. In introvert a few rudimentary baskets and buttons and rosettes; in stalk of tentacles almost straight rods, of similar type to those of the feet; in the finer branches rosettes.

Type locality.— Surinam (Semper).

From the northern coast of South America to Barbados, St. Thomas, Virgin Islands; abundant at Bermuda. As far as our present knowledge goes, an exclusively eastern form in the West Indian region. Shallow water form, collected under rocks at low tide.

Remarks.— The one difference between *C. punctata* and *C. surinamensis*, which can be inferred from the literature, is the number of Polian vesicles, 5 in *punctata*, 1–2 in *surinamensis*.

Thyone suspecta Ludwig

Plate 16, figs. 3, 4

Thyone suspecta Ludwig, 1874, p. 16, pl. 6, fig. 19. Lampert, 1885, p. 157. Théel, 1886, p. 133. Sluiter, 1910, p. 333. Clark, 1919, p. 63. Deichmann, 1926, p. 23.

Thyone braziliensis Verrill, 1868, p. 370. Rathbun, 1879, p. 141.

About 20 specimens examined

In size and other external features resembling *Thyone surinamensis*, except that the skin is extremely soft, almost devoid of calcareous deposits, and the color is in all specimens examined more dirty, with a streak of brown along the middle of each ambulacrum. The internal anatomy seems to agree in all essentials with that of *Thyone surinamensis*.

The spicules consist of a very scattered layer of large-holed buttons with 4 holes and small hemispherical knobs on the margin, and a small layer of baskets of the same type as those found in *T. surinamensis* but much smaller and often incomplete, partly flat. In the feet a large end plate composed of several smaller plates and a number of supporting rods with large holes and undulated margin. In the introvert rosettes and in the tentacles a variable number of perforated rods.

Type locality.— Barbados; shallow water form, collected at low water mark.

Type in Würzburg.

Ranges from Brazil and Colombia to Barbados.

The differences in the spicules between this species and *Thyone surinamensis* have been pointed out in my Barbados-Antigua report (1926); it should be added that examination of a large series shows that the rosettes are very variable in size in both species.

Thyone pervicax Théel

Plate 16, figs. 9–12

Thyone pervicax Théel, 1886, p. 93, pl. 5, fig. 9; pl. 2, fig. 3.

Maximum length about 7 cm. Body slightly curved with blunt oral and anal ends (when tentacles are withdrawn the oral opening is pentagonal). Tentacles 19, the two ventral ones smaller, all filled with

spicules; numerous tapering appendages, which in young specimens may be completely retracted, only visible as pits; in older specimens the feet are conical, uniformly distributed and often retracted to low warts. Skin stiff, filled with deposits; color whitish with brown spots or entirely pale brown.

Internally a calcareous ring with long anterior teeth and short posterior prolongations, these prolongations being merely indicated in the type specimen. One Polian vesicle and one very small stone canal attached to the dorsal mesentery; muscle stomach short, course of intestine normal; respiratory trees laterally attached; muscle bands feeble; retractors attached about one third body length from the oral end; genital organs placed near middle of body, present as slender tubules.

Deposits.— Four-holed knobbed buttons of different sizes and an outer layer of cups and also a few large mulberry-shaped bodies. In the feet no end plate seems to be present; only supporting rods, thick, tapering, with a few small holes; in retrovert no rosettes but buttons; in tentacles elongate perforated rods.

Type locality.— Bahia.

Type in British Museum.

Ranges from Bahia to Florida and found also in Vineyard Sound. ("Fishhawk," United States National Museum.) (It may be that *Thyone gemmata* Ayres, with posterior prolongations on the calcareous ring, is identical with this species.)

Thyone belli Ludwig

Plate **14**, figs. 10–13

Thyone belli Ludwig, 1887, p. 21, pl. 1, fig. 6.

Length a few cm.; body slightly curved; tentacles 10, the 2 ventral much smaller; pedicels numerous, indistinctly arranged in rows along the ambulacra, able to contract completely; 5 small anal teeth present. Skins stiff, filled with deposits; color dirty, gray, finely sprinkled with dark, sometimes slightly violet.

Calcareous ring high, radials and interradials high and narrow, of almost the same width; the radials have long slender prolongations and are cleft almost to the middle of the interradials, which themselves are but slightly incised behind. One long ventrally placed Polian vesicle, one long stone canal embedded in the mesentery with an unusually large coiled head, very fragile. The muscle stomach is short, the intestine is long, of the usual course; the muscle bands are thin; the

retractors are attached about one third body length from the oral end, where the long and thin, apparently immature genital organs also are fastened; the respiratory trees are attached in the lateral interambulacra.

Calcareous deposits.— Numerous 4-holed regular, knobbed buttons with 8 marginal knobs and central ones, which in most cases are united by a distinct handle. End plate well developed, and numerous oblong supporting tables often with only a rudiment of a spire. In introvert and stalk of tentacles tables and rosettes; in tentacles rosettes and delicate perforated rods.

Ludwig mentions also that a few large perforated plates may be found in preparations of spicules from the ventral side; I have failed to find these.

Type in the United States National Museum.

Type locality.— Abrolhos Reef, Bahia.

Five specimens dredged in the harbor of Colon, Panama, off Hotel Washington, from 5 fms. depth. Deposited in United States National Museum and Museum of Copenhagen.

Thyone gemmata (Pourtalès)

Plate **17**, figs. 1–3

Colochirus gemmata Pourtalès, 1851, p. 11.
Thyonidium gemmata Selenka, 1867, p. 345.
Thyone gemmata Semper, 1868, p. 138. Théel, 1886, p. 138. Sluiter, 1919, p. 337.
Thyonella gemmata Verrill, 1872, p. 437.

Probably not *Thyone gemmata* Ayres, 1854, p. 246 (posterior prolongations on calcareous ring indicate *Thyone pervicax* Théel), nor *Thyone gemmata* Rathbun, 1879, Bahia.

About 50 specimens examined

Maximum size of preserved specimens, about 15 cm. with the tentacles withdrawn. A slender, tapering form with feet in double rows, along the ambulacra, not crowded, but also spread in the interambulacra; these are cylindrical, but toward the end of the animal they become more papilliform; the skin is rigid, thick, filled with numerous deposits; color mottled brown.

Internally a simple calcareous ring with very long anterior teeth, both on radials and interradials; the posterior margin undulated, but seems never to develop any trace of prolongations; one Polian vesicle

and one small stone canal, embedded in the mesentery; muscle stomach long, slender; intestine very long, attached to the dorsal ambulacrum, turning forward just behind the genital organs (which are situated near the middle of the body cavity), running closely along the left side of the dorsal midline, afterwards running backward again to the cloaca and then taking the usual course across the left dorsal and ventral muscle band, with perforations for the respiratory tree; finally it runs backward, partly attached to the midventral muscle band. The respiratory trees are laterally placed and reach almost to the oral end; their stems are wide, and they have very few secondary branches. The longitudinal musculature is thick and fleshy, band-like, with a deep longitudinal furrow. The thick retractors are attached about one third of the body length behind the oral end. The unbranched genital tubes are numerous and 2–3 cm. long in the mature specimen examined, which was about 15 cm. long; they are fastened near the middle of the body.

Deposits.— Four-holed buttons with small holes and undulated surface with low knobs; their size and shape being very variable; an outer layer of flattened cups with about 8 broad spines. In the cylindrical feet no end plate, only numerous thick, supporting rods with a series of small holes; they are sometimes narrow at the middle, in other cases they have a short third arm; in the conical appendages numerous triangular plates or rods. In the introvert heaps of small rosettes and scattered delicate spectacle-shaped rods: in the tentacles numerous heavy rods, with small perforations.

Type locality.— Sullivan Island, South Carolina.

Type apparently lost.

Ranges from Yucatan to Maine, also in Barbados; quite common along the coast of North and South Carolina; a single specimen from off Potomac River, Virginia, and 2 specimens have been taken off the coast of Maine. (Records all based upon the collections in the United States National Museum.) Shallow water.

Thyone sabanillaensis sp. nov.

Plate **17**, figs. 4–9

Only 2 specimens examined

The largest specimen examined is 11 cm. long and 1.5 cm. wide; slender form, with pentagonal oral and anal ends; oral valves distinct as in a *Colochirus*, composed of stiff, spinelike papillae; appendages arranged in double rows along the ambulacra and at the middle of

the animal scattered in the interambulacra, especially ventrally; near the middle of the animal the feet are partly cylindrical pedicels, partly conical papillae towards the ends. Tentacles withdrawn in both specimens, but examination showed that the ventral were smaller, and they all were much branched and filled with spicules. Skin of medium thickness, filled with deposits; color uniformly grayish.

The calcareous ring has very short posterior prolongations on the radials; the interradials are very little incised posteriorly, and end anteriorly in a pointed tooth almost as long as the radial bifid tooth; a single Polian vesicle and a small stone canal embedded in the dorsal mesentery; long muscle stomach, relatively short intestine of the usual course; the third loop runs along the odd muscle band.

The respiratory trees are, as usual, attached in the lateral ambulacra, the right being the longest; the stem of the trees is wide and the branches fine and thread-like. The musculature is thick and fleshy; the retractors are unusually short, being only one fifth of the total length of the animal.

The unbranched genital organs, which in the specimen examined were ripe and filled with eggs, are placed far back in the last third of the body cavity.

The outer layer of deposits consists of very flattened baskets with 4 spokes, and often a small hole in the brim, corresponding to each spoke; the margin is uneven, with short blunt teeth, or smooth.

The inner layer of deposits consists of plates with several holes, and usually smooth surface, and a great number of four-holed oval buttons of various shapes, with strongly knobbed surface.

In the pedicels no end plate, but several supporting rods, which are thick, slightly curved, and with small holes scattered over the entire length of the rod; in the papillae large triangular plates, with several holes, and often bent in one direction.

Type in the United States National Museum.

Only 2 specimens have been recorded as yet; from Sabanilla, Colombia, collected March 10–12, 1884. Shallow water.

The species seems to be most closely related to *Thyone gemmata*, which it resembles somewhat in its outer shape.

Pentacta Jaeger 1833

Diagnosis partly after Ekman, 1918.

Tentacles 10, the two ventral much smaller. Appendages more or less distinctly restricted to the ambulacra and developed as cylindrical

pedicels in 3 crowded rows on the ventral side, but towards the ends and in the dorsal ambulacra developed as conical papillae, and much more sparsely distributed; the papillae form (at least around the oral opening) distinct valves.

Calcareous ring simple; other anatomical features seem to be as in *Thyone;* the third loop of the intestine runs along the midventral muscle band.

Deposits numerous, consisting of an outer layer of baskets, an inner layer of knobbed buttons and simple plates, and a number of complicated large deposits; in tentacles and appendages heavy plates or rods; in introvert rosettes.

Type.— *Pentacta doliolum* (Pallas).

Pallas' *C. doliolum* from Cape of Good Hope is usually regarded as the type species. It has never been taken again, and has been regarded by Ludwig and subsequent authors as identical with *Colochirus australis* or *C. minutus*, or finally as Théel's *C. pygmaeus.*

Pallas' figures of *doliolum* are rather poor, if they really pretend to give an idea of *australis*, and the name *doliolum* is somewhat unfortunate for a form which invariably presents itself in the shape of an angulate stick, but the figure and the name are very appropriate for Théel's *Cucumaria discolor* from Cape of Good Hope, and I am almost sure that the latter (which is a real *Pentacta*, after our present definition) is identical with Pallas' much discussed species.

From the West Indian region only one species is known at present.

Pentacta pygmaeus (Théel)

Plate 21, figs. 10–16

Colochirus pygmaeus Théel, 1886, p. 92, pl. 4, fig. 9. Ludwig, 1892, p. 349 (footnote), Ekman, 1918, p. 32.

Maximum length seems to be about 7 cm. The smallest, easily recognized specimens examined were about 3 cm. in length. It is a characteristic form, of very constant outer shape; short, rectangular, with flattened ventral side with closely packed cylindrical feet in 3 rows, and toward the ends, thick, blunt cylindrical papillae, which form 5 valves around the oral opening; dorsally 2 double rows of similar papillae, which in very old specimens also may spread into the interambulacra. The introvert is thin walled, the tentacles, which in most cases are retracted, filled with spicules; the 2 ventrals are much smaller than the others. Skin thick, filled with deposits; color brown, the pig-

ment often worn off at the ends of the papillae; the animal greatly resembles a piece of not too fresh chocolate candy.

Internally a low, well-developed calcareous ring, the radial pieces are almost heart shaped, with the anterior tooth forming the apex; the interradials are similar in shape but slightly smaller; one Polian vesicle and one small stone canal; short muscle stomach; intestine attached in dorsal interambulacrum near the right muscle band, crossing the left dorsal and ventral muscle bands, and finally running along the left side of the midventral muscle band. The respiratory trees are laterally attached, almost reaching the oral end; the muscle bands are narrow with longitudinal furrow; the thin retractors are attached one third body length from the oral end; the long, unbranched genital organs are attached near the middle of the body.

The deposits are knobbed, regular buttons with 10 globular knobs; roughly speaking, they are present in two sizes, one about half as long as the other. An outer layer of irregular baskets, very hollow, resembling reticulated eggs, and with irregular margin, often incompletely developed. In the cylindrical feet a small end plate may be developed; numerous strong supporting rods, often with a third arm arising from the middle, and perforated at the middle and at the ends. In the papillae these supporting rods are developed as strong, triangular, or irregularly formed plates. In the introvert numerous large rosettes; in the stem of the tentacles strong perforated rods, and in the remaining part numerous rosettes.

Locality.— Bahia.

Type in the British Museum.

Distribution.— This species, which hitherto has been known only from the type, is represented by about 20 specimens in the collections of the United States National Museum. These were all collected in Florida at low tide level, or a few (1–3) fathoms depth.

Remarks.— I have been unable to find any difference between the specimens in the United States National Museum and the small type in the British Museum.

This species belongs apparently to the same group as *P. doliolum* (Pallas) which I regard as identical with *Cucumaria discolor* Théel as recorded by Clark from the Cape of Good Hope. The genus *Pentacta* needs, however, revision, as do the rest of the Dendrochirota.

Pseudocolochirus gen. nov.

Diagnosis.— Tentacles of equal size; appendages ventrally as cylindrical feet, placed in 3 rows, toward the ends replaced by scattered

papillae; dorsally likewise papillae along the ambulacra, smaller ones may in some species occur in all interambulacra. Skin thick, fleshy, contains very few deposits. Calcareous ring simple; other anatomical features like those of *Pentacta*.

Type.— *Pseudocolochirus violaceus* (Théel).

Théel mentions how unnaturally this form fits into the genus *Pentacta*, and a separate genus has therefore been established to take up all species of this peculiar type. The name has been proposed by Pearson, but was never published.[1]

In the West Indian region this genus is represented by one species.

Pseudocolochirus mysticus sp. nov.

Plate **21**, figs. 7–9

Cucumaria frondosa Pourtalès, 1851, p. 8.

About 20 specimens examined

Short barrel-shaped form, 4–5 cm. long and 3–4 cm. wide. Tentacles of equal size, bushy, with very little calcareous matter, contracted in all specimens examined. Appendages ventrally well expanded, cylindrical pedicels, very soft, arranged in 3 distinct rows; toward oral and anal ends as few, scattered, broad and low papillae, with peculiar dark brown tips; dorsally a zigzag row of similar very low and broad papillae with dark brown tips. Five dark brown anal papillae and 5 small calcareous anal teeth. Integument thick, fleshy, soft, almost devoid of deposits. Color pale yellowish with the remarkable dark brown tips of the papillae.

Internally a low calcareous ring, with short conical anterior teeth and undulated posterior margin; one Polian vesicle and one stone canal, with round head, fastened in the mesentery; short muscle stomach; intestine relatively short; course as usual; the third loop runs along the odd muscle band, attached to the left side of it. Two laterally fastened respiratory trees with wide stem, and few short branches. Musculature well developed; the retractors are attached near the middle of the body; the genital organs form 2 tufts of apparently unbranched tubules; in he specimens examined they were filled with ripe eggs.

Deposits.— Irregular four-holed plates with low knobs; no end plate in the pedicels, only a few almost straight supporting rods, perforated in their entire length with relatively large holes; in the introvert no

[1] In letter to Dr. Mortensen.

deposits were present, but rosettes may be expected; in the tentacles numerous curved slender rods with a few holes in the ends only, decreasing in size towards the ends of the smaller branches, filling the entire tentacles, but without making them especially rigid.

Type locality.— Off Alligator Reef (Pourtalès).

Type in Museum of Comparative Zoölogy.

Twenty well-preserved specimens are in the United States National Museum, from between Charleston and Bermuda, "Albatross" station 2691 (34° 39′ 5″ lat. N., 75° 33′ 35″ long. W., depth 10 fms.

Remarks.— This species is interesting, not so much for its own sake, but because its existence relieves the literature of the remarkable record of the occurrence of *Cucumaria frondosa*, a typical subarctic form, in the tropical waters around Florida. Everybody has doubted the record, but nevertheless it has always been quoted when *C. frondosa* and its distribution was mentioned.

Psolus Oken 1815

Diagnosis.— Tentacles 10; pedicels developed almost exclusively on the ventral sole; besides the ventral sole a few appendages only on the soft-skinned introvert, and in the shape of small papillae, around the anal opening; the whole dorsal side is otherwise devoid of appendages. Body covered with scales, except for the ventral sole and the introvert often with small grains on their surface. In the ventral sole deposits of various kinds, crowded or scattered.

Type species.— *P. phantapus* (Strussenfeldt).

Key to the species of Psolus known from the West Indian Seas and East Coast of the United States

1. Five distinct oral valves 2
1. Not 5 distinct oral valves 6
2. Surface of scales smooth, without any grains (except a few in very old specimens). About 5 dorsal scales between oral and anal scales. Deposits in sole scattered, delicate, four-holed plates with small pearl-like marginal knobs, widely separated from each other. Maximum size about 2 cm.
   Psolus valvatus Oestergren
2. Scales not smooth, covered with grains 3
3. Among the dorsal deposits reticulated grains and small four-spoked cups. Deposits in sole plates, with knobbed surface, sometimes united to an outer network. Attains a length of at least 4 cm.
   Psolus complicatus nov. sp.
3. Among dorsal deposits reticulated grains, no cups 4

4. Exterior, squamata-like, with thin, rounded scales covered with grains. Distinct oral valves with blunt apex not closing the aperture completely; 5 inner narrow "teeth" are sometimes visible; anus surrounded by 2–3 circles of scales in mature specimens 3 cm. long. Deposits in sole, heavy four-holed buttons with large knobs on the margin; the deposits increase in number with advancing age. Largest specimens known, about 3 cm. long ..... *Psolus operculatus* (Pourtalès)

4. Exterior not squamata-like; scales angular, few, with grains which fuse with scale and form low or high protuberances. Oral valves with pointed apex, closing the aperture completely; inner "teeth" usually not visible; one circle of 5 scales around anus; in small specimens 2–3 scales, in larger ones (2–3 cm. long) apparently 5 scales between oral and anal valves. In sole, perforated plates with usually two large holes, and a variable number of smaller outer holes, knobbed to almost smooth, wide range of variation 5

5. Five small ambulacral scales outside the oral valves.
Psolus tuberculosus Théel

5. Not 5 small ambulacral scales outside the oral valves.
Psolus tuberculosus Théel var. *destituta* var. nov.

6. Scales very smooth, without any trace of grains; numerous, about 18 between oral and anal scales. Deposits in sole few, four-holed smooth plates, sometimes only developed as crosses ..... *Psolus pourtalesii* Théel

6. Scales with grains. In sole, hollow cups with 3–4 holes, in older specimens as complicated reticulated bodies 7

7. Tail-like posterior projection with numerous circles of scales; scales small, numerous and very closely packed. Sole in large specimens small, rectangular; in small specimens of usual form; 3 rows of pedicels; maximum size 15 cm. from oral to anal end ..... *Psolus phantapus* (Strussenfeldt)

7. No tail-like posterior projection; only a few circles of scale around anus. Sole large, of normal size, with feet only along the edge of sole. Maximum length of sole about 19 cm. ..... *Psolus fabricii* (Düben and Koren)

Psolus valvatus Oestergren

Psolus valvatus Oestergren, 1904, p. 659. Mortensen, 1913, p. 325, 1914, p. 144, figs. 121, 122. Grieg, 1913, p. 139, figs. 7, 8. Ekman, 1923, p. 30–35, fig. 30.
Psolus operculatus Théel (part in 1886, p. 87. Specimen from 43° N., 63° 39′ W., 85 fms.)

A small form, never more than a few cm. long. Large oral valves, also distinct anal valves; about 5 scales between oral and anal end.

Dorsal side covered with relatively large scales, macroscopically apparently smooth; a few grains may very rarely be found.

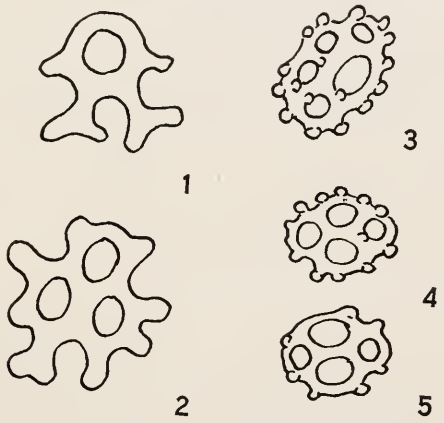
Sole thin; feet confined to the margin.

Internal anatomy not examined.

Deposits.— In the sole, scattered four-holed, very delicate buttons, with small pearl-like knobs on margin.

Type locality.— Coast of Norway; also known from south of Iceland.

This species was taken by the "Albatross" at several stations off New England, always from some hundred fathoms depth.



FIGS. 1–2. Deposits from sole of *Psolus squamatus* Düben and Koren.
FIGS. 3–5. Deposits from sole of *Psolus valvatus* Oestergren. From Mortensen's Denmark's Fauna (× 145).

Remarks.— Ekman has been of the opinion that this species is the young of *P. squamatus*. The text-figures clearly show the difference between the two species. Moreover, *P. squamatus* has never been collected in the western part of the Atlantic Ocean, where *P. valvatus* has been found. The few older records refer all to *P. fabricii* (see p. 192).

PSOLUS COMPLICATUS n. sp.

Plate **19**, figs. 6–9

Psolus operculatus Théel, partim, 1886a, p. 9.

Only one large specimen is at hand, namely the same which Théel very doubtfully referred to *operculatus*, calling attention to the fact that it had some peculiar cups beside the grains on the dorsal side.

A large specimen, the sole about 4 cm in length. Dorsal side very high, vaulted; scales thin, resembling those of *Psolus squamatus;* about 6 dorsal scales between oral and anal scales; oral opening closed by 5 triangular valves; inside these, 5 radial "teeth" and outside, 5 small

radial scales; scales covered with large grains, easily rubbed off. On the sole, only marginal pedicels, those in the outer row much smaller than those in the inner row. Sole parchment-like, rough from the numerous deposits.

Internally not examined.

Deposits in sole, numerous knobbed buttons or plates of variable size; sometimes the knobs unite and form an outer secondary network. The dorsal grains have a platelike basis; the outer part is built up of numerous pillars united by cross beams. Between the grains are numerous four-spoked deep cups with small blunt teeth on the margin.

Type locality.— Off Barbados; depth 137 fms.

Type in the Museum of Comparative Zoölogy.

Psolus tuberculosus Théel

Plate 20, fig. 3

Psolus tuberculosus Théel, 1886a, p. 13, 14, fig. 5.

The outer aspect of this form is very variable in the different stages, which, in the present material, ranges from less than 1 cm. to about 3 cm. in length. The scales are few, relatively large, and only slightly overlapping; in the smaller specimens they are thin, in the largest specimen thick, on account of the secondary layer of calcareous matter which has developed upon the scales, almost hiding their margins. Some of the animals are almost smooth, with a few larger flat knobs on the scales, while others have several knobs which form short spines, and, in the largest specimen, each of the larger scales has a strong, solid, blunt projection. The oral opening is closed by 5 large valves which close completely, and in most cases it is impossible to see the 5 inner narrow "teeth"; 5 minute scales, almost grains, are placed between the bases of the valves. The anus is surrounded by about 2 circles of scales, well separated from the surrounding large scales. There are 3–4 dorsal scales between the oral and anal scales. The sole is provided with a double row of large feet along the margin beside the outer row of much smaller feet.

Internal anatomy not examined, but from what could be observed through the holes cut in the sole, it is quite normal.

Deposits in sole, perforated plates; often with 2 larger central holes and a number of smaller outer ones; sometimes the difference in size between the holes is very slight. The surface is smooth, with a few knobs in young specimens; entirely knobbed, sometimes forming a secondary outer network in large specimens.

The largest individual is from off Sand Key, Florida, 500 fms. depth; the smaller specimens are from Florida, 120–135 fms. depth; northeast of Tortugas, 101 fms.; Campeche Bay, Mexico, 95 fms.

All in the Museum of Comparative Zoölogy.

Psolus tuberculosus Théel var. destituta var. nov.

Plate **20**, fig. 4

This form differs from typical *tuberculosus* in having a decidedly high forepart, fewer larger scales (only 2 between oral and anal scales, compared to 3 in typical specimens of the same size), and no small scales at the bases of the oral valves.

The deposits in the sole show so much variation that they are of very little help; they are plates of similar size to those in the typical form, but it seems as if they are more knobbed in young specimens, and, with advancing age, become larger and more smooth.

Type locality.— Off Barbados, 73–125 fms., 8 specimens; also Dominica, 118 fms., 1 specimen.

In the Museum of Comparative Zoölogy.

From Barbados there are furthermore 2 small specimens about 1 cm. in length, with abnormally heavy, flattened, and almost smooth scales. I believe they belong to this variety, as they lack the small outer scales around the valves, but the determination is dubious.

Psolus operculatus (Pourtalès)

Plate **20**, figs. 1, 2

Cuviera operculata Pourtalès, 1868, p. 127; 1869, p. 359, 361.
Psolus operculatus Théel, 1886, p. 130; 1886a, p. 12, 13, fig. 4. Ludwig, 1901, p. 159.
Not *Psolus operculatus* Théel, 1886, p. 87.

The type specimens range in size from 1–4 cm. in length. They are extremely "squamata-like" in their appearance, being flattened, with thin, rounded scales, smoothly overlapping and covered with grains, which may be absent in the smallest specimens. Five blunt interradial valves which are unable to close the oral aperture completely, inside these 5 narrow "teeth," and around them 5–12 scales, which are not very different from the ordinary scales of the body. Anus surrounded by a few circles of small scales. Three to five dorsal scales between the oral and anal scales; in the largest specimen, which is incomplete, perhaps 6–7 such scales may have been present. The sole is thin in

small specimens and of medium thickness in large ones; pedicels only along the margin of the sole in an inner crowded row of large feet, and an outer of smaller feet; a few feet at the ends of the odd ambulacrum.

Internal anatomy normal, not studied in detail; the paired dorsal retractors are attached very far back; the paired ventral on a level with the posterior margin of the oral scales, which are near the middle of the body.

Deposits in the sole, heavy four-holed buttons with knobbed margin in the large specimens, also knobs at the middle; the deposits become more solid with smaller holes toward the margin of the sole.

In young specimens the deposits are scattered, with advancing age they become rather crowded, but change very little in character. In the feet a well-developed end plate and numerous supporting rods with some holes.

Type locality.— Off Sand Key, Florida, 120–128 fms. depth.

Types in the Museum of Comparative Zoölogy.

Also from off Key West, Florida, 120–135 fms. depth, and off Barbados, 137 and 103 fms. depth; in the latter locality associated with *Psolus complicatus*, which Théel with some doubt referred to the present species.

Ludwig, 1901, p. 159, records this species from Spitzbergen, from 500 fms. depth; there is good reason for assuming that he is dealing with *Psolus valvatus* Oestergren, which Théel in his "Challenger" report mistook for *Psolus operculatus* Pourtalès.

Psolus pourtalesi Théel

Plate 20, figs. 5–7

Psolus pourtalesi Théel, 1886a, p. 14, pl. 1, fig. 6.

The mature specimens, which seem to be full grown, are all of the same size, about 2–3 cm. long. Dorsal side always flattened, covered with numerous small smooth scales, smoothly overlapping each other; about 18 between oral and anal end; the scales around mouth and anus are arranged in circles and become gradually smaller toward the openings. The ventral side is provided with a zigzag marginal row of large feet and a thin row of much smaller outer pedicels. The integument of the sole is thin, semitransparent, and the internal features are partly visible through the skin.

Internally a simple, well-developed calcareous ring, a small Polian vesicle and small dorsally attached stone canal. Distinct muscle

stomach; intestine attached in the dorsal interambulacrum, nearest the right side, making a large coil, then crossing the left lateral interambulacrum and the ventral left and midventral muscle bands behind the retractors, then running in the right ambulacrum to anus. Respiratory trees well developed, slender, with slender secondary branches; the right attached to its interambulacrum, the left apparently free, shorter, and more bushy. The retractors are relatively short, and the dorsal as well as the ventral pairs are attached about one third body length from the oral end. The genital tubes, which contain ripe eggs in the specimen examined, are few and slender, and as usual in these forms, attached just behind the vascular ring.

Deposits thinly scattered plates, varying from simple crosses to plates with 3–4 holes, usually completely smooth; toward the margin the plates become more solid and have smaller holes. In the pedicels, a large end plate and very heavy branched supporting rods and plates.

Type locality.— East of Nantucket, lat. 41° 24′ 45″ N., long. 65° 35′ 30″ W.; depth 1,242 fms.

Type in the Museum of Comparative Zoölogy.

Psolus phantapus (Strussenfeldt)

Holothuria phantapus Strussenfeldt, 1765.
Psolus laevigatus Ayres, 1854, p. 25, 26.
Psolus granulatus Ayres, 1854, p. 63.
Psolus regalis Verrill, 1866, p. 353. Bell, 1882, p. 646.
Psolus phantapus Verrill, 1874, p. 519. (For other references, see Ludwig, 1901, p. 155, who has a complete bibliography concerning its occurrence in European waters.)

Maximum size of a well-expanded specimen from oral to anal end about 15 cm. Sole in full-grown specimens small, rectangular, with 3 double rows of feet, which are developed even in small specimens, 2–3 cm. long.

Oral and anal ends placed on long projections. Dorsal side covered with numerous, relatively small scales, which in large specimens become very closely packed; even in young specimens they are provided with granules, which increase in number during age; the two names *granulatus* and *laevigatus* have been given to very old specimens; in the first case the grains were very obvious, in the second case, so numerous that they formed an almost smooth covering over the scales.

In young specimens the scales are relatively few, and usually placed along the free edge of the scale. There is no trace of valves around oral

or anal end, both of which are surrounded by a great number of scales arranged in rings, and even in quite small specimens these numerous rings, especially around the anus, form an important distinguishing character to separate the young from small specimens of *Psolus fabricii*. Color of large specimens, almost black.

The internal anatomy offers some features of interest. The calcareous ring is low, with broad anterior radial teeth and more pointed interradial teeth; posterior margin undulated. Single Polian vesicle and a small stone canal embedded in the dorsal mesentery. Long muscle stomach. The first loop of the intestine is much coiled, and runs in the dorsal interambulacrum nearest to the right side, then it crosses the left interambulacrum behind the attachment of the dorsal retractors, which in this species are shifted into the lateral interambulacra, and runs forward, behind the left ventral retractor, crossing the midventral band and runs backward in the right ventral interambulacrum. The respiratory trees are well developed; the right being attached to the right interambulacrum; the left mostly free, very bushy and relatively short.

The muscle bands are fleshy, except that part which runs over the sole; the midventral retractor is attached to the anterior side of the sole; the lateroventral ones are attached near the middle of the sole and the dorsolateral have more or less distinctly shifted out into the lateral interambulacra; in the male examined they were entirely independent of the corresponding muscle bands; in the female examined, from the same locality and of the same size, they had not completely lost their connection with the muscle bands. According to Oestergren's observation (see Dr. Th. Mortensen, 1924), the retractors are placed in the lateral interambulacra at a very early stage.

Deposits.— In the sole, cups with 3–4 broad spokes and blunt teeth in the margin, often with a knob arising from the centrum of the cup eventually developing into a long spine. This type of spicule is visible with low magnification in quite small specimens, 0.5 cm. long, which may be mounted *in toto* in balsam; in old specimens they become more and more numerous and complicated, with secondary rods arising from the margin. In the feet there is a well-developed end plate, and a few rods around the end plate, and cups. In introvert and tentacles, a few perforated plates.

Dorsally there is a layer of reticulated bodies outside the scales; these bodies become more and more numerous and complicated with advancing age.

Type locality.— The Sound, Denmark.

Type not preserved.

Ranges in American waters from off the coast of New England to Labrador. Common along the west coast of Greenland, also from west and south coast of Iceland, coast of Norway to Spitzbergen, coast of Ireland and England, except the southern part. In Denmark it reaches the Sound.

Usually occurring between 20–100 m. depth; according to Ludwig, it is found also in depths up to 400 m.

Remarks.— The development of this species is known; it has a red, free-swimming larva, which sometimes is met with in great numbers. Runnström, 1917, has studied its development.

Psolus fabricii Düben and Koren

Psolus fabricii Düben and Koren, 1846, p. 316. Ludwig, 1901 (complete list of references).

Length of sole up to 10 cm.; outer shape of body very variable, often flattened, edge of sole often uneven. Scales imbricating; in young specimens they are covered with numerous pearl-like granules, which in older specimens often fuse with the scales and form irregular ridges. The number of scales between oral and anal end is about 8–10 in the adult. Around oral opening, 5–6 blunt triangular scales, not forming distinct oral valves; inside these, 5 narrow tooth-like scales; around anus, 5 anal teeth, and outside these 1–2 circles of scales, 5–6 in each circle. Sole thick, leathery, except in very young specimens; feet in double rows; in old specimens there may be up to 4 rows. Odd ambulacrum naked, except in very old specimens, where a complete double row may be present; little difference between the outer and inner row of marginal feet.

Internal anatomy typical for the genus; the retractors are attached to the longitudinal muscle bands as usual.

Deposits.— Specimens 2–3 cm. long already have complicated baskets or ellipses, and with advancing age these deposits become more and more numerous and complicated. In pedicels, end plate, sometimes composed of several pieces, and perforated plates; in tentacles, few curved, perforated plates or rods; usually these disappear with age.

Type locality.— Coast of Norway.

Type not existing.

This species reaches as far south as off Massachusetts, and is quite common at a depth of a few hundred fathoms. In the remaining parts of the Atlantic Ocean it is known from almost the same localities as

Ps. phantapus; it does, however, not extend very far south along the coast of Norway and is not known from off the British Islands.

Remarks.— Old specimens which have been poorly preserved, so that the grains of the scales have been lost, have from time to time been referred to *Ps. squamatus*, and they certainly have some similarity to that species. It has, however, been proved by reëxamination of the specimens in question, that they all belong to *fabricii*, and *squamatus* must therefore be excluded from the list of American Holothurians. (See Ludwig, 1901.) The spicules in the sole are very different; in old specimens of *squamatus* they are scattered, on their way to reabsorption, in old *fabricii* they are numerous, almost crowded and very complicated.

The young of *fabricii* is very easily mistaken for the young of *phantapus;* there is some difference in the spicules, and in the number of scales between oral and anal end, but the question has not yet been satisfactorily worked out.

Thyonepsolus Clark 1901

Diagnosis.— Tentacles 10, the 2 ventral smaller. Dorsal side with scales, some of which are perforated for the passage of feet; these are distributed without any order. Ventral side with distinct sole, with 3 rows of pedicels; third loop of intestine running in left interradius; other anatomical features as in *Psolus*.

Deposits.— In sole, perforated plates and cups; dorsally a distinct layer of deposits outside the scales, consisting of perforated plates, hour glass shaped tables and high, complicated towerlike tables, the latter being especially numerous in young specimens.

Type species.— *Thyonepsolus nutriens* Clark.

Thyonepsolus braziliensis (Théel)

Plate **21**, figs. 1–6

Psolus braziliensis Théel, 1886a, p. 15, fig. 7.

The specimens at hand are either extremely small or in bad condition. The type specimen is 3.2 cm. long with vaulted dorsal side, with numerous small scales and covered outer layer of deposits; the plates are perforated by 1–3 holes for the passage of the dorsal appendages; tentacles 10, the 2 ventral smaller.

Internal anatomy not examined.

Deposits.— In sole, perforated, relatively thin smooth buttons,

irregular, often with 2–4 larger central holes. Dorsally, there is a thin layer of large wide-meshed plates, and a number of the characteristic hour glass shaped tables, which, as far as I know, occur only in this genus. There are also a number of very large towerlike tables, built up of reticulated meshwork. These are most numerous in small specimens.

Type locality.— Porto Seguro, Brazil.

Type in the Museum of Comparative Zoölogy.

Also numerous specimens from Tobago, Buccoo Bay (Clark coll.).

Shallow water form.

Remarks.— It is very extraordinary to find a species of *Thyonepsolus* in the West Indian Seas; the only species hitherto known is from the Bay of Monterey, California. The two species are totally distinct; the Californian species is much smaller when full grown and its spicules are distinctly different, although of the same type.

MOLPADONIA Haeckel

MOLPADIIDAE J. Müller

Diagnosis, from Clark, 1907, p. 135.— More or less elongated, rather stout holothurians, with an anterior, flat, circular oral disk, and generally tapering posteriorly into a more or less evident caudal portion; with well-developed respiratory trees, but with water-vascular system greatly reduced; 15 (in one species only 10) circumoral tentacles, simple or digitate, usually with conspicuous ampullae; radial water vessels are present, but excepting a few very rudimentary papillae at their posterior termination, they are rarely associated with any outgrowth of the body surface; circular muscles interrupted at each radius, and each radial longitudinal muscle usually consists of 2 parallel bands; no special sense organs are present, nor are there ciliated funnels on the mesenteries or wall of the body cavity; calcareous deposits commonly in the form of tables, fusiform rods, or perforated plates, usually present; anchors sometimes occur, but wheels and sigmoid bodies do not; phosphatic deposits often present.

Key to the genera of Molpadiidae which are known from the western part of the Atlantic Ocean

1. A few long whiplike papillae present on the dorsal side . . . . 3. *Gephyrothuria*
1. No long whiplike papillae on the dorsal side 2

2. Tentacles with 3–7 short blunt digits, the terminal one large. Phosphatic deposits often present ..... 1. *Molpadia*
2. Tentacles with two pairs of rather long pointed digits; no terminal digit present ..... 2. *Caudina*

Molpadia Cuvier 1817

Diagnosis, from Clark, 1907, p. 156. Tentacles 15, with one, sometimes two, rarely 3 pairs of digits, and a terminal digit, which is commonly the largest of all. Body rather stout, usually with distinct, although short, caudal portion, which is generally much less than one third of the total length. Radial piece of the calcareous ring with conspicuous bifurcate prolongations. Calcareous deposits in the form of tables, often very incomplete perforated plates and more or less fusiform rods. In many cases anchors are also present in connection with either a simple irregular plate or a group of 2–8 plates, which are often racket-shaped and form a rosette from which the anchor rises. Phosphatic deposits of a yellow brown or deep red color often present.

Type species.— *M. musculus* Risso.

The genus is not at all satisfactorily known, according to Clark. It seems as if anchors and racket-shaped plates are often most numerous in young specimens, and it is not settled whether the phosphatic bodies are always developed during age or are actually absent in some species. We know practically nothing about the changes which take place in the spicules. In some species, *M. oolitica* and the form which is found in the Arctic sea, it is evident that the spicules decrease with advancing age, in other forms such as *M. musculus* it seems as if a certain type of tables becomes scarce while other deposits increase in number.

Key to the species of Molpadia known from the western part of the Atlantic Ocean, including one from the eastern part

1. Spire of the table distinctly built up of 3 rods united by cross beams; no elongate fusiform rods present, not even in the tail region 2
1. Spire fused into a simple rod, sometimes the base shows indication of three pillars; fusiform rods or tables numerous, especially in the tail region .. 3
2. Tables with 3–10 holes; phosphatic bodies are early present, at first in connection with the margin of the tables, later the tables are reduced and restricted to the tail region, while the rest of the body may become almost black with phosphatic deposits ..... *M. oolitica* (Verrill)
2. Tables with 6 large central holes and a variable number of outer smaller holes; no phosphatic deposits present, the tables are well developed all through life in all parts of the body ..... *M. parva* (Théel)

3. Deposits very small, usually with 3 holes in the disc of the tables and sometimes 3 small outer holes; spire usually high, composed of 3 rods which have fused into a slender pillar ..... *M. blakei* (Théel)
3. Deposits large, usually with more than 3 holes in the disk of the tables, or plates 4
4. Deposits with holes in the prolongations of the spicule; tables with numerous holes in the large disk, often stellate in outline.
(*M. maroccana* Perrier)
4. Deposits with solid prolongations without any perforations 5
5. Regular, almost circular plates with numerous holes, the central ones being the largest; a few smaller but solid heavy tables with 3 large and 3 small holes in disk and simple spire; the fusiform rods in the tail region have 4 small central holes ..... *M. agassizi* (Théel)
5. No regular circular plates with numerous holes 6
6. Tables with 6 large regularly shaped holes in tables, and often 2–3 short slender projections from the margin of the disk. Few cm. long, immature
M. musculus (Risso)
6. Tables usually with 3–4 holes, a few with 6 holes; marginal projections generally present. Heavy fusiform bodies in the body wall, with 4 large holes, sometimes plate-like with 3 arms. More than a few cm. long.
M. musculus (Risso)

Molpadia oolitica Pourtalès.

Plate **22**, figs. 1–3, 14–18

Chiridota oolitica Pourtalès, 1857, p. 13.
Trochostoma oolitica Théel, partim, 1886, p. 57.
Molpadia oolitica, Clark, partim, 1907, p. 160. Selenka, 1867, p. 357.
Trochostoma antarcticum Théel, 1886a, p. 16.
Embolus pauper Selenka, 1867, p. 359.

The type, abnormally distorted, is about 20 cm. long. Under normal conditions it must have been about 15 cm. long. The outer and inner features seem to be quite typical.

The integument in the type and in the other full-grown specimens I have examined, is packed with phosphatic deposits almost to blackness. The calcareous deposits are practically absent, except near the tail, where small irregular tables are present, with up to 10 holes in the disk and three-pillared spire with several cross beams. These tables are evidently old, and on their way to be resorbed.

From Havana there are 3 small specimens determined by Théel as *Trochostoma antarcticum* with some doubt. As far as I can see, these are the juvenile stage of *M. oolitica*. The tables are numerous, of almost the same size as that species, with three-pillared spire, with cross beams; the disk has larger more perfectly rounded holes, as we

often have it in young specimens. Some are imperfect. A few phosphatic deposits are present, not sufficient in number to discolor the skin, and they are lying in close contact with the margin of some of the tables. The only other species in this region which has similar three-pillared tables is *M. parva* (Théel) and that form seems to retain its spicules throughout life and develops no phosphatic deposits.

Type locality.— Massachusetts Bay.

Type in Museum of Comparative Zoölogy.

Distribution.— From coast of New England; off Charleston (Selenka's *M. pauper,* which by mistake got a label from Cape Palmas into the jar); and from off Havana (Théel's *M. antarctica*). In deeper water, about 600 to 800 fathoms.

The present species has usually been united with the form which occurs in the Arctic sea, *M. jeffreysii* (Danielssen and Koren). The latter species has, however, only one pillar in the tables, and a tendency to have elongated tables in the tail region. I have had occasion to compare Pourtalès' type with several specimens from the Kara Sea, with spicules which agree perfectly with the figures Hérouard has given in 1923, and I think that at present *M. oolitica* is known only from the western part of the Atlantic Ocean.

Molpadia parva (Théel)

Plate **22**, figs. 10–13

Trochostoma arcticum var. *parva* Théel, 1886a, p. 17.
Trochostoma arcticum var. *coeruleum* Théel, ibid., p. 17.
Molpadia parva Clark, 1907, p. 168.

The type specimens are 6–7 cm. long. Color brownish to violet, but without any trace of phosphatic deposits. Internal anatomy not examined. Deposits, tables with three rods in spire and six large and a few smaller holes in the well-developed disk. No fusiform bodies.

Type locality.— Off Grenada in 416 and 583 fms.

Type in the Museum of Comparative Zoölogy.

Distribution.— From the type locality. Also in the Caribbean Sea and south of Nantucket (see Clark).

Molpadia blakei (Théel)

Plate **22**, figs. 19–23

Trochostoma blakei Théel, 1886a, p. 16, pl. 1, fig. 8.
Molpadia blakei Clark, 1907, p. 163.

Few cm. long, thin walled, with short tail. Skin finely rough. Internal anatomy not peculiar. The mesentery is very delicate, composed

of wide-meshed network. Respiratory trees long and slender; the left one has practically no lateral branches. Genital organs in the specimen examined, short fingerlike tubes, arranged in 2 tufts near the oral end.

Deposits.— Extremely small tables, commonly with 3 regular holes, sometimes 1–3 small outer holes besides. Spire high, in most cases composed of 3 rods, which fuse into a simple pillar. In the caudal part more elongate tables with a low spire ending in 2 or 3 hooks.

Type locality.— Off Grenada, from 955 fathoms depth.

Type in the Museum of Comparative Zoölogy.

Hérouard, 1923, p. 137, pl. 9, figs. 13–16 and 21–32, describes two varieties, namely *grossularia* and *excentrica* from the eastern part of the Atlantic Ocean. I have been unable to find sufficient distinguishing characters between the type form and these two varieties, but such may exist. We know too little about the range of variation of spicules in the single species, or even one individual, to judge whether these differences are of importance or not.

A third form, *M. blakei* var. *groenlandica* Mortensen from Greenland is, according to Hérouard, related not to *blakei*, but to one of the other Arctic forms, *M. jeffreysii* (Danielssen and Koren).

M. angulata (Hérouard), 1923, from off Nova Scotia, 5,270 m. depth, seems to me to be so closely related to *M. blakei* that I do not think it can be kept separate.

It is remarkable to note the varied depths in which these forms live.

Molpadia maroccana Perrier

M. maroccana Perrier, 1898, p. 1666; 1901, p. 533, pl. 22, figs. 9–15. Clark, 1907, p. 166, pl. 10, figs. 17, 18.

This species is well characterized by its large tables with numerous holes, and often star-shaped outline with perforations in the marginal projections. The fusiform bodies are also perforated by numerous holes, which likewise extend into the projections. Hérouard believes it to be a variety belonging to the *musculus* group, but I think the spicules, which are of the size found in *musculus*, are so different that it is natural to regard the species as distinct.

Known only from the type locality, off Morocco, from 221 m. depth.

Molpadia agassizi (Théel)

Plate **23**, figs. 1–3

Ankyroderma agassizi Théel, 1886a, p. 19.
Molpadia agassizi Clark, 1907, p. 169.

The type specimen is about 5–6 cm. long and quite colorless, with a stiff and glassy integument; caudal portion short.

Internal anatomy not examined.

Its deposits are very characteristic, large circular plates, perforated by numerous holes, which decrease in size toward the margin. Besides we find smaller tables with 3–4 holes and the rudiments of a one-pillared spire. In the tail, long slender rods, perforated by 4 small holes at the middle. Tables are probably more common in young specimens. No trace of phosphatic deposits are present, and as the animal seems to be mature, they are most likely always totally absent in this species.

Type locality.— Off Bequia, from 2,712 m. depth.

Also from off Grenada, and no loc., 1904 m. depth.

The types, which are the only known specimens, are in the Museum of Comparative Zoölogy.

Molpadia musculus (Risso)

Plate **22**, figs. 4–9. Plate **23**, figs. 4–7

M. musculus Clark, 1907, p. 165, pl. 11. Complete list of references. Perrier, 1901, p. 529, pl. 22, figs. 16–22. Hérouard, 1923, p. 132, pl. 5, fig. 1.
M. oolitica Théel, 1886a, p. 18. Clark, 1907, p. 160 (partim).
M. loricata Perrier, 1901, p. 535, pl. 22, figs. 23–28. Hérouard, 1923, p. 133.
Trochostoma affinis Théel, 1886a, p. 20. Clark, 1907, p. 163 (partim).

Fully grown specimens measure about 8 cm. The integument is thin, with numerous phosphatic bodies scattered more or less densely. Caudal appendages short. Inner anatomy as usual.

The spicules in the fully grown specimens are represented by relatively few, regular tables, with 6 large holes and 2–3 slender projections from the margin; the spire is a simple rod. Beside these, numerous very large fusiform bodies with usually 3–4 central holes, and generally no trace of a spire and 2, rarely 3 long, solid, marginal projections. In the tail region, long slender rods with 4 central holes. In a single individual, which was exceptionally large, I found plates with more holes, thus resembling the deposits of *M. loricata* Perrier which, as far as I can see, is simply an old specimen of *M. musculus*.

Small specimens a few cm. long have only tables with marginal projections and solid spire. The large fusiform plates are totally absent from the body wall. The fusiform rods in the tail region are smaller, but it seems evident that they increase in size with advancing age in this species.

Comparison of the spicules of those small specimens which Théel has labeled *A. affinis,* with figures of the spicules of the Arctic form *M. affinis* (Danielsen and Koren) shows that the two forms are not

identical; the Arctic form has tables in which the holes throughout life are never closed, and of much more irregular shape.

M. musculus seems to be a truly circumequatorial species, as Perrier has already pointed out. The specimens from the West Indies have been compared with those which Ludwig described as *musculus* from the Gulf of Panama, and when the great individual variability of the spicules is considered, no important differences can be noted. A specimen labeled *musculus* from off Chile seems, however, to be a slightly different form.

The species is represented from the following localities in the West Indies and off the coast of New England: off Grenada, Gulf of Mexico, off South Carolina, off Nantucket.

The young specimens, labeled *affinis* by Théel, were from off Dominica, in 391 fms.

Distribution.— The species seems to be common off the European coasts and off the coast of North and Central America. Also common in the Indo-Pacific. It seems, however, to have been so often confused with other forms that nothing definitely can be said about its actual limits, nor about the depth wherein it occurs. Usually it is from 100 to 500 fathoms.

(Molpadia turgida Verrill

Trochostoma turgida Verrill, 1879, p. 473; 1885, p. 538. Théel, 1886, p. 52. Clark, 1907, p. 164.

The tables are very regular, with high spire, and the dish is more or less regular with 12–40 holes.

Color reddish or purplish brown, skin thin, semitranslucent.

Type locality.— Massachusetts Bay from 72–180 m. depth, also from Gulf of St. Lawrence, Gulf of Maine, Casco Bay, etc.

According to Verrill, 1885, p. 538, it is not uncommon.

This species is not included in the key, as I have seen no specimens which could be referred to it.)

Caudina Stimpson 1853

Diagnosis, from Clark, 1907, p. 172.— Tentacles 15, with 2 pairs of digits, the distal pair longer than the proximal; no terminal unpaired digit. Body rather stout, more or less tapering posteriorly, and usually with a distinct caudal portion, which is generally one-third of the total length or even more. Radial pieces of calcareous ring with conspicuous bifurcate posterior prolongations. Calcareous deposits of

very various kinds, with no particular kind characteristic of the genus. Phosphatic deposits are usually entirely wanting, and are known to occur in one species only.

Type species.— *C. arenata* Gould.

Key to the species known from the western part of the Atlantic Ocean

1. Calcareous deposits four-spoked disks, with marginal knobs. *C. obesacauda* Clark
1. Calcareous deposits tables.
2. Disk of tables about 90–140 μ in diameter; spire rather low and irregular, usually with 4 somewhat converging rods ..... *C. arenata* Gould
2. Disk of tables about 150–270 μ in diameter; spire high with strong spines, apparently consisting of 3 converging rods ..... *C. albicans* (Théel)

Caudina arenata Gould

Plate **24**, figs. 2–5

Caudina arenata Gould, 1841, p. 345. Théel, 1886, p. 54. Gerould, 1895, p. 123, 190, pl. 1–8. Clark, 1907, p. 174, p. 10, figs. 1, 2, 11. Hérouard, 1923, p. 139, pl. 2, fig. 3; pl. 5, fig. 9.

Maximum length up to 25 cm., but most specimens are much smaller. A relatively slender form; the tail forms a large part of the animal. Tentacles with 4 pointed digits, rarely contracted. Internally, a calcareous ring of the usual type, with long radial posterior prolongations with bifid end. A small ventral Polian vesicle, dorsally a small, coiled stone canal, attached to the anterior margin of the mesentery. Long muscle stomach, intestine relatively short; the first loop runs closely along the right dorsal muscle band to the beginning of the cloaca; the second loop runs forward along the lower side of the left dorsal muscle band; both loops are attached by narrow complete membranes. The third loop, which is a much wider tube than the rest of the intestine, is attached by numerous long strands to the upper margin of the two lateroventral muscle bands. A fine rete mirabile is connected, essentially with the first loop.

The respiratory trees are long and slender, with small secondary tufts. The right is undivided; the left has an upper dorsal branch entangled in the rete mirabile; the other is apparently free. The musculature is well developed; the longitudinal bands are fleshy and completely divided.

The genital organs are arranged in two tufts near the oral end;

they consist of long tubules several times divided. In the specimen examined they fill the entire body cavity.

Deposits.— Numerous large tables with 4 central holes and 8–10 outer holes, margin knobbed; spire low, strong, with numerous teeth on the top. It is difficult to decide whether the spire is composed of 2 or 4 rods. We also find a number of oval four-holed buttons with two large and two small holes, and a number of knobs on the margin and between the holes.

Type locality.— Coast of New England, at present only known from that region. It is usually washed up on shore after heavy storms, and undoubtedly lives buried in the bottom. Clark gives its bathymetrical range from 1 to 35 m. Hérouard reports this species from 0–1000 m. and 1,458 m., but such records require confirmation.

Caudina obesacauda Clark

Plate **24**, figs. 6–8

C. obesacauda Clark, 1907, p. 38, 176, pl. 9, figs. 1–5.

Ten to fifteen cm. long. A stout form, often with the tail indistinctly set off. On the whole it is more robust than *C. arenata*. Internal anatomy seems to agree in all details with that species; the left respiratory tree seems to have a few accessory branches near the base.

The deposits are peculiar, regular four-spoked buttons or flattened closed baskets with a number of knobs.

Only known from the type locality, Marco, Florida, and from Galveston, Texas.

It seems to be very closely related to *C. chilensis* Müller. Its spicules have been compared with those of a specimen of *chilensis* from New Zealand, and there is some difference between them, but how constant this may prove to be it is impossible to tell at present.

Caudina albicans (Théel)

Plate **24**, fig. 1

Trochostoma albicans Théel, 1886, p. 44, pl. 3, fig. 2; pl. 11, figs. 3, 9, 10.
T. albicans var. *glabra* Théel, 1886, p. 46. Koehler and Vaney, 1905, p. 89. Perrier, 1901, p. 526, pl. 22, figs. 7, 8.
T. arenata var. *armata* Théel, 1886a, p. 17.
Caudina arenata var. *armata* Gerould, 1896, p. 19, pl. 3, figs. 34–37.

Specimens 7.5–11.5 cm. long have hitherto been collected only. The caudal portion is very long and slender. The skin is rough, and semitransparent.

Deposits.— Very large tables with strong spinous spire, apparently built up of 2 rods.

Type locality.— "Challenger" station 45, south of Nova Scotia; depth 1,240 fms.

Also taken from off Cape Cod, 1,600 m.; off Cape Hatteras, 2,235 m. Reported also by Perrier from off Senegal, 3,200 m. and by Koehler and Vaney from Gulf of Bengal. No difference can be found in the figures of the spicules which the different authors give. There is also a variety *T. albicans* var. *glabra* Théel from off New Zealand; it has not been compared with any of the Atlantic specimens.

Gephyrothuria Koehler and Vaney

Syn. *Himasthlephora* Clark, 1907

Diagnosis, after Koehler and Vaney, 1905.— Body form recalling that of a *Molpadia;* mouth terminal surrounded by 15 tentacles, which end in a pair of lobes. The oral end is slightly narrower than the remaining part of the body. Each of the dorsal ambulacra carries a series of few, very slender appendages, but the ventral side is naked, or provided with very small appendages; anal papillae present. Calcareous bodies seem to be entirely lacking in body wall; some deformed deposits may be present in the tentacles. Two respiratory trees are present, each developed as a short tube with few lobes.

Type species.— *G. alcocki* Koehler and Vaney.

This genus has previously been put in the Order Molpadonia, but Hérouard (1923) placed it among the Synallactidae, near to *Pseudostichopus*, and he united Clark's *Himasthlephora*, which was distinguished by having 2 pairs of lobes on tentacles and long genital papillae; its long caudal appendage being only an ejected portion of the intestine.

Further investigation will be necessary, before the natural position of this form can be correctly determined.

Only one species seems to occur in the Atlantic Ocean.

Gephyrothuria glauca (Clark)

Himasthlephora glauca Clark, 1907, p. 40, 184, pl. 13, figs. 1–4.
Gephyrothuria europeensis Hérouard, 1923, p. 30, pl. 9, figs. 10a-b.

Fifteen small tentacles of very equal size, partly retracted so that their exact form could not be determined; according to Clark there are small fingerlike lobes; mouth and anus terminal, mouth not retracted.

Body cylindrical with 4–5 long whiplash-like appendages on dorsal side in each ambulacrum; small tubelike projections are also found on most parts of body; Hérouard regards these projections as appendages similar to those found in *Pseudostichopus*. Anus is surrounded by some large typical anal papillae; the caudal appendage which Clark described is simply a part of the intestine, which seems to be ejected when the animal is captured. Skin thin, grayish, semitransparent; Hérouard notes that some brownish spots are present on his specimen.

As the internal anatomy is very fragmentary in the two specimens I have examined, the following is partly quoted from Clark and Hérouard. The calcareous ring is solid with 10 pieces; the radial and interradial pieces being of almost the same size and height, very little incised in front, almost straight posteriorly; no author mentions Polian vesicle or stone canal; a short oesophagus (muscle stomach?) is present; the intestine seems to have the normal course. Respiratory trees are well developed, the right being attached to the right ventral interambulacrum, the left being shorter and more bushy. Muscle bands thin, undivided, as in a *Pseudostichopus*. Genital organs and tubes in tufts on each side of mesentery, which according to Hérouard is reduced to mere threads; the duct opens on dorsal side in the midline, with a long conical papilla (in both sexes?).

Deposits.— No deposits in body wall; in tentacles I have found some heaps of very irregularly shaped deposits, of a form which give us no help in solving the systematic position of this peculiar form.

Type locality.— Off Georgia, "Albatross" station 3,678; depth 2,632 m.

Types in the United States National Museum, Washington and in the Museum of Comparative Zoölogy.

Remarks.— I have been quite unable from Clark's and Hérouard's description to find anything which indicates that the two species, *glauca* and *europeensis*, are different. Unfortunately Hérouard does not compare his species with that of Clark; he simply mentions that *Himasthlephora* is congeneric with *Gephyrothuria*.

APODA Brandt 1835

Diagnosis, from Clark, 1907, p. 42.— More or less cylindrical elongated Holothurians with terminal mouth, without respiratory trees and with water-vascular system greatly reduced; circumoral tentacles, either simple, pinnate or digitate are present, but lack ampullae; there are no pedicels or papillae; circular muscles of body wall con-

tinous, i.e. not broken or interrupted at radii; characteristic sense organs (positional organs) present, situated beside radial nerves near nerve rind; minute ciliated funnels, apparently having an excretory function, usually present in body cavity on or near mesentery; calcareous deposits in form of anchors and plates, wheels or sigmoid bodies usually present, but no tables or phosphatic deposits occur.

Three families are known, two of which are treated in the present paper.

Key to the families

1. No wheels, sigmoid or bracket-shaped particles present in the integument, but usually anchors and perforated plates; deposits rarely wholly wanting; tentacles never peltate-digitate ..... Fam. *Synaptidae* Oestergren
1. Wheels, sigmoid or bracket-shaped particles commonly present in the integument; deposits sometimes wholly wanting; tentacles commonly peltate-digitate 2
2. Wheels present or wanting; if present, not normally with more than 6 spokes ..... Fam. *Chiridotidae* Oestergren
2. Wheels present, with 8 or more spokes .. (Fam. *Myriotrochidae* Oestergren)

SYNAPTIDAE Oestergren 1898

Diagnosis, from Clark, 1907, p. 70.— Tentacles with stalk, cylindrical or terete, not becoming widened distally, either with digits along each side for most of its length (pinnate) or with only one or two digits on each side near the tip (digitate) or without digits at all (simple). Calcareous deposits usually anchors and perforated plates (anchor-plates), often accompanied by irregular curved rods or minute particles (miliary grains) but any of these may be wanting. Hermaphroditic so far as known, except possibly the genus *Rhabdomolgus*.

Key to the genera known from the western Atlantic region

Clark, 1907, p. 71.— (The genera from the region here studied belong, as far as our present knowledge goes, to the group which has anchors and anchor plates. For other genera see Clark.)

1. Arms of anchors smooth, vertex usually with minute knob-like projections . 2
1. Arms of anchors usually serrate; vertex usually smooth, without knobs . . . 3
2. Stock of anchors branched irregularly; large forms with numerous digits on side of tentacles ..... *Euapta* Oestergren
2. Stock of anchors not branched; the large holes in anchor plates dentate and regularly arranged ..... *Synaptula* Oersted

3. Tentacles pinnate, 5–21, usually more than 7, digits or simply pinnately notched without digits ..... *Leptosynapta* Verrill
3. Tentacles digitate with 3–5 digits; anchor plates not narrowed into a handle. *Protankyra* Oestergren

Euapta Oestergren 1898

Diagnosis, from Clark, 1907, p. 73.— Fifteen tentacles (young, 13–14), with 10–35 digits on each side; cartilaginous ring usually present. Numerous Polian vesicles; stone canal one or more; often pigment eyes at base of tentacles.

Stock of anchor distinctly branched, arms smooth; vertex with some minute knobs; anchor plates with large central holes surrounded by 6, rarely 7 other large holes, all more or less dentate, and with several holes of variable size and arrangement (one on each side large) but with smooth margin at posterior end, where a well-formed and arched bow crosses the outer surface of plate.

Type species.— *E. lappa* (J. Müller).

Euapta lappa (J. Müller)

Synapta lappa J. Müller, 1850, p. 134.
Euapta lappa Clark, 1907, p. 73, pl. 4, figs. 23–25; 1924, p. 464, pl. 1, figs. 5–7. Sluiter, 1910, p. 335. Deichmann, 1926, p. 26.

Maximum length, one meter. Color silvery gray, often longitudinally striped.

The species cannot be confused with any other form in West Indian waters. A parallel form *E. godeffroyi* Semper occurs in the Pacific Ocean with smaller anchors and other minute differences in the spicules.

Type locality.— "West India."

Ranging from the coast of tropical America all over the Caribbean Sea; not yet known from Bermuda. Recorded from Teneriffe (Théel).

Typical shallow water form, usually found beneath dead coral blocks.

Synaptula Oersted, 1849

Diagnosis, from Clark, 1907, p. 80.— Tentacles pinnate, 10–15; at least 5 digits on each side; calcareous ring present; 3 or more Polian vesicles; single unbranched stone canal. Sense organs in form of pigment eyes at the base of tentacles on oral disk often present.

Stock of anchors finely toothed but not branched. Arms smooth, but vertex with a few minute knobs; anchor plates with a large central

hole, surrounded by 6 other large holes, all more or less dentate, and with two large smooth holes at the narrow posterior end, where a well-formed and distinctly arched bow crosses outer surface of plate.

Type species.— *S. hydriformis* (Lesueur).

Synaptula hydriformis (Lesueur)

Holothuria hydriformis Lesueur, 1823, p. 162.
Synaptula hydriformis Clark, 1907, p. 23, 82, pl. 6; 1924, p. 473, pl. 3, figs. 5–6; pl. 4, fig. 4. Deichmann, 1926, p. 27.

A small species, a few cm. in length; common from Brazil to Bermuda; found in shallow water.

Viviparous.

Leptosynapta Verrill 1867

Diagnosis, after Clark, 1907, p. 86.— Tentacles pinnate, 10–13. Digits usually 4 or more on each side (rarely 3 or only 2 or none). Cartilaginous ring wanting. Polian vesicles usually single, rarely more than one. Stone canal single, unbranched. Sense organs never in form of pigment eyes, but as minute cups, probably olfactory, on inner surface of stalk of tentacles. Stock of anchors finely toothed but not branched; arm usually with upwardly or outwardly projecting teeth on outer edge; vertex smooth. Anchor plates oval or somewhat elongate, with large central hole, surrounded by 6 other large holes, usually more or less dentate and without any arched bow across the outer surface; at the broad end there are often additional holes; a few species have a greater number of holes.

Type species.— *Leptosynapta inhaerens* (O. F. Müller).

Key to the species of Leptosynapta from the western part of the Atlantic Ocean

1. Anchor and anchor plates extremely large (300–600 μ in length), at least some of them near the anal end, smaller anchors and anchor plates may be intermingled with the large ones 2
1. Anchor and anchor plates small (200 μ or less) 4
2. Anchor with 3 teeth on each arm; anchor plates not especially oblong in outlines, with 7 regular holes arranged in a rosette; numerous granules present ..... *L. multigranulata* Clark
2. Anchor with 6–9 teeth on each arm; large anchor plates, distinctly oblong with numerous holes (10–20), not in a regular rosette 3
3. Granules present ..... *L. acanthia* Clark

3. No granules present ..... *L. multipora* Clark
4. Anchor plates almost circular, practically devoid of teeth in the large holes; no miliary grains present ..... *L. circopatina* Clark
4. Anchor plates more or less oblong, with indistinct to distinct teeth in the large holes 5
5. Arms of anchor very widely spread; anchor usually longer than anchor plates, which usually are more than 140 μ in length. Scattered groups of miliary grains, mostly oblong in shape ..... *L. inhaerens* (O. F. Müller)
5. Arms of anchor not widely spread; anchor plates less than 140 μ in length 6
6. Anchor plates relatively robust and up to 140 μ in length, often distinctly oblong; anchors slightly longer than anchor plates; miliary grains in groups of 4–5, scattered ..... *L. crassipatina* Clark
6. Anchor plates not distinctly oblong, less than 110 μ in length; no miliary grains present 7
7. Anchor plates with distinct teeth on inner edge of the large holes; anchors distinctly longer than anchor plates ..... *L. roseola* Verrill
7. Anchor plates with teeth poorly developed on inner edge of the large holes; anchors as long as anchor plates, often without teeth on arms. *L. parvipatina* Clark

Leptosynapta multigranulata Clark

Leptosynapta multigranulata Clark, 1924, p. 486, pl. 8, figs. 3–7.

Few cm. long; resembles *inhaerens* superficially, but its spicules are entirely different.

Type locality.— Tortugas, Florida.

Type in the Museum of Comparative Zoölogy.

Shallow water form, taken among roots of eel grass.

Leptosynapta acanthia Clark

Synapta acanthia Clark, 1899, p. 126.

Leptosynapta acanthia Clark, 1907, p. 92; 1924, p. 477, pl. 6, figs. 12–16.

Up to 35 cm. in length; found in shallow water.

Type locality.— Bermuda.

Type in the Museum of Comparative Zoölogy.

Not known from any locality outside Bermuda.

Leptosynapta multipora Clark

Leptosynapta multipora Clark, 1924, p. 488, pl. 9, figs. 1–5.

Length in life up to 9 cm.

Type locality.— Kingston Harbor, Jamaica.

Type in Museum of Comparative Zoölogy.

Taken from sand bottom.

Leptosynapta circopatina Clark

Leptosynapta circopatina Clark, 1924, p. 478, pl. 4, figs. 6, 7.

Only a single specimen, a few cm. long, has been collected.
Type locality.— Port Royal, Jamaica.
Type in Museum of Comparative Zoölogy.
Taken under a brick at low water.

Leptosynapta inhaerens (O. F. Müller)

Holothuria inhaerens O. F. Müller, 1776, p. 232.
Leptosynapta inhaerens Clark, 1907, p. 88, pl. 5, figs. 14, 15, 18, 20 (complete list of references); 1924, p. 483, pl. 7, figs. 12–16.
L. gracilis Selenka, 1867.

Maximum size 15 cm. The specimens which have been examined are from the coast of New England. The species ranges apparently from Maine to South Carolina and is also reported from Bermuda.

Oestergren suggests (1898) that American specimens belong to a different species from the Norwegian, and I believe he is right.

The question has been very carefully discussed by Clark in 1924.

Leptosynapta crassipatina Clark

Leptosynapta crassipatina Clark, 1924, p. 479, pl. 6, figs. 1–4.

Grows to the same size as *inhaerens*.
Type locality.— Key West, Florida.
Type in the Museum of Comparative Zoölogy.
Taken from sandy mud.

Leptosynapta parvipatina Clark

Leptosynapta parvipatina Clark, 1924, p. 490, pl. 4, figs. 8, 9; pl. 6, figs. 5–8.

Length 4–5 cm.
Type locality.— Buccoo Bay, Tobago.
Type in the Museum of Comparative Zoölogy.
From muddy sand.

Protankyra Oestergren 1898

Diagnosis, from Clark.— Tentacles digitate, 12 in number. Digits 2 (rarely one only), on each side. Cartilaginous ring wanting. Polian vesicles 2–10, or rarely only one. Stone canals usually single, but rarely there are several.

Stock of anchors more or less branched, or only finely toothed; arms usually serrate; vertex without knobs. Anchor plates without a handle, with numerous irregular perforations, and with a more or less imperfectly developed bow across outer surface of posterior end; plates and perforations also with either smooth or dentate margins.

Type species.— *P. benedeni* (Ludwig).

Key to the species of Protankyra known from the western part of the Atlantic Ocean

1. Anchor plate with extremely small holes; handle broad; strong teeth on arm and anchors, reaching the tip of the anchor arms . . . . . *P. brychia* Verrill
1. Anchor plate with well-developed holes, narrow or irregular handle 2
2. Anchor plate simple without irregular network. Anchors with teeth only on some part of the arms not reaching the tips. Shallow water form. *P. benedeni* (Ludwig)
2. Anchor plates with irregular network; anchors with teeth reaching the tip of anchor arms. Deep-sea form . . . . . *P. abyssicola* (Théel)

Protankyra brychia Verrill

Protankyra brychia Verrill, 1885, p. 539; Clark, 1907, p. 103, pl. 4, figs. 12–14.

Of this species only a few, imperfect specimens are known; the spicules are, however, very characteristic.

Type locality.— Off Cape Hatteras; depth 1,688 m.

Type in the United States National Museum.

Known only from the type locality.

Protankyra benedeni (Ludwig)

Synapta benedeni Ludwig, 1881, p. 55, pl. 3, figs. 19, 20. Clark, 1907, p. 103.

Ludwig's description.— Three specimens are at hand, respectively 2.3, 3 and 3.5 cm. long; the following description is essentially based upon the second specimen. This has a diameter of 8 mm. The twelve tentacles resembling in their shape that of *Synapta digitata;* besides a short terminal one, each tentacle has on each side only 2 larger digits. Color whitish, the thin integument renders the muscle band visible. The entire habitus recalls that of *S. digitata.*

The anchors are 0.62 mm. long and provided with a few blunt teeth near the ends of the arms; the anchor plates have a length of 0.48 mm.; approximating in their shape that of *S. pseudodigitata* Semper and

S. similis Semper, the holes in the anchor plates are, however, provided with irregularly distributed spines.

Beside these, we find in the integument numerous dumbbell-shaped bodies, the so-called miliary grains (0.025 mm. long).

The longitudinal muscle band becomes narrower from oral end to anal end; in the anterior part of the body cavity they are almost as broad as the intermuscular areas. Six Polian vesicles, 2–4 mm. long, attached to the vascular ring. In dorsal mesentery there is a single stone canal embedded, with rounded head, forwardly directed and coiled.

A small bundle of short genital organs at most once divided are placed left and right to the dorsal mesentery; they are not functioning in the specimen examined, as neither distinct sperma nor egg cells could be traced. The opening of the oral sinus is relatively large; it occupies the entire diastema between the tentacle canals.

The intestine is coiled and the coils reach into the anterior and posterior part of the body cavity. I have missed the ciliated funnels in the mesentery on the first part of the intestine, and found a few on its second, forward-running loop, and numerous on the third backwards running loop; but ciliated funnels seem never to migrate out upon the wall of the body cavity.

Type locality.— Coast of Brazil.

Type, most likely in Bruxelles.

Remarks.— Not known from other localities. Ludwig's figures show an anchor plate and anchor, clearly proving that it is distinct from the related forms. It has never been taken again.

Protankyra abyssicola (Théel)

Synapta abyssicola Théel, 1886, p. 14, pl. 1, fig. 11.

Protankyra abyssicola Clark, 1907, p. 105, p. 4, figs. 8–11; 1924, p. 11, pl. 11, figs. 6, 7, pl. 12, fig. 1.

I have examined the fragments from off New Jersey, depth 1,394 fathoms. The specimen is too poor to allow a real comparison with *P. pacificus* Ludwig, from off west coast of South America, which by some authors is regarded as identical with the Atlantic species.

In the Atlantic Ocean this species ranges from the coast of New Jersey and Gulf of Mexico to Senegal; depth between 2,000–3,000 m.

CHIRIDOTIDAE Oestergren 1898

Diagnosis, after Clark, 1907, p. 112.— Tentacle with stalk short, becoming widened toward the ends where it bears 3–10 digits on each

side; the digit-bearing portion forms a sort of disk which can, in many cases (perhaps always?), be drawn downward in contraction, more or less into the basal portion of the stalk; such tentacles may be called peltately digitate; cartilaginous ring wanting; stone canal single; eye pits wanting; genital organs seldom present; calcareous deposits either six-spoked wheels or conspicuous sigmoid or C-shaped bodies, or both, often accompanied by curved or straight rods or oval miliary granules; rarely minute curved rods only are present, or deposits are wholly wanting. Sexes apparently separate in many species, perhaps in all.

Key to the genera known from the western part of the Atlantic Ocean

For all other genera, see Clark, 1907, p. 112

1. No sigmoid bodies; wheels present, collected in little papillae; tentacles 12; ciliated funnels mostly single and scattered ..... *Chiridota* Eschsholtz
1. Wheels wanting; minute curved rods present ..... *Toxodora* Verrill

Chiridota Eschscholtz 1829

For synonyms, see Clark, p. 113

Diagnosis.— Tentacles 12, exceptionally 13 or even 14. Digits 2–10 on each side, the terminal pair longest. Polian vesicles numerous, 3–20. No gustatory organs are known to occur. Ciliated funnels usually single, sometimes collected into little groups, but not forming true stalked clusters. Calcareous deposits in the form of six-spoked wheels, collected in little papillae, containing 10–80 of divers sizes. No sigmoid bodies, but small curved rods with enlarged ends are often present, and minute oval miliary grains, or somewhat large rod-shaped particles, frequently occur in connection with the longitudinal muscles.

Key to the species known from the western part of the Atlantic Ocean

1. In integument, no curved rods; wheel-papillae very few, large. *Chiridota laevis* (Fabricius)
1. In integument, curved rods 2
2. A thin, scattered layer of curved rods; wheel-papillae abundant; wheels of very variable size, up to 0.2 mm. wide ..... *Chiridota rotifera* Pourtalès
2. A crowded layer of curved rods; wheel-papillae few (?). Wheels mostly of large size, more than 0.2 mm. wide ..... *Chiridota pelorica* nov. sp.

Chiridota laevis (Fabricius)

Holothuria laevis Fabricius, 1780, p. 353.
Chiridota laevis Clark, 1907, p. 119 (complete list of references).
Chiridota typica Selenka, 1867, p. 366.

The question about the various species which are united under this name is yet unsettled (see Clark, 1907, p. 29, 119).

In the following, only the species is considered described by Selenka as *C. typica* from Massachusetts Bay.

The specimens are a few cm. long, with 12 tentacles of the typical shape, short with 2–3 pairs of digits; the terminal pair is longest. Integument semitransparent; large heaps of deposits scattered along the interradials, most numerous posteriorly.

Internally not examined.

Nothing can, at present, be said about the distribution of this species. From off the Azores v. Marenzeller describes a species as *C. abyssicola* (1893, pl. 19, pl. 1, fig. 5; pl. 2, fig. 7). It has wheels which are about 0.08–0.1 mm. in diameter. These dimensions are similar to average wheels in Selenka's specimens, but much larger wheels are found in the ones before me; the wheels of *Chiridota* are, however, so little known, that no conclusion can be drawn about the importance of the size. Marenzeller notes that his specimen is closely related to the Arctic form, but thinks it is better to keep them separate.

Chiridota rotifera Pourtalès

Synapta rotifera Pourtalès, 1851, p. 15. Ludwig, 1881, p. 41, pl. 3, figs. 1–15. Clark, 1907, p. 115. Sluiter, 1910, p. 341.

A very characteristic form, which grows to a length of about 10 cm. Numerous wheel papillae, which contain a number of wheels of very various size, from less than 0.1 mm. to 0.2 mm.; curved rods are thinly scattered.

Type locality.— Biscayne Bay, Florida.

Type not preserved.

Common all over the eastern part, at least, of the West Indian region; also known from Bermuda.

According to Clark it lives on sandy beaches, or among corals, in shallow water. It is viviparous, and its development has been studied (in preserved material) by Ludwig and Clark.

Chiridota peloria sp. nov.

Two specimens are at hand, in fragments. When intact they must have been about 25 cm. in length.

Seven pairs of digits on the tentacles, all long and slender and of almost equal size; skin thin, semitransparent, with numerous small warts.

Internal anatomy seems to be quite typical, with a low calcareous ring; a number of small Polian vesicles, and a single dorsally attached stone canal. Course of the sand-filled intestine could not be studied; muscle bands narrow, with the typical retractorlike anterior part; a few genital tubules were found, but torn loose from their base.

Deposits.— A uniformly spread layer of small curved rods, also in the warts; near the oral end, in one specimen, I found some larger warts which contained wheels. These are of variable size, but, on the whole, they are larger than most wheels in *C. rotifera*, where the layer of rods is much thinner.

Type locality.— Montego Bay, Jamaica.

Type in the Museum of Comparative Zoölogy, cat. no. 87.

Remarks.— This form is distinguished from *rotifera* by its much larger size, and the amount of spicules. The label indicates that it was found "buried in lined holes in sand, on the beach." It was taken September 1, 1910, by Professor E. A. Andrews of the Johns Hopkins University, but Dr. Clark tried in vain to find it again on his later visit to Montego Bay. It is, according to him, a quite unique mode of life for a *Chiridota*. On account of its remarkable size, Dr. Clark has suggested the name *C. peloria*.

Toxodora Verrill

Diagnosis, from Clark, 1907.— Tentacles 12. Digits numerous, 10–16. Wheels wanting, calcareous particles consisting exclusively of minute slender plates in the shape of bows or parentheses with the ends incurved.

Type species.— *Toxodora ferruginea* Verrill.

Toxodora ferruginea Verrill

Toxodora ferruginea Verrill, 1882, p. 220. Clark, 1907, p. 126.

Incompletely known; length 3 cm. or perhaps more; color reddish brown. Deposits, rods 0.06 mm. in diameter, resembling those found in *C. rotifera*.

Type locality.— Martha's Vineyard, from 140–280 m. depth.

Paratypes in the Museum of Comparative Zoölogy.

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INDEX

Synonyms are in *italics*

EXPLANATION OF PLATES

The scale of magnification (0.01 mm.) is given on each plate.

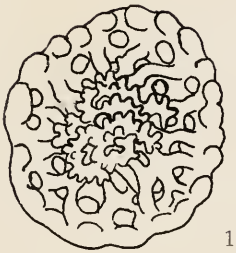
PLATE 1

Holothuria cubana Ludwig

Fig. 1. Complicated large table.
Fig. 2. Small, less complicated table from near ventral appendage.
Fig. 3. Disk of juvenile table.
Fig. 4, 5. Supporting plates from feet.
Fig. 6, 7. Large buttons from dorsal side.
Fig. 8. Small button from dorsal side.

Holothuria pseudofossor spec. nov.

Fig. 9. Disk of juvenile table.
Fig. 10. Table from body wall of adult specimen.
Fig. 11–14. Buttons from body wall of adult specimen.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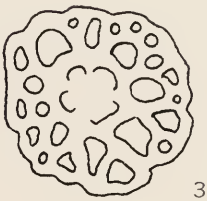
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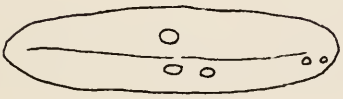
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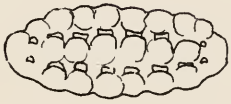
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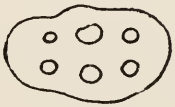
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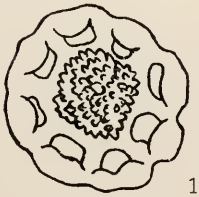
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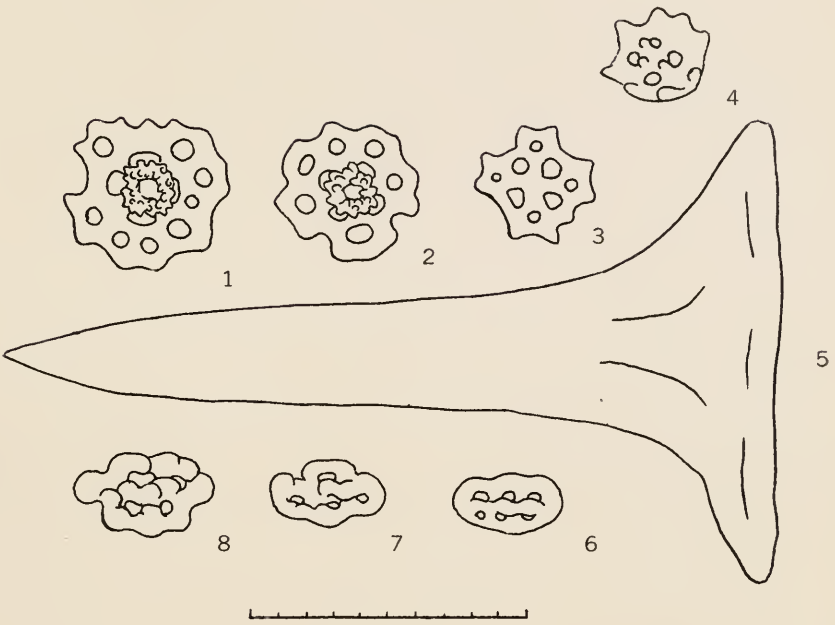
PLATE 2

Holothuria princeps Selenka

Fig. 1–4. Various stages of tables.
Fig. 5. Large table from appendage.
Fig. 6–8. Buttons.

Holothuria occidentalis Ludwig

Fig. 9–11. Tables.
Fig. 12–16. Buttons.
Fig. 17. Supporting rod from feet.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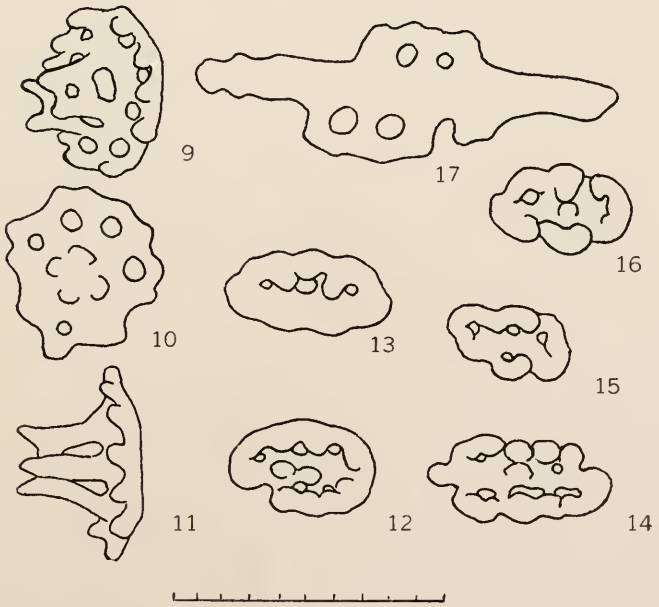
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PLATE 3

Holothuria imperator spec. nov.

Fig. 1–3. Tables with reduced spire.
Fig. 4–10. Buttons.
Fig. 11. Supporting rod.

Holothuria surinamensis Ludwig

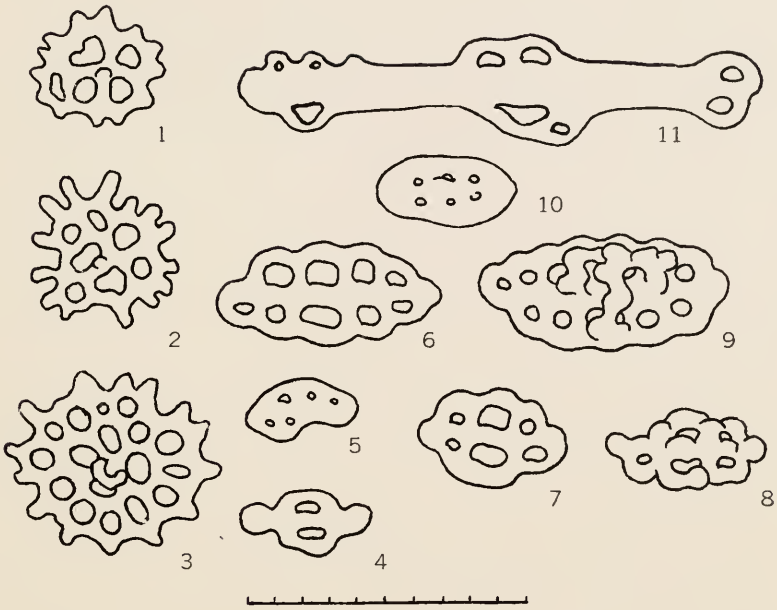
Fig. 12–14. Tables.
Fig. 15. Part of rod from body wall.
Fig. 19. Disk of table.

Holothuria languens Selenka

Fig. 16. Table.

Holothuria impatiens (Forskål)

Fig. 17. Table.
Fig. 18. Button.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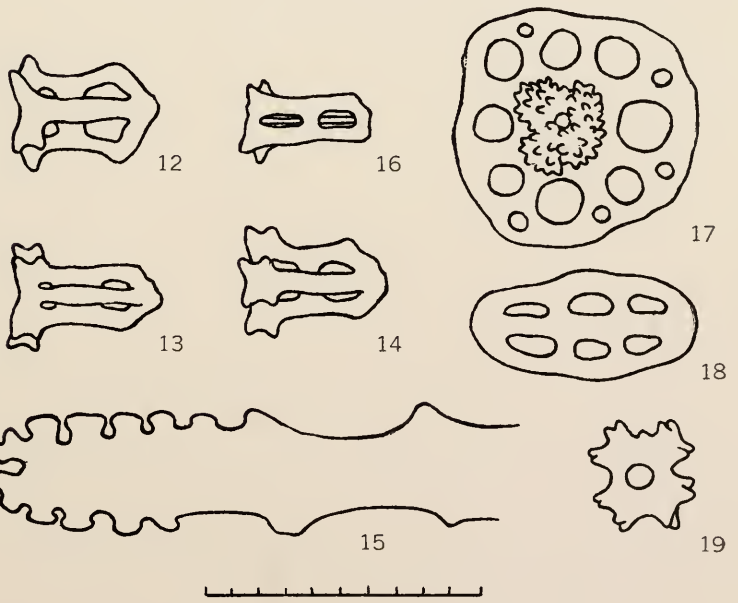
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PLATE 4

Holothuria arenicola Semper

Fig. 1–4. Buttons.
Fig. 5. Table.
Fig. 6. Disk of young table.
Fig. 7–9. Supporting rods.

Holothuria glaberrima Selenka

Fig. 10–13. Rods from integument.

Holothuria parvula (Selenka)

Fig. 14. Rod from tentacle.
Fig. 15. Juvenile buttons.
Fig. 16, 17. Juvenile tables.
Fig. 18, 19. Supporting plates and rods from feet.
Fig. 20. Table from adult.
Fig. 21, 22. Buttons from adult.

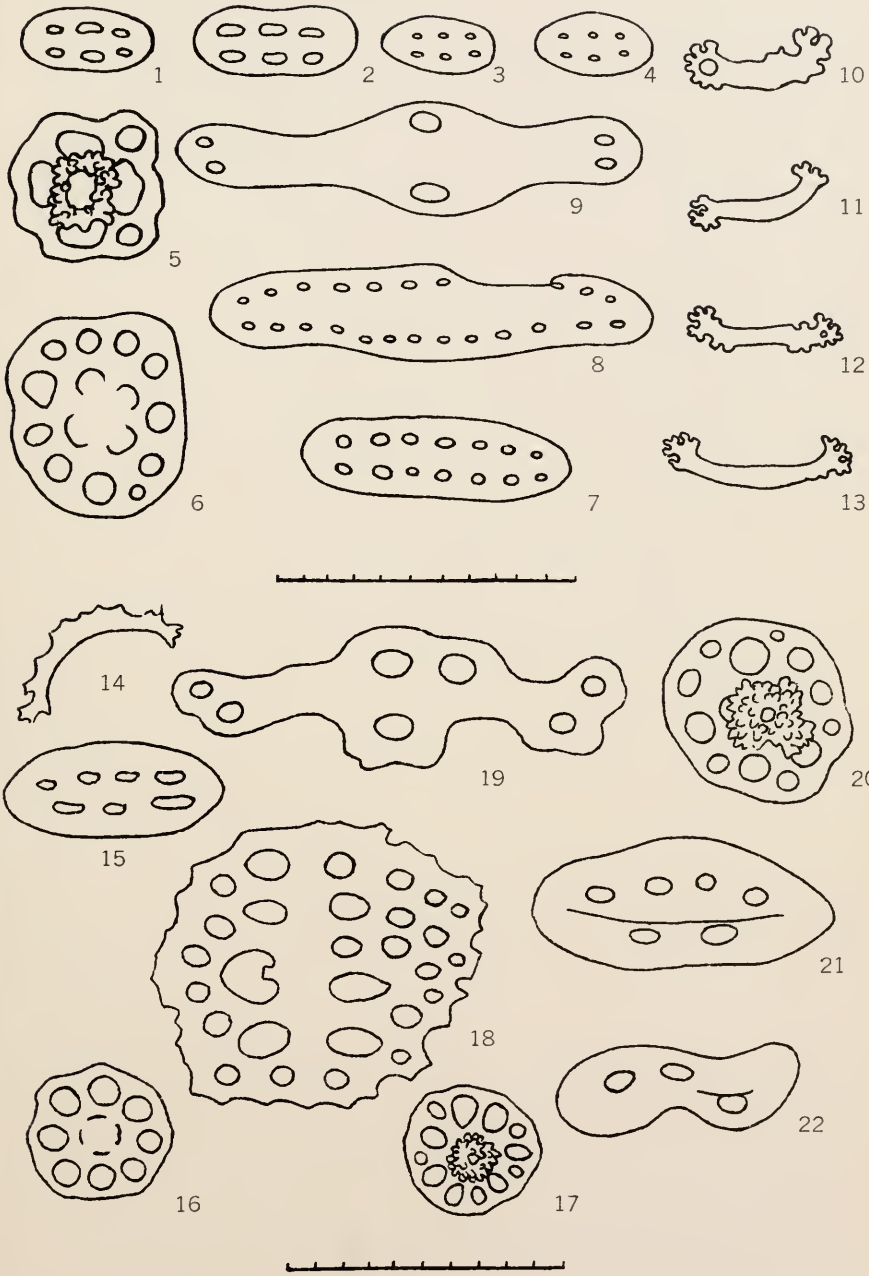
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PLATE 5

Holothuria grisea Selenka

Fig. 1. Supporting rod.
Fig. 2. Plate from integument.
Fig. 3. Disk of table.
Fig. 4. Table, lateral view.

Holothuria floridana Pourtalès

Fig. 5. Table.
Fig. 6–9. Rosettes.

Holothuria atra (Jaeger)

Fig. 10–14. Rosettes.

Holothuria mexicana Ludwig

Fig. 15–20. Biscuit-shaped plates.

Actinopyga agassizi (Selenka)

Fig. 21–29. Plates and rods from body wall.

Stichopus badionotus Selenka

Fig. 30, 31. Tables from adult.
Fig. 32, 33. Disk of table from adult.
Fig. 34, 35. Tables from young specimens.
Fig. 36. Lateral view of table from young specimen.

Stichopus macroparenthesis Clark

Fig. 37. Exceptionally small table.
Fig. 38. Table from young specimen.
Fig. 39, 40. Tables from adult specimen.
Fig. 41, 42. Lateral view of tables.
Fig. 43. C-shaped body.

Astichopus multifidus (Sluiter)

Fig. 44. C-shaped bodies.
Fig. 45. Grains.
Fig. 46, 47. Rods from tentacles.

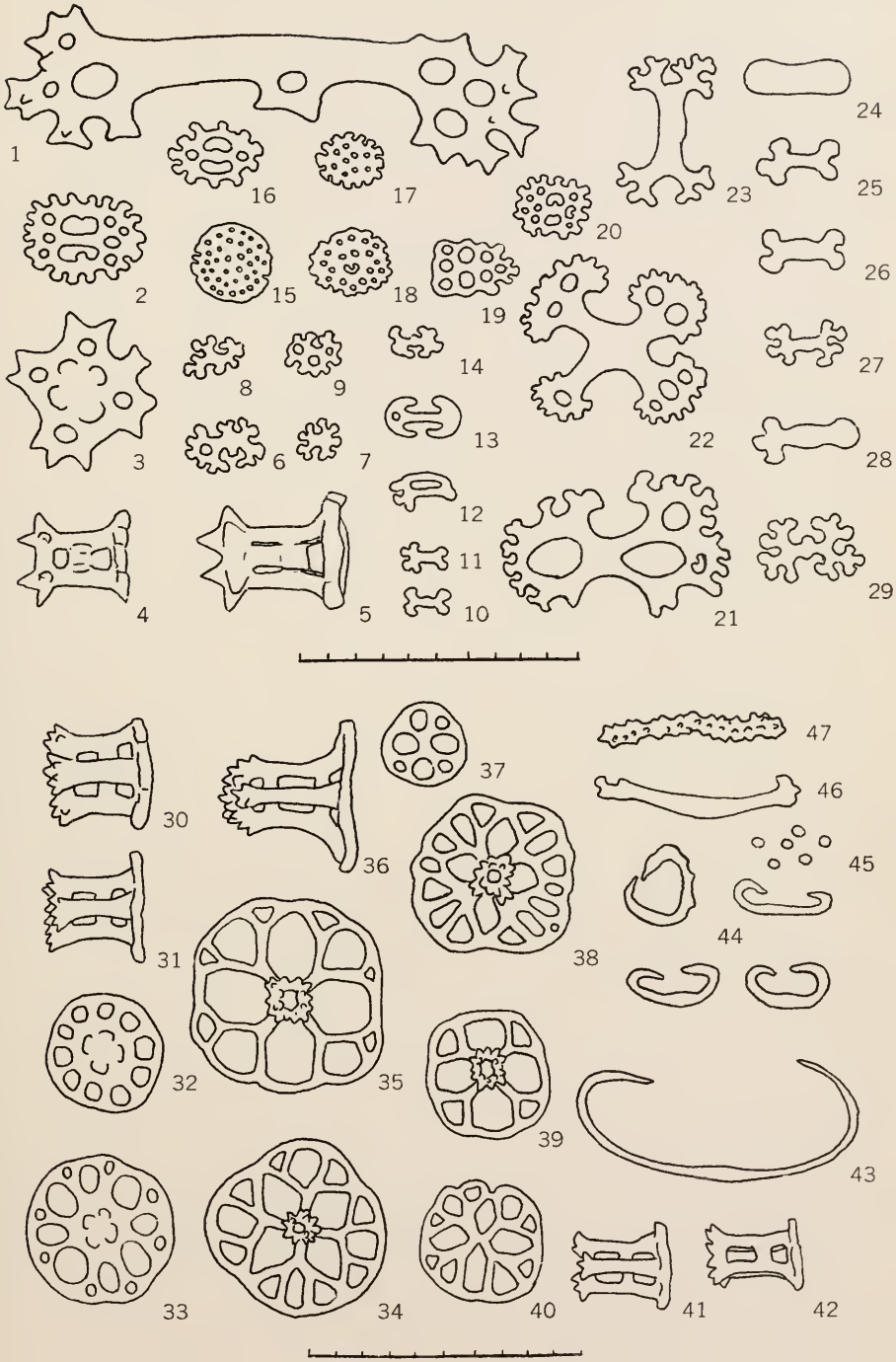
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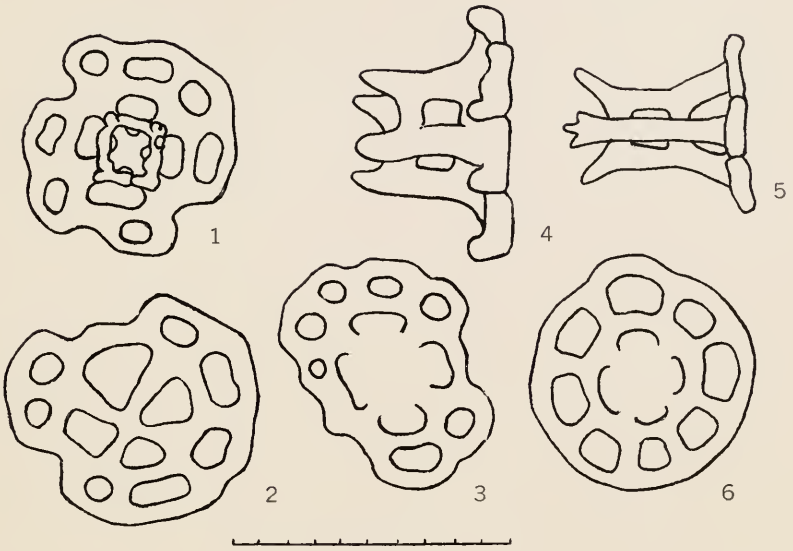
PLATE 6

Mesothuria verrilli (Théel)

Fig. 1–3. Disk of common type.
Fig. 4. Lateral view of table of common type.
Fig. 5. Lateral view of table of rare type.
Fig. 6. Disk of table of rare type.
Fig. 7. Lateral view of table from young specimen.
Fig. 8. Disk of table from young specimen.

Mesothuria intestinalis (Asc. and Rathke)

Fig. 9. Table seen from above.
Fig. 10. Disk of table.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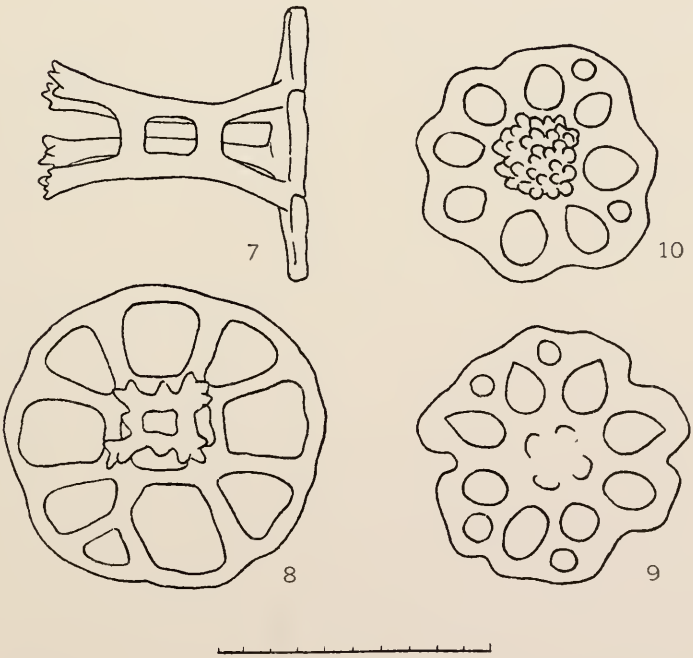
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PLATE 7

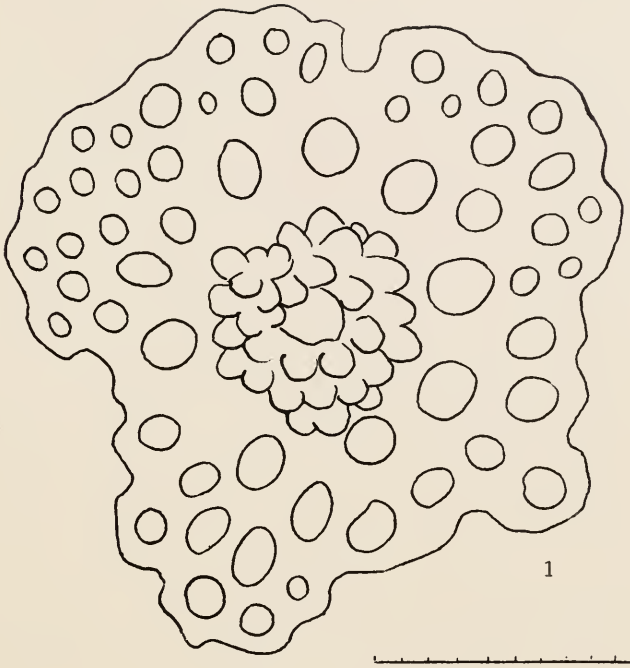
Mesothuria gargantua spec. nov.

Fig. 1. Typical table of the large kind.

Mesothuria marrocana Perrier

Fig. 2–5. Tables from body wall.

Figs. 6, 7. Lateral view of tables from appendages.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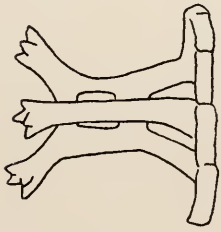
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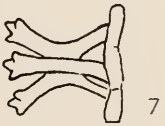
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PLATE 8

Mesothuria rugosa Hérouard

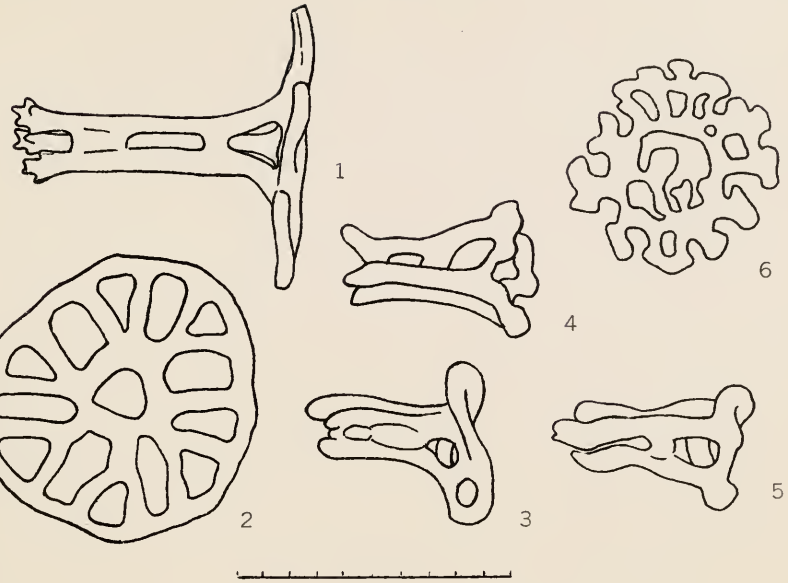
Fig. 1. Lateral view of table.
Fig. 2. Disk of table.
Fig. 3–5. Lateral view of tables from appendages.
Fig. 6. End plate.

Zygothuria sp.

Fig. 7. Disk of table.

Zygothuria lactea (Théel)

Fig. 8. Disk of table.
Fig. 9. Lateral view of table with undivided spire.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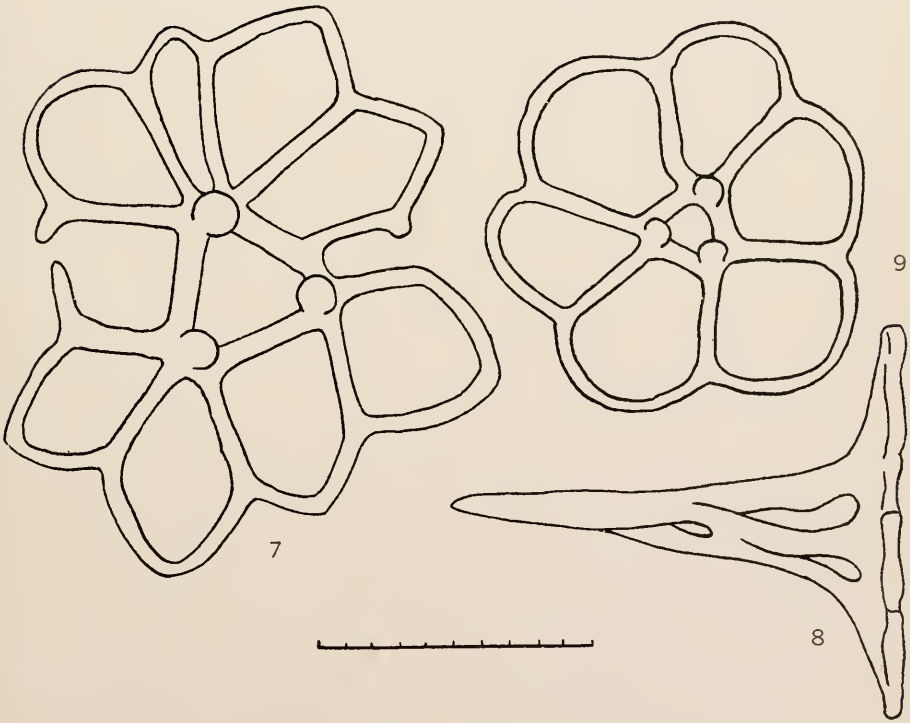
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PLATE 9

Bathyplotes natans (Sars)

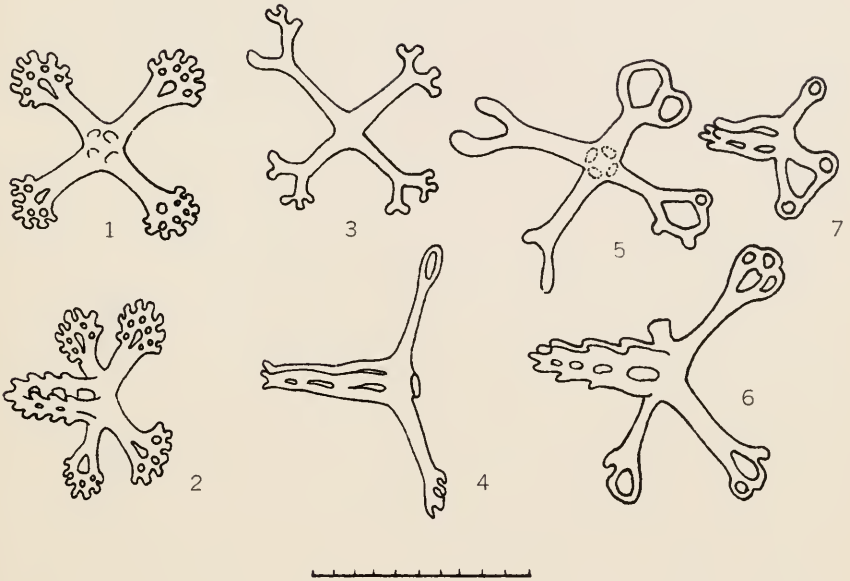
Fig. 1, 2. Cross-shaped tables.
Fig. 9. Total figure (about half size).

Bathyplotes pourtalesi Théel

Fig. 3, 4. Deposits from typical form.
Figs. 5–7. Deposits from untypical form (no fungiform papillae).

Amphigymnas bahamensis spec. nov.

Fig. 8. Total figure (about half size).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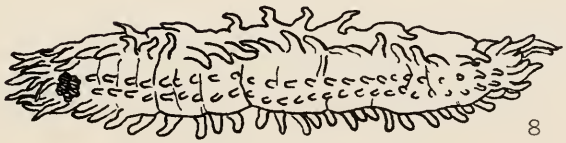
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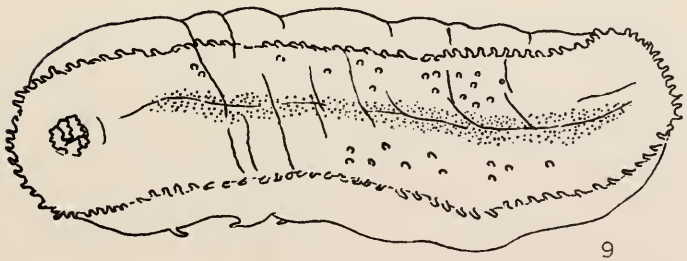
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PLATE 10

Amphigymnas bahamensis nov. sp.

Fig. 1, 2. Supporting rods.
Fig. 3. Small table from appendage.
Figs. 4, 5. Plates (tables with reduced spire).
Fig. 6. Small table with well-developed three-pillared spire.

Deima blakei Théel

Fig. 7. Plate from body wall.
Fig. 8. Rod from layer outside the plates.
Fig. 9, 10. Plates from near tentacles.
Fig. 11. Rod from appendage.

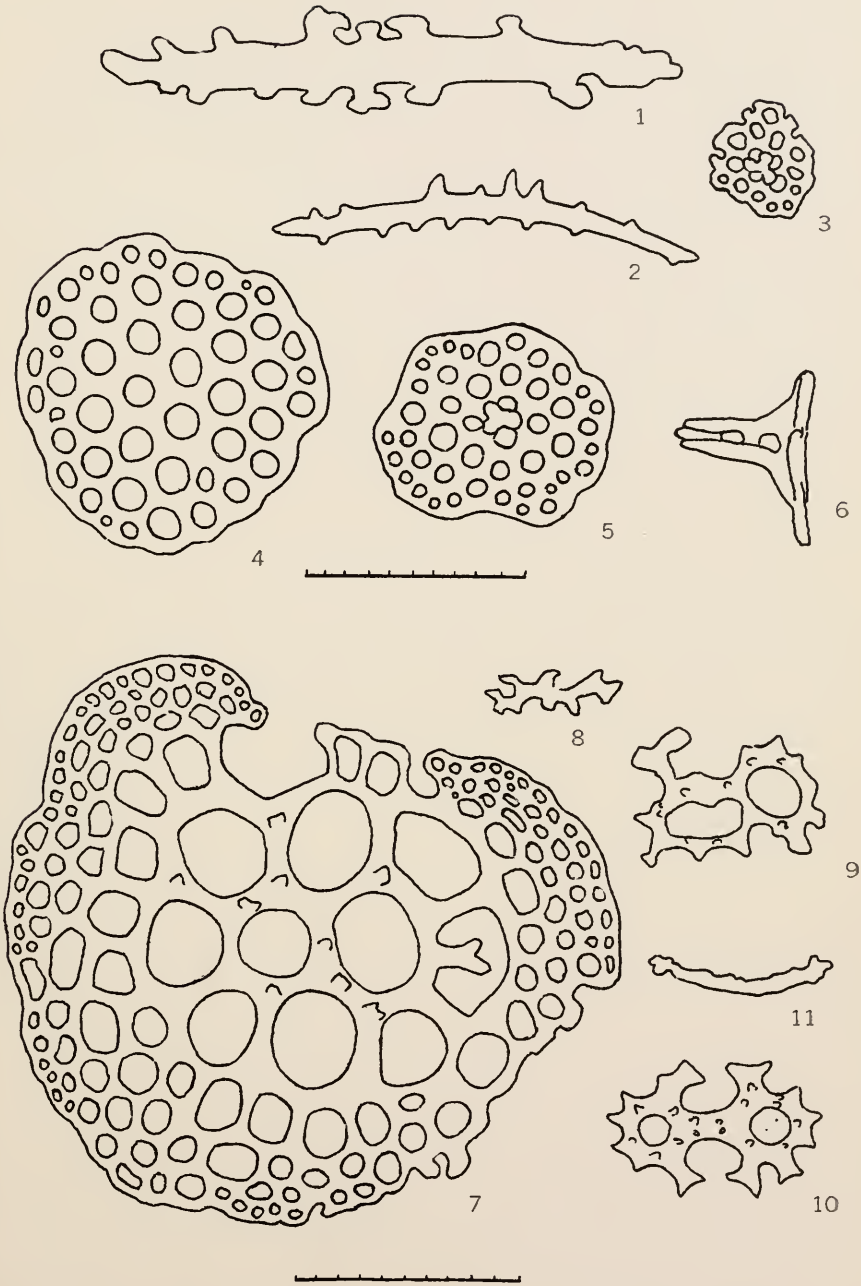
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PLATE 11

Deima blakei Théel

Fig. 1–3. Deposits from wall of genital organs.

Orphnurgus asper Théel

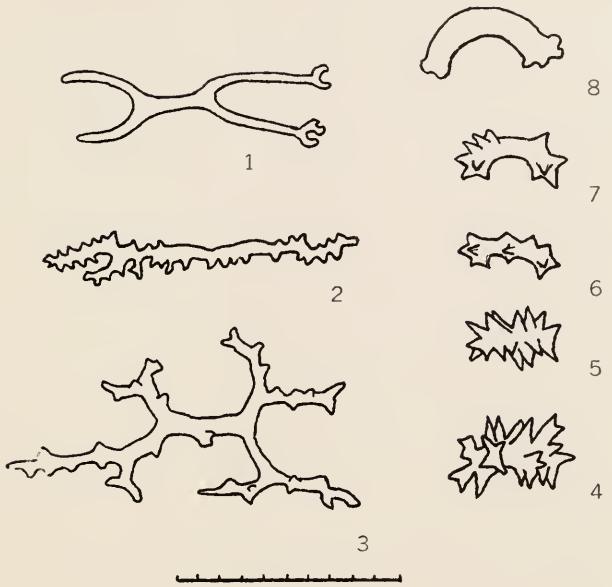
Figs. 4–8. Rods from body wall.

Cucumaria calcigera Stimpson

Figs. 9, 10. Tables.
Figs. 11, 12. Plates.

Cucumaria pulcherrima (Ayres)

Figs. 13, 14. Tables with reduced spire.
Fig. 15. Supporting rod (elongate table).
Fig. 16. Plate near end of appendage.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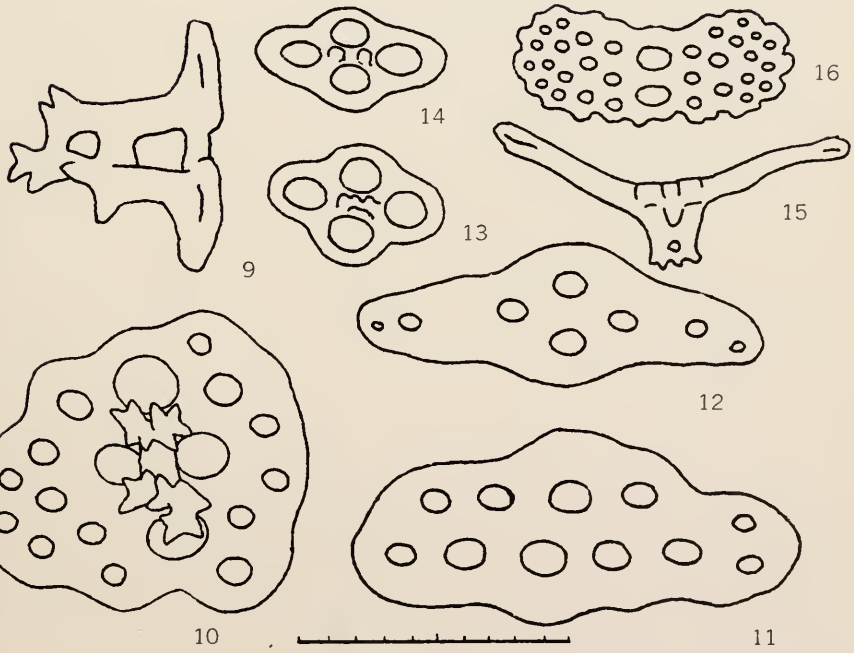
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PLATE 12

Cucumaria nina spec. nov.

Fig. 1–3. Plates.
Figs. 4, 5. Flat baskets.

Cucumaria frondosa (Gunnerus)

Figs. 6–9. Various stages of plates.

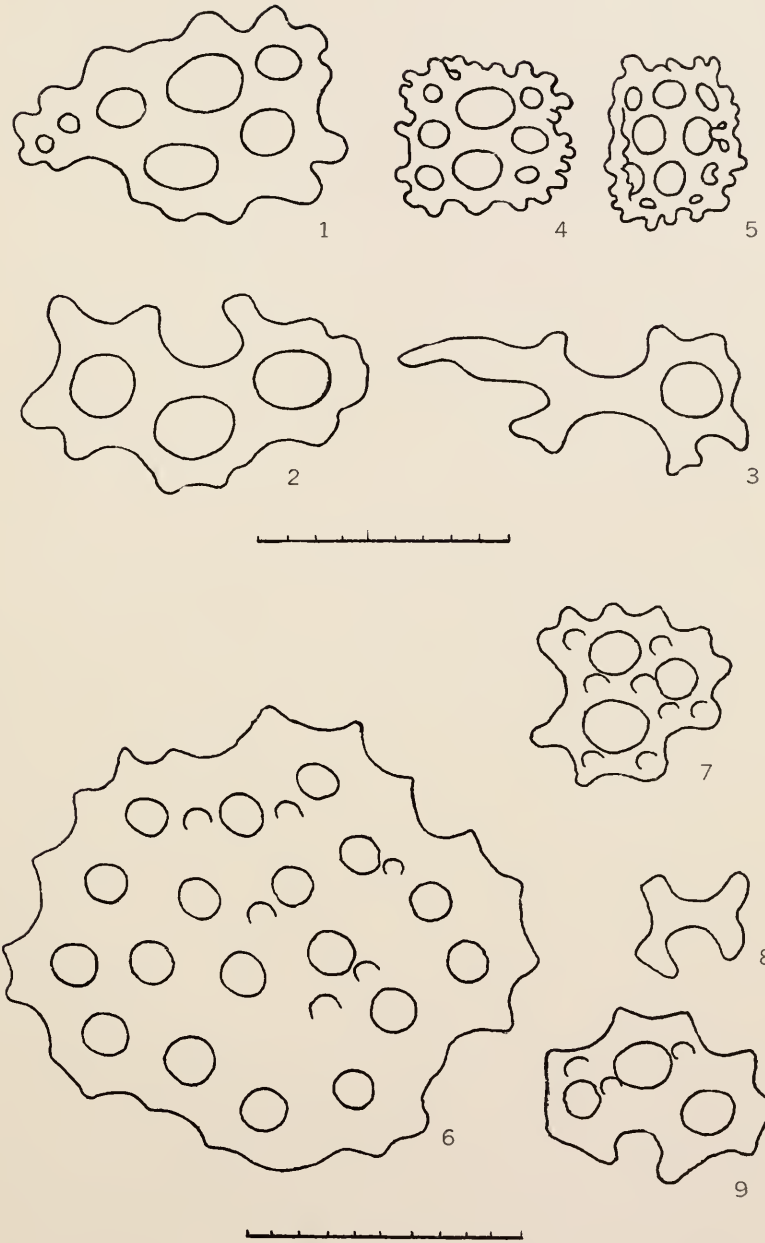
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PLATE 13

Cucumaria parassimilis spec. nov.

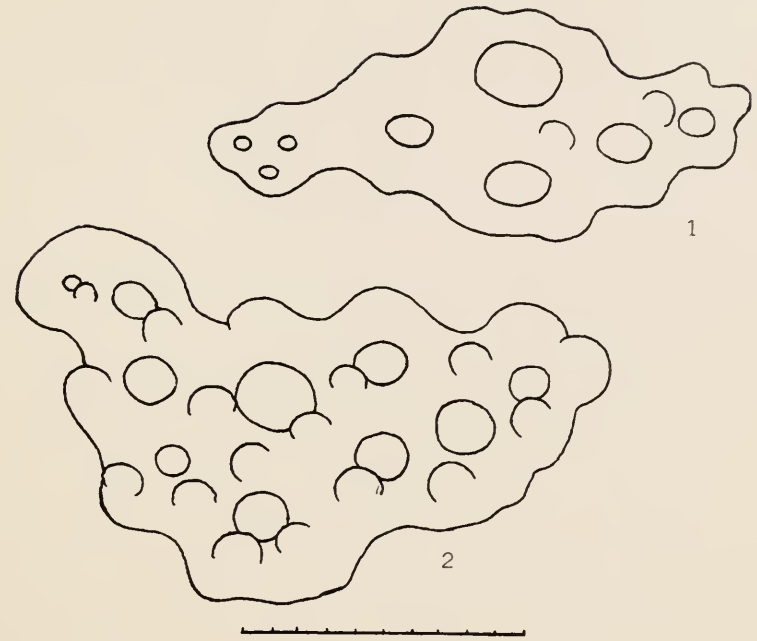
Figs. 1, 2. Plates from body wall.

Thyone scabra Verrill

Fig. 3. Table.
Fig. 4. Supporting table.

Thyone briareus (Lesueur)

Fig. 5. Supporting table.
Fig. 6. Table from body wall.
Fig. 7. Table from introvert.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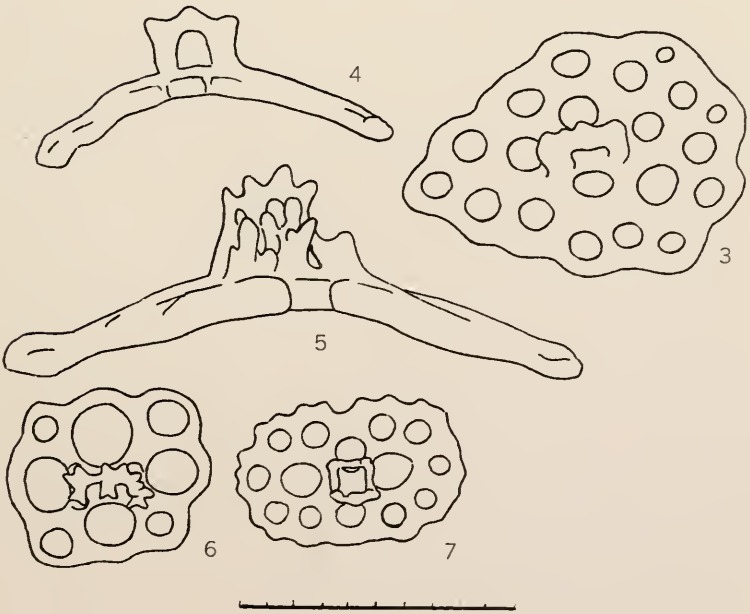
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PLATE 14

Thyone fusus (O.F.M.)?

Figs. 1–4. Table from body wall.
Fig. 5. Table from introvert.

Thyone pseudofusus spec. nov.

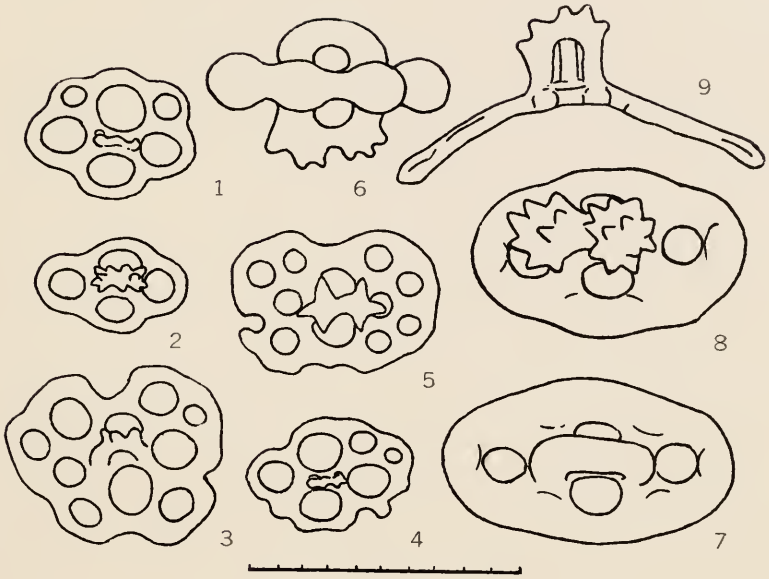
Figs. 6–8. Tables from body wall.
Fig. 9. Supporting rod as table, from appendage.

Thyone belli Ludwig

Fig. 10. Supporting rod as table.
Figs. 11, 12. Buttons.
Fig. 13. Rosette from introvert.

Thyone micropunctata Sluiter

Fig. 14. Large plate from inner layer of deposits.
Fig. 15. Small button with spinous handle.
Fig. 16. X-shaped stage of button.
Fig. 17. Normal button.
Fig. 18. Supporting rod as table.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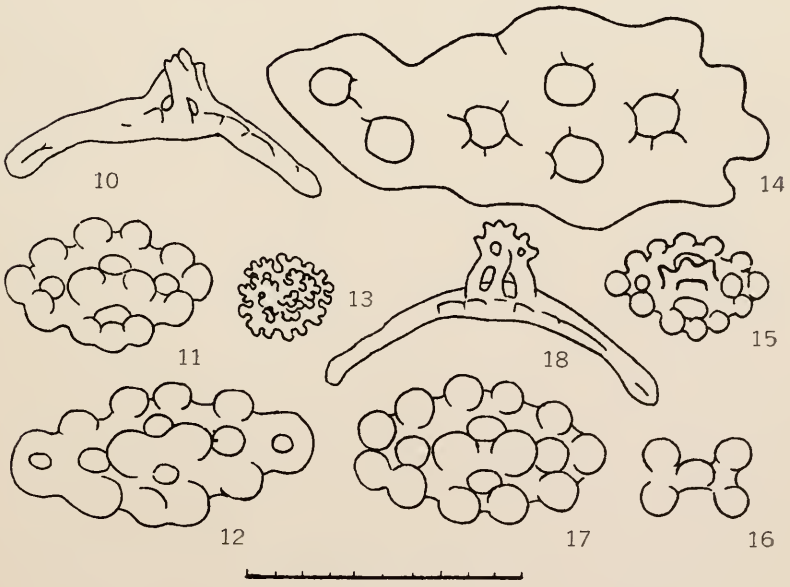
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PLATE 15

Thyone cognita Lampert

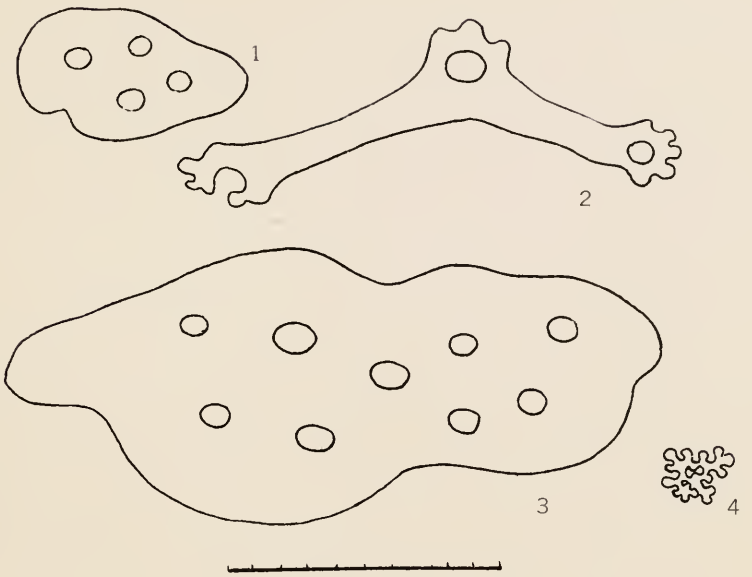
Figs. 1, 2. Plates
Fig. 3. Supporting rod.
Fig. 4. Rosette from introvert.

Thyone unisemita (Stimpson)

Fig. 5. Plate from introvert.
Figs. 6–8. Buttons from integument.
Fig. 9. Incomplete button from integument.
Fig. 10. Supporting rod.

Thyone solida spec. nov.

Figs. 11, 12. Buttons from integument.
Figs. 13, 14. Rosettes from introvert.
Figs. 15, 16. Baskets from integument.
Fig. 17. Simple plate from integument.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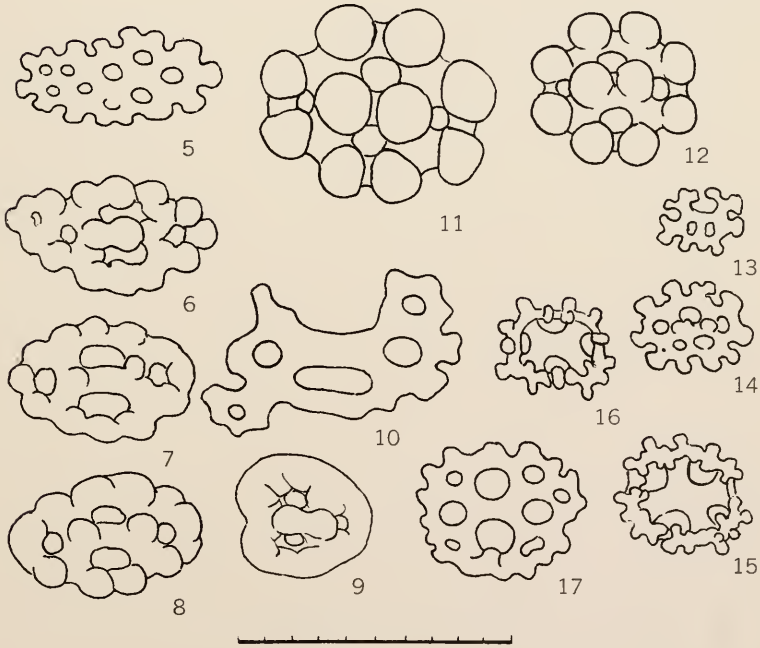
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PLATE 16

Thyone solida spec. nov.

Figs. 1, 2. Supporting rods.

Thyone suspecta Ludwig

Fig. 3. Basket.
Fig. 4. Button.

Thyone surinamensis Semper

Figs. 5, 6. Buttons.
Fig. 7. Basket.
Fig. 8. Supporting rod.

Thyone pervicax Théel

Figs. 9, 10. Buttons from body wall.
Figs. 11–12. Baskets.

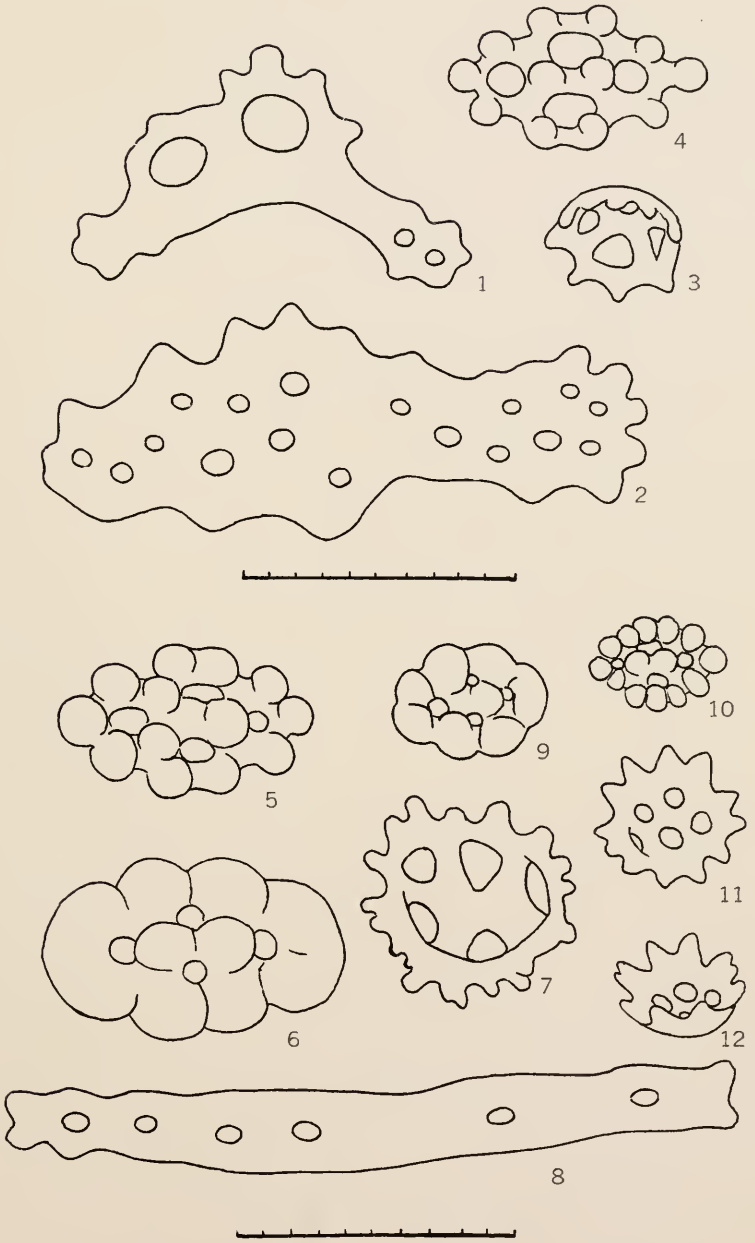
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PLATE 17

Thyone gemmata Pourtalès

Figs. 1, 2. Buttons.
Fig. 3. Basket.

Thyone sabanillensis spec. nov.

Figs. 4–6. Buttons.
Fig. 7. Plate.
Figs. 8, 9. Baskets.

Phyllophorus seguroensis spec. nov.

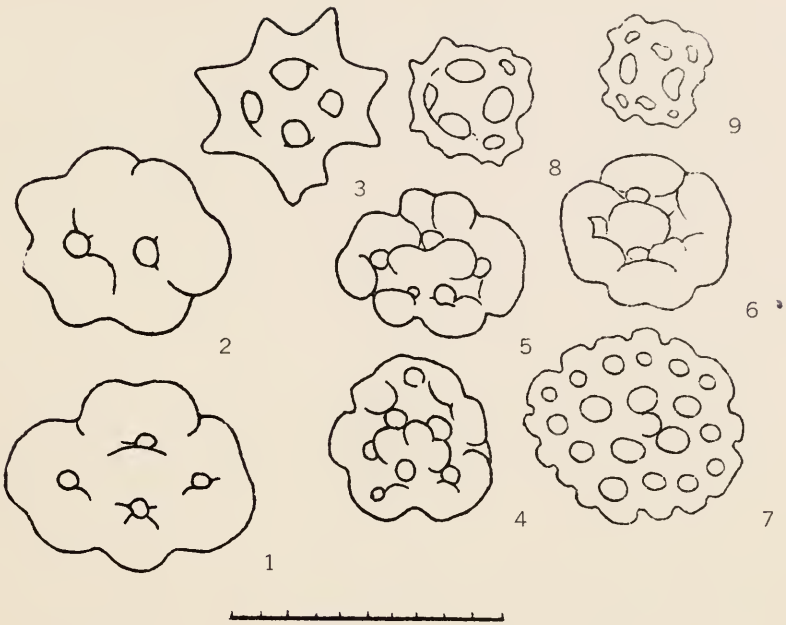
Fig. 10. Table from introvert.
Figs. 11, 12. Tables from body wall.
Fig. 13. Rosette from introvert.

Phyllophorus conchilegum Pourtalès

Figs. 14, 15. Tables.

Phyllophorus communis Forbes

Figs. 16, 17. Tables from introvert.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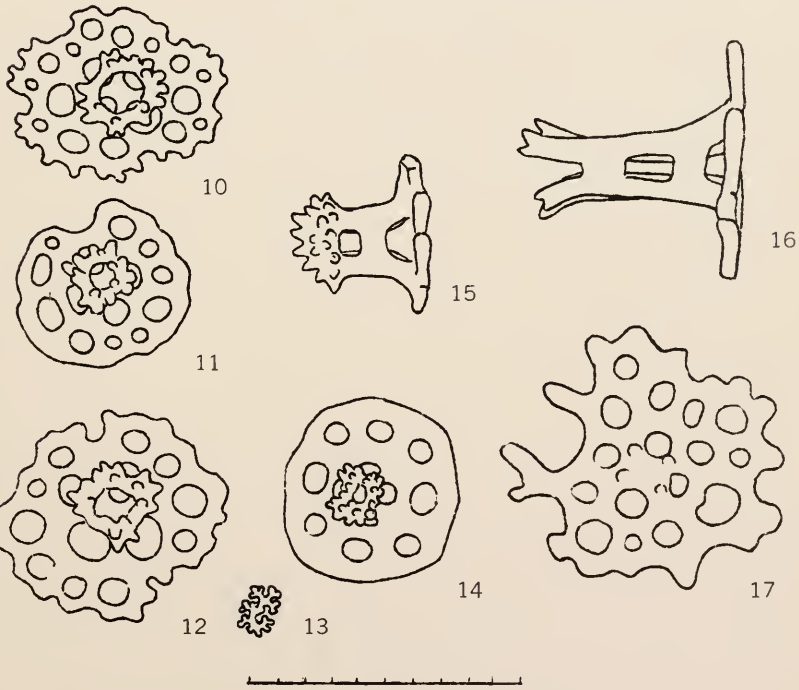
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PLATE 18

Phyllophorus occidentalis Ludwig

Figs. 1, 2. Tables.

Phyllophorus destichadus spec. nov.

Fig. 3. Table.

Phyllophorus trita (Sluiter)

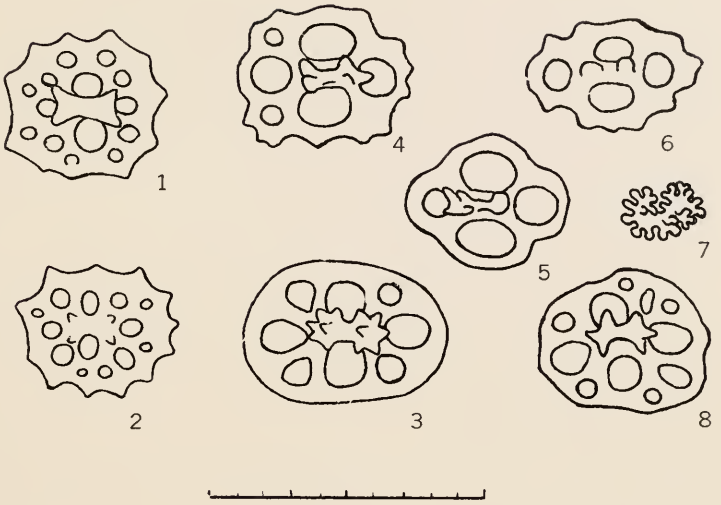
Figs. 4–6. Tables.
Fig. 7. Rosette from introvert.
Fig. 8. Table from introvert.

Echinocucumis hispida (Barrett)

Fig. 9. Medium-sized plate with eccentric spire.

Echinocucumis hispida var. atypica Théel

Fig. 10. Solid spire from large plate.
Fig. 11. Medium-sized plate with rudimentary spire.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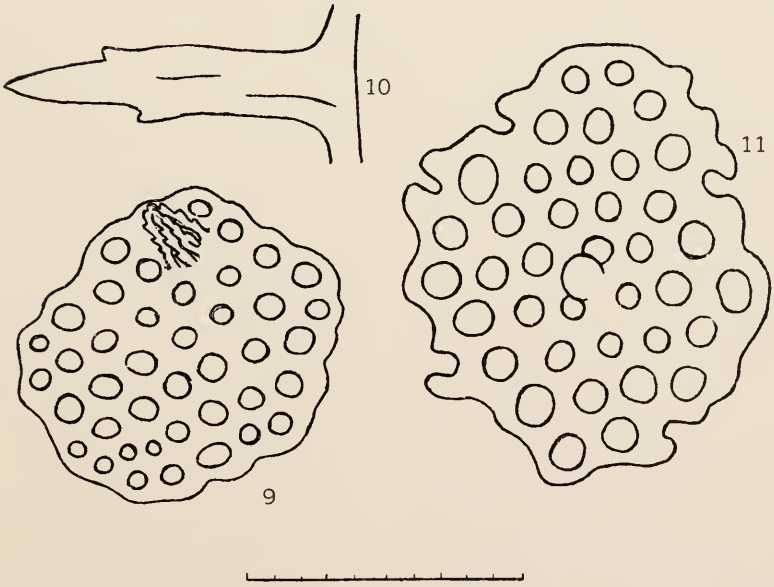
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PLATE 19

Sphaerothuria asperrima (Théel)

Fig. 1. Simple plate from young specimen.
Fig. 2. Plate from tentacle.

Sphaerothuria talismani (Perrier)

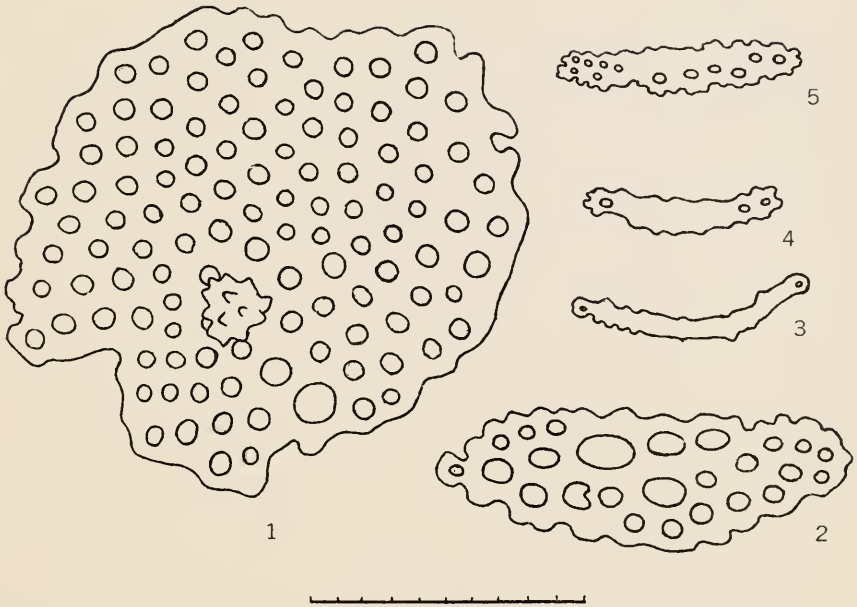
Fig. 3. Rod from tentacle.

Sphaerothuria bitentaculata Ludwig

Figs. 4, 5. Plates from tentacle.

Psolus complicatus spec. nov.

Figs. 6–8. Plates from sole.
Fig. 9. Basket from dorsal side.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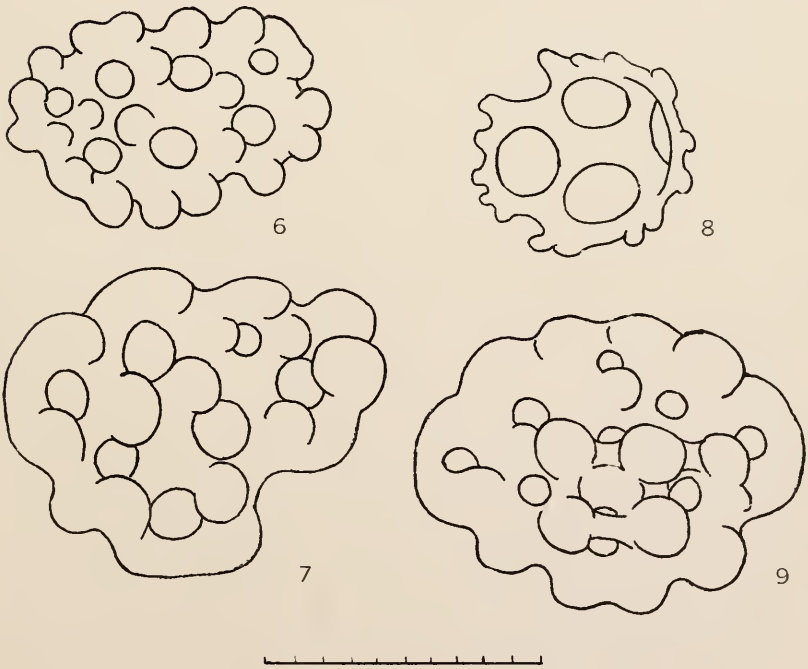
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PLATE 20

Psolus operculatus (Pourtalès)

Figs. 1, 2. Plates from sole.

Psolus tuberculosus Théel

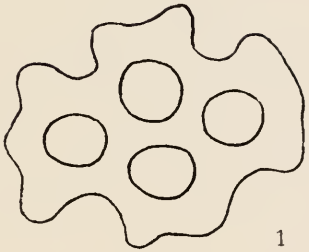
Fig. 3. Plate from sole.

Psolus tuberculosus var. destituta

Fig. 4. Plate from sole.

Psolus pourtalesi Théel

Figs. 5–7. Plates from sole.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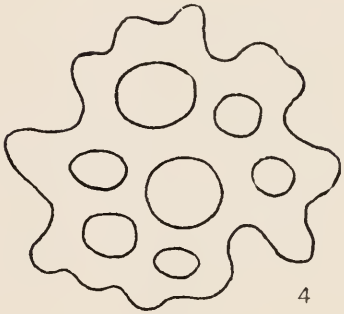
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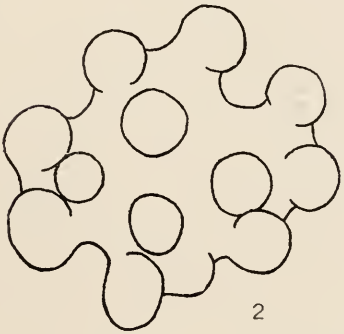
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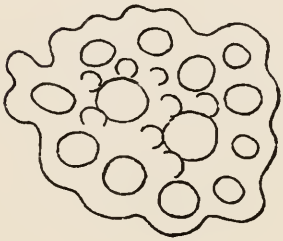
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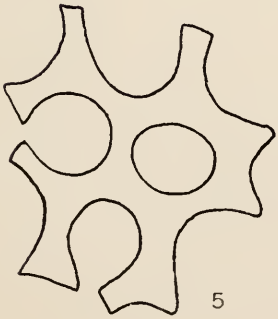
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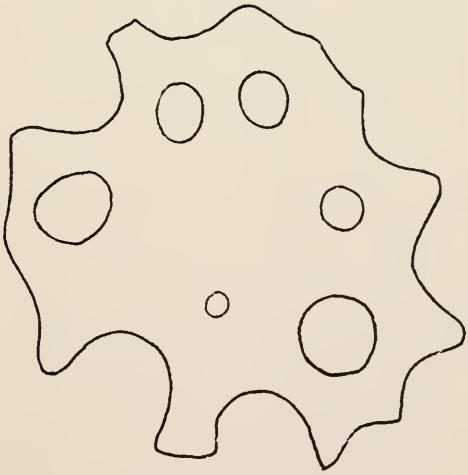
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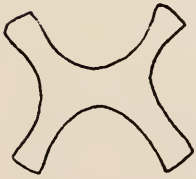
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PLATE 21

Thyonepsolus braziliensis (Théel)

Figs. 1, 2. Plates from sole.
Fig. 3. Towerlike deposit from dorsal side (low magnification).
Figs. 4, 5. Hour glass shaped deposits from dorsal side.
Fig. 6. Plate from dorsal side.

Pseudocolochirus mysticus spec. nov.

Figs. 7, 8. Buttons.
Fig. 9. Supporting rod.

Pentacta pygmaeus (Théel)

Figs. 10, 11. Baskets.
Figs. 12, 13. Buttons.
Fig. 14. Supporting rod.
Figs. 15, 16. Rosettes from introvert.

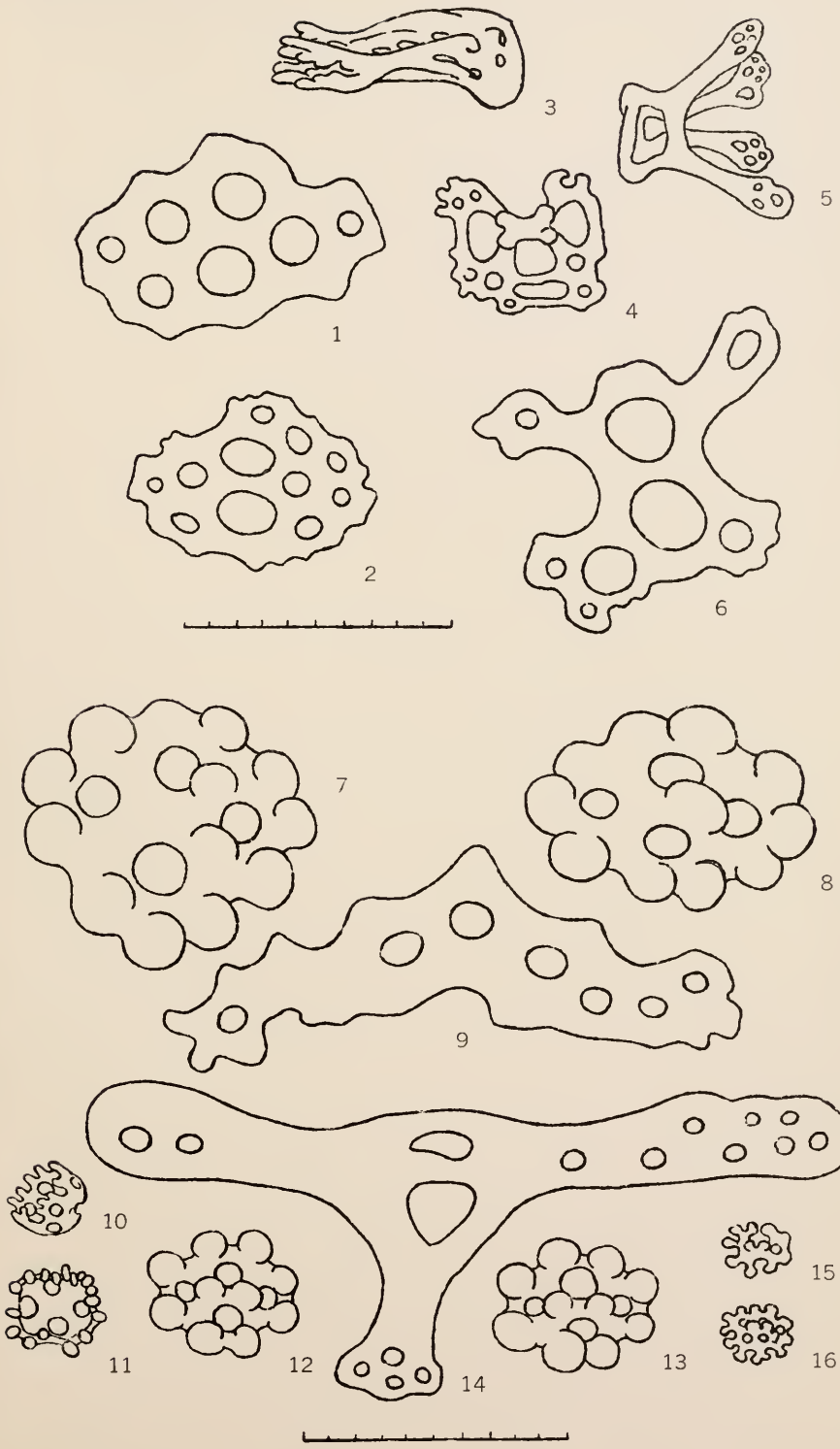
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PLATE 22

Molpadia oolitica Verrill (M.C.Z. Cat. no. 138)

Figs. 1–3. Tables with more or less preserved disk.

Molpadia musculus Risso (young)

Figs. 4, 5. Tables.
Fig. 6. Part of racket-shaped deposit.
Figs. 7, 8. Fusiform tables from body wall (large specimens).
Fig. 9. Fusiform rods from tail.

Molpadia parva (Théel) (M.C.Z. Cat. no. 135)

Figs. 10–12. Disk of tables.
Fig. 13. Lateral view of table.

Molpadia oolitica Verrill (young)
[Théel's antarcticum]

Figs. 14–18. Tables from body wall.

Molpadia blakei (Théel)

Fig. 19. Spire of table with anchor-like hooks.
Figs. 20, 21. Tables from tail.
Figs. 22, 23. Tables from body wall.

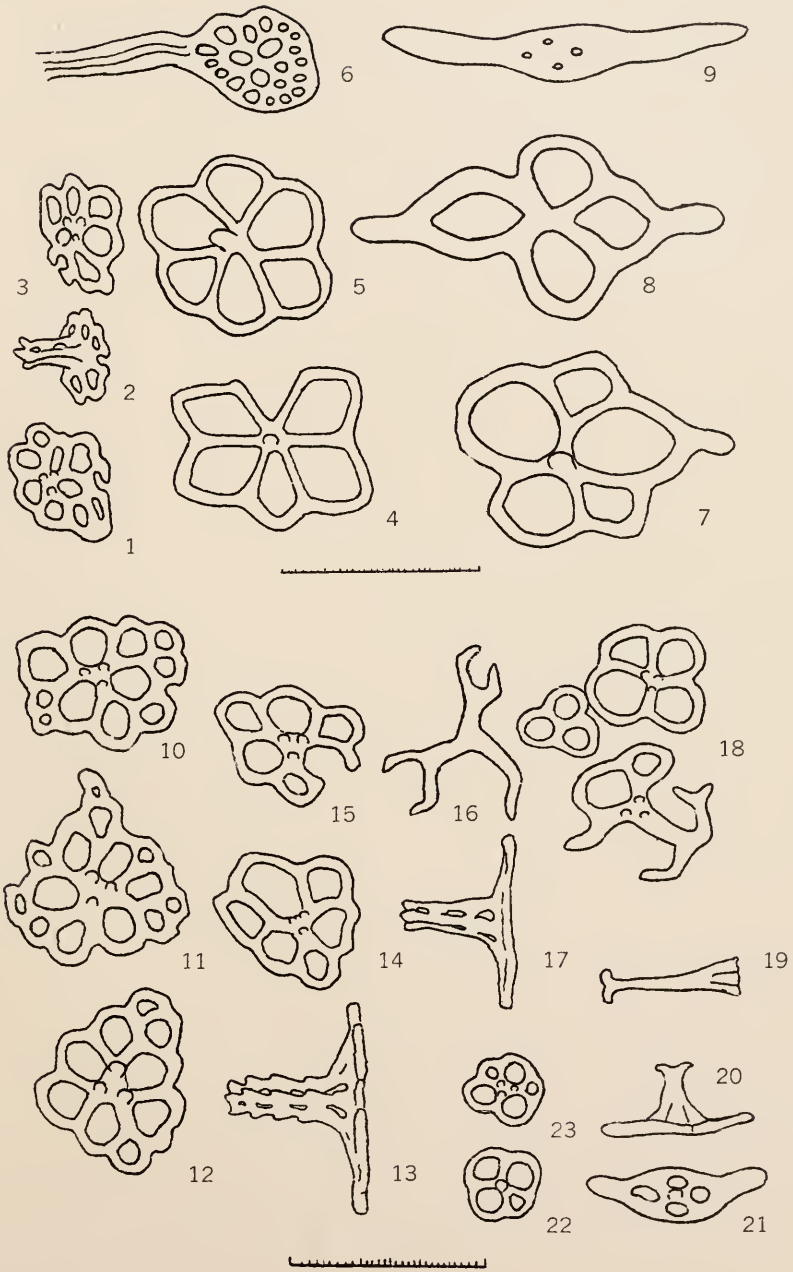
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PLATE 23

Molpadia agassizi (Théel)

Fig. 1. Large typical plate.
Fig. 2. Small plate with rudiment of spire.
Fig. 3. Fusiform rod from tail.

Molpadia musculus (Risso)

Fig. 4. Large plate with numerous holes from large specimen (loricata stage).

Molpadia musculus (Risso)

Figs. 5–7. Typical fusiform bodies from body wall with low number of holes.

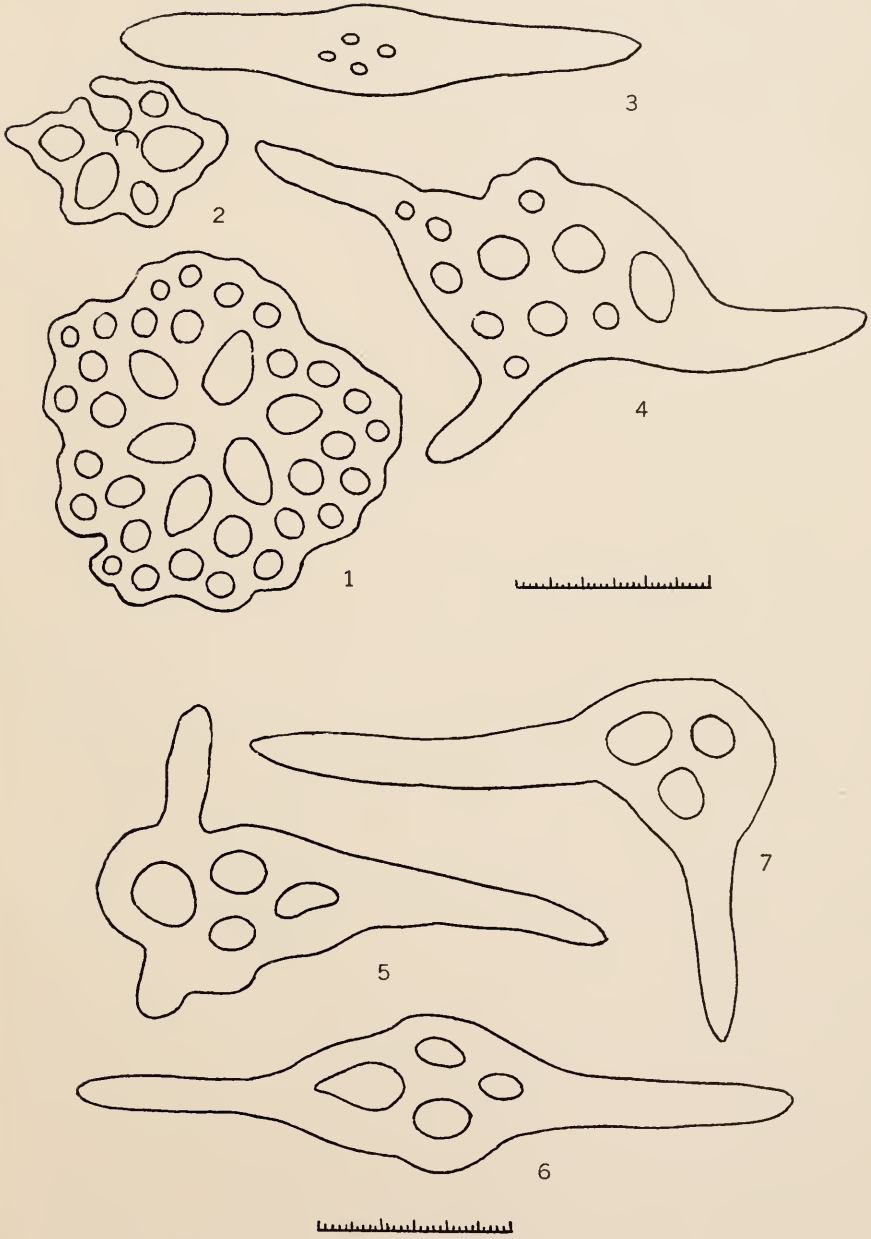
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PLATE 24

Caudina albicans (Théel)

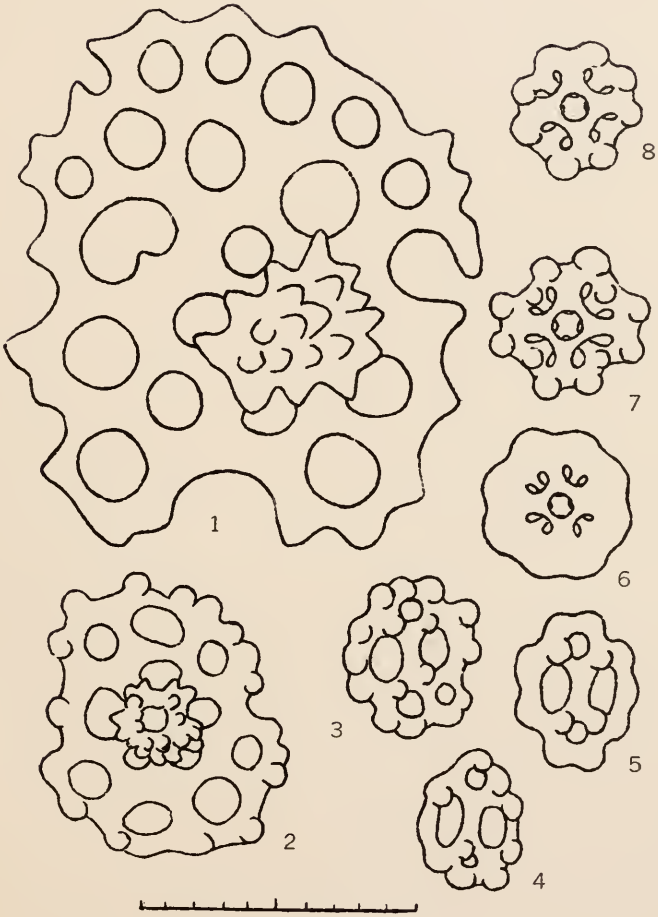
Fig. 1. Table.

Caudina arenata Gould

Fig. 2. Table.
Figs. 3–5. Buttons.

Caudina obesacauda Clark

Fig. 6–8. Four-spoked buttons.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