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Article XVI.—ASCIDIANS OF THE WEST INDIAN REGION AND SOUTHEASTERN UNITED STATES

By Willard G. Van Name

The subject of the present monograph is one that has been neglected by zoologists in recent times. Nearly twenty years have elapsed since the publication of the latest of the principal articles dealing with it, and there is no comprehensive work bringing together the scattered information which has appeared in various publications, many of them not easily accessible except to those having the use of an extensive scientific library. It is hoped, therefore, that this article will accomplish a little toward filling a real deficiency in zoological literature and serve as a step toward greater advances in the future.

The West Indian marine fauna, besides including the vicinity of the islands themselves, the Caribbean Sea and Gulf of Mexico, extends, though in diminished variety of species and with more or less admixture of forms from the colder latitudes, to include Bermuda and the American coast as far north as the vicinity of Beaufort, North Carolina, as well as the eastern coast of South America to near the southern boundary of Brazil. These should, therefore, be the proper geographical limits of this article but, as little has been recorded about the ascidians of the Atlantic coast from New York southward, this region has also been covered as well as the insufficient material at hand would permit. No collections from the east coast of South America have been available and very little has been published concerning its ascidians; that part of the region can, therefore, be only very unsatisfactorily dealt with here and still affords an almost new field for future collecting and study. The east coasts of Mexico and Central America and the northwestern part of the Gulf of Mexico have also been very insufficiently investigated, and even in the other parts of the region there are smaller sections which have been either entirely or partially neglected by collectors. Aside from all this, many of the known species are represented by material insufficient for the proper determination of their characters and distribution, and many of the descriptions given by the older writers are so deficient that their species cannot be recognized at present. It will, therefore, be appreciated that in the study of the ascidians of this region we have really only made a beginning, and that the present attempt to cover this large field will have to be supplemented by many additions and corrections in the future.

Review of Literature and Previous Work

The list of works and articles giving descriptions or first-hand information of the ascidians of the region this article covers is not a long one, though numerous other brief notices and references occur in various works and papers.

Lesueur, 1823, in an article entitled 'Descriptions of several new species of Ascidia' (Journ. Acad. Nat. Sci. Philadelphia, III), described ten forms, not all of which are recognizable from his descriptions and illustrations.

Stimpson, 1852 (Proc. Boston Soc. Nat. Hist., IV), added three more from the southern Atlantic States; his descriptions are brief and without illustrations.

Heller, 1878, in his 'Beiträge zur nähern Kenntniss der Tunicaten' (Sitzungsber. Akad. Wiss. Wien, LXXVII), described ten more West Indian forms, giving in many cases fairly detailed descriptions but illustrating only the external appearance.

Traustedt in 1882 and 1883 (Vidensk. Meddel. naturh. For. Kjöbenhavn, ann. 1881, 1882) published articles that even up to the present time remain the most important contributions to our knowledge of the subject. Seventeen species from this region are dealt with (not all of them new); his descriptions are detailed and accurate and his illustrations of the highest merit, leaving no difficulty in recognizing the species. These articles of Traustedt's are of a character to win increasing respect the more familiarity one has with the ascidian fauna of this region.

The preceding papers dealt practically exclusively with simple ascidians. The Challenger Expedition, though it did not collect in the West Indies, made stops at Bermuda and on the east coast of South America, and Herdman in his reports on the ascidians of that expedition (Challenger Reports, Zool., VI and XIV) records a total of thirteen species, mostly new, from the two regions; the majority of them are compound ascidians.

Sluiter (1898, Mém. Soc. Zool. France, XI) described or recorded twenty-seven species of ascidians, all but four of them simple forms, and mostly new species, collected by the Chazalie Expedition in various parts of the West Indies and on the northern South American coast. His descriptions and illustrations are by no means as full as those of Traustedt. Particularly striking is the large number of species of *Polycarpa* which he describes, a genus which in other West Indian collections has been only scantily represented as far as variety of species is concerned.

The Bermuda ascidian fauna has been dealt with in papers published by Verrill (1900) and by myself (1902).

Michaelsen (1908) in his studies of the collections in the Hamburg Museum has discussed the characters and relationships of certain of the West Indian species.

Hartmeyer, 1909-1911, completed the work on the ascidians in Bronn's 'Tier-reich' which was left unfinished by Seeliger and, in the part dealing with the geographical distribution, gives lists of the species of the West Indies, the Bermudas, and the eastern South American coast; also discussions of the relations of these faunas to those of other regions, which are valuable contributions to the literature of the subject. The lists are mainly compilations from the works of previous authors; although Hartmeyer has made extensive collections of ascidians in the West Indian region, he has published but little informaton of a systematic character regarding them.

References to a number of other papers and records of minor importance will be found in the lists of synonyms given in the descriptive part of the present article.

Material and Collections Studied

This account is based on an extensive series of specimens from Porto Rico, collected by Professor R. C. Osburn of Ohio State University and Mr. Roy W. Miner of The American Museum of Natural History in 1914 and 1915,[1] as well as on other West Indian material in that Museum; on collections made by myself at Bermuda and on the Florida coast, and on the collections in the Yale University Museum which were placed at my disposal for study, through the kindness of Professor W. R. Coe of that University. Many of the types and original specimens of the articles by Professor A. E. Verrill and myself on the Bermuda species, have been re-examined and the list of Bermuda species revised in accordance with the information which a study of the West Indian material now affords. The extensive series of specimens in the United States National Museum has also been gone over and has been of especial importance, not merely from its size and from its containing several new forms, but because it consists largely of dredged material, while in the other collections material obtained by collecting along the shores predominated, so that they were deficient in specimens from any but very shallow water. I wish to express my thanks to the staff of the National

[1]Expeditions in co-operation with the New York Academy of Sciences and the Porto Rican Government.

Museum for the opportunity of studying these specimens, especially to Dr. Paul Bartsch, Curator of the Division of Invertebrates, and to Messrs. Waldo L. Schmitt and C. R. Shoemaker for the assistance and information kindly given me in dealing with this large collection. In addition to the above, material from various other sources has been examined, and my thanks are due to those who have collected or loaned it or otherwise assisted me, especially to Mr. Roy W. Miner of the American Museum, to whose interest and encouragement the carrying out of this work is largely due.

The areas best covered by the collections studied are the coasts of southern and western Florida, Bermuda, Porto Rico, Jamaica, certain of the Lesser Antilles (particularly the former Danish West Indies), parts of the coast of the Carolinas, and Chesapeake Bay, but many additional specimens from other parts of the region, as well as reliable records by other authors, assisted in making the survey of the subject more complete than the above statement would indicate.

The species represented are shallow-water forms or those characteristic of the continental shelf; only one really deep-water species (*Pyura antillarum* from 496 fathoms) was found in the collection.

The descriptive part of this article deals only with the species which I have myself seen and studied. These number fifty-five from the West Indian region proper and two additional species from the middle Atlantic states, to which must be added four forms or variations not regarded as sufficiently distinct to be treated as species. On account of the insufficiency of many of the descriptions it is uncertain how many of the other species that have been described from this region are valid and distinct from those dealt with here. A few are undoubtedly distinct; a majority are probably synonymous. No doubt some of the uncertainty will eventually be cleared up by a re-examination of the original specimens or by material collected in the type localities. Separate lists of species and forms known from the four parts of the region which have been the scene of the most thorough collecting are given at the end of this article, Florida being credited with 43, Bermuda with 31, Porto Rico with 26, and the former Danish West Indies also with 26.

Collecting in other places has not been sufficiently thorough for the preparation of local lists and, until more has been done in the southern part of the region (the South American coast and the islands near it), we must accept with caution conclusions that many species are found only in the northern part, though present records seem to indicate that this is the case.

Bermuda constitutes an isolated outlying district which many of the West Indian species do not appear to have reached; the compound ascidians are better represented there than the simple ones.

Relationships to Species of Other Regions

The relationships of the West Indian ascidians are, as would be expected, chiefly with those of other tropical and subtropical regions rather than with the faunas to the north and south, though with some overlapping of the ranges from or into the latter regions in the case of certain species. The most striking instance of such overlapping is *Bostrichobranchus pilularis*, which appears to range from the Gulf of St. Lawrence, if not from farther north, to the Gulf of Mexico, inclusive; at least I have been as yet unable to establish constant and reliable specific differences between northern and southern specimens. *Molgula manhattensis* and *Aplidium* (*Amaroucium*) *pellucidum* have similar but less extensive ranges.

The relationships between the West Indian ascidian fauna and those of the west coast of Africa and the Mediterranean are less close than might be expected, the identity of West Indian forms with those from one or both of the above regions having been certainly established in only six or seven cases, though there are other closely allied species that may prove to be identical and somewhat extend this list. It is to the fauna of the Indian Ocean, Red Sea, and Malay region that the most significant relationship exists.[1] We now know no less than eighteen species which are common to the West Indies and the Indo-Malayan regions, while in the case of several more of them there are very closely allied representatives that may eventually prove to be inseparable. The species in common are:

Polyclinum constellatum
Aplidium lobatum
Tridemnum savignii
Didemnum candidum
Leptoclinum macdonaldi
Cystodytes dellechiaiæ
Phallusia nigra
Phallusia sydneiensis
Rhodosoma pellucidum
Corella eumyota
Botryllus niger
Symplegma viride
Polyandrocarpa maxima
Polycarpa circumarata
Styela plicata
Pyura momus form *pallida*
Microcosmus exasperatus
Microcosmus helleri

[1]Notice and discussion of this relationship, particularly as concerns the Red Sea species, is contained in a work of Michaelsen (Denk. Akad. Wiss. Wien., math.-nat. Kl., part 9, pp. 4, 5, 1919) which was not received until the present article was in type.

These species are mostly not known from the eastern side of the Atlantic, and none of them from the American side of the Pacific; their distribution is not circumtropical, but discontinuous. The West Indies and the Indian Ocean, inclusive of the Malay Archipelago, seem to be centers of ascidian faunas having too much similarity to be merely the result of accidental transportation and interchange of species, especially as the southward extension of the American and African continents and the cold subantarctic currents which flow along their western coasts would seem to be an almost insuperable barrier to the extension of the range of tropical forms. The close relationship of the faunas does not seem explainable without assuming some continuous warm-water communication within a comparatively recent geological time. Yet that such communication was through the Mediterranean is not indicated; more probably it was around South Africa.

The West Indian region is very much less rich in ascidians than the East Indian, even allowing for its smaller extent, for its having been less studied, and for the fact that the East Indian list undoubtedly contains a very large percentage of synonyms.

The ascidian fauna of the west coast of tropical America is as yet little known and no species is on record as common to it and the West Indian region.

Identification of Specimens

It is only recently that the great individual variability in ascidians of the same species and the very wide geographical distribution of a considerable proportion of the forms has begun to be realized. In the case of the compound ascidians especially, the number of valid species has apparently been greatly over-estimated. In certain genera of compound ascidians, such as *Trididemnum*, *Polycitor*, *Didemnum*, *Leptoclinum*, *Aplidium* (inclusive of *Amaroucium*), it is very hard to discover reliable characters for making specific diagnoses, so that, until more is known of their life history, of the details of their anatomy and development, and the effect of external influences on their growth and appearance, the species recognized must in many cases be regarded as provisional and likely to require more or less revision as our knowledge is increased. In cases where there has been an opportunity to study considerable series of specimens a great deal of variation is found, and it is evident that many of the characters which have been employed by authors to differentiate supposed species are of little or no value for such a purpose. It is questionable whether, in soft-bodied animals like the

ascidians, differentiation of the genera into a large number of slightly yet definitely separated species, such as occurs in insects and mollusks for example, is possible. If it can and does occur, we do not know how it may be manifested—certainly not in such characters as those on which many of the supposed species have been based.

The determination of specimens of ascidians is therefore often a matter of considerable difficulty, and it may be well to call the attention of those who use this and other works on the subject to the great allowance which must often be made for individual peculiarities, different degrees of contraction incident to preservation, and the variations in the degree of transparency, color and consistency of the tissues which depend on the physiological condition of the animal at the time of preservation, the strength and nature of the preserving fluids employed, and the presence of other material which may give off substances that discolor, shrink, or otherwise alter the tissues. In the simple ascidians many of the more important characters, as the number of folds and internal longitudinal vessels of the branchial sac, the size and number of component glands of the reproductive organs, etc., vary with the age and size (or both) of the individual. In this connection it must be remembered that size is influenced not only by age but also by environment and food supply, and that of two specimens the smaller one will often be the older and show more fully adult characteristics.

The shape of the body or colony and the character of its external surface are very liable to be affected by the environment, especially in those species which attach themselves in exposed situations, as on piles, rocks, etc. Other species, particularly those that bury themselves in the sand or mud, are more uniform in these respects, though the material in which they conceal themselves often affects the character and color of the test by adhering to it and becoming imbedded in it.

With a series of specimens at hand it is usually possible to recognize the characters of the species and to distinguish them from the variations due to the above-mentioned extrinsic factors; with but a single specimen this may be very difficult. Among the compound ascidians especially, many examples, because of unsatisfactory preservation, immaturity, poor development or degeneration, or from being in a quiescent stage of growth, present scarcely any diagnostic characters, and their positive determination may be difficult or impossible unless they happen to be found along with better specimens evidently of the same kind.

To so word a description as to cover all the numerous variations to which these soft-bodied animals are subject, both from internal and extrinsic factors, is manifestly impossible. Only the usual, well-developed, and normal can be described and illustrated, as otherwise the descriptions would be too long and too indefinite, and the mention of accidental individual peculiarities would obscure those of general occurrence and real importance. As a rule, the type of structure of the reproductive organs and branchial sac, with due allowance for possible immaturity or incomplete development and for individual variations in the number of vessels and component parts of those organs, will be found to give the safest indications in identifying specimens of simple ascidians; in the compound forms the general habit of growth and the characters of the colony as a whole must be considered as well as the zooids, and also the stage in the life history of the colony, for in some species the colonies are known to pass through periods of degeneration in which many of the distinctive characters are lost or obscured. The practice of basing specific distinctions on the number of oral tentacles seems to be unwarranted; it is one of the characters most subject to variation with age and with the individual. Distinctions based on the form or stoutness of soft parts such as the lobes of the branchial, atrial, and anal apertures, the dorsal and atrial languets, etc., which change shape with the degree of contraction of the tissues, likewise appear to be practically worthless. The dorsal tubercle is subject to much more individual variation than has commonly been assumed. No general rule can, however, be given; a certain character may be very constant and of diagnostic importance in one genus or family, yet in another it may be entirely unreliable. While it is hoped that the descriptions and figures here given will enable those with a little zoological knowledge to identify most of their specimens, they must not expect to be always able to do so without dissection and microscopical examination of some of their material, and (especially in the compound species) without some perseverance in the study of the subject. Such analytical keys as have been given in other works usually prove total failures when tested.

Classification and Phylogeny of the Ascidians

The classification followed is substantially that adopted in recent works of Hartmeyer. Attention is called to the change in the application of the name *Tethyum*, which is here used for a section of the old genus *Halocynthia*, as Huntsman (1912) has shown to be required by the law of priority, *Pyura* being retained for the remaining members of the

genus. The names *Styela* and Styelidæ, *Molgula* and Molgulidæ, and *Polycarpa* are restored to use in their old and familiar applications (see Hartmeyer, 1914), a change which will certainly be welcome.

It will be observed that I have reversed the usually adopted order in treating the families and orders so that the compound ascidians precede the simple ones. This is because my present view regarding the relationships of the several families and orders is radically different from that which the generally adopted arrangement represents.

It can hardly be an unsafe statement to make that most zoologists, including a majority of those who have specialized in the study of the Tunicata, hold that the compound ascidians have been derived from simple ascidians by a decrease in the size and complexity of structure of the individuals and by the acquirement of the power of budding. All recent authors have, however, recognized the fact that some compound ascidians were more closely related to certain simple ones than to each other, and, to explain this, the assumption has been made that the power of budding has been independently acquired in two or more different groups of ascidians.

This hypothesis has become less and less satisfactory to me in the course of my studies of the Tunicata, since it is very difficult to imagine how an animal of apparently unquestionable relationship to the highest forms of animal life should suddenly acquire this extraordinary power, otherwise found only in the lower phyla. The advocates of the prevailing theory must assume that the function has developed very rapidly if not suddenly. We have examples of closely allied ascidians distinguished by characters of no more than generic or even specific importance; one member of these pairs of allied forms, however, produces buds and forms colonies, the other does not. Such instances are afforded by the genera *Polycarpa* and *Polyandrocarpa* in the Styelidæ, by *Rhopalæa* and *Rhopalopsis* in the Diazonidæ, and by the close relationships between the Phallusiidæ and Perophoridæ. Such pairs of closely related simple and compound genera would indicate, according to the usually accepted theory, that the budding power has been very recently acquired, since no other important morphological differentiation has since taken place. Moreover, were the process a gradual one, it would be expected to begin with the development of incomplete non-functional buds, and it is difficult to see how any utility could insure the continued production of such buds (with progress toward perfection) until a complete functional individual could be produced. As a matter of fact, we know of no ascidians habitually producing such rudimentary or imperect buds.

They have the power of budding fully developed and functional, or they do not have it at all.

The above-mentioned and other difficulties regarding the acquirement of this power are removed if we assume that budding was a function formerly possessed by all Tunicata; that it was inherited from ancestors so remote and so simple that their budding was nothing more than cell division; and that the physiological process has been continuously maintained and gradually developed in complexity as, in the phylogenetic history of the group, the morphological structure has become more complex and more highly organized. Certain of the ascidians have lost this function, perhaps largely on account of their increase in size and their development of a more complex organization (a similar loss of the budding function takes place in the large actinians), and I do not believe that groups in which the function has been abandoned or disused throughout any period of extensive phylogenetic development can again acquire it. Reproduction by budding being an inconvenient method for animals of active habits, owing to the increased difficulty of locomotion and obtaining food, it is not surprising that we do not find it retained in the appendicularians, and its loss or absence in that group presents no strong argument against the view here advocated.

An extended discussion of this question and of the conclusions to which it might lead, would be out of place in a systematic article of this character, but the above statement will indicate my reasons for changing the order in which the several groups are arranged and for abandoning the subfamilies Styelinæ and Polyzoinæ as an unnatural subdivision of the Styelidæ. I have likewise united the Perophoridæ and Phallusiidæ, as their relationships are similar to those between the compound and simple Styelidæ. I will only add that, if accepted, this view lends increased importance and a necessarily high degree of antiquity to the adult fixed stage of the ascidians, and no longer permits us to regard the latter merely as a comparatively lately acquired degenerative modification of a free-swimming type of organism.[1]

Other departures from the now accepted classification are for the most part small and are sufficiently explained where they occur; they consist chiefly in the reduction of certain slightly distinguished genera to subgenera. Unfortunately, it seems necessary to take this course in the case of the well-known genus *Amaroucium*. Not only are the characters separating it from *Aplidium* Savigny, 1816, unimportant and variable,

[1]See another article ('Budding in Compound Ascidians and Other Invertebrates, and Its Bearing on the Question of the Early Ancestry of the Vertebrates'), by the writer, in this volume (pp. 275 to 282)

but there are a number of intermediate species making any separation of the two genera a purely arbitrary one. Its retention in modern classifications is due chiefly to its long-established use for a number of well-known species, and to the belief that if the two genera were combined the resulting group would be "too large." The latter argument should carry very little weight. If there are large genera in nature there must also be large genera in our classification if it is to reflect nature; for the convenience of specialists these can be divided into subgenera or sections. For all who are not specialists large genera are vastly more convenient than small ones. If we recognize *Amaroucium* as distinct from *Aplidium*, most of the known species have to go in the former, so that we have one rather large genus anyway, unless indeed a large percentage of the supposed species prove to be synonyms, a probability which is by no means remote. It seems, therefore, to be time to reduce *Amaroucium* to the grade to which it is entitled, that of a subgenus or section; it has no place among genera distinguished by real and definite structural characters and it encumbers and impairs the natural character of our classification if so included.

Several genera of the Didemnidæ, though distinguished by better and more constant characters than *Amaroucium*, do not merit exception from similar treatment. Higher rank than a subgenus of *Didemnum* does not seem to be deserved by *Tetradidemnum* Della Valle, 1881, *Polysyncraton* Nott, 1891, and *Leptoclinides* Bjerkan, 1905, although in previous articles I have employed them as genera. Of these, only *Polysyncraton* is represented in the region covered by this article; the difficulty of separating it from *Didemnum* has already been noted by Hartmeyer, 1912*a*, p. 325. Even in its comprehensive sense, *Didemnum* will probably not prove to be a very large genus, since a very large proportion of its supposed species are apparently synonyms. Moreover, all these minor groups are retained as subgenera and the names remain as available as before for those who wish to designate the subdivisions which they denote or who prefer to use the subgeneric rather than the generic names as the first part of their binomials.

Nomina Conservanda

The confusion resulting from the brief diagnoses which were customary and the imperfect understanding of the nature and relationships of many of the marine invertebrates which prevailed during the early development of zoological nomenclature makes the application of the law of priority to the ascidians very uncertain and leaves the validity of many

important and familiar names more or less open to question. I fully agree with the belief of many that the law of priority alone, unsupported by the decrees of some body having internationally recognized authority, cannot bring about stability of nomenclature. A list of *nomina conservanda* (Tunicata by Hartmeyer, Michaelsen and Sluiter) has been published by Apstein (1915), and extended and explained so far as the ascidians are concerned by Hartmeyer (1915). It is my belief that neither personal preferences for particular names nor prejudices against others nor animosity due to the late war should be permitted to stand in the way of attaining a stable nomenclature, and I would be glad to see this list of names authorized by the next International Zoological Congress. I cannot, however, see any justification for using a name that appears to violate the law of priority until after such authorization has been given. Nevertheless, I have in the present article called attention to the changes which the above list will make if adopted, by noting the proposed *nomen conservandum* (when different) under the headings of the several species affected.

The real importance of such a list of *nomina conservanda* is not the restoration of familiar names but the permanent preservation of names against being invalidated by objections raised against them in the future. Unfortunately, it affords no protection against the unrestrained splitting of genera which is practised by many zoologists, which has been carried to such an extent in some groups of the animal kingdom that the nomenclature has lost all the convenience and advantages that the binomial system should (and formerly did) afford. Nothing can protect us against such offenders but the exercise of good judgment and a determination to be governed in the acceptance of genera by the requirements of a nomenclature which will be convenient for general use. Its permanence should not be sacrificed on account of trivial considerations.

List of Species Described and Figured

As stated above, the descriptive part of this article deals only with the species that I have seen and studied. For additional species described by other authors the reader is referred to the alphabetic list of names and synonyms in the last part of this article, where references to the original description and other important literature are given.

The 57 species that are described are listed below. Seven of them *Didemnum fusiferum*, *Holozoa bursata*, *Polycitor* (*Eudistoma*) *hepaticus*, *Polyandrocarpa sabanillæ*, *Polyandrocarpa* (*Eusynstyela*) *floridana*, *Pyura antillarum*, and *Tethyum microspinosum*, are apparently new to science.

SYNOICIDÆ

1. *Polyclinum constellatum* Savigny, 1816
2. *Aplidium lobatum* Savigny, 1816
3. *Aplidium* (*Amaroucium*) *bermudæ* (Van Name), 1902
4. *Aplidium* (*Amaroucium*) *stellatum* (Verrill), 1871
5. *Aplidium* (*Amaroucium*) *pellucidum* (Leidy), 1855

5a. *Aplidium* (*Amaroucium*) *pellucidum* form *constellatum* (Verrill), 1871

6. *Aplidium* (*Amaroucium*) *exile* (Van Name), 1902

DIDEMNIDÆ

7. *Trididemnum savignii* (Herdman), 1886

7a. *Trididemnum savignii* form *porites* (Van Name), 1902

8. *Trididemnun solidum* (Van Name), 1902
9. *Trididemnum orbiculatum* (Van Name), 1902
10. *Didemnum candidum* Savigny, 1816

10a. *Didemnum candidum lutarium* (Van Name), 1910

11. *Didemnum fusiferum*, new species
12. *Didemnum* (*Polysyncraton*) *amethysteum* (Van Name), 1902
13. *Leptoclinum macdonaldi* (Herdman), 1886
14. *Lissoclinum fragile* (Van Name), 1902
15. *Echinoclinum verrilli* Van Name, 1902

POLYCITORIDÆ

16. *Polycitor* (*Eudistoma*) *olivaceus* (Van Name), 1902

16a. *Polycitor* (*Eudistoma*) *olivaceus* form *obscuratus* (Van Name), 1902

17. *Polycitor* (*Eudistoma*) *convexus* (Van Name), 1902
18. *Polycitor* (*Eudistoma*) *hepaticus*, new species
19. *Polycitor* (*Eudistoma*) *clarus* (Van Name), 1902
20. *Polycitor* (*Eudistoma*) *capsulatus* (Van Name), 1902
21. *Clavelina oblonga* Herdman, 1880
22. *Clavelina gigantea* (Sluiter), 1919
23. *Cystodytes dellechiaiæ* (Della Valle), 1877
24. *Holozoa bermudensis* (Van Name), 1902
25. *Holozoa bursata*, new species

DIAZONIDÆ

26. *Rhopalæa abdominalis* (Sluiter), 1898

PHALLUSIIDÆ

27. *Perophora viridis* Verrill, 1871
28. *Ecteinascidia turbinata* Herdman, 1880
29. *Phallusia nigra* Savigny, 1816
30. *Phallusia hygomiana* Traustedt, 1882
31. *Phallusia sydneiensis* (Stimpson), 1855
32. *Phallusia curvata* Traustedt, 1882

RHODOSOMATIDÆ

33. *Rhodosoma pellucidum* (Stimpson), 1855
34. *Corella minuta* Traustedt, 1882

BOTRYLLIDÆ

35. *Botryllus schlosseri* (Pallas), 1766
36. *Botryllus* (*Botrylloides*) *niger* (Herdman), 1886

STYELIDÆ

37. *Symplegma viride* Herdman, 1886
37a. *Symplegma viride brakenhielmi* (Michaelsen), 1904
38. *Polyandrocarpa sabanillæ*, new species
39. *Polyandrocarpa maxima* (Sluiter), 1904
40. *Polyandrocarpa* (*Eusynstyela*) *tincta* (Van Name), 1902
41. *Polyandrocarpa* (*Eusynstyela*) *floridana*, new species
42. *Polycarpa obtecta* Traustedt, 1883
43. *Polycarpa spongiabilis* Traustedt, 1883
44. *Polycarpa circumarata* (Sluiter), 1904
45. *Styela partita* (Stimpson), 1852
45a. *Styela partita bermudensis* Van Name, 1902
46. *Styela plicata* (Lesueur), 1823
47. *Styela atlantica* (Van Name), 1912

PYURIDÆ

48. *Tethyum microspinosum*, new species. [Possibly not West Indian]
49. *Pyura vittata* (Stimpson), 1852
50. *Pyura antillarum*, new species
51. *Pyura momus* form *pallida* (Heller), 1878
52. *Microcosmus exasperatus* Heller, 1878
53. *Microcosmus helleri* Herdman, 1881

MOLGULIDÆ

54. *Molgula occidentalis* Traustedt, 1883
55. *Molgula manhattensis* (De Kay), 1843
56. *Molgula lutulenta* (Van Name), 1912
57. *Bostrichobranchus pilularis* (Verrill), 1871

In addition to the forms listed above *Polycarpa fibrosa* (Stimpson), 1852, a northern species, ranges southward in deeper water off the coast into the latitudes covered in this paper. A poor and somewhat doubtful specimen is recorded from 39° 56′ 30″ N., 70° 59′ 45″ W., 238 fathoms. See Van Name, 1912, under name *Pandocia fibrosa*.

Among the species of other authors not represented in the collections studied, the following seem deserving of special mention as certainly not synonyms of any of the above (see references on pp. 483, 485, 486).

Corella eumyota Traustedt, 1882
Ascidiella styeloides (Traustedt), 1882
Microcosmus anchylodeirus Traustedt, 1883
Molgula eugyroides Traustedt, 1883
Molgula contorta Sluiter, 1898

The following three species from New England are likely to be found to range southward along the coasts of the Middle States in shallow water on sandy bottom. See Van Name, 1912.

Molgula arenata Stimpson, 1852 (syn. *Cæsira arenata*)
Molgula robusta (Van Name), 1912 (syn. *Cæsira robusta*)
Molgula singularis (Van Name), 1912 (syn. *Cæsira singularis*)

Descriptions of Species

The descriptions here given have been prepared from material from the region covered by this article and are not, except where indicated, based on the statements of other authors. The brief statements of some of the principal characters given under the headings of the families and genera are not intended as complete diagnoses but are for the convenience of those whose unfamiliarity with the classification of the ascidians would otherwise make it necessary to refer to other works for this general information. For a full statement of generic and family characters, the reader should consult Hartmeyer's work (1909–1911) in Bronn's 'Tier-reich,' III, supplement, pp. 1281–1773.

The text figures are from drawings by the author, and have been made somewhat diagrammatic. In the illustrations of the branchial sacs the folds are shown lying in their natural positions, hence covering partially or completely the flat intervals of the sac or, when the folds are very high, also the bases of the folds next above. The illustrations represent chiefly the internal parts but, as in the case of the external characters, the internal organs may exhibit great differences in appearance, size, and form due to different states or degrees of development and functional activity; this must be kept in mind when using such characters for the determination of species.

The external form and appearance of most ascidians varies so greatly and is so much modified by the conditions and circumstances of the preservation of the material that illustrations of the external features are generally but a poor guide in identification of specimens. Often, in fact, they are misleading. Such illustrations (reproduced from photographs) of many of the species here described will, however, be found in previous articles (1902, 1910, 1912, 1918) by the writer.

In view of the very detailed descriptions of certain compound ascidians (taking account of histological characters, minute differences in the size and shape of soft parts subject to contraction, etc.) that have recently been published, it seems worth while once more to call the readers' attention to the remarks regarding variability made on the preceding pages (see p. 288) and to state that the brevity of some of the descriptions here given is due to the large amount of material studied having shown the variability of such characters in specimens undoubtedly of the same species, and their unreliability or absolute uselessness in diagnosing species or identifying specimens.

Explanation of Lettering on Illustrations

at	atrial orifice	*l*	liver
br	branchial orifice	*lg*	languet
ccl	common cloacal aperture	*lv*	larva
ecp	endocarp	*mb*	muscle band
em	embryo	*mp*	muscular process
en	endostyle	*od*	oviduct
g	gonad	*oe*	œsophagus
gc	gastric cæcum	*r*	rectum
ilv	internal longitudinal vessel	*rf*	rudimentary fold
in	intestine	*sd*	sperm duct
ing	intestinal gland	*st*	stomach
ip	incubatory pouch	*trv*	transverse vessel
k	kidney	*vp*	vascular process

Order **APLOUSOBRANCHIATA** Lahille

[=Krikobranchia Seeliger]

Compound ascidians having the body divided into two or three distinct parts or segements (thorax, abdomen, and sometimes post-abdomen), the digestive tract and reproductive organs being situated in the posterior part or parts of the body. Tentacles simple; branchial sac without folds or internal longitudinal vessels.

Synoicidæ Hartmeyer, 1908

[=Polyclinidæ *auct. mult.*]

Body consisting of three divisions or segments, the last (post-abdomen) containing the reproductive organs and heart. Budding by segmentation of the post-abdomen.

POLYCLINUM Savigny, 1816

Post-abdomen a small oval sac connected by a narrow elongated neck with the abdomen. Stomach wall smooth, intestine twisted into a closed loop posterior to the stomach. Inner aspect of transverse vessels of branchial sac with small papillæ.

Polyclinum constellatum Savigny, 1816

Figures 1 and 2

1816. *Polyclinum constellatum* Savigny, 'Mém. s. l. animaux sans vertèbres,' pt. 2, p. 189, Pl. IV, fig. 2; Pl. XVIII, fig. 1.

1820. *Polyclinum constellatum* Savigny-Oken, Isis, pp. 660, 874, figs. on Pls. XII and XVIII.

1891. *Polyclinum constellatum* Herdman, Journ. Linn. Soc. London, Zool., XXIII, p. 619.

1905. *Polyclinum festum* Hartmeyer, Zool. Jahrbücher, Syst., VIII, suppl., p. 401, Pl. XIII, figs. 6, 7.

1909–1911. *Polyclinum constellatum* + *P. festum* Hartmeyer, Bronn's 'Tierreich,' III, suppl., pp. 1461, 1640, 1641.

1912. *Polyclinum constellatum* Hartmeyer, 'Deutsch. Tiefsee-Exp.,' XVI, p. 334.

1916. *Polyclinum constellatum* + *P. festum* Hartmeyer, Sitzungsber. Gesell. naturf. Freunde, Berlin, ann. 1915, p. 429.

1918. *Polyclinum festum* Van Name, Bull. U. S. Nat. Mus., No. 100, I, p. 162, fig. 111.

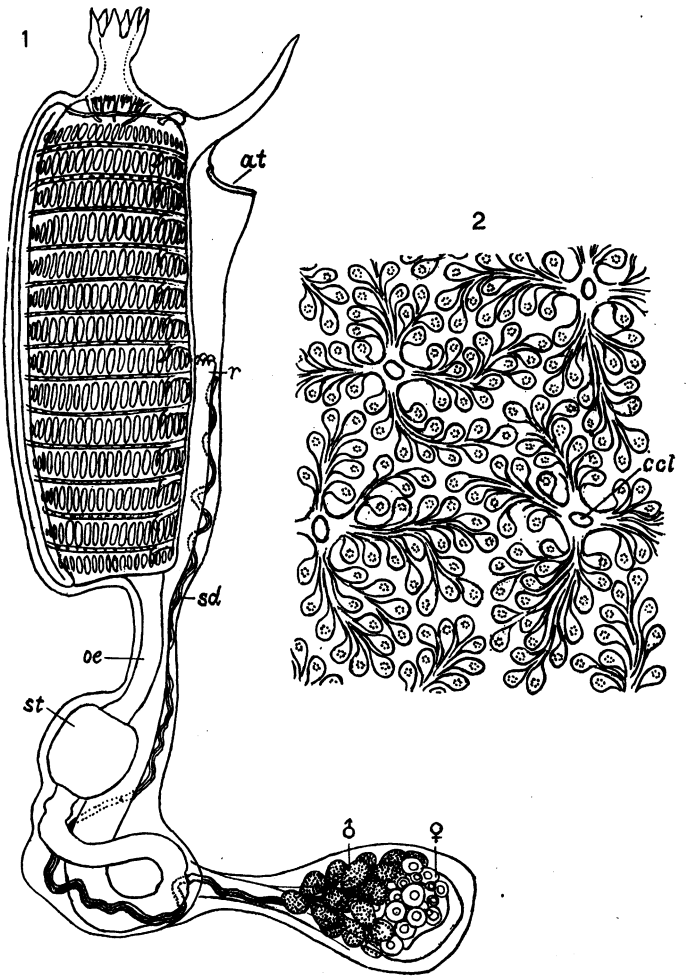
1919. *Polyclinum constellatum* Michaelsen, Jahrb. Wiss. Anst., Hamburg, XXXVI, Suppl., p. 87.

1919. *Polyclinum constellaum* Michaelsen, Denkschr. Akad. Wiss. Wien, math.-nat. Kl., XCVII, part 9, p. 10.

For other possible synonyms see the above articles of Michaelsen (1919).

This species forms colonies of a grayish-brown color which, when of small or medium size, tend to assume a capitate oval or pyriform shape. The attachment is by the smaller end; the top may be rounded or more or less flattened. Larger colonies often become broader and sometimes even assume expanded and flattened or umbrella-like forms, but the area of attachment is usually small, so that much of the base of the colony, as well as the sides and top, are free, though the zooids are chiefly confined to the upper portions. In some cases the basal part of the colony tapers gradually to the size of the attached area, but a distinct pedicel is rarely developed, not even a very short one, the colony being sessile on the object on which it grows. Some colonies are cleft into two or more distinct lobes; these are perhaps often separate colonies that have grown together more or less at the base. Naturally, among the numerous examples collected, there are many which vary greatly in shape from the above-described usual types.

In all but the smallest colonies the zooids are arranged in several or many distinct systems. The small round or oval common cloacal orifices are scattered over the surface of the colony at distances of a centimeter apart, or less. Each orifice opens from a small common cloacal cavity, into which several branching cloacal ducts or groups of individual ducts open. These lead from the atrial orifices of the individual zooids; the



Figs. 1 and 2. *Polyclinum constellatum* Savigny, 1816

Fig. 1. Left side of zooid, × 30. **Fig. 2.** Part of surface of colony showing arrangement of zooids and common cloacal canals, × 4.6.

latter are arranged in short curved rows and clusters. The arrangement of the zooids and manner of branching of the cloacal ducts is shown in Fig. 2. In many specimens the anterior ends of the zooids, the small six-lobed branchial orifices, and the cloacal orifices, may be very distinctly seen on the surface, and the course of the cloacal ducts and the limits of the systems very easily followed. In other cases, at least in alcoholic material, some or all of these features may be greatly obscured by the

dark pigmentation of the test and the contracted condition of the colony. As already noted, the systems do not generally occupy the entire surface of the colony; on parts of the sides and on the lower portions near the area of attachment they are generally wanting.

The pear-shaped or ellipsoidal colonies become 30 to 40 mm. high and 30 to 60 mm. in diameter near the top, or occasionally larger. One very low but wide colony is 160 mm. across the upper surface, though no more than 18 to 20 mm. high at any point, its attachment being by a small central area on the lower side. Surface of colony generally smooth but not shiny, and generally free from incrusting sand; if a coating of sand is present, it does not pervade the interior of the colony to any considerable extent. Test usually dark-colored, of gelatinous consistency. In the alcoholic specimens, at least, it is much firmer toward the outside of the colonies than in the center, where it becomes very soft and there may be a large cavity. This, however, does not have any connection with the cloacal cavities. The dark color is due chiefly to pigment grains in the test cells and in some of the cells in the tissues of the zooids. A few colonies show, in the preserved state at least, very little pigmentation, and are yellowish or light grayish.

Zooids, when expanded and straightened out, 5 to 6 mm. long or more; the thorax, with the long branchial sac, occupying nearly half the total length of the body. The abdomen and the thorax are separated by a narrow neck, and the pear-shaped post-abdomen is also connected to the abdomen by a neck of considerable length. The post-abdomen arises from one side of the abdomen and generally lies with its axis more or less at right angles or at least very obliquely to that of the rest of the body.

Branchial orifice with six lobes, which are rather long and pointed except in greatly contracted specimens; atrial orifice a large plain-edged oval opening, from the front border of which a narrow pointed languet, extremely long in some individuals, has its origin.

Four first order, four second order and eight third order tentacles are present, and in well-preserved material fourth order tentacles can also be demonstrated in the intervals between the larger ones, making the normal number 32 when all are present. In some individuals, at least, the first order tentacle in the median dorsal position is larger than the other three.

Dorsal languets narrow and pointed, arising from the median dorsal vessel but fused with the transverse vessels of the left side of the branchial sac for a distance equal to the width of four or five stigmata so that they appear to arise from the transverse vessels.

Branchial sac with 14 to 18 rows of stigmata with from 19 to 22 stigmata in a row on each side of the body, except in the most posterior rows, where the sac becomes narrower and the number a little less. The transverse vessels bear very minute papillæ projecting inward into the cavity of the branchial sac; they do not correspond in number to the stigmata but are somewhat fewer, though arranged along the vessels with considerable regularity. They are probably to be considered as projections of the edge of a narrow membrane borne on the vessel, but in well-preserved material they are quite definite and well-marked structures, though very minute. These papillæ have been noted in other species and are probably present in all members of the genus, though it is difficult to demonstrate such delicate structures except in favorable material (see Hartmeyer, 1916, p. 427).

The digestive tract has the peculiar course characteristic of this genus, the intestine being twisted to form a small closed loop posterior to the stomach, which is smooth-walled. The rectum is rather long, extending to about the middle of the thorax, where it ends in a six-lobed aperture.

The anterior part of the post-abdomen is occupied by the male reproductive organs, which consist of a group of twenty or more small pyriform or oval testes. Their common sperm duct extends through the pedicel of the post-abdomen into the abdomen and then accompanies the intestine almost to the end of the rectum. The more posterior part of the post-abdomen contains the ovary, visible as a group of eggs in various stages of growth; the heart is in the extreme end.

Hartmeyer (1908, 1916) has already recorded this genus, but without naming any species, from Tortugas, Florida.

The genus is widely distributed in the West Indian region; in some places it is very common. Though very variable in form, size, pigmentation, and in the number of rows of stigmata in the branchial sac of the zooids, I can find no sufficient reason for believing that more than one species is represented, nor can I find characters upon which it may be separated from Savigny's species from Mauritius, except that Savigny's figure shows the number of tentacles as twelve instead of sixteen. In this genus, however, the tentacles appear to be normally in multiples of eight, not of six, and, as the tentacles are often difficult to count exactly, I cannot have confidence in this apparent difference. I also follow Michaelsen (1919a, p. 87) in identifying *P. festum* Hartmeyer, 1904, from Mauritius and the Philippines, with this species. The described species of this genus are mostly separated by very indefinite and untrustworthy

characters, so that it is not improbable that this form is more widely distributed than our present information shows.

The American specimens that I have examined are from the west coast of Florida (depths down to 26 fathoms), including Tortugas; off the north coast of Yucatan (24 fathoms); Bahamas; Cuba (Cienfuegos); Jamaica; Porto Rico (Guanica, on piles); and Sabanilla, Colombia. One specimen appears to have grown on a crab.

APLIDIUM Savigny, 1816

[=*Aplidium*+*Amaroucium* Milne-Edwards, 1841]

Post-abdomen (when fully developed) elongate, not separated from the abdomen by an elongate neck, though there may be a slight constriction between these two parts of the body. Stomach usually with distinct longitudinal plications; an atrial languet is present in all the West Indian forms.

Subgenus APLIDIUM

Distinguished by having the branchial sac short, with rather few (commonly five to ten) rows of stigmata, the post-abdomen short, the atrial aperture back from the anterior end of the thorax and often without a languet, and the testes in a more or less compact group (see Michaelsen, 1919a, p. 90) instead of an elongated series.

Aplidium lobatum Savigny, 1816

Figure 3

1816. *Aplidium lobatum*+*A. tremulum* Savigny, 'Mém. s. l. animaux sans vertèbres,' pt. 2, pp. 182, 184; Pl. III, fig. 4, Pl. XVI, figs. 1, 2.
1820. *Aplidium lobatum*+*A. tremulum* Savigny—Oken, Isis, pp. 660, 871, 872, figures on Pls. XII and XVII.
1909–1911. *Aplidium lobatum*+*A. tremulum* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1469, 1638.
1919. *Aplidium lobatum* Michaelsen, Jahrb. Wiss. Anst., Hamburg, XXXVI, suppl., p. 86.
1921. *Aplidium lobatum* Michaelsen, Denk. Akad. Wiss. Wien., math.-nat. Kl., XCVII, p. 22, figs. 11, 12.

The colony in this species is apparently normally of a rather thick incrusting type with rounded edges. The borders and surfaces show a tendency to be raised into low rounded elevations at many points or produced into more or less distinct rounded lobes. Greatest diameter of largest colony about 75 mm.; average thickness, where covering an even surface, probably not much over 3 mm. Zooids arranged in elongate groups and rows; the limits of the systems are hard to determine, but in large colonies, at least, they appear to be quite extensive and more or less

branched. The branchial orifices may or may not be slightly prominent on the surface; the common cloacal apertures are ordinarily inconspicuous in the preserved material. The test itself is rather transparent and nearly colorless or somewhat yellowish, but the colonies are rather opaque from the considerable quantities of sand which are present all through the test and assume more or less the color of the sand. This included sand renders the test rather firm but easily broken in the alcoholic specimens.

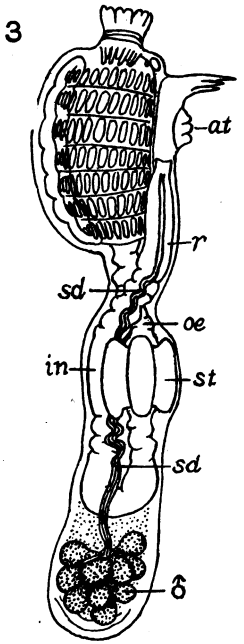


Fig. 3. *Aplidium lobatum* Savigny, 1816. Left side of zooid, × 32.

Zooids small and short; in the contracted condition found in preserved material not usually over 2 to 3 mm. in total length, or even less when the body is bent or distorted. Thorax short, separated by a constriction from the rest of the body; post-abdomen short and wide even when the reproductive organs are well developed.

Branchial aperture with six bifid lobes. Atrial aperture on the dorsal side of the thorax; less prominently lobed than the branchial aperture. Close in front of it is a small languet cleft into three pointed lobes.

Mantle musculature consisting mainly of the sphincters of the apertures and a few narrow longitudinal bands on the thorax.

Tentacles well developed, but the specimens were found too much contracted to determine the number.

Dorsal languets on the transverse vessels of the left side a little way from the median dorsal vessel.

About seven rows of stigmata (fairly long and narrow when the sac is expanded) with about fifteen or sixteen in a row on each side.

Stomach wall with five very deep furrows and the same number of very thick prominent longitudinal ridges. Intestinal loop quite long in well-expanded zooids.

Ovaries not developed in the individuals studied. Testes few in number (about fifteen to twenty) and forming a compact rounded group as is characteristic of this subgenus.

The American Museum collection contains a small colony dredged off Guanica Harbor, Porto Rico, in five fathoms. The National Museum

collection contains several larger specimens all dredged at St. Thomas, W. I. Savigny described it from the Red Sea. (Gulf of Suez).

Subgenus **Amaroucium** (Milne-Edwards) 1841

Distinguished from the subgenus *Aplidium* by having zooids with a more elongate branchial sac and post-abdomen, and the atrial aperture placed well forward near the anterior end of the thorax. Atrial languet always present. Rows of stigmata numerous; testes arranged along the sperm duct in an elongate single or double series.

The species of this group show a great deal of individual variation in the form, color, and character of the colony, in the number of rows of stigmata in the branchial sac, and in the number of plications in the stomach wall, etc., and there is much difficulty in finding reliable and constant characters for separating them. The difficulties of dealing with the material are increased by the shrunken and poorly preserved condition in which much of it reaches the investigator, so that many of the essential characters of the zooids are often very difficult to make out. It is possible that more species should be recognized from this region than I have done. If so, I am at a loss to name the characters by which they can be satisfactorily distinguished. The question of the possible identity of some of these forms with those from other parts of the world cannot be dealt with on the basis of the material and information now available.

Aplidium (Amaroucium) bermudæ (Van Name), 1902

Figure 4

1902. *Amaroucium bermudæ* Van Name, Trans. Conn. Acad. Sci., XI, p. 352, Pl. L, fig. 20; Pl. LVIII, figs. 96, 97.

1909–1911. *Amaroucium bermudæ* Hartmeyer, Bronn's 'Tier-reich,' III, suppl. pp. 1466, 1633.

This species was originally described from Bermuda (Van Name, 1902) from small capitate or wedge-shaped colonies, with rather abrupt sides and a rounded or flattened top. No large colonies were collected there. The Yale University and National Museum collections contain, however, much larger specimens that appear to be of this species from other localities. These large colonies vary greatly in shape; generally they are thick and massive, rounded or irregularly ovoid, sometimes compressed in one direction, but rarely to such an extent that they can correctly be termed plate-like. The area of attachment is generally small and variously situated, often near one end or on one of the narrower borders. The largest colony (from North Carolina) is a dome-shaped mass about 110 mm. by 60 mm. in diameter and about 70 mm. high.

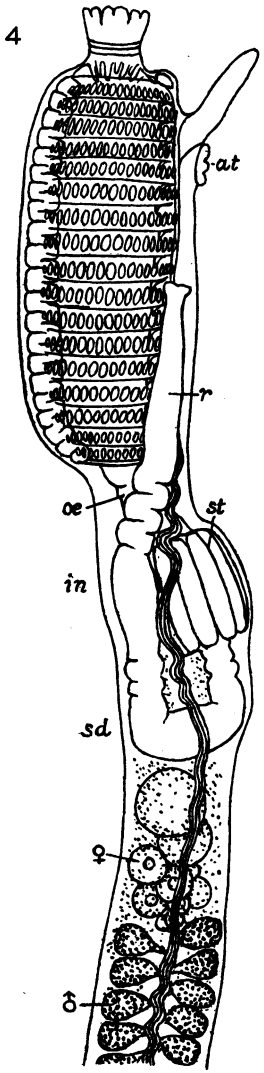


Fig. 4. *Aplidium* (*Amaroucium*) *bermudæ* (Van Name), 1902
Left side of zooid, × 25.

Another (from southern Florida) is of somewhat flattened ovoid form, about 90 mm. by 50 mm. in diameter and over 40 mm. thick, attached by a small area on one of the broad sides.

Test rather firm, of somewhat cartilaginous character on the surface, but often softer in the interior. Surface usually, though not always, free from sand. In color the preserved specimens are usually yellowish, or brownish yellow, the zooids showing indistinctly through the test, which varies from merely translucent to semi-transparent. The Bermuda specimens, when fresh, were opaque grayish with a bluish or sometimes a pinkish cast; in preservation the test became more transparent. Zooids usually brightly colored, orange or in part vermilion red when alive; in preservation they fade to a dingy yellowish or brownish-yellow color. An arrangement of the zooids in systems cannot always be readily made out, but in some colonies they can be clearly seen to be arranged in small circular or oval systems, each surrounding a small common cloacal cavity and aperture. In preservation, owing to the greater contraction of these structures than of the intervening solid test, the surface of the colony becomes slightly depressed where they are situated, giving the surface a pitted appearance, but this is probably a purely artificial effect and would not be noticeable in fresh material under normal conditions.

Zooids usually rather large and stout. In a fairly well preserved, though nevertheless somewhat contracted, individual the body measured 3.3 mm. long, exclusive of the post-abdomen; the latter often measures 5 to 10 mm. additional. Branchial aperture with six (occasionally seven) somewhat bifid lobes. Atrial aperture usually also distinctly lobed and

provided just in front of its anterior margin with a long languet, usually of simple form but sometimes with a small lateral tooth or projection on each side. Mantle provided with strong longitudinal muscles which form distinct but rather narrow, closely placed bands on the thorax. These spread out and become diffuse on the abdomen, and mostly disappear on the post-abdomen.

Tentacles of at least two sizes, but difficult to count owing to the contracted condition of the material.

Dorsal languets arising from the transverse vessels a little way to the left of the median dorsal vessel.

Branchial sac elongate, with about sixteen or seventeen rows of stigmata in most colonies. There may be as many as eighteen stigmata in a row on each side. The rather large number of rows of stigmata appears to be one of the characteristics of the species, and I have found it to prevail in most of the specimens, yet in some colonies the number of rows seems to average smaller, only a dozen to fifteen.

Stomach unusually thin-walled as compared with its condition in the majority of species of this genus. Commonly it has a rather small number (generally from ten to eighteen) of longitudinal plications; these may be fairly sharp and distinct, but more often they appear rather faint, and in some colonies the stomach appears practically smooth-walled—a condition rare, if not unique, in this genus. The stomach is, however, generally found folded and crushed in by the contraction of the body muscles. Folds thus produced may generally be distinguished by their irregularity from the normal ones, though they are often so numerous and deep as to obscure the normal ones partially or entirely, or to produce in conjunction with them an apparent areolated or sacculated condition of the stomach wall.

Ovary situated as usual in the anterior part of the abdomen; the testes, which are very numerous in well-developed individuals, form a double longitudinal row along the sperm duct in the part posterior to the ovary.

Beside the types and cotypes from Bermuda already mentioned, the Yale University collection contains many colonies, several of them large, from Fort Macon, North Carolina, collected by Dr. H. C. Yarrow. Except small and not very characteristic (or perhaps somewhat doubtful) specimens from Water Island (in the former Danish West Indies) and Jamaica, the material in the National Museum collection is all from the coasts of North and South Carolina and from the Gulf of Mexico, mostly from the west coast of Florida. The depths of these stations are

generally not given; the greatest recorded is 14 fathoms, off the southern part of the North Carolina coast.

I have also assigned to this species several specimens consisting of small, closely crowded heads, densely incrusted with sand. They are from Cedar Keys, Florida, and from off the north coast of Yucatan (26 fathoms). Such specimens appear to bear the same relation to the ordinary colonies that the sand-incrusted *pellucidum* form of *A. pellucidum* bears to the *constellatum* form of that species, and they closely resemble the form *pellucidum* as described on p. 309 in the size and external appearance of the heads.

Aplidium (Amaroucium) stellatum (Verrill), 1871

1871. *Amouroucium stellatum* Verrill, Amer. Journ. Sci., (3) I, p. 291.
1873. *Amarœcium stellatum* Verrill and Smith, 'Report on Invert. Animals of Vineyard Sound,' pp. 402 (411), 419 (424), 704.
1878. *Amarœcium stellatum* Coues and Yarrow, Proc. Acad. Nat. Sci. Philadephia, p. 304.
1909–1911. *Amaroucium stellatum* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1467, 1619.
1910. *Amaroucium stellatum* Van Name, Proc. Boston Soc. Nat. Hist., XXXIV, p. 416, Pl. XXXIV, fig. 1, text fig. 25.
1913. *Amaroucium stellatum* Sumner, Osburn and Cole, Bull. U. S. Bureau of Fisheries, XXXI, pp. 75, 76, 159, 160, 733; chart 197.
1916. *Amaroucium stellatum* Pratt, 'Manual Common Invert. Animals,' p. 670.

For other references and a more detailed description, see Van Name, 1910.

This species forms flattened plate-like colonies resembling, when alive, pieces of raw pork in color and consistency. The colonies are very variable in shape, often long and narrow, sometimes divided into finger-like lobes; often they are shaped like disks attached by one edge. They become very large, sometimes as much as 300 to 600 mm. long, over 20 mm. thick and of very variable width. The edges are rounded; the zooids arranged in small circular systems, which in preserved specimens sink in, covering the surface with small depressions, but in life the surface is smooth, even, and shiny.

The zooids resemble those of *A. bermudæ*, though they appear to average a trifle smaller and generally to have fewer rows of stigmata (often only about eleven) with seventeen or eighteen in a row on each side. The stomach wall is, however, thicker and more rigid; it has usually about a dozen sharply defined longitudinal plications, which are not easily obliterated or obscured by the contraction of the body muscles. The discovery in the Yale University collection of the specimens on which Coues and Yarrow (1878) based their record of this

species from North Carolina (Fort Macon) now confirms the correctness of their statement. These specimens are said to have grown on piles; on the New England coast this species grows only attached to stones or gravel on the bottom where there is a strong current. This appears to be the most southern record of the species; a few possible specimens that I have seen from farther south I refer rather to *A. bermudæ*, a species which in some of its numerous variations sometimes approaches the present species in characters and appearance, including, though only rarely, the flattened form of the colony.

Aplidium (Amaroucium) pellucidum (Leidy), 1855

Figure 5

1855. *Alcyonidium? pellucidum* Leidy, Journ. Acad. Nat. Sci. Philadelphia, (2) III, p. 142, Pl. x, fig. 24.
1871. *Amouroucium pellucidum* Verrill, Amer. Journ. Sci., (3) I, p. 290.
1871. *Amouroucium constellatum* Verrill, Amer. Journ. Sci., (3) II, p. 359.

This species, common and well-known on the southern New England coast, exists in two forms very different in external appearance, but not only connected by specimens intermediate in character but by colonies exhibiting in one part the characters of one form, in another that of the other in its extreme development. They are not, therefore, true subspecies.

In one form the colony is split up into a multitude of small heads of pyramidal or wedge-shaped form, each 5 to 10 mm. in diameter at the top, generally containing one small system of zooids and densely incrusted with sand, which is present also in the interior of the test. In the more perfect colonies of this form, these small heads are so closely crowded and fitted together as to give the whole colony the appearance of a rounded sand-incrusted mass several centimeters in diameter. In the other form the colony is not thus subdivided, though often cleft into a few larger lobes or heads; it is not incrusted with sand to any considerable extent, and the systems, though sometimes small and round or oval, often become large and of irregular outline. Verrill considered the two as separate species; he identified the sandy lobulated form with Leidy's *pellucidum* and described the massive sand-free form as a new species, *constellatum*. They have been treated as two species in most of the literature since that time. The massive or *constellatum* form appears, however, to be the usual manner of growth of the species, the other form developing chiefly on sandy bottoms where there is a strong current keeping the sand stirred up. The sandy form is, therefore, local in its

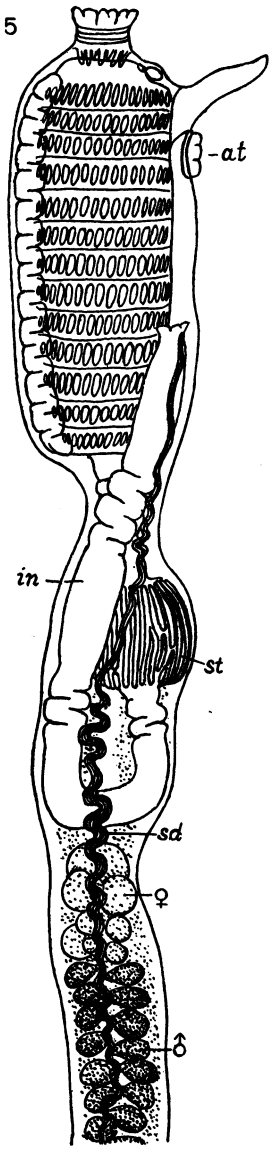


Fig. 5. *Aplidium (Amaroucium) pellucidum* (Leidy), 1855
Left of side zooid, × 25.

distribution, and it is unfortunate that the species was described from it and that another name has become associated with the usual and more widely distributed form of growth.

Though Verrill and Smith (1873) report the sandy (*pellucidum*) form as ranging from North Carolina to Vineyard Sound, Massachusetts, most of the specimens from the southern states that I have seen are decidedly of the *constellatum* form, or, if intermediate, nearer to that form than to the extremely sandy and lobulated *pellucidum* as the latter occurs on the New England coast.

The chief references to this form are as follows:

1871. *Amouroucium constellatum* Verrill, Amer. Journ. Sci., (3) II, p. 359.

1873. *Amarœcium constellatum* Verrill and Smith, 'Rept. on Invert. Animals of Vineyard Sound,' pp. 704, 388, 393, 403, etc.

1910. *Amaroucium pellucidum* form *constellatum* Van Name, Proc. Boston Soc. Nat. Hist., XXXIV, p. 406, Pl. xxxvi, figs. 4, 5; Pl. xxxviii, fig. 9; text fig. 23.

1913. *Amaroucium pellucidum* form *constellatum*, Sumner, Osburn and Cole, Bull. U. S. Bureau of Fisheries, XXXI, pp. 155, 158–160, 733; chart 196.

1916. *Amaroucium constellatum* Pratt, 'Manual Common Invert. Animals,' p. 670.

For other references, including both forms of the species, see Van Name, 1910.

The normal shape of the colony of this form is that of a rounded or somewhat flat-topped head, tapering below to a rather narrow base or short peduncle; such heads may reach 15 to 25 mm. in height and be of very varying diameter. Larger colonies may consist of two or more such heads united at the base; very large ones may be quite broad (80 mm.) and of hemispherical or somewhat flattened cushion-like shape, though attached only by a small part of the

lower surface. Generally, however, large colonies, as well as many of the small ones, are of very irregular shape and are usually more or less divided into lobes by clefts of varying depth and width. In life the test varies from cream-color to pale orange or reddish; the zooids are brightly colored (largely orange-yellow, the stomach generally bright orange-red) and show more or less through the test, in spite of the latter being somewhat opaque. These bright colors fade out completely in alcohol. The consistency of the test and colony as a whole is generally rather softer and more flexible than that of *A. bermudæ*.

Zooids arranged in systems as above noted; they are of moderately large size (4 mm. or more long exclusive of the post-abdomen), which of course varies in length with age and the development of the reproductive organs. In most characters, they resemble too closely those of *A. bermudæ*, described above, to require a separate description; the number of rows of stigmata, however, appears to average less (9 to 15), and the atrial languet to always be of simple form without lateral projections.

The most conspicuous difference is in the stomach, whose wall has a much larger number (usually over twenty, sometimes between thirty and forty) of distinct but narrow longitudinal plications. These are generally somewhat irregular and interrupted in some places, often to an extent such as to cause an areolated condition of a part of the stomach surface. The species as a whole ranges from a little north of Cape Cod (Isles of Shoals, New Hampshire) to the west coast of Florida and the neighboring banks, and from near low-water mark to 26 fathoms. I failed to find it on the coast of southeastern Florida and its distribution may be discontinuous and interrupted by the southern part of the Florida peninsula.

Aplidium (Amaroucium) exile (Van Name), 1902

Figure 6

1902. *Amaroucium exile* Van Name, Trans. Conn. Acad. Sci., XI, p. 354, Pl. L, fig. 21; Pl. LVIII, fig. 98.

1909–1911. *Amaroucium exile* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1467, 1633.

In addition to *A. bermudæ*, described above, there is also a smaller form found at Bermuda, which appears to be a distinct species. This forms small, rounded or button-shaped colonies, attached by the greater part of the lower surface. The edge or border of the colony is thick and rounded. Size up to 15 or 20 mm. across and 5 to 6 mm. high. Test colorless and transparent, but often more or less filled with sand grains and shell fragments, though some colonies are entirely free from such

included matter. In the latter case the zooids, which vary from orange to bright scarlet, are very conspicuous and make the colony a very pretty object. Consistency of test rather soft. Zooids small, the post-abdomen usually shorter than the remainder of the body; in the preserved and contracted state they are often not over 3 mm. in total length; sometimes not so much. Branchial aperture with six or seven lobes, atrial aperture plain or slightly lobed, and provided with a long languet of simple form at its anterior edge.

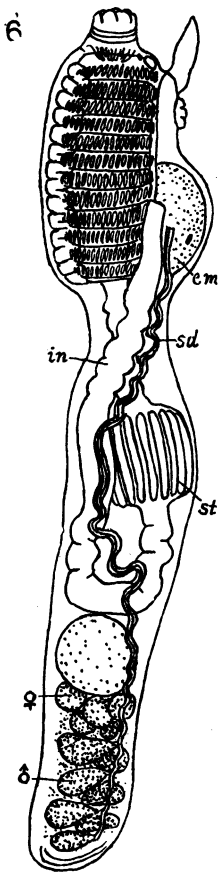


Fig. 6. *Aplidium* (*Amaroucium*) *exile* (Van Name), 1902
Left side of zooid, × 30.

Tentacles of two sizes.

Dorsal languets borne on transverse vessels of left side a little way from the median dorsal vessel.

There are about a dozen rows of stigmata, with apparently from sixteen to eighteen in a row on each side. The number of rows is subject to a little variation in different individuals.

Intestinal loop of moderate length, usually twisted, in the contracted specimens at least.

Stomach rather thick-walled, with from ten to twenty narrow longitudinal folds (the number given in the original description was too few) that are sometimes slightly irregular or broken up into areolations on a part of the surface of the stomach.

Ovary in the anterior part of the post-abdomen; testes in the posterior part. Many of the zooids contain larvæ in the atrial cavity, these beginning the secretion of test substance while still within the atrial cavity of the parent.

The structure of the zooids shows that this species is a close ally of *A. pellucidum* of the Atlantic coast of the United States. It is common at Bermuda, growing on stones along the shore, as well as on corals, etc., in deeper water. There is also in the Yale University collection a specimen from Key West, Florida, collected by Prof. A. S. Packard, which may be of this species, though in my collecting in southern Florida, I failed to find it, nor have I seen an undoubted specimen from any West Indian locality. The type is in the Yale University collection.

Didemnidæ Verrill, 1871

Compound ascidians with minute zooids, having the body divided by a constriction into two parts (thorax and abdomen); branchial sac with only three or four rows of stigmata. They have a peculiar method of budding by which each new zooid grows from two buds (one for the thorax and one for the abdomen), arising from or near the constricted middle part of the body, so that characteristic double zooids with the two individuals joined together by the middle part of the body are temporarily formed.

Michaelsen has recently (1919*a*, 1920) called renewed attention to certain modified areas ("Seitenorgane" in his terminology) on the external surface of each side of the thorax of zooids of this family. These structures have been noted by many writers and are probably present in varying degrees of development in most members of the family, in some stages at least of their life history. They are oval or rounded areas, sometimes prominent on the body surface and definitely bordered by a raised rim, in other cases depressed below that surface or even deeply invaginated into the thorax; in the test adjacent to them or occupying their cavity, numerous very small spicules are commonly present. Dr. Michaelsen regards them as spicule-forming organs and likewise attributes to them considerable weight as specific characters, but the varying degree of their development in different specimens and their apparent absence in many cases suggests that they may be organs of a more or less temporary nature, so that further studies of their development and constancy will be needed before depending on them as specific characters. I regret that, owing to the delays and interruptions which have prevailed in the publication and distribution of scientific literature since the war, the above articles of Michaelsen were not received in time for me to include a study of these structures in the species dealt with in this article, but they should certainly not be neglected in any future investigations of this family.

Trididemnum Della Valle, 1881

Distinguished by having three rows of stigmata, a single testis about which the sperm duct is spirally coiled, and often a short tubular atrial siphon, but no atrial languet. Stellate calcareous spicules present in the test.

As found in the West Indian region, the colonies of this genus are very variable in their minor characters, and the question of how many species should be recognized is not an easy one to settle. The larger series of specimens now available contains intermediate examples that make it necessary to unite certain forms treated as distinct species in my account of the Bermuda ascidians (1902).

Trididemnum savignii Herdman, 1886

Figures 7-9

1896. *Didemnum savignii* Herdman, 'Rept. Voy. Challenger, Zool.,' XIV, p. 261, Pl. XXXIV, figs. 1–5.

1891. *Didemnum savignii* Herdman, Journ. Linn. Soc. London, Zool., XXIII, p. 629.

1902. *Didemnum savignii*+*D. atrocanum* Van Name, Trans. Conn. Acad. Sci., XI, pp. 358, 359, Pl. LI, figs. 27, 30, 34, 35; Pl. LIX, figs. 112, 114.

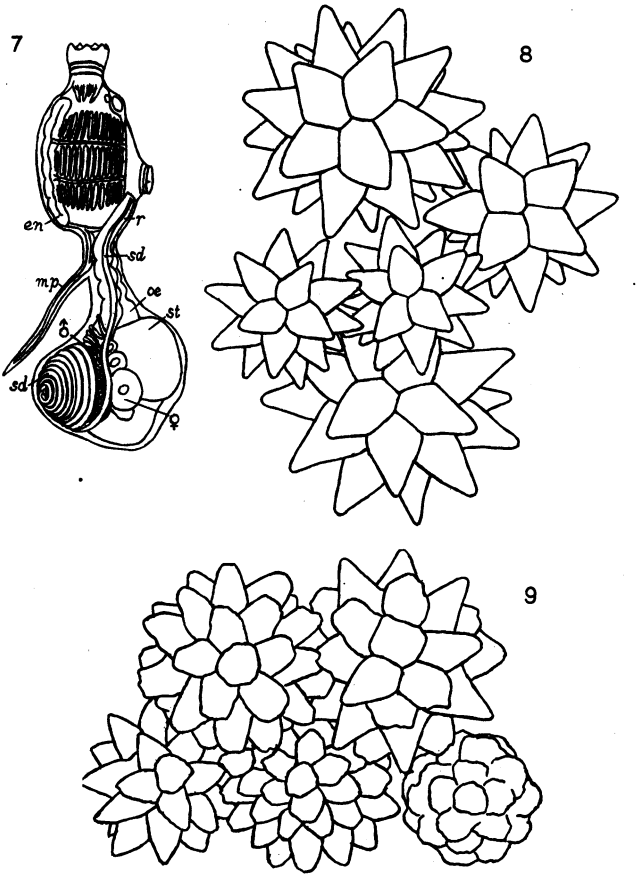
1909–1911. *Trididemnum savignyi*+*T. atrocanum* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., p. 1446, 1633.

1920. *?Trididemnum natalense*+*T. savignyi*+*T. atrocanum* Michaelsen, Jahrb. Wiss. Anst., Hamburg, XXXVII, suppl., pp. 3, 6, text fig. 1.

This ascidian forms incrusting colonies, occasionally of considerable size (one specimen measures 75 mm. across) and of very variable thickness, usually only about 2 to 3 mm., but often considerably more when growing on an irregular surface. The external appearance of the colony is greatly dependent on two characters, both subject to very great variability in different specimens, first, the number and distribution of the large stellate spicules and, second, the abundance and distribution of the pigment cells in the test. The spicules are of comparatively large size, generally at least .04 to .06 mm.; in some colonies some of them are .08 or .10 mm. in diameter, or even more. They are generally beautifully regular in form, being stellate, with moderately numerous conical points which taper to a rather sharp extremity, though in many colonies among such regularly formed spicules there will be found many in which the points are irregular and broken or blunted at the tip. Occasional colonies occur in which the majority or all of the spicules exhibit such imperfections, the points being reduced to mere irregular protuberences on the spherical central portion of the spicule. In some specimens the spicules exhibit striking uniformity in size, in others large and small ones occur in varying proportions. Their distribution and relative abundance in the test are also subject to much variation. Generally the spicules are chiefly or entirely confined to a layer in the test a little beneath the upper surface, leaving the latter smooth and glossy. The spicules are often distributed in this layer in groups and patches, which may show white, in strong contrast to the dark areas where spicules are few or wanting, giving the surface of the colony a very conspicuously mottled or spotted coloration, but this occurs only in a small proportion of the specimens.

The branchial apertures of the zooids are usually distinguishable on the surface, though less conspicuous than in the form *porites* described below, and not raised above it as in that form; and the zooids themselves are often more or less distinctly visible through the test when they

are not obscured by the abundance of spicules or by too heavy pigmentation of the test. The zooids are arranged in branching and anastomosing systems, apparently of considerable extent and complexity, but the common cloacal apertures are not easy to find.



Figs. 7–9. *Tridemnum savignii* (Herdman), 1886

Fig. 7. Left side of zooid, × 40. **Fig. 8.** Typical spicules, × 460. **Fig. 9.** Poorly formed spicules from another colony, × 460.

Where free from spicules, the test is of moderately firm gelatinous character; in some colonies, particularly young ones, it may be whitish or nearly colorless, but as a rule a dark smoky brown or blackish pigment is present both in the test and on some parts of the zooids, especially about the anterior end and on the thorax and sometimes on much of the

mantle. The pigment is chiefly contained in special cells which are most abundant in the superficial parts of the test and vary in form from the most irregular and elongate shapes to regularly oval. Generally the pigment cells just described give the upper surface of the colony, or sometimes the whole test, a brownish or blackish color, according to their abundance; after preservation in alcohol for some time, this pigment becomes of a warmer brown tint. Bladder cells are usually very abundant, especially in the superficial parts of the colony.

The zooids show this to be a typical member of the genus. In the preserved material they vary from 1.5 to 1.6 mm. to less than 1 mm. in length, this being largely dependent on the state of contraction they are in. They have a tapering muscular process extending out into the common test from the constricted middle part of the body; its length and thickness are very variable in different colonies.

Branchial aperture with six short lobes. Atrial aperture round, situated on the dorsal side of the thorax at about the middle or somewhat farther toward the posterior end, the position varying in different colonies and often also in different individuals of the same colony. It is slightly produced, but usually not sufficiently to be called a tube.

Mantle with well-developed longitudinal muscle bands on the thorax.

Tentacles not less than eight, of at least two sizes arranged alternately, additional smaller third-order tentacles are probably present in the intervals.

Dorsal languets (two in number) borne on the transverse vessels of the left side, a little way from the median dorsal vessel.

Branchial sac with three rows of stigmata. The number in a row on each side in adult zooids appears to be variable. It reaches and possibly sometimes exceeds a dozen, but the number given in my previous description (1902), fifteen or sixteen, is too large. The sac extends a little posterior to the last row of stigmata, but this is not noticeable in strongly contracted specimens.

The rounded stomach and the other parts of the digestive tract present no peculiarities. The tubular organ of doubtful function which surrounds parts of the intestine in most ascidians is demonstrable in good material of this species and consists of a few delicate branching tubes which clasp the ascending part of the intestine where it passes the stomach.

Testis single, of conical form; the sperm duct arises from its apex and coils about it, often making as many as ten or twelve turns before

leaving it to accompany the rectum. The ovary, consisting of a very few eggs in different stages, lies near the base of the testis.

T. savignii was described by Herdman from a specimen obtained by the 'Challenger,' whose locality was marked as doubtful but probably from a station in 150 fathoms off the Cape of Good Hope. The close correspondence of Herdman's very detailed description with Bermuda and Florida specimens from shallow water suggests that the type may really have come from shallower water, and perhaps from Bermuda, where the Challenger Expedition also made collections. The American Museum contains specimens from Biscayne Bay, Florida, collected by myself, and one from off Salinas Cove, south coast of Porto Rico; the National Museum contains many from various points off the west coast of Florida from Cedar Keys to off Key West, also one from off the southeastern part of Jamaica. In American waters it grows on stones, shells, corals, gorgonians, etc., both along the shore at low-water mark and on the reefs and banks to depths of at least 27 fathoms.

The series of specimens now available indicates that *T. atrocanum* (Van Name), 1902, from Bermuda was based on immature colonies of the present form and is not a distinct species. *T. natalense* Michaelsen, 1920, from a tide pool at Isipingo, Natal, does not appear to be distinct from this species. Michaelsen gives only eight to ten as the number of stigmata in a row, while American examples certainly usually have more, but he may have made the count on immature zooids.

Trididemnum savignii form **porites** (Van Name), 1902

1902. *Didemnum porites*+*Didemnum lucidum* Van Name, Trans. Conn. Acad. Sci., XI, p. 360, Pl. LI, figs. 26, 28, 29, 33, 37; Pl. LIX, fig. 115.
1909. *Trididemnum porites*+*T. lucidum* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1446, 1633.
1920. *Trididemnum lucidum* Michaelsen, Jahrb. Wiss. Anst., Hamburg, XXXVII, suppl., p. 6.
1921. *Trididemnum lucidum* Michaelsen, Arkiv för Zoologi XIII, No. 23, pp. 23, 24.

This form can claim only very doubtful validity as a species, and is so close to *T. savignii* that it seems better to regard it as a form of that very variable species. The zooids and spicules do not present any differences which make their description necessary; though the spicules average somewhat smaller, they are subject to the same variations in size and in the form of their points as in the typical *savignii*.

The chief differences are in the general character of the colony. Of the few specimens available, several reach a considerable size, in one case measuring about 90 mm. by 55 mm. across and 3 mm. or more

thick. The spicules are abundant and evenly distributed; often they are numerous in the superficial layer of the test, giving the surface a granular character. The branchial orifices of the zooids are usually very conspicuous and are slightly raised above the surface of the colony, which from these causes loses the smooth glossy character usual in typical examples of *T. savignii*. The abundance and more general distribution of the spicules give the test a grayish color and sometimes render it quite hard and brittle. Dark pigment is present in cells in the superficial part of the test and on the mantle of the zooids; in life it is black, the dark pigment and white spicules combining to give a gray color to the colony, which deepens to blackish where the pigment is thickest. In preservation this pigment usually remains quite dark, though assuming more or less of a brown or sometimes purplish shade.

Type locality, Bailey's Bay, Bermuda, growing on algæ. Type in the Yale Museum. The other specimens referable to this form that the writer has seen are from Florida (Cedar Keys, Salt Pond Key, and Stock Island), from the south coast of Porto Rico (vicinity of Cajo de Muertos, Guanica Harbor, and Parguera), and from eastern Jamaica, as well as a rather doubtful one from Andros Island, Bahamas. They are all from shallow water, and are preserved in the collections of the National and American Museums.

The additional material now available indicates that *T. lucidum* (Van Name), 1902, from Bermuda, was based on small and poorly pigmented colonies of this form and should no longer be regarded as distinct.

Tridemnum solidum (Van Name), 1902

Figures 10–12

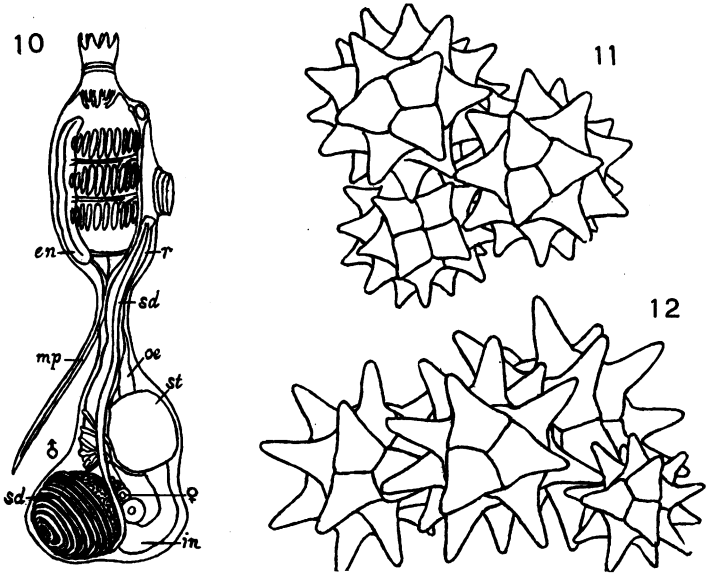
1902. *Didemnum solidum* Van Name, Trans. Conn. Acad. Sci., XI, p. 358, Pl. LI, figs. 31, 36; Pl. LIX, fig. 119.

1909–1911. *Tridemnum solidum* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1446, 1633.

This species was described from a single specimen now in the Yale University collection obtained at Coney Island, Bermuda, in shallow water. It is of irregular form, 45 mm. in greatest length, and 4 to 5 mm. in thickness in some parts, and incrusts a piece of seaweed. The test is rather hard and opaque, owing to the abundance of the spicules, which are quite uniformly distributed throughout the colony. During life it was of a pale reddish-gray color, almost a flesh-color, darker above; this faded in preservation to a yellowish white. Surface slightly raised over the position of each zooid; branchial apertures moderately conspicuous, not very close together. Spicules seldom exceeding .05 to .06 mm. in

diameter; they have quite numerous well-formed and regular conical points; the points are short and arise from a large central spherical mass. The individual points have the form of concave-sided cones and are thus rather narrow toward the apex in spite of having a broad base. Bladder cells few in most parts of the colony.

The zooids do not appear to differ materially from those of *T. savignii*, except in being rather small and slender and perhaps also in having somewhat fewer stigmata in the rows.



Figs. 10–12. *Tridemnum solidum* (Van Name), 1902

Fig. 10. Left side of zooid, × 60. Fig. 11. Spicules of type colony from Bermuda, × 460. Fig. 12. Spicules of a colony from Porto Rico, × 460.

Among the Porto Rico material collected by the American Museum expeditions there are two good-sized colonies and one small one which agree well with the type of *T. solidum* from Bermuda in most characters. The larger colony incrusts a convex head of dead coral and would measure, if flattened out, about 130 mm. across and 4 to 5 mm. thick, or in some places even thicker. In its yellowish white color (in alcohol) and in the character of the surface and of the test it closely resembles the Bermuda specimen. The zooids likewise are elongate and slender and have only about eleven or twelve stigmata in a row on each side. Some of them have well-developed reproductive organs similar to those of

T. savignii, described above. The spicules in all the colonies are numerous and closely crowded; they average greater in diameter than those in the Bermuda type of *T. solidum*, sometimes reaching .07 mm. or even .08 mm. across the points. The points are much fewer and longer and slenderer than in the type colony, but quite regular and the spicules have in consequence a very symmetrical stellate form. These Porto Rican specimens were dredged south of Guanica on sandy bottom with coral rocks and algæ, in depths of about 23 and 35 fathoms, and between Cajo Caribe and Cayo Parguera in 5½ to 8 fathoms. The National Museum contains similar specimens (also with rather long-pointed spicules) from the Bahamas, collected by B. A. Bean, 1903, and from Mosquito Bay, St. Thomas, collected by C. R. Shoemaker, also several very large ones from St. John (former Danish W. I.), growing on millepore corals, collected by Mr. Shoemaker. One of these is 250 mm. in maximum length, covering a flattened branch of the coral on both sides and having a maximum width of over 80 mm., but it is not very thick at any point.

This species is evidently closely allied to *T. savignii*, especially to the form *porites*, and its distinctness cannot be regarded as very well established.

Tridemnum orbiculatum (Van Name), 1902

Figures 13–15

1902. *Didemnum orbiculatum* Van Name, Trans. Conn. Acad. Sci., XI, p. 361, Pl. LI, figs. 32, 38; Pl. LXI, figs. 127*a*, 128.

1909–1911. *Tridemnum orbiculatum* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1446, 1633.

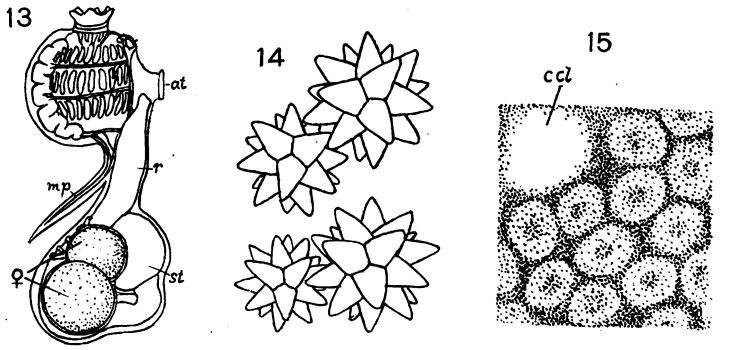
1916. *Didemnum orbiculatum* Pratt, 'Manual Common Invert. Animals,' p. 671.

1921. *Tridemnun orbiculatum* Michaelsen, Arkiv för Zoologi, XIII, No. 23, p. 24.

Colony (in contrast to that of *T. savignii*) always very thin, flat and incrusting, translucent; during life of a characteristic light slate-gray color fading to almost white on preservation. Size of the largest specimens 25 to 30 mm. across and 2 mm. or less in thickness. Surface smooth in fresh specimens; in preserved material often uneven and raised over the positions of the zooids, which are usually quite thickly and evenly distributed, and are more or less concealed by a rather dense layer of spicules in the upper stratum of the colony. The spicules are so distributed that the surface of the colony usually shows over the position of each zooid a circular or oval area of about the diameter of the thorax, more transparent than the intervening spaces, which latter are whiter and more opaque, owing to the greater abundance of spicules there.

Spicules mostly between .035 and .04 mm. in diameter, quite regularly stellate, with a moderate number of rather long points of fairly regular tapering conical form.

Zooids very small, often only 1 mm. long when much contracted. Usually there is much blackish pigment in the cells of the mantle in the thoracic region. Branchial orifice six-lobed; atrial orifice almost plain-edged, without a languet. It is situated either opposite the middle of the thorax, or farther toward the posterior end, and is produced into a very short tube. A strong muscular process extends back into the common test from the constricted middle region of the body.



Figs. 13–15. *Trididemnum orbiculatum* (Van Name), 1902

Fig. 13. Left side of zooid, × 40. Fig. 14. Spicules, × 460. Fig. 15. Part of surface of colony showing distribution of spicules in superficial layer of test, × 15.

Strong sphincters are present about the apertures and many strong longitudinal muscle bands on the thorax, which so contract that part of the body that a satisfactory study of the internal parts becomes very difficult.

There is a total of at least eight tentacles of two sizes; possibly additional smaller ones may be present.

Three rows of stigmata with probably not over eight or ten in a row on each side.

No peculiarities in the alimentary organs were noted; stomach rounded; intestinal loop small.

Although zooids from many colonies collected in April and May were examined, no male reproductive organs were found. (Specimens of *T. savignii* collected at that season usually have them well developed). Many of the zooids, however, contain one or two large eggs in the abdomen.

This species is known only from Bermuda, where it was found common on the under side of large stones at many points along the shore, especially at Long Bird Island, Waterloo, and Castle Harbor, growing in company with other ascidians such as *Didemnum*, *Lissoclinum* and *Botryllus*.

As a considerable number of specimens were obtained, all very constant in their characters and quite different in appearance from *T. savignii* during life and in preservation, it seems likely that this is a valid species in spite of the variability shown to exist in *T. savignii* by the material now available.

The type is in the Yale University collection.

DIDEMNUM Savigny, 1816

[=*Leptoclinum auct. mult.*]

Four rows of stigmata in the branchial sac. Proximal part of the sperm duct wound spirally about the testis. Calcareous spicules present in the test.

Subgenus DIDEMNUM

Atrial orifice not produced into a tube and usually without a languet. Testis single or divided into not more than two lobes or separate glands.

The white or yellowish (sometimes reddish) colonies of animals of this group, which incrust stones, sponges, algæ and other objects, and are often so densely crowded with minute spherical or stellate spicules as to become hard and brittle, are common in many parts of the world. Under the wrongly applied name *Leptoclinum* Milne-Edwards, they are familiar to nearly everyone who has collected marine invertebrates. Their systematic treatment involves many difficulties. The colonies are too opaque to study in a living state, and the zooids are minute and exceptionally hard to preserve except in a violently contracted condition that makes a study of the organs difficult. Such features as the character of the surface of the colony, whether smooth or wrinkled, whether the apertures and the systems in which the zooids are arranged are conspicuous or obscurely visible, or differences in the size of the zooids or in the proportions and shape of their soft parts are not reliable as specific or even varietal characters. Many such apparent differences are due to varying states of muscular contraction or varying degress of shrinkage incident to preservation, or to modifications due to the immediate effect of the conditions under which the colony grew. Differences in the spicules of the colonies exist, but with a large series of specimens at hand such a complete gradation between the extremes is shown that these differences lose most of their weight, and I have been forced to the con-

clusion that most of the members of the subgenus *Didemnum* inhabiting the Atlantic Coast from southern Massachusetts southward to Brazil, including Bermuda and the West Indies, as well as a large proportion of the supposed species described from the warmer parts of the Old World, belong to one variable species. For this the specific name *candidum* Savigny, 1816, appears to have priority. The evidence seems to be increasing that, instead of *Didemnum* being one of the largest genera of ascidians, the members of it which can be distinguished by any reliable and constant characters are in reality few, though in some cases widely distributed geographically.

Didemnum candidum Savigny, 1816

Figures 16–25

1816. *Didemnum candidum* Savigny, 'Mém. s. 1. animaux sans vertèbres,' pt. 2, pp. 14, 194, Pl. IV, fig. 3; Pl. XX, figure 1.

1886. *Leptoclinum speciosum*+*L. s.* var. *asperum* Herdman, 'Rept. Voy. Challenger, Zool.,' XIV, pp. 274, 277, Pl. XXXIV, figs. 8–13; Pl. XXXVI, figs. 1–9.

?1886. *Leptoclinum annectens* Herdman, 'Rept. Voy. Challenger, Zool.,' XIV, p. 280, Pl. XXXIV, fig. 14; Pl. XXXVIII, figs. 5–9.

1891. *Leptoclinum speciosum*+*L. s.* var. *asperum* Herdman, Journ. Linn. Soc. London, Zool., XXIII, p. 631.

1897. *Leptoclinum speciosum* var. *aspera* Sluiter, Zool. Jahrb., Syst., XI, p. 39.

1902. *Leptoclinum speciosum*+varieties, Van Name, Trans. Conn. Acad. Sci., XI, p. 363, Pl. LII, figs. 39, 42–52; Pl. LXI, fig. 127; Pl. LXII, figs. 130c, 132, 134-136.

1909–11. *Didemnum speciosum*+varieties Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1450, 1633, 1634.

1920. *Didemnum speciosum* Michaelsen, Jahrb. Wiss. Anst., Hamburg, XXXVII, suppl., p. 32.

See also Michaelsen, Abhand. Nat. Verein, Hamburg, XXI, pt. 1, p. 23, 1919.

The above list includes only synonyms and references applying to this species as found in the region covered by this paper. See also p. 331.

[The following also belongs to this species but is probably distinguishable as a subspecies or geographical race.

1910. *Didemnum lutarium* Van Name, Proc. Boston Soc. Nat. Hist., XXXIV, p. 371, Pl. XXXVII, fig. 7, text figs. 8, 9.

1909–11. *Didemnum lutarium* Hartmeyer, Bronn's 'Tierr-reich,' III, suppl., p. 1741.

1911. *Didemnum lutarium* Sumner, Osburn and Cole, Bull. U. S. Bureau of Fisheries, XXXI, p. 731; chart 194.

1912. *Didemnum lutarium* Hartmeyer, 'Deutsch. Tiefsee-Exp.,' XVI, p. 326.

For a discussion of the synonyms and distribution of this form see Van Name, 1910.]

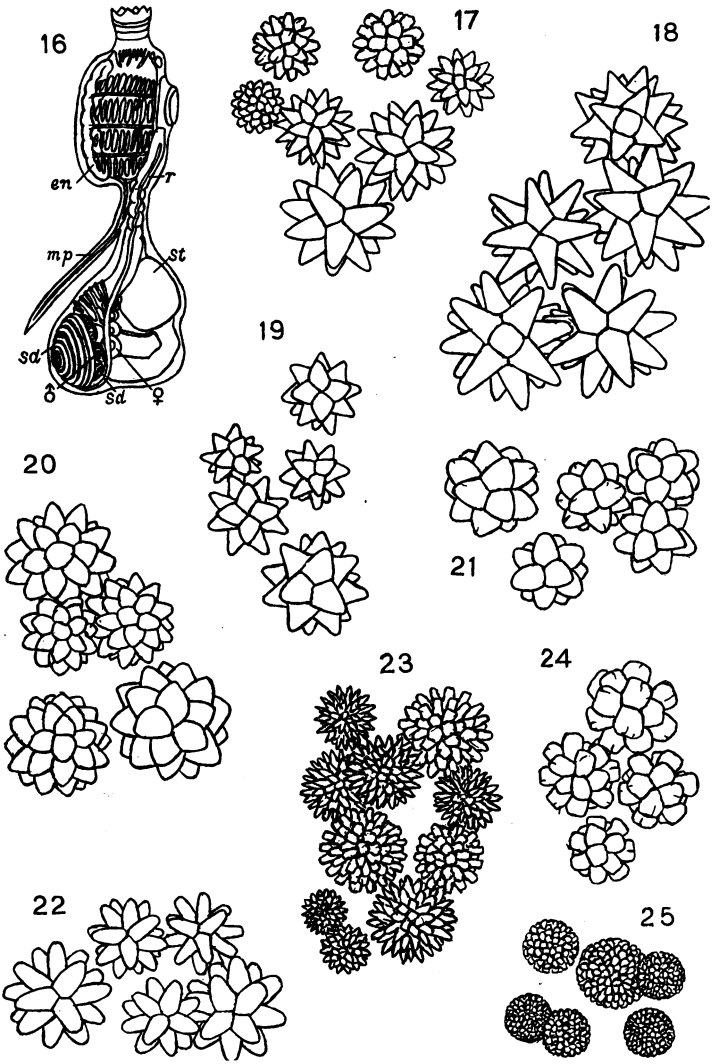
Colony of the incrusting type, usually thin (not over 2 or 3 mm. thick), though sometimes measuring 60 to 70 mm. across or occasionally considerably more. When growing on uneven objects, its thickness in some places may become considerably greater than above stated. This is its usual form of development when growing on a continuous surface as a stone or a shell, but often it grows on an irregular branching object, as a gorgonian, hydroid, or branching sponge. In such cases it surrounds the branches and often binds together or incloses two or more of them. As it grows larger it may finally entirely envelop the object, covering all its branches and assuming more or less its form. Such colonies are intermediate between the usual incrusting form and certain other peculiar ones that at first sight might be taken for a different species. These latter have the form of large rounded or dome-shaped masses with a deeply convoluted and plicated surface penetrated in different directions by numerous clefts, canals and passages of various diameters, giving the colony as a whole a sponge-like character as far as its shape is concerned. There are zooids opening on the walls of the clefts and canals as well as on the outer surface. The National Museum contains such colonies dredged at stations in the Gulf of Mexico in water down to 28 fathoms deep, that measure 100 to 130 mm. in diameter. I regard such colonies as resulting merely from the original attachment of the colony to an object of complex branching form as a hydroid, alga, or perhaps a sponge, which in course of time the ascidian may entirely inclose and kill, the different lobes of the ascidian colony finally uniting where they approach close together but leaving many clefts and canals between them, thus forming the sponge-like colony. Similar forms occur in the Malayan representatives of this genus (see Van Name, 1918, p. 148), and Sluiter (Siboga-Exp., LVI*b*, p. 67) has described a species, *D. spongioides*, on the basis of such a colony-form, a course which does not seem justified.

Color usually white, sometimes very pure white, in other cases yellowish or less frequently reddish; in turbid waters more or less discolored with mud. Borders of the colony varying from thin to thick and rounded, surface very variable, sometimes quite even, in other cases much wrinkled. The surface, if comparatively free from spicules in the extreme superficial part, may be somewhat glossy and smooth to the touch, but any abundance of spicules there renders it a dead white and makes it feel slightly gritty. When the spicules are abundant, the zooids, which are yellow or in parts orange during life, may be entirely concealed, unless their branchial apertures are expanded, but their positions are often indicated by a small, low, rounded elevation over the anterior end of each

zooid. When less abundant the spicules are often chiefly gathered in the upper layers of the colony, leaving the deeper portions of the test yellowish and translucent and the colony comparatively soft. In some colonies the branchial apertures are conspicuous in the preserved condition and each is surrounded by a minute circle of more densely crowded spicules within which the six-lobed character of the aperture is indicated by six minute groups of very small spicules between the lobes. (This is, however, not always demonstrable, and is not peculiar to this species.) Bladder cells are present in the test in varying quantity; their number or distribution does not appear to afford a diagnostic character. The systems in which the zooids are arranged are complex, and except in small colonies a number of common cloacal apertures are present, though in preserved material these are usually by no means easy to demonstrate. Different colonies vary very greatly in respect to the clearness with which these systems and the courses of the common cloacal ducts show on the surface. These features may be very conspicuous, so that the zooids are seen to be arranged in branching and curving lines, or they may be impossible to follow out, the zooids appearing to be merely scattered irregularly in the superficial part of the colony.

The varying abundance and distribution of the spicules, which are of spherical stellate form, have already been noted. It should be added that colonies growing on hard rigid objects (corals, stones, mollusk shells, etc.) usually have the most abundant and uniformly distributed spicules, and become very rigid and brittle, as there is no necessity for any movement or bending of the common test except to permit of the expansion of the zooids. Those growing on soft sponges, flexible plants, etc., which do not provide a rigid and immovable support, are more apt to have the spicules less closely placed, giving a more flexible colony capable of yielding to movements of the supporting surface.

In some colonies the spicules exhibit very striking uniformity in size, in others they are of various sizes, which may be present in varying proportions; occasional abnormally large spicules ("giant spicules") may be found in a few specimens. The usual diameter of the spicules varies in different colonies from .025 mm. (sometimes even less) to about .04 or .05 mm.; rarely more. Commonly there is within a single colony great uniformity in the shape of the spicules, as well as in their size; different colonies, even those growing side by side on the same stone, may differ conspicuously in the type and average size of their spicules. The illustrations here given (Figs. 17–25) show typical groups of spicules from different colonies and illustrate the principal modifications that occur,



Figs. 16–25. *Didemnum candidum* Savigny, 1816

Fig. 16. Left side of zooid, × 40. Figs. 17–25 inclusive, spicules from different colonies, × 460. (Fig. 19 represents spicules of subspecies *lutarium*).

except that there will often be found a greater or less number of imperfect and incompletely formed spicules, some with only slight defects in form, regularity, etc., others so imperfect that their nature is doubtful, and they may be regarded as merely shapeless calcareous deposits. In a majority of the colonies, however, such imperfect spicules are few or wanting almost entirely, and the spicules under magnification present a picture of striking uniformity and regularity in shape and size.

Such spicules as shown in Fig. 18 may be regarded as the typical shape for this species. They have moderately numerous, tapering, conical points or rays, beautifully regular in form and arrangement, but the stoutness of the cones in proportion to their height, the number of points or rays, and the bulk of the solid central mass formed by their bases (or from which they may be regarded as projections) vary in different colonies, though often fairly constant within any single colony. Such spicules are usually from .030 to .045 mm. in diameter.

From this typical form modifications may take place in several directions, as shown in the illustrations, resulting in extreme cases in spicules of quite different appearance. These modifications are apparently often a manifestation of a certain degree of deficiency in the spicule-forming function of the colony or, as suggested by Michaelsen (1919*a*, p. 6), of arrested development of the spicules before they have attained their perfect form.

The chief modifications from the typical form of spicules consist in (1) a blunted or more or less broken condition of the points (Figs. 17, 23, 24) which, when carried to an extreme, results in considerable shortening of the latter and an approach to a knobbed spherical form for the spicule as a whole (Figs. 17, 25); (2) a rounding out of the sides of the cones which may nevertheless remain sharp (Figs. 20, 21); (3) an approach to a cylindrical form in the points or rays, the tips being blunted or rounded (Fig. 22); and (4) in the points or rays becoming weak, slender and needle-like, resulting in a burr-like spicule (Fig. 23). In this last modification the spicules often become much reduced in size. All these various modifications occur in varying degrees and may be accompanied by increase or decrease in the number of rays or components of the spicules, so that a great variety of minor modifications result.

Except in the form treated below as a separate species (*D. fusiferum*) and in one other case I have been unable to connect variation in the spicules with geographical distribution. Colonies with typical or nearly typical spicules are the most numerous; those exhibiting extremes of variation of any kind are less often met with. The modifica-

tions shown in Fig. 23 are, however, quite frequent; when colonies grow under conditions unfavorable for spicule formation, the production of such burr-like spicules (usually small in size and reduced in numbers) seems to be the most common result.

In a previous article (1902) I gave names to several variations of this species that were collected at Bermuda (vars. *bermudense, pageti, hamiltoni, harringtonense, acutilobatum* and *somersi*), but at the present time I cannot regard these as representing true races or subspecies. Herdman's (1886) var. *asperum*—the name *asperum* is antedated by *D. asperum* (Milne-Edwards), 1841—may likewise merely represent an individual variation. *Didemnum lutarium* Van Name, 1910, on the other hand, may have some claims to validity as a subspecies (see below).

In completing this description of the general character of the colony, it should be mentioned that there are occasional colonies, apparently of this species, which for some unexplained reason develop very few spicules in the test, so that the colony remains soft, flexible, semitransparent, and (in the preserved material) of a yellowish or grayish color. The few spicules present are generally in the upper parts of the colonies (sometimes chiefly about the branchial apertures of the zooids) and are of small size and usually of the forms shown in Fig. 23. Such colonies may attain a large size and appear normal in all other respects except in the scarcity and poor development of the spicules, though this deficiency gives them a very different superficial appearance. I have seen such colonies from widely separated localities (Florida, Porto Rico, and South Carolina).

There are also colonies containing large accumulations of dark-colored fæcal pellets in the cloacal canals and cavities and imbedded in the solid test substance. I quite agree with Michaelsen's view (1919*a*, p. 11) that this is merely the result of some abnormal or pathological condition, the water currents being insufficiently strong to carry off this waste material. Its presence in large quantities may greatly alter the appearance of the colonies and make it difficult to realize that they belong to the same species as normal examples, and Sollas, 1903, even went so far as to found a genus (*Hypurgon*) on a colony of one of the common species of *Didemnum* exhibiting the above conditions. (See Michaelsen 1919*a*, p. 11.) That some of the fæcal pellets occur imbedded in the test itself requires no difficult explanation. In the course of the growth and development of the colony certain branches of the cloacal canals cease to be functional because of the death and absorption of the zooids discharging into them. The growth of the test substance closes these

functionless branches and gradually fills their cavities, leaving the deposits of fæcal pellets they contained entirely surrounded by test substance.

When considerably expanded, the zooids may measure 1.6 mm. in total length, even in preserved material, but in most alcoholic specimens they will be found strongly contracted and often not more than 1 or 1.1 mm. long. They have six lobes to the branchial tube; these lobes vary greatly in length and form in different colonies. A tapering muscular process, often of considerable length, extends out into the test from the constricted middle part of the zooid; its development is very variable in different colonies, though often quite constant within the same colony. Atrial orifice round, without a languet. Its border is usually almost flush with the dorsal surface of the thorax; even if slightly raised it is not produced sufficiently to form a tube.

In adult zooids there are generally sixteen tentacles representing three orders (4+4+8), but one or two of the large ones may exceed the others in size and the small tentacles do not appear to be always developed.

Dorsal languets borne on the transverse vessels of the left side of the branchial sac a little removed from the median dorsal vessel.

Stigmata in four rows; twelve on each side was the maximum number demonstrated in a single row; in many cases the number in a row does not appear to be so large, about ten in the anterior rows and as few as eight in the posterior row.

Stomach rounded; ascending part of the intestine surrounded by a branching glandular organ composed of from five to ten thin-walled tubules which unite to form a duct opening into the proximal part of the intestine just beyond the pylorus. One or more valvular constrictions may be present in the intestinal loop; their presence does not seem to be a constant character.

Testis sometimes cleft into two more or less completely or almost completely separated lobes or distinct glands, but oftener it is undivided. I have never observed it cleft into three lobes or glands. The sperm duct usually makes six or eight spiral turns about the testis. Ovary consisting of a few eggs situated in the region between the stomach and testis.

This species ranges on the American coast from the Isles of Shoals off the coast of New Hampshire (though it is local or rare north of Cape Cod) to Bahia, Brazil (Herdman, 1886), including Bermuda, and is in many parts of the West Indian region the commonest of the littoral and shallow-water ascidians, and the species that in a miscellaneous collection will usually be most numerously represented. Almost all the speci-

mens in the collections studied are from shallow water (low water to 28 fathoms), but the National Museum collection contains a few specimens from deeper water, 98 to 201 fathoms (see below) that appear to belong here.

It is abundant at Bermuda, on both coasts of Florida and in the comparatively shallow water of the eastern part of the Gulf of Mexico, and at Porto Rico (south coast). Other localities are the Bahamas; St. Thomas (on piles); off Cape San Antonio, Cuba; Montego Bay, Jamaica; Colon, Panama. Specimens from along the coast of the United States between Florida and Long Island, N. Y., are few. The National Museum collection, however, contains colonies from Winyah Bay, South Carolina, and from Stations 2617, Steamer Albatross (33° 37′ 30″ N., 77° 36′ 30″ W., 14 fathoms) and 2619 (33° 38′ N.; 77° 36′ W., 15 fathoms); also from Hampton Roads, Virginia. On the coasts of Long Island, N. Y. and southern New England it again becomes common; the specimens from this region appear to represent a slightly distinguished northern race or subspecies described originally as a species, *D. lutarium* Van Name, 1910. This race was for a long time confused by Verrill and others with *D.* (*Tetradidemnum*) *albidum* (Verrill), 1871, a totally different arctic and subarctic species whose range overlaps that of the present one on the New England coast. The New England subspecies or race (*lutarium*) is characterized by rather small spicules (in many colonies only .02 to .025 mm. or less in diameter), with rather short, though well-formed, conical points, rounded off at the extreme tip (Fig. 19); rather small zooids; and, in contrast to the great variability exhibited by Florida, Bermuda and West Indian specimens, by a considerable degree of constancy in the above characters. On the coasts of the Southern States it appears to grade into the typical form.

Specimens of this species from deeper water were collected by the Steamer Albatross and Fish Hawk at the following Stations: Station 2387, 29° 24′ N., 88° 04′ W., 32 fathoms, sand, gravel, and broken shells; Station 2147, 9° 32′ 20″ N., 79° 54′ 45″ W., 34 fathoms, coral; Station 7511, Gulf Stream off Cape Florida, 45 fathoms, rocky; Station 2159, 23° 10′ 39″ N., 82° 20′ 08″ W., 98 fathoms, coral; Station 2168, 23° 10′ 36″ N., 82° 20′ 20″ W., 122 fathoms, coral; Station 2323, 23° 10′ 51″ N., 82° 19′ 03″ W., 173 fathoms, coral; Station 2264, 37° 07′ 50″ N., 74° 34′ 20″ W., 167 fathoms, gray sand; Station 2167, 23° 10′ 40″ N., 82° 20′ 30″ W., 201 fathoms, coral. Most of these deeper stations are so located that the bottom temperature cannot have been very low.

It grows on any kind of bottom affording objects to attach itself to, and is often found on other ascidians. Two colonies (apparently of this species, though containing very few and small spicules) covered the backs of crabs, probably *Dromidia antillensis*, found on piles of the railroad wharf at Montego Bay, Jamaica.

Savigny's type of this species was from the Red Sea. Material from that region has recently been studied and described in detail by Hartmeyer, 1916, p. 419, and Michaelsen, 1919a, p. 18, and there seems to be no sufficient reason for maintaining the American form distinct from it. I believe that the species is very widely distributed in the Indian Ocean and Malay region, and that a number of the supposed species that have been described from those parts of the world must be united with it. The Philippine form *D. grande* (Herdman), 1886, (see also Van Name, 1918) is among those probably synonymous. Michaelsen (1919a, p. 18) would also unite specimens from the region of the Straits of Magellan with Savigny's form. If no distinguishing character can be discovered, the justification for this course must be admitted, although the occurrence of a more or less decidedly tropical form in a region of such cold water is hardly what would be expected. I must, however, differ most decidedly with him in his proposal (*loc. cit.*, p. 23) to separate the Bermuda Didemnums from the other tropical American ones and unite them with *D. studeri* Hartmeyer, 1911 (type from Kerguelen Id.), apparently merely because they often have the testis divided into two parts. That is an individual peculiarity which occurs also in some West Indian and New England specimens and does not appear to be of importance. But, even if it were so, the fact that *D. studeri* commonly, if not normally, has a three-parted testis, a condition I have never observed in the many West Indian and Bermuda colonies I have examined, would seem to exclude identity with that antarctic and sub-antarctic species, aside from the improbability of it on account of climatic reasons.

Didemnum fusiferum, new species

Figure 26

In dealing with the species just described, instances of colonies with poorly developed spicules were noted. In such specimens the spicules are generally below the normal both in respect to number and size and in the development of their rays or points, which may deviate from the normal conical form in either of two principal ways, by being irregularly blunted and shortened, or by becoming slender and less regular (sometimes needle-like) and very numerous, resulting in a burr-like, rather

than a stellate, spicule. Either of those modifications, if carried to an extreme, results in a nearly spherical spicule whose true character is visible only by considerable magnification.

The National Museum collection, however, contains some specimens from the Gulf of Mexico having spicules of a totally different character, a considerable proportion of them being fusiform, that is, composed of two cones placed base to base. Such may be regarded as two-rayed spicules. In the same colonies are other spicules composed of four, six, eight, or more such conical points; when these points are sufficiently numerous the spicule approaches the usual stellate form.

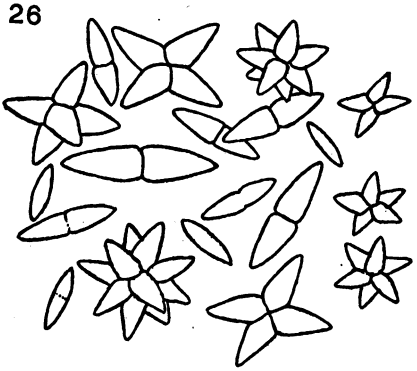


Fig. 26. *Didemnum fusiferum*, new species
Spicules, × 460.

I have been at a loss as to how to deal with these specimens. They may represent merely another of the endless variations of *D. candidum*, but, if so, the deviation of the spicules from the usual type is not of the nature either of arrested development or degeneration, since the points, even when only two or four in number, are commonly perfectly formed. The occasional occurrence of similar spicules in *Didemnum japonicum* (Herdman), 1886 (p. 302, Pl. XXXIV, figs. 1–7), is recorded, though most of the spicules in that form are of the usual stellate type.

Colony of the incrusting type, in some parts quite thin (3 mm. or less) but sometimes becoming thick and massive, especially when growing upon irregularly shaped objects. Several large colonies from off Cedar Keys, Florida, growing on branching gorgonians, surround their branches, and where the latter are near together envelop and bind together two or more of them in the test, which becomes very thick and massive (sometimes over 30 mm. thick, where there are zooids on all aspects). One of these irregularly lobed and extended colonies measures

not less than 220 mm. by 125 mm. in its greatest dimensions. The free edges are for the most part thick and rounded.

Test in alcohol of the usual yellowish color, not pigmented, translucent; the more opaque but light-colored zooids are visible through it and are arranged along complex branching and anastomosing common cloacal canals, which in the preserved (but probably not in fresh) material are often rendered still more conspicuous by furrows on the surface. The apertures are not conspicuous in any of these specimens.

Spicules generally too few to have much effect on the transparency or consistency of the test; they are irregularly distributed, chiefly in the upper parts of the colonies, and are entirely wanting in most parts. Their peculiar forms (Fig. 26) have been already described; in size they present nothing unusual, the larger ones averaging only from .02 to .03 mm. in diameter from point to point. Among the perfectly formed spicules are also imperfectly or incompletely formed ones, and also crystalline and irregular deposits of calcareous material, which may much exceed the true spicules in number and bulk.

Zooids fairly large, 1.25 mm. or more long when only moderately extended. They agree too closely with those of *D. candidum* in their characters to require separate description or illustration. The muscular process extending into the test is long and well developed; the testis, as in *D. candidum*, may be either single or distinctly cleft into two divisions.

The specimens are all from off the west coast of Florida. The type and also several other colonies (or perhaps fragments of the same colony) are from Station 7147, Steamer Fish Hawk (29° 52′ 10″ N., 83° 51′ 47″ W., 3 fathoms, sand and coral); some large colonies (see above) were collected in the vicinity of Cedar Keys, Florida, by the Steamer Bache, in February 1887, probably also in water several fathoms deep.

Subgenus **Polysyncraton** (Nott), 1891

Differs from the typical subgenus of *Didemnum* in having the testis divided into several entirely separate glands, disposed in a circular group, about which the sperm duct coils. The typical species (including the West Indian form) have an atrial languet.

Didemnum (Polysyncraton) amethysteum (Van Name), 1902

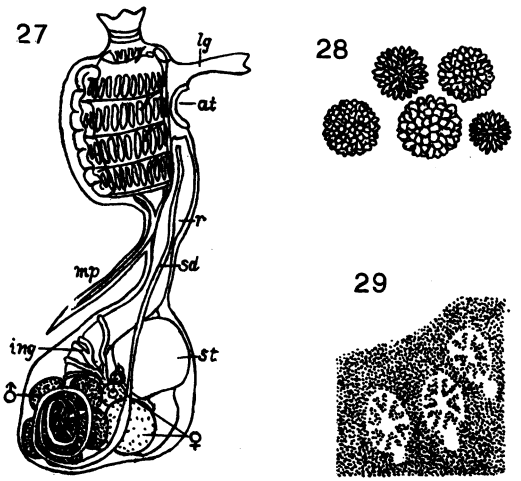
Figures 27–29

1902. *Polysyncraton amethysteum* Van Name, Trans. Conn. Acad. Sci., XI, p. 366, Pl. LIV, figs. 62, 64–67; Pl. LVIII, fig. 102.

1909–11. *Polysyncraton amethysteum* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1452.

1912. *Polysyncraton amethysteum* Hartmeyer, 'Deutsch. Tiefsee-Exp.,' XVI, p. 325.

The colonies in this species are of the flat, incrusting type; the upper surface is nearly smooth and even, the thickness of the colony is about 3 mm., and the greatest diameter rarely over 25 or 30 mm. In spite of their small size, they are during life of striking appearance. The test is transparent and of a handsome purple or rose-purple tint which fades to yellow on preservation. The color is due to pigment in the test cells. The zooids during life are bright red. The upper surface-layer of the colony contains a layer of small white burr-like or almost spherical spicules, but small oval areas about the branchial apertures of the



Figs. 27–29. *Didemnum* (*Polysyncraton*) *amethysteum* (Van Name), 1902

Fig. 27. Left side of zooid, × 40. Fig. 28. Spicules (all from same colony), × 460. Fig. 29. Part of surface of colony showing distribution of spicules in superficial layer of test, × 11.

zooids and a large central area on the upper surface of the colony surrounding the common cloacal aperture (there appears to be usually but one) are without spicules, except that in the small areas about the branchial orifices there are six small V-shaped groups of them corresponding to the intervals between the six lobes of the branchial tubes. The deep purple of the exposed areas of the test, with the contained brightly colored zooids, often shows in a strong contrast to the pure white of the spicule-covered portion. The layer of test containing the spicules may readily be stripped off. Spicules always small, .015 or .02 mm. in diameter or even less, with short and often more or less blunted rays, so numerous that the spicule appears nearly spherical except under high magnification.

Zooids about 1.5 mm. long when well expanded. Body strongly constricted between thorax and abdomen; a tapering muscular process extends ventrally and posteriorly out into the test from the constricted part of the body. Branchial aperture six-lobed, atrial plain, with a languet at its anterior border. This languet is, in well-expanded zooids, fairly long and wider toward the end, where it is slightly forked. In strongly contracted individuals it is merely a small tongue-like projection.

Well-developed longitudinal muscle bands present on the thorax.

Tentacles at least eight in number, additional smaller ones are probably present.

The dorsal languets apparently arise from the transverse vessels of the left side, but the sac was too much contracted in the specimens studied to determine this satisfactorily.

Stigmata in four rows; apparently about a dozen in a row on each side.

Male reproductive organs consisting of a group of about five or six radially disposed, pear-shaped testes, whose narrow ends are connected with the origin of the common sperm duct by very short individual ducts. The common sperm duct makes about five loose spiral turns about the whole group before accompanying the distal branch of the intestine. Ovary between the testis and stomach. Eggs very large when fully grown.

This species is moderately common at Bermuda on stones along the shore and in other shallow situations. I have also found it growing on calcareous algæ on the banks near Soldier's Key, Biscayne Bay, Florida.

The type (from Bermuda) is in the Yale University collection.

LEPTOCLINUM Milne-Edwards, 1841

[= *Diplosoma* MacDonald, 1859. Proposed *nomen conservandum*, *Diplosoma*]

In this genus there are four rows of stigmata, the testis is divided into two separate glands, and the sperm duct is not spirally coiled. No atrial languet or atrial tube is developed and the test is without spicules. Usually the common cloacal cavities are greatly developed.

Leptoclinum macdonaldi (Herdman), 1886

[*Diplosoma macdonaldi* under proposed system of *nomina convervanda*]

Figure 30

1886. *Diplosoma macdonaldi* Herdman, 'Rept. Voy. Challenger, Zool., XIV,' p. 315, Pl. XLII, figs. 1–4.

1891. *Diplosoma macdonaldi* Herdman, Journ. Linn. Soc. London, Zool., XXIII, p. 633.

1898. *Diplosoma macdonaldi* Gottschaldt, Abh. Senckenb. Gesell., XXIV, p. 657.
1902. *Diplosoma macdonaldi+D. lacteum+D. atropunctatum* Van Name, Trans. Conn. Acad. Sci., XI, pp. 368–370, Pl. LIII, figs. 56, 59, 60; Pl. LVIII, fig. 103; Pl. LX, fig. 124; Pl. LXII, fig. 137.
1909–11. *Leptoclinum macdonaldi+L. lacteum+L. atropunctatum* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1454, 1455, 1633, 1634, 1645.
1918. *Leptoclinum macdonaldi* Van Name, Bull. U. S. Nat. Mus., No. 100, I, p. 159, fig. 109.
1920. *Diplosoma macdonaldi+D. lacteum+D. atropunctatum* Michaelsen, Jahrb. Wiss. Anst., Hamburg, XXXVII, suppl., p. 71.

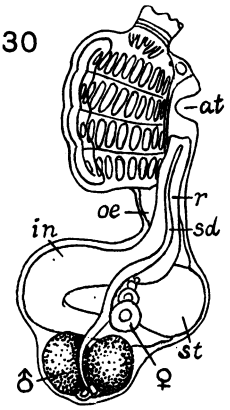


Fig. 30. *Leptoclinum macdonaldi* (Herdman), 1886
Left side of zooid, × 48.

Colony thin and incrusting, rarely much over 2 mm. thick, but sometimes 50 mm. or more across. (One specimen surrounds a blade of turtle grass for a length of 138 mm.) Test transparent and colorless in life, sometimes suffused with milky white which commonly disappears on preservation. The zooids are clearly visible through the test and often quite conspicuous as small, irregularly distributed, blackish objects, since they usually have more or less black pigment in the mantle cells about the branchial tube and on the surface of the abdomen. Their tissues are otherwise light colored, except that the stomach and part of the intestinal loop are yellow or orange during life, fading out in preservation.

Common cloacal cavities very extensive, though developed to a varying degree in different colonies; in extreme cases the entire interior of the colony may be hollow, except for columns or trabeculæ of test substance in which the zooids are imbedded. Large and conspicuous, pale yellowish, oval cells are often present in the test substance; they are perhaps symbiotic vegetable cells.

Zooids very small; their apparent length is further diminished by the fact that the axis of the abdomen is usually bent at right angles to that of the thorax, so that they often average only .8 or .9 mm. long in the preserved colonies, but when moderately expanded and straightened out they may measure 1.5 or 1.6 mm. in total length. As seen from the surface of the colony, the branchial apertures appear round or oval, without lobes, but the usual six lobes are slightly developed on the branchial tube and are often visible within the circular exterior orifice. No atrial tube or atrial languet; the atrial opening is large and plain-

edged; no muscular process from the constricted middle part of the body, but one or two vascular processes may extend from this part of the body. Mantle musculature insignificant.

Tentacles twelve, of three sizes, regularly arranged.

Dorsal languets apparently long and narrow; very difficult to demonstrate.

Four rows of stigmata with about ten in a row on each side.

Stomach rounded, smooth-walled, intestine of rather large diameter. I have not succeeded in demonstrating in this genus the glandular tubules clasping the intestine, which are so conspicuous in *Didemnum* and *Tridemnum*.

Testis consisting of two large oval glands lying beside the intestinal loop (the lateral bending of this loop brings them, however, to the extreme posterior end of the body). They are connected with the proximal end of the common sperm duct by short individual ducts. The common sperm duct does not coil about the testis. Female reproductive organs represented by one or more eggs beside the intestinal loop.

The additional material now available comprises specimens intermediate in character between this species, *L. lacteum* and *L. atropunctatum*, and in the present paper all three are united under Herdman's name *macdonaldi*.

This is a common and widely distributed animal, ranging from Bermuda and South Carolina (Blackfish Banks off Charleston, specimen in National Museum) to Bahia, Brazil, the locality of Herdman's type. I have collected it at Bermuda in shallow water and the American Museum expedition obtained it in Guanica Harbor and at several points off the southern coast of Porto Rico in depths from 6 to 8 fathoms. In the National Museum collection it is also represented by many specimens dredged off the west coast of Florida from Cedar Keys to the vicinity of Key West, in depths down to 27 fathoms, and by specimens from Charlotte Harbor, Florida; Jamaica, W. I.; and St. Thomas, W. I., (shore). Hartmeyer (1909–1911, p. 1629) reports a *Leptoclinum*, very probably this species, from Tortugas, Florida, and West Indian localities. It appears, moreover, to be much more widely distributed, since what seems to be the same species occurs in the Malay Region (Ternate and the Philippines); see Gottschaldt, 1898, and Van Name, 1918.

It appears to grow more commonly on corals, gorgonians, sponges, and other ascidians in water at least a few feet deep than near low-water mark, perhaps because its delicate structure is not adapted to withstanding either exposure to the air or to strong waves.

LISSOCLINUM Verrill, 1871

[=*Diplosomoides* Herdman, 1886]

Similar to *Leptoclinum* in general characters, but with stellate calcareous spicules in the test. Four rows of stigmata, testis partially or completely divided into two or more glands or lobes; sperm duct not coiled, atrial orifice with a languet.

Lissoclinum fragile (Van Name), 1902

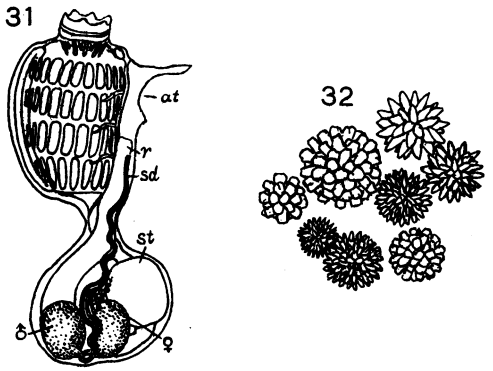
Figures 31 and 32

1902. *Diplosomoides fragile* Van Name, Trans. Conn. Acad. Sci., XI, p. 370, Pl. LIII, figs. 57, 58; Pl. LXI, fig. 126.

1909. *Diplosomoides molle* (part) Sluiter, 'Siboga-Exped.,' LVI*b*, p. 85.

1909–1911. *Diplosomoides fragile* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1546, 1633.

1912. *Diplosomoides fragile* Van Name, Proc. Boston Soc. Nat. Hist., XXXIV, p. 389.



Figs. 31 and 32. *Lissoclinum fragile* (Van Name), 1902

Fig. 31. Left side of zooid, branchial sac well expanded, × 36. Fig. 32. Spicules (all from same colony), × 460.

This animal forms very thin, flat, incrusting colonies, often of considerable extent (60 mm. to 80 mm. across), but only 2 to 3 mm. thick. Living specimens collected at Bermuda were easily recognizable by two characters; first, their snowy whiteness without the least tinge of yellowish (though preserved specimens become somewhat yellowish) and, second, by their very fragile character. The test breaks or tears at the slightest touch, and the colony cannot readily be removed entire from the surface on which it grows. The white color is due to the spicules that densely crowd the test and conceal the zooids, which are yellow or orange during life. The spicules are minute (usually not more than .02 to .023 mm. in diameter) and stellate or burr-like in form, built up of

very numerous rays which may end in sharp points, but are more often truncated or broken at the tips (see Fig. 32). The rays or points are so short and numerous that under low magnification the spicules appear nearly spherical. The fragile character of the colony is in part due to the brittleness of the test, caused by the great abundance of spicules, but still more to the very extensive development of the common cloacal cavities which commonly reduce the test substance to two thin layers forming the upper and lower surface of the colony respectively, and to small masses or trabeculæ connecting these two layers. In these trabeculæ the bodies of the zooids are contained. The colony thus consists of extensive systems, whose cloacal cavities are more or less confluent. The apertures of the zooids are usually quite conspicuous on the surface of the colony, which is fairly smooth though not glossy during life, but becomes much wrinkled through the collapse of the common cloacal cavities in preserved specimens.

Zooids about 1.5 long when fairly well expanded. They have the branchial aperture six-lobed; the atrial is provided with a languet. No muscular process extending out into the test is developed.

Mantle musculature and muscles of the branchial sac very weak.

Tentacles slender, of at least two sizes.

Dorsal languets difficult to demonstrate.

Branchial sac large, with four rows of large stigmata; probably about ten or eleven in a row on each side.

Intestinal loop small; stomach very thin-walled, so that it becomes folded in preservation, but it is probably round and smooth-walled during life.

Male reproductive organs consisting of two large oval testes beside the extreme posterior part of the intestinal loop. Their short individual ducts unite to form a stout common duct which accompanies the ascending or distal branch of the intestinal loop without making any spiral turns about the testes. The ovary, a small group of eggs, lies beside the common sperm duct a little from its origin.

This species was found common at Bermuda at a number of stations along the shore, growing on the under side of stones near low water. The only other locality is St. Thomas, W. I., where some good-sized colonies were collected by Mr. C. R. Shoemaker in 1915 (National Museum collection) growing on ascidians (*Phallusia hygomiana*), on piles, and elsewhere in shallow water ($\frac{1}{2}$ to $2\frac{3}{4}$ fathoms). Sluiter (1909) has expressed the belief that this species is not distinct from the Malayan species, *Diplosomoides molle* Herdman, 1886, originally described from the Aru

Islands, but his conjecture does not seem to be based on any actual comparison of material. That species is reported to form habitually dome-shaped colonies with a large common cloacal aperture at the summit and, considering the widely separated localities of the two species, the question should be left open for the present.

The atrial languet does not appear to be present in immature zooids and, even in fully adult ones, it is very easily torn off in dissecting out the zooid for examination. The original description and figure gave it as wanting. The demonstration of its presence appears to remove the reason for considering *Diplosomoides* Herdman, 1886, as a genus distinct from *Lissoclinum* Verrill, 1871.

ECHINOCLINUM Van Name, 1902

This genus is closely related to *Lissoclinum* and *Leptoclinum* and perhaps better regarded as a subgenus of the former, though at once distinguishable from it by the peculiar form and arrangement of the spicules described below, and it is hardly necessary to add that I most decidedly oppose Michaelsen's (1915, p. 481) proposal to remove it to the Clavelinidæ or to regard it as in any way intermediate between that family and the present one, although the material available has unfortunately not proved favorable for a study of its budding.

The following is the only known species.

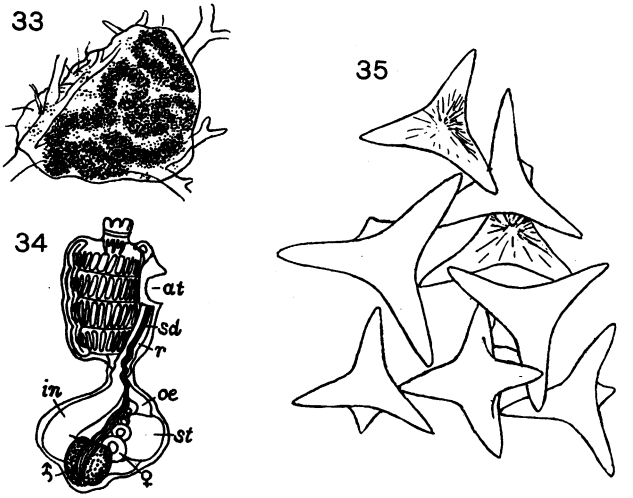
Echinoclinum verrilli Van Name, 1902

Figures 33-35

1902. *Echinoclinum verrilli* Van Name, Trans. Conn. Acad. Sci., XI, p. 372, Pl. L, figs. 23-25.
1907. *Echinoclinum verrilli* Seeliger, Bronn's 'Tier-reich,' III, suppl., p. 1236.
1908. *Echinoclinum verrilli* Hartmeyer, Zool. Annal., III, p. 44.
1909-11. *Echinoclinum verrilli* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1452, 1630, 1633.
1915. *Echinoclinum verrilli* Michaelsen, 'Beitr. Meeresfauna Westafrikas,' I, p. 481.

Colony of the flat incrusting type but usually rather thick, with the upper surface generally smooth but uneven. It attains a considerable size, one specimen from near Key West, Florida, measuring 125 mm. by 95 mm. across and averaging at least 5 or 6 mm. in thickness (at some points considerably more). Zooids arranged in systems often of considerable extent and complexity. In large specimens the zooids can often be seen to be in double rows, between which run the common cloacal canals; these branch and anastomose in a net-like manner, leaving in the meshes islands of completely inclosed areas of test, bordered by the rows

of zooids, but free from zooids in their central portions. In the preserved material these inclosed areas of solid test shrink less than the parts of the surface where the zooids and cloacal canals are situated, and often stand out as low, rounded elevations, separated by distinct furrows representing the ramifications of the systems. This may, however, be largely an artificial condition; at least it must be much less conspicuous in living, expanded material. Test colorless or somewhat yellowish and transparent in preserved specimens. No notes on its colors during life. Common cloacal cavities not extensive. Test tough externally, softer and



Figs. 33–35. *Echinoclinum verrilli* Van Name, 1902

Fig. 33. Colony (type) growing upon a branching seaweed, × 2. Fig. 34. Left side of zooid, × 36. Fig. 35. Spicules, × 230.

more gelatinous within, except immediately about the zooids where most of the spicules are located. There it forms a tough membranous investment around each zooid from which it is very difficult to remove the latter, especially as the test adheres very strongly to the bodies of the zooids about the atrial aperture and at a point on each side of the thorax near its posterior end where there is a deep depression in the wall of the thorax that unquestionably represents the "Seitenorgan" of Michaelsen (see p. 313). The test, especially the above-mentioned tough layer, contains many large, yellowish, irregularly oval cells with refractive globules in the cytoplasm. The spicules are peculiar, having the form of tetrahedrons whose four apices are produced into somewhat elongated points. These spicules are mostly so placed about the bodies of the zooids

that they form a spiny capsule about them, one of their four points projecting radially outward. Similar spicules are also scattered in other parts of the test, sometimes in considerable abundance, especially in the superficial layer of the colony. The larger spicules measure up to about .10 to .14 mm. from point to point, but there are many smaller ones. Some of the specimens contain additional calcareous matter deposited in the test in irregular granular or semicrystalline form; in one specimen the spicules have acted as centers for the disposition of such material to an extent that conceals their original form.

Zooids small, often less than 1 mm. long in the strongly contracted preserved condition. Branchial aperture six-lobed, atrial a large plain-edged opening whose anterior margin may be a little produced, but hardly enough to be termed a languet. No muscular process extending out into the test was observed.

The tentacles and dorsal languets were visible with difficulty in the contracted specimens; there are at least two sizes or orders of tentacles.

Branchial sac with four rows of stigmata, probably nearly a dozen in a row on each side.

Stomach rounded and smooth-walled externally, though slightly ridged in a longitudinal direction internally.

The ovary, consisting of a small cluster of eggs, is situated beside the ascending part of the intestinal loop. The male organs consist of a rather large, rounded testis beside the posterior or transverse part of the intestinal loop. The testis is partially divided by a deep groove extending across its outer aspect. The large, stout sperm duct arises from the posterior border of the gland and lies in this groove; it then extends to and accompanies the intestine to near its end. It is not spirally coiled.

This species was originally described from three small specimens collected at Bermuda in 1898 by Professor A. E. Verrill. Hartmeyer (1909–1911) reported it from Tortugas, Florida. The National Museum collection contains a number of colonies, some of them of considerable size, all dredged in the vicinity of the Florida Keys in three to eleven fathoms except one (also from southern Florida) which is attached to a blade of turtle grass and hence evidently came from very shallow water. One of the specimens covers the back of a small maioid crab, which it much exceeds in size.

Polycitoridæ Hartmeyer, 1915

[=Polycitoridæ+Clavelinidæ *auct. plur.*]

Compound ascidians having the body consisting of two parts (thorax and abdomen) joined by a constricted part or neck usually rather long. The buds form on vascular processes or stolons (often of considerable length) arising from the posterior

end of the abdomen of the parent. Dorsal lamina represented by separate languets. Reproductive organs in the abdomen (or in a diverticulum of it) on or near the loop formed by the intestine.

POLYCITOR Renier, 1804

Genus including forms with many rows of stigmata, and a plicated stomach wall (constituting the subgenus *Polycitor*) and those with but three or four rows of stigmata and a globular stomach, always smooth-walled, which constitute the subgenus *Eudistoma*. To this latter group the species here included in the genus all belong.

Subgenus EUDISTOMA Caullery, 1908

See above, under *Polycitor*.

Polycitor (Eudistoma) olivaceus (Van Name), 1902

Figure 36

1902. *Distoma olivaceum* Van Name, Trans. Conn. Acad. Sci., XI, p. 344, Pl. XLVIII, fig. 9; Pl. LIX, fig. 113.
1909. *Distoma olivaceum* Caullery, Bull. Sci. France et Belgique, XLII, p. 43.
1909–1911. *Polycitor (Eudistoma) olivaceus* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., p. 1432.
1915. *Polycitor olivaceus* Michaelsen, 'Beitr. Meeresfauna Westafrikas,' I, p. 66.

The usual form of the colony in this species is a group of numerous, small, somewhat flat-topped heads of circular outline, with fairly abrupt sides which contract toward the base into a rather thick peduncle. The several peduncles expand and unite into a basal mass by which the colony is attached. These heads are usually only 5 to 8 mm. across and 8 to 10 mm. high, or often much smaller, but many may be united into one colony. The color in life varies from olive-green or yellowish olive to olive-brown, often more or less blackish on the upper surface. The color holds fairly well in alcoholic material.

Upper portion of colony smooth and shiny, free from incrusting or imbedded sand; the basal parts and peduncles contain sand grains and are often covered with an outside layer or pellicle densely crowded with fine sand. This pellicle, however, usually ends abruptly at the top of the peduncle. Test gelatinous and semitransparent, in spite of its dark coloration which is in part due to pigment contained in the test cells.

Zooids rather elongate, often 3.5 to 4 mm. long in the considerably contracted preserved condition. They are light-colored, with the stomach and parts of the intestinal loop orange during life. The mantle, especially on the anterior part of the thorax, is dotted with blackish pigment, sometimes to a very conspicuous extent; in other cases there is very little such pigment. In many colonies the regions over the ganglion and anterior end of the endostyle are much more deeply pigmented than

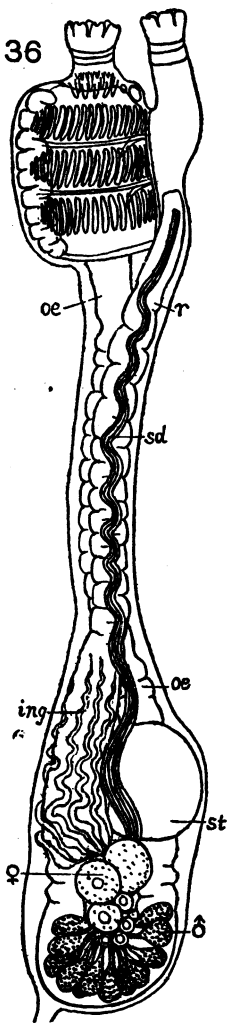


Fig. 36. *Polycitor* (*Eudistoma*) *olivaceus* (Van Name), 1902
Left side of zooid, × 32.

any other part, so that these areas show from the outside of the colony as black dots on the otherwise light-colored zooids. Both apertures on tubes, the atrial usually the longer. Branchial aperture with six or seven, the atrial with six lobes.

Mantle musculature strong on the thorax, where it consists of many stout longitudinal bands and underlying transverse fibers. On the abdomen the long bands spread out and gradually become weak. They disappear near the posterior end of the body.

Tentacles of three sizes, apparently normally thirty-two in number, the small ones inserted a little nearer the branchial aperture than the larger ones.

Dorsal languets long and narrow.

The more extensive and better material now available shows that there are but three, instead of four, rows of stigmata in the branchial sac and that the original description and figure are wrong in that particular. The number of stigmata in a row is at least sixteen on each side; possibly several more.

Intestinal loop long and narrow; stomach large, globular and smooth-walled. Intestinal gland consisting of a number of thin-walled parallel tubules which at their posterior ends unite to form a common duct in the usual manner. They lie upon the external wall of the ascending part of the intestine near where it passes the stomach and, after running forward some distance along the intestine, each tubule tapers off and ends in a narrow point without branching. These tubules may, when the intestine is well extended, have a nearly straight course, but usually they are more or less sinuous and probably remain so even during the maximum extension of the intestine that normally occurs.

Reproductive organs beside the intestinal loop (more or less on the left side of the body according to the amount the intestine is twisted). Testes small, oval or pear-shaped, usually eight to twelve in number in

the specimens studied. They communicate with the origin of the large, thick-walled common sperm duct which accompanies the distal branch of the intestine by small delicate individual ducts. Ovary situated beside the testes.

This species is common and widely distributed in shallow water, growing especially on mangrove roots and on corals, etc., at or near low-water mark. Bermuda is the type locality (type in Yale University collection); it is represented in the collection of the American Museum by specimens from Andros Island, Bahamas; Porto Rico (mangrove roots in Guanica Harbor); Florida (Biscayne Bay on banks near Soldier's Key, and from the west shore of Plantation Key); and Cuba (Cayo Christo near Isabella on the north coast, 3 to 4 feet). In the National Museum collection there are specimens from several points on or near the west coast of Florida (depth given in one case only, Marco, Florida, 1 to 2 fathoms) and from St. Thomas, W. I. (shore).

There are also in this collection several colonies from Cedar Keys, Florida, and from Station 8269, Steamer Fish Hawk (Wingate Bay, South Carolina, 5 fathoms) that appear to belong to this species, but have the entire heads, which are narrow but of the usual height, very densely incrusted with sand. Sand also occurs to a greater or less extent in the interior of the test.

Polycitor (Eudistoma) olivaceus form **obscuratus** (Van Name), 1902

1902. *Distoma obscuratum* Van Name, Trans. Conn. Acad. Sci., XI, p. 343. Pl. XLVIII, fig. 11; Pl. LVIII, figs. 105, 106.

1909. *Distoma obscuratum* Caullery, Bull. Sci. France et Belgique, XLII, p. 43.

1909–1911. *Polycitor (Eudistoma) obscuratus* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1432, 1633.

The status of this species must be regarded as so doubtful, and its relationship to *P. olivaceus* so close, that it seems best to treat it as a form of the latter; possibly the colonies are merely abnormally shaped and colored examples of that species, yet they are certainly of very different appearance. It was described on the basis of two specimens in the Yale University Museum collected on corals in rather shallow water in Castle Harbor, Bermuda. They are of flattened, incrusting form, 20 to 30 mm. across and 3 to 4 mm. in thickness, with rounded edges. Test firm, with a smooth glossy surface free from adherent matter; common cloacal apertures appear to be present. Color uniform black (with a greenish tinge while alive) due to numerous pigment cells in the test and on the mantle of the zooids, where they are so abundant that the entire thorax is black.

In size and characters the zooids resemble those of the typical *P. olivaceus*. The tubules of the gland surrounding the intestine are exceedingly crooked, and somewhat swollen in their proximal portion, but a careful examination discloses that their distal parts ascend upon the wall of the intestine and taper off as usual in *P. olivaceus*, and that the original figure does not show this character correctly.

The National Museum collection contains two small flattened black colonies that also appear to be of this form; their test contains some sand grains. These specimens are from Drift Bay, Water Island (in the former Danish West Indies), and Tortugas, Florida, respectively.

Polycitor (Eudistoma) convexus (Van Name), 1902

1902. *Distoma convexum* Van Name, Trans. Conn. Acad. Sci., XI, p. 342, Pl. XLIX, fig. 16; Pl. LVIII, fig. 104; Pl. LIX, fig. 118.
1909. *Distoma convexum* Caullery, Bull. Sci. France et Belgique, XLII, p. 43.
1909–1911. *Polycitor (Eudistoma) convexus* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1431, 1633.
1911. *Polycitor (Eudistoma) mayeri* Hartmeyer, Pub. No. 132, Carnegie Ins. Washington, p. 91, Pl. I.
1915. *Polycitor convexus* Michaelsen, 'Beitr. Meeresfauna Westafrikas,' I, p. 466.

Closely related to *P. olivaceus*, above described, but having a different habit of growth. The colony is larger and much more massive, usually forming an irregularly rounded or elliptical mass; in other cases it is broad and thick, and attached by most of the lower surface. Sometimes it may be capitate or consist of several heads united at their bases, but these are few and large; the colony does not break up into a multitude of small heads, as *P. olivaceus* commonly does.

It is also differently colored, being pale yellowish or brownish, often with a reddish or violet tint during life or even in preservation, instead of the greenish, olive, or blackish color of that species. The test in well-preserved material is translucent, so that the zooids may be more or less distinctly seen, and of fairly firm, often slightly cartilaginous, consistency. The basal parts of the test may contain, or be incrusted, with sand and shell fragments. Sand may be present to some extent in the interior of it, but in most specimens not in any great quantity, and the upper surface is smooth and glossy. In parts of some colonies an arrangement of the zooids in small circular or oval systems grouped about a small common cloacal cavity, with a rather large, rounded aperture, can be clearly demonstrated. In other specimens, or in other parts of the colonies, there is no apparent regularity in the distribution of the zooids. Most of the colonies are of rather small size, not over 20 to 30 mm. in diameter

and, if of the sessile type, not over 15 to 20 mm. high; if of the capitate type, proportionately higher. But very much larger colonies occur; the largest ones are generally of irregular outline and often divided by clefts into several lobes or heads. The National Museum contains large ones from the southern and western Florida coasts (55 mm. by 42 mm. across and 28 mm. high, also a crest-like colony 65 mm. high and 108 mm. by 40 mm. in its other maximum diameters, and another irregularly lobed one 115 mm. in greatest diameter and 60 mm. high), while one from Andros Island, Bahamas, in the American Museum collection surrounds a mangrove root for a length of 75 mm. The free edges and lobes of such colonies are thick, and rounded. The largest colony of all that I have seen is a dome-shaped mass about 170 mm. by 110 mm. in diameter and 75 mm. in greatest height.

The zooids resemble those of *P. olivaceus*, except that they are a little larger and stouter, ordinarily 4 to 6 mm. long in the somewhat contracted condition in which they are found in preserved material, but doubtless nearly twice as long when fully expanded. The mantle is very muscular, with strong longitudinal bands and underlying transverse fibers. The longitudinal muscles extend down on the abdomen, but posterior to the thorax they spread out and unite into a thin, broad sheet on each side of the body.

Tentacles apparently normally thirty-two in number, of three orders (8+8+16) regularly arranged.

There are three rows of stigmata, not four as originally stated and figured. In one specimen eighteen or nineteen were present in the anterior rows on each side, and sixteen or seventeen in the last row. These numbers may perhaps be a little exceeded in other cases.

The stomach is rounded and smooth-walled; the gland surrounding the intestine consists of a number of more or less parallel tubules which vary from quite straight to very sinuous in different individuals, and may in some places, especially near the lower end, become more or less distended with their secretion. The main direction of their course is, however, parallel with that of the intestine, along which they ascend for some distance, becoming smaller and tapering off to an exceedingly small diameter at their upper ends.

Large and well-developed zooids may have as many as thirty or forty testes. In most characters, however, the zooids closely resemble those of the last-described species and, as in that form, they are often, if not normally, more or less spotted with dark pigment (usually brown in the preserved specimens), especially on the anterior part of the body.

The type specimen of this species, a rounded colony 24 mm. in diameter, attached by much of its lower surface, was collected at Bermuda, where it does not seem to be very common. Other localities are Andros Island, Bahamas (see above); Cayo Christo near Isabella, north shore of Cuba, 3 to 4 feet; and near Georgetown Light, Winyah Bay, South Carolina (large colony thrown up on beach). It is, however, along and off the west and southwest coasts of Florida that this species seems to occur in greatest abundance and to grow to the largest size. There it was obtained at a number of localities, mostly in depths of under 10 fathoms. Though sometimes found near low-water mark, it seems to inhabit more frequently water a few feet or several fathoms deep (deepest station: Station 2362, Steamer Albatross, 22° 08′ 30″ N., 86° 53′ 30″ W., 25 fathoms). This species generally grows attached to corals, shells, gorgonians, etc.; one colony appears to have grown on the back of a crab.

There can be little question that Hartmeyer's (1911) *P. mayeri* from Tortugas, Florida, is this species. His failure to identify it as such was doubtless due to the error in the number of rows of stigmata (given as four instead of three) in the original description and figure.

Polycitor (Eudistoma) hepaticus, new species

Very closely allied to *P. convexus*, just described, and possibly representing merely a variation of that species, is a large and massive form which is found in the same region. Characteristic specimens of it present a very different appearance from *P. convexus*, as described in the foregoing pages; the colonies usually form large ovoid or ellipsoidal masses, commonly more or less flattened in one direction and generally attached by a rather small area on or near one of the narrower sides or by one end; the surface of the test is more or less uneven, and large colonies are often partly divided by narrow clefts into two or more large lobes, which may have one or more of their sides flattened and the borders sharp and angular as a result of pressure against each other. In such cases the form of the colony, the dark color, and the consistency of the rather soft test give it an appearance suggesting the liver of a vertebrate animal, except that the color (in preservation) instead of red is a pure, intense purple, caused by grains of purple pigment in the test cells. There are no notes of the color in life. In some specimens the purple pigment is much less in amount, the colonies having sometimes only a pale purple or violet shade—in extreme cases only a purplish buff color; this may, of course, be in part due to fading. Such lightly pigmented colonies approach *P.*

convexus in color and appearance; the test, however, in the present form appears to be rather softer and less cartilaginous, and the surface more wrinkled and less glossy; the test, when pulled apart, tears rather than breaks.

As above stated, the colonies become large and massive; the type colony is a fair example of one of the larger specimens. It is of flattened, oblong form, about 80 mm. by 45 mm. by 25 mm. in its diameters, and was apparently attached by a rather small area near, but not on, one edge. The test is of a uniform deep purple color, due to the abundant purple pigment cells; the tissues of the zooids are not pigmented. Consistency of test rather soft, the solid interior parts a little firmer; surface slightly wrinkled and exhibiting small, rounded, depressed areas indicating the small circular or elliptical systems in which the zooids are arranged. The center of each of these systems, which appear usually to comprise eight to ten or more zooids, is occupied by a small common cloacal cavity with a rounded or somewhat lobed aperture.

Zooids apparently exactly like those of *P. convexus*, except that they average a little smaller and less stout. The testes numbered fifteen to twenty in the individuals studied, some containing young larva in the atrial cavity.

The type colony, above described, is one of several similar ones collected by the 'Albatross' at Jamaica, W. I., January 1–11, 1884. Three exactly similar smaller ones of an equally deep purple color were collected by the 'Albatross' at St. Thomas, January 16–22, 1884; these appear to have grown on crabs. In July 1915, Mr. C. R. Shoemaker, of the National Museum, obtained a number of other specimens at St. Thomas on piles near the town. These exactly resemble the 'Albatross' specimens found over thirty years previously, both in their color and other characters; one of them is the most massive and bulky colony of a compound ascidian that I have ever seen. It is a somewhat flattened mass with thick rounded edges, about 270 mm. by 240 mm. across and about 100 mm. high, attached by a small area of the lower surface and partially divided by a wide, deep cleft into two nearly equal lobes connected at the base. This colony has on one side an irregular lateral extension which, if straightened and stretched out, would make the diameter of the colony passing through it reach 450 mm. The Yale University collection also contains a good-sized, rather deep purple colony, as well as some paler ones, from Fort Macon, North Carolina, collected by Dr. H. C. Yarrow; and the National Museum has some poorly preserved ones labeled Merida, Yucatan.

There seems, therefore, to be no possibility that the remarkable color of these specimens can be due to artificial or accidental staining from other material with which they may have been preserved.

Paler purple or slightly purple colonies in the National Museum collection, some of them of considerable size, which appear to be of this species, were obtained at Gunston, Potomac River, Virginia, and at Cedar Keys and Charlotte Harbor on the west coast of Florida. Such specimens, on account of their close approach to *P. convexus* make the problem of dealing with this form a very perplexing one, yet it would appear unjustified to stretch the diagnosis of *P. convexus* to include such very diverse specimens as would be necessary if this form were to be included there, and it seems best to treat it provisionally as a new species. Its range, excepting that it is not known from Bermuda, is even more extensive than that recorded for *P. convexus*, extending from Chesapeake Bay to Yucatan, Jamaica, and St. Thomas, W. I., which seems to exclude regarding it as a geographical race or subspecies of *convexus*.

This species is also nearly allied to a form found in the Philippines which I have identified with Sluiter's (1909) *P. ianthinus* (see Van Name, 1918, p. 135).

Polycitor (Eudistoma) clarus (Van Name), 1902

Figure 37

1902. *Distoma clarum* Van Name, Trans. Conn. Acad. Sci., XI, p. 345, Pl. XLVIII, fig. 10; Pl. LIX, fig. 117.
1909. *Distoma clarum* Caullery, Bull. Sci. France et Belgique, XLII, p. 43.
1909–1911. *Polycitor (Eudistoma) clarus* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1431, 1633.
1915. *Polycitor clarus* Michaelsen, 'Beitr. Meeresfauna Westafrikas,' I, p. 466.
1916. *Distoma clarum* Pratt, 'Manual Common Invert. Animals,' p. 669.

Colony a small, rounded or oval mass without a peduncle, attached by most of the under surface. Test transparent and colorless in preserved specimens, but slightly opalescent in life, with a grayish, pinkish, or sometimes a blue or green cast. Size of the largest colonies about 12 mm. across and 6 mm. or less in height. Zooids irregularly distributed, lying in preserved colonies at all angles to the surface, no systems discernible. The zooids are visible with perfect clearness through the test.

Zooids small, provided with very strong longitudinal muscle bands on the thorax and anterior part of the abdomen; these usually produce such violent contractions in preserved specimens that the natural size and form of the zooid is entirely changed and distorted. Both apertures on tubes; the branchial tube very stout, six or seven-

lobed; the atrial longer, six-lobed. In immature zooids, both tubes may be mere conical projections. Posterior end of the body produced into a vascular process which is often very large and thick. Length of the zooids when moderately extended 3 to 4 mm. or more, but in the strongly contracted and distorted condition in which they are found in preserved specimens, usually much less (2 mm. or under). During life the thorax of the zooids is white, the stomach and more or less of the intestinal loop yellow or orange. In preservation the zooids fade to yellow or flesh-color, and usually eventually turn dark colored (dark yellow or brown).

Tentacles rather few but of three sizes, the smallest ones appear to be inserted in a circle somewhat anterior to the larger ones.

Dorsal languets inserted on the transverse vessels of the left side of the sac a little way from the median dorsal vessel.

Branchial sac with three rows of stigmata, not four as given in the original description and figure. About fifteen or sixteen stigmata in a row on each side.

Intestinal loop fairly long when not contracted; stomach proportionately large, globular and smooth-walled, but in preserved specimens the wall is usually found irregularly folded in consequence of the contraction of the body.

Testes and ovaries beside the intestinal loop, the stout common sperm duct accompanying the intestine to near its end. Testes few, usually six or eight in number, pear-shaped. Eggs large; the embryos develop into tailed larvæ in the atrial cavity of the parent. Sometimes four or five large embryos or larvæ, together equaling in bulk their parent, are found in the dorsal region of the body of a single zooid, greatly distending that part of the body, though no distinct incubatory pouch is formed.

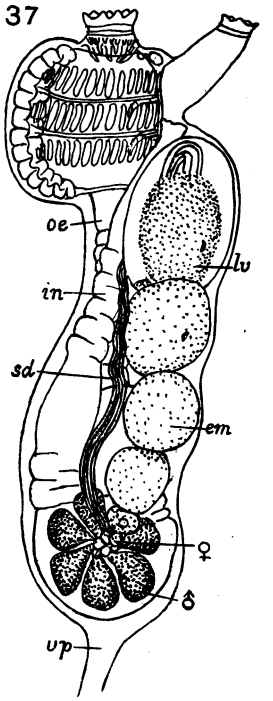


Fig. 37. *Polycitor* (*Eudistoma*) *clarus* (Van Name), 1902

Left side of zooid containing four developing embryos or larvæ, × 35.

This is one of the most abundant ascidians at Bermuda, occurring attached to stones along the shore and on corals, etc., on the reefs, but I have not yet seen it from any other locality. The type is in the Yale University collection.

Polycitor (Eudistoma) capsulatus (Van Name), 1902

1902. *Distoma capsulatum* Van Name, Trans. Conn. Acad. Sci., XI, p. 341, Pl. XLVI, fig. 2; Pl. LVIII, fig. 107.
1906. *Distoma capsulatum* Rennie and Wiseman, Proc. Zool. Soc. London, p. 908, Pl. LXV, fig. 21.
1909. *Distoma capsulatum* Caullery, Bull. Sci. France et Belgique, XLII, p. 43.
1909–1911. *Polycitor* (*Eudistoma*) *capsulatus* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1431, 1633.
1915. *Polycitor capsulatus* Michaelsen, 'Beitr. Meeresfauna Westafrikas,' I, p. 66.

This species was described from a few small colonies obtained at Bermuda in shallow water; only two of them were sufficiently large and well developed to afford any distinctive characters; the type, which measured 17 mm. by 11 mm. across and 5 to 7 mm. in thickness, and a somewhat smaller similar colony found with it. The latter has been at hand for re-examination in preparing this paper, but has not availed to clear up the uncertainty as to the validity and systematic position of this species, which must still be regarded as a doubtful one.

The colonies are small, irregularly convex masses of unsymmetrical outline, attached by the entire lower surface. Upper surface uneven, often slightly raised over the position of each zooid. Test colorless or nearly so, but rendered white, opaque, and rigid by numerous included sand-grains and shell-fragments, which are especially closely packed about the zooids so as to form a sort of capsule around them.

As far as the general character of the colonies is concerned, there would seem to be no great objection to regarding them as merely poorly developed and slightly abnormal colonies of *P. convexus*. The zooids are few and mostly much contracted. The few well-developed ones are rather large and suggest from their strong thoracic musculature (which at the posterior end of the thorax is gathered into a broad band passing down on each side of the abdomen) the zooids of the genus *Cystodytes*. The way in which the calcareous sand-grains in the test surround in capsule-like fashion the bodies of the zooids is also suggestive of that genus. Whether there are actually four rows of stigmata (which would further support its relationship to *Cystodytes*, since the West Indian Polycitors have but three) I was unable to determine on account of the condition of the zooids. A careful search, however, failed to reveal any of the characteristic disk-like spicules of *Cystodytes* in the test, or anything that could be certainly regarded as a fragment of such a spicule, and in their absence the specimens cannot be assigned to that genus.

A further peculiarity of the zooids is in the structure of the gland surrounding the intestine, which is demonstrable in several of the zooids.

The tubules are numerous and close together, clasping and entirely surrounding the ascending branch of the intestine for a short distance; they are somewhat distended and appear to end in enlarged bulbs. I could not find the slightest evidence of their ascending along the intestine and tapering off to narrow, pointed tips as in *Polycitor convexus*, although the conditions for demonstrating the structure appeared very favorable.

These peculiarities appear to stand in the way of identifying this form with any of the other species here described. The only other record for it, besides the original one from Bermuda, is that of Rennie and Wiseman, who somewhat doubtfully identify a small colony from the Cape Verde Islands with this form. The type is in the Yale University collection.

CLAVELINA Savigny, 1816

As here employed, this genus is used in a comprehensive sense, including *Chondrostachys* MacDonald, 1858, *Podoclavella* Herdman, 1890, and *Rhodozona* Van Name, 1902, on the ground that the characters distinguishing these groups are unessential and purely superficial, depending mainly on the degree of separation of the zooids, which may each have a separate covering of test or may be more or less buried in a common mass of test, a character not even of specific value. Several other genera should probably also be included.

No reason is at present apparent to the writer why even the rank of a subgenus should be accorded to any of these groups. It would, however, certainly be premature to claim that a valid basis may not sometime be found for subdividing the genus *Clavelina*, taken in this comprehensive sense, into two or possibly more well-defined groups worthy of at least subgeneric rank. *Clavelina detorta* (Sluiter) from the Malay region, for instance, might be regarded as deserving of such separation on account of certain peculiarities in the form and structure of the zooids. But such subdivision of *Clavelina* should await more complete knowledge of the subject.

Since, as shown below, specimens undoubtedly belonging to *Clavelina* may have the zooids completely buried in a common mass of test and may have the stomach wall plicated, the distinction between *Clavelina* and the typical subgenus of *Polycitor* Renier, 1804, which is characterized by many rows of stigmata and a plicated stomach wall, apparently disappears, and *Clavelina* should perhaps be treated as a synonym of *Polycitor*. As no specimens of that subgenus have been available for study (the West Indian Polycitors are all of the subgenus

Eudistoma), this problem cannot be dealt with here, and the generic name *Clavelina* will be retained in the present article for the two following species.

Clavelina oblonga Herdman, 1880

Figures 38, 39, and 53

1880. *Clavelina oblonga* Herdman, Proc. Roy. Soc. Edinburgh, X, p. 724, figs. 93–95.

1882. *Clavelina oblonga* Herdman, 'Rept. Voy. Challenger, Zool.,' VI, p. 246, Pl. xxxv, figs. 6–10.

1890. *Stereoclavella oblonga* Herdman, Trans. Biol. Soc. Liverpool, V, p. 161.

1891. *Stereoclavella oblonga* Herdman, Journ. Linn. Soc. London, Zool., XXIII, p. 604.

1900. *Clavellina oblonga*+*Diazona picta* Verrill, Trans. Conn. Acad. Sci., X, pp. 588–591, Pl. LXX, fig. 8.

1902. *Clavelina oblonga*+*Rhodozona picta* Van Name, Trans. Conn. Acad. Sci., XI, pp. 334, 335, Pl. XLVI, figs. 1, 3; Pl. XLVII, figs. 5, 7; Pl. LX, fig. 122; Pl. LXII, fig. 130a.

1907. *Rhodozona picta* Seeliger, Bronn's 'Tier-reich,' III, suppl., p. 1208.

?1908. *Stereoclavella* species Hartmeyer, Year Book Carnegie Inst., Washington, No. 6, p. 111.

1909–1911. *Chondrostachys oblonga*+*C. picta* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1427, 1633.

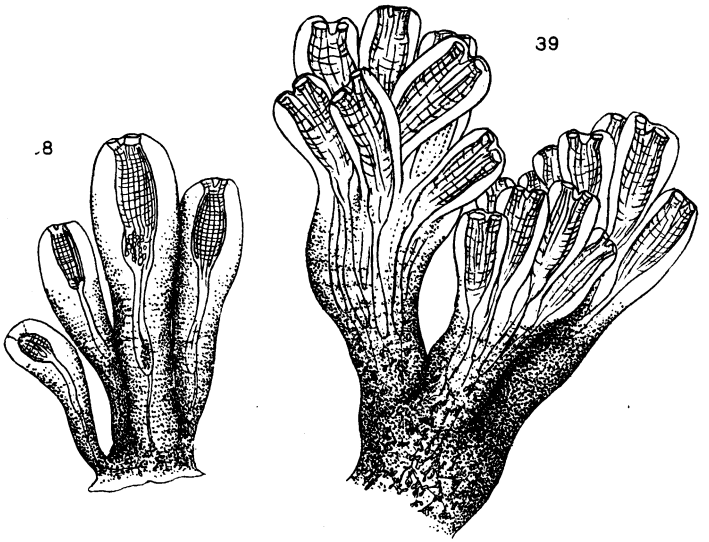
1912. *Chondrostachys oblonga*+*C. picta* Hartmeyer, 'Deutsch. Tiefsee-Exp.,' XVI, p. 295.

The type of this species, collected by the Challenger Expedition and described and figured by Herdman (1882), consisted of a colony of about forty zooids or individuals, each with its separate covering of test, united only at the posterior end, where, according to Herdman's description, they "form a thick irregular stolon." In such colonies as the above the individuals are club-shaped, usually 20 to 30 mm. long (high) inclusive of the test; each is inclosed in a thick covering of test, which is wide and rounded at the summit or anterior end, where the two apertures are situated, and tapers into a narrow base by which it is attached to the other members of the colony through a basal mass of test containing branching vessels that may bear a few bulbs or enlargements.

Colonies of this type (Fig. 38) are frequent, but along with them are often found others in which the posterior half of each zooid (or a greater or less part of its length) is buried in the common basal mass of the colony; only their anterior parts have a separate and independent test covering; in immature or imperfectly developed colonies the entire length of the zooid may be thus buried, as it is in most compound ascidians, the colony consisting of one or more capitate lobes; in some

specimens this entirely buried condition persists even though the zooids have attained full size and fully adult condition.

The usual condition is, however, that of at least partial separation of the zooids; large colonies, which may include some hundreds of zooids and measure 160 mm. or more across, are made up of many lobes or groups of more or less intimately joined individuals. Fig. 39 shows a part of the colony comprising three such groups or lobes. *Diazona picta* Verrill, 1900, was based on a large colony of this character.



Figs. 38 and 39. *Clavelina oblonga* Herdman, 1880

Fig. 38. Small colony with separate zooids, × 1.8. Fig. 39. Three lobes of a large colony with partially united zooids, × 1.8. (In both figures the zooids are represented with the branchial sac expanded.)

The test is gelatinous, more or less perfectly transparent, sometimes entirely colorless, in other cases with a pinkish or violet tinge which may or may not be retained in preserved material. In some living specimens obtained at Bermuda, the zooids showed through the test as light yellowish, with the stomach and intestine deep yellowish brown. Some opaque white pigment was present about the apertures and elsewhere on the thorax. There was no pink or carmine color on any part of the specimens, but in some colonies, as in those described by Verrill as *Diazona picta*, there is a carmine ring about the oral aperture and often a stripe of the same color down the ventral side of the thorax of each zooid. A colony collected off Biscayne Bay, Florida, by Dr. Paul Bartsch, is

noted as "transparent with a delicate tinge of crimson." In alcoholic material the test generally loses some of its transparency; preserved specimens do not usually show conspicuous pigmentation, whatever may have been their condition during life, yet in one specimen the zooids exhibit a conspicuous ring of bright yellow pigment about the oral aperture. This, of course, may have been some other color when fresh.

Zooids (Fig. 53, p. 377) very variable in size in different colonies; in some their length is quite uniform, in others it is not at all constant. Large zooids, well expanded, may reach 25 mm. long. In the ordinary, contracted, preserved condition they do not usually exceed half or two-thirds this length. A vascular process from the posterior end of each zooid joins it to the branching stolons in the base of the colony. Thorax of zooid large, oval when contracted, more barrel-shaped in expansion; the orifices on very short tubes at the anterior end, the branchial orifice being the larger of the two. The abdomen or posterior part of the body is long and narrow. Sphincter muscles of apertures not very strong. Both apertures frequently have six distinct lobes; in other specimens the border may be merely sinuous or even perfectly plain.

Mantle musculature developed mainly on the thorax, where there are rather slender longitudinal muscle bands, rather widely spaced, and underlying them a somewhat larger number of narrower, less perfectly formed, transverse bands, so that an open network of square or oblong meshes is formed.

Tentacles not very numerous; in a large individual only about thirty were demonstrated. They represent three orders.

Dorsal tubercle of plain oval form, longitudinally elongate.

Dorsal languets triangular, broad at the base. They arise directly from the median dorsal vessel and are continuous with inwardly projecting membranes which extend along the transverse vessels of the sac.

Branchial sac with from about ten to twenty-two rows of small oval stigmata; there are often forty or more in a row on each side. Transverse vessels stout, each provided with a membrane along the side toward the interior of the sac as above noted.

Intestinal loop long and very narrow; rectum extending only a short distance into the thorax. Stomach elongate oval, largest at the pyloric end, generally smooth-walled, with a single internal longitudinal ridge or typhlosole; yet in some colonies its wall exhibits about a dozen longitudinal folds which are sometimes so distinct and regular as to leave no doubt that they are permanently present, not due to contraction.

Reproductive organs beside the posterior part of the intestinal loop. The ovary, situated near the posterior end of the stomach, is sac-like and is prolonged into a stout oviduct which accompanies the ascending branch of the intestine. The oviduct is crowded with small eggs in some specimens. Testes small and pear-shaped, very numerous, forming a dense cluster near and posterior to the ovary. The common sperm duct accompanies the oviduct and intestine. The peribranchial cavity often contains numerous, small, tailed larvæ.

This is a common and widely distributed species, ranging from Bermuda and South Carolina to Brazil, and occurring both along the shore near low-water mark and in deeper water (to 28 fathoms), though apparently more abundant in shallower situations (not over 6 or 8 fathoms). Its great variability in size, color, appearance, form of the colony, and the degree of separation of the zooids have led to much disagreement and confusion as to its proper generic and specific name. Some of the colonies of this species are, from their large size, delicate structure, transparency and bright coloration, among the most beautiful members of the varied marine fauna of the West Indian region. Colonies in which the zooids are completely buried in a common mass of test are not always easily distinguishable from small examples of the next-described species; yet, in spite of the occasional occurrence of such perplexing specimens, the two species appear to be distinct, and with living or fresh specimens the difficulty might largely disappear. This species is found growing attached to a great variety of objects, stones, shells, corals, etc.; some of the largest and handsomest colonies grow on gorgonians. One very small one appears from the form of its base to have grown on the back of a small crab.

The type of this species was obtained by the Challenger Expedition of Bermuda, where it is common, and has also been collected by Professor Verrill (1901) and by myself along the shore and in depths of a few feet.

Hartmeyer (1912*a*) reports it from the Brazilian coast, and from St. Thomas and other West Indian localities, and would identify it with Lesueur's (1823) *Ascidia claviformis* from St. Vincent, but Lesueur's description and figure would apply also to *Ecteinascidia turbinata* (see p. 375), so that it seems advisable to retain Herdman's name.

The National Museum collection contains examples from numerous localities. Most of the specimens were dredged off the west coast of Florida from the vicinity of Cedar Keys southward to off Key West, at various depths down to 28 fathoms; several were from southeastern Florida and one large colony from the Blackfish Banks off Charleston, South Carolina.

At Porto Rico it was dredged by the American Museum Expedition at several points off the southern coast in from 15 to 42 feet, but the colonies were of small size.

Clavelina gigantea (Sluiter), 1919

Figure 40

1919. *Polycitor giganteus* Sluiter, Bijdr. Dierkunde, Feestnummer, p. 10, Pl. 1, figs. 18–20.

The National Museum collection contains a number of specimens that appear to belong to this species, recently described by Sluiter.

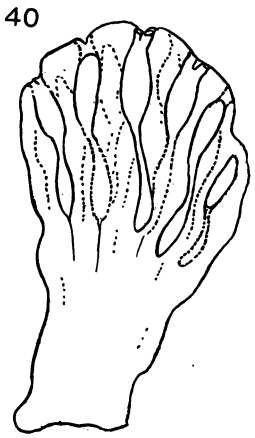


Fig. 40. *Clavelina gigantea* (Sluiter), 1919
Vertical section through colony, natural size.

The colony is large and massive, sometimes consisting of two or more lobes or heads connected at the base, but in other cases it is undivided. In form the heads may be irregularly spherical, though more often they are pear-shaped, cuneate or capitate; a more or less well-defined thick peduncle may be developed, or it may merely be attached by a narrowed base. The surface of the colony varies from smooth to quite deeply pitted with small depressions over the positions of the zooids; the latter condition is probably largely artificial, due to the greater shrinkage of the zooids than the solid test substance. The test is, in the alcoholic specimens, rather hard and tough and somewhat opaque, in contrast to the transparent gelatinous character seen in well-preserved specimens of *C. oblonga*. Its color in life is uncertain. Some of the colonies, though they have been kept in alcohol for many years, are chocolate-brown, due to brown pigment in the test cells; others show no pigment at all, the test and tissues being of the usual yellowish white color. Whether these were originally unpigmented or are merely faded is not certain, but no intermediate, slightly pigmented specimens are in the collection.

The zooids are scattered and placed perpendicularly to the surface without being arranged in groups or systems. They are of large size, so that their posterior ends extend down into the central or even into the basal parts of the colony. The test immediately inclosing the body of each zooid is tougher and harder, forming a sort of sheath.

The size of the colonies (some of which may be lobes or divisions of more extensive colonies that have become separated) is quite variable; the larger heads do not ordinarily exceed 50 or 60 mm. in total height, including the narrowed basal part of peduncle, and a diameter in the upper portion of 30 or 35 mm., but there are a few specimens in which these dimensions are considerably exceeded. The zooids, though very variable in size, average considerably larger than in the last species, attaining in some of the colonies a length of about 30 mm., even in the preserved and not fully extended condition. In structure they so closely correspond to those of *C. oblonga* that no separate description or figure is needed. The rows of stigmata are, however, more numerous, sometimes over 30 in large zooids, with 70 or more stigmata in a row on each side, and the testes may be also exceedingly numerous. As in *C. oblonga*, the branchial and atrial apertures may be distinctly six-lobed, and the stomach wall may exhibit about a dozen distinct longitudinal plications, but either or both of these characters may be only obscurely developed or absent. Vascular appendages extend down into the lower part of the colony from the posterior end of the zooids, but they are not usually very conspicuous. The tentacles are of three orders; the normal total number is probably thirty-two, but the smaller ones are usually wanting in some of the intervals.

Sluiter describes the dorsal tubercle as U-shaped and I have also found it presenting this appearance, but believe that when this is the case it is due to a notch or interruption in the border of the tubercle, and that the actual orifice has merely an elongate oval form as usual in the genus. However, in very old and large zooids, such as those in Sluiter's specimen, an actual U-form may perhaps be developed.

The specimens here referred to this species were all obtained in the Gulf of Mexico at stations off the west coast of Florida, from the vicinity of Cedar Keys to that of Key West, except one from off the southern coast of Yucatan. The depths, where given, range from 6 to 28 fathoms; the bottom was sandy in a majority of cases where it was recorded. It is apparently not a littoral form.

Sluiter (1919) described the species to which they are here referred from a single colony of somewhat cylindrical form, 12 cm. high and 8 cm. in diameter, of a brownish color on the surface, containing very large zooids (4.5 cm. long). The specimen was from the West Indies, exact locality not given.

None of the National Museum specimens equal Sluiter's example in the size of the zooids, but this character is very variable in this group. A

much more serious discrepancy is that Sluiter found minute papillæ along the inner side of the transverse vessels of the branchial sac, while the best preserved specimens in the National Museum series show that a continuous plain-edged membrane, not a series of papillæ, is present. This difference, reported by so experienced an observer as Professor Sluiter, would seem to prevent regarding the two forms as identical, were it not for the fact that in more or less poorly preserved and laterally contracted zooids the edge of the membrane becomes sinuous and often notched and broken so as to strongly suggest a series of papillæ. In fact, in the first specimen examined, which happened to be rather poorly preserved, the writer was deceived in the same way, and spent some time in looking (of course in vain) for the internal longitudinal vessels of which he thought these supposed papillæ might be the supports.

No other character separates this species generically from *Clavelina oblonga* (indeed small and poorly developed colonies of the present species are difficult to distinguish from that form); it is, therefore, placed in *Clavelina* in this paper, since that generic designation is retained for *oblonga*.

CYSTODYTES von Drasche, 1884

Distinguished from *Polycitor* chiefly by possessing disk-shaped calcareous spicules in the test.

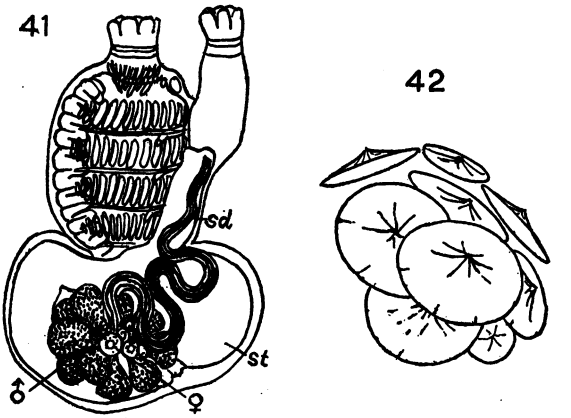
Cystodytes dellechiaiæ (Della Valle), 1877

Figures 41 and 42

1877. *Distoma dellechiaiæ* Della Valle, 'Contribuzioni alla storia naturale delle Ascidie composte del Golfo di Napoli,' p. 40 (*fide* Herdman).
1886. *Cystodytes draschii* Herdman, 'Rept. Voy. Challenger, Zool.,' XIV, p. 137, Pl. XIX, figs. 1–15.
1891. *Cystodytes draschii* Herdman, Journ. Linn. Soc. London, Zool., XXIII, p. 615.
1902. *Cystodytes draschii*+*C. violaceus* Van Name, Trans. Conn. Acad. Sci., XI, pp. 347, 348; Pl. XLVIII, figs. 12–14; Pl. XLIX, fig. 17; Pl. LVIII, figs. 99–101.
1907. *Cystodites draschei* Seeliger, Bronn's 'Tier-reich,' III, suppl., p. 1222.
1909. *Cystodites violaceus* Caullery, Bull. Sci. France et Belgique, XLII, p. 45.
1909–1911. *Cystodites draschei*+*C. violaceus* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1434, 1633, 1634.
1912. *Cystodites draschei*+*C. violaceus* Hartmeyer, 'Deutsch. Tiefsee-Exp.,' XVI, pp. 314, 373.
1915. *Cystodytes dellechiajei*+*C. draschei* Michaelsen, 'Beitr. Meeresfauna Westafrikas,' I, p. 483.

The above references are those applying to this species as found in American waters. See below, p. 362.

Colony usually with a fairly even surface and with rounded edges, though in some places these may expand into a thin margin. Size of largest specimens 60 to 80 mm. across and about .5 mm. thick. Surface fairly smooth; color of colony varying from brown, blackish or purple (due to oval pigment cells in the test) to pale buff or almost white. Purple colonies turn brown in preservation. The pigment may or may not be abundant enough to conceal the white, calcareous capsules that inclose the posterior parts of each zooid, and into which they withdraw when they contract. They are built up of overlapping, thin, disk-like, slightly concave spicules (Fig. 42), .4 or sometimes .5 mm. or more across, though many of them are much smaller. Some of the spicules



Figs 41 and 42. *Cystodytes dellechiaiæ* (Della Valle), 1877
Fig. 41. Left side of zooid, × 32. Fig. 42. Spicules, × 52.

may also be scattered in the basal parts of the colony, taking no part in forming any capsule. In many colonies, the capsules are poorly formed and the spicules are mostly very badly broken; sometimes the spicules are largely replaced by irregular granules of calcareous matter. The test is largely composed of small, hollow bladder cells, as is the case in many other compound ascidians.

The zooids resemble those of the subgenus *Eudistoma* in most characters, but are proportionately shorter. The longitudinal muscles of the mantle of the thorax form distinct bands, but the bands of each side of the body are gathered together into a single very broad, thick one on each side in the constricted middle part of the body. This serves to retract the anterior part of the body into the capsule formed by the spicules. In preserved specimens these strong bands generally violently

contract and distort the body, shortening it into some such form as shown in Fig. 41.

Apertures six-lobed, on well-developed tubes, the atrial tube much the longest.

Tentacles numerous, of three sizes; Herdman gives the number as about fifty. The smaller ones are inserted in a circle farther forward than the large ones.

Dorsal languets arising from the transverse vessels of the left side of the body.

Four rows of stigmata with at least a dozen in a row on each side. Intestinal loop short, stomach apparently round and smooth-walled; its wall is, however, thin and is usually thrown into folds in preserved specimens.

Reproductive organs beside the intestinal loop as in *Polycitor*, the common sperm duct accompanying the distal part of the intestine to near its end. Testes pear-shaped, ten or more in number in well-developed zooids. Ovary a group of eggs near the commencement of the common sperm duct.

In spite of considerable variations in color and in the size of the spicules and an unusually wide range in depth of habitat, the larger series of specimens now available leads me to doubt whether more than one species of this genus can be recognized in the West Indian region, and I follow Michaelsen (1915, p. 485) in identifying it with Della Valle's (1877) Mediterranean form, and in regarding several other Old World species, including *C. philippinensis* Herdman, 1886, from the Philippines (see Van Name, 1918) as synonyms or mere varieties of it. But with Michaelsen's course in separating Herdman's *C. draschii* as a distinct species merely for the reason that the bladder cells in the test of his type were not so closely crowded together as in some of the others, I must totally disagree. I cannot agree with Dr. Michaelsen's belief that two species can be separated on such a difference; it is, indeed, not even an individual character, as it no doubt varies in different stages of growth of the same colony. Herdman's *C. draschii* was obtained by the 'Challenger' at Barra Grande, Brazil, in 400 fathoms, a considerably greater depth than any of the other records, but it does not appear to differ from the rest in any important respect. At Bermuda this species is not uncommon on corals, gorgonians, etc., on the reefs, and I have collected it on stones along the shore. The National Museum contains specimens from shallow water off the west coast of Florida and from deeper situations, Station 7279, Steamer Fish Hawk (Gulf Stream off Key West, Florida, 98 fathoms,

sand) and Station 2333, Steamer Albatross (23° 10′ 36″ N., 82° 19′ 12″ W., 169 fathoms, fine white coral).

HOLOZOA Lesson, 1830

[= *Distaplia* Della Valle, 1881. Proposed *nomen conservandum, Distaplia*]

Branchial sac with four rows of stigmata, each row crossed at its middle by a slender transverse (dorsoventral) vessel. Development of the embryos (in the typical species, at least) takes place in a large pouch or external diverticulum of the peribranchial cavity into which the oviduct passes.

Holozoa bermudensis (Van Name), 1902

[*Distaplia bermudensis* under proposed system of *nomina conservanda*]

Figure 43

?1870. *Cellulophana collectrix* O. Schmidt, 'Grundz. Spongienf. Atlant. Geb.,' p. 25.
1902. *Distaplia bermudensis* Van Name, Trans. Conn. Acad. Sci., XI, p. 349, Pl. XLIX, figs. 15, 18, 19; Pl. LIX, figs. 108, 111; Pl. LXII, fig. 130*b*.
1909. *Distaplia bermudensis* Caullery, Bull. Sci. France et Belgique, XLII, p. 45.
1909–1911. *Holozoa bermudensis* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1437, 1633.
1911. *Holozoa bermudensis* Hartmeyer, 'Deutsch. Südpolar-Exp., Zool.,' XII, p. 486.

Form of colony very variable, sometimes capitate, consisting of one or more heads, usually somewhat flattened on top with rather abrupt sides tapering into a short peduncle; in other cases it forms a flat incrusting sheet, commonly 4 or 5 mm. thick and often several centimeters across. The colony may, however, have any of an infinite variety of intermediate forms. The heads in the capitate colonies may reach a diameter of 20 mm. or more. They are rarely of very symmetrical form. Colors of the colonies as variable as their shape, often very brilliant during life, but usually fading to a green, blue-green, yellowish or olive tint in preserved material, though some alcoholic specimens are reddish or pink, or are mottled or marbled with areas of greenish or blue-green and red or pink. As a rule, the basal parts of the colony are pale, the upper portions darker, sometimes shading into blackish. The colors of living specimens are much more varied and beautiful, often chocolate-brown, shading into or marbled with olive, violet, purple, black, rose color, or even an intense orange-red; any one of these colors may predominate. White pigment is often present about the orifices. These colors are chiefly due to oval pigment cells in the test.

Test translucent or semitransparent; surface of the colony not shiny. Zooids arranged in systems, sometimes composed of but few zooids, in other cases extensive and complex. Vascular processes,

straight and unbranched, extending down from the posterior ends of the zooids, are often conspicuous in the basal parts of the colonies.

Expanded zooids may measure over 3 mm. long and 1.3 mm. across the thorax, even in preserved material, but are much subject to shrinkage owing to the delicacy of their tissues, which are often beautifully transparent. Mantle musculature slight, consisting chiefly of very delicate bands in the thorax, which run mostly in an oblique direction.

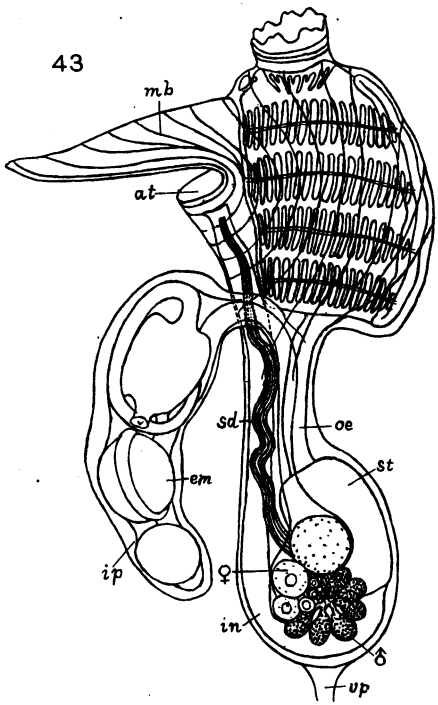


Fig. 43. *Holozoa bermudensis* (Van Name), 1902
Right side of zooid with incubatory pouch containing three embryos or larvæ, × 30.

This is in strong contrast to the condition prevailing in the genus *Polycitor*, where there are very powerful longitudinal bands on the thorax. Even the sphincter of the branchial orifice is comparatively weak in the present genus. Margin of branchial orifice with irregular rounded teeth or crenations; when contracted often appearing plain. Atrial orifice large, smooth-margined, its anterior lip produced into a large languet.

Tentacles about sixteen, of two sizes placed alternately.

Dorsal languets long and narrow.

Branchial sac with four rows of long narrow stigmata. The delicate structure of the sac and its consequent liability to folding and distortion makes accurate counting of the stigmata difficult. An examination of some unusually favorable material indicates a somewhat smaller number of stigmata than given in my original description; there are probably eighteen or nineteen in a row on each side. Those of each row are crossed, without being interrupted, by a delicate intermediate transverse vessel.

Stomach elongate-oval, tapering toward the pyloric end. In all of many zooids from different colonies and localities, its walls were found to be smooth within and without, except for a minutely granular roughness, visible on considerable magnification, and for a single, internal, longitudinal ridge or typhlosole. Stomach and proximal part of intestine orange or yellow during life.

Zooids hermaphroditic; reproductive glands on the right side of the intestinal loop. The small, oval testes (about ten to twelve in number) and the ovary lie close together. The thick-walled sperm duct accompanies the ascending branch of the intestine. The delicate, thin-walled oviduct does also for a distance, then enters the incubatory pouch. This structure is not present on all zooids, and in many colonies none will be found on any of them. Apparently it develops only when needed to receive the embryos. It is a large, elongate, curved, tapering evagination of the wall of the right posterior dorsal part of the peribranchial cavity connected with the body of the zooid by a neck too narrow to allow the embryos to pass out again when they have attained their growth, and they escape by bursting the walls of the pouch and the surrounding test substance. The embryos are arranged in the pouch in one row, the oldest in the proximal part. Often pouches with their contents of developing young are found lying in the test unattached to any zooid, having broken away, or the zooids originating them having died and been absorbed.

This species appears to be well differentiated from the well-known *H. clavata* Sars of the northern seas of Europe and America (see Van Name, 1910), but its relationships to the Mediterranean species require further investigation. Perhaps it may be identical with *Cellulophana collectrix* O. Schmidt, 1870, from Tortugas, Florida, described as a sponge. The specimens in the collections studied show its range to include Bermuda (the type locality), South Carolina, Florida (both coasts), Porto Rico,

and the former Danish West Indies. It is a shallow-water species which grows on stones, piles, corals, and a great variety of other objects, including other species of ascidians, but a specimen from off the northern part of the South Carolina coast was dredged in 15 fathoms and a poor and somewhat doubtful one in 27 fathoms off the west coast of Florida. These are the deepest records. It is one of the commonest shallow-water species at Bermuda and at St. Thomas, W. I. At Porto Rico it was found common along the shores of Guanica Harbor, and was also dredged off the mouth of that harbor in 5 fathoms and near the mouth of Guayanilla Harbor in 15 feet. One colony was also obtained in San Juan Harbor below San Antonio bridge.

Holozoa bursata, new species

[*Distaplia bursata* under proposed system of *nomina conservanda*]

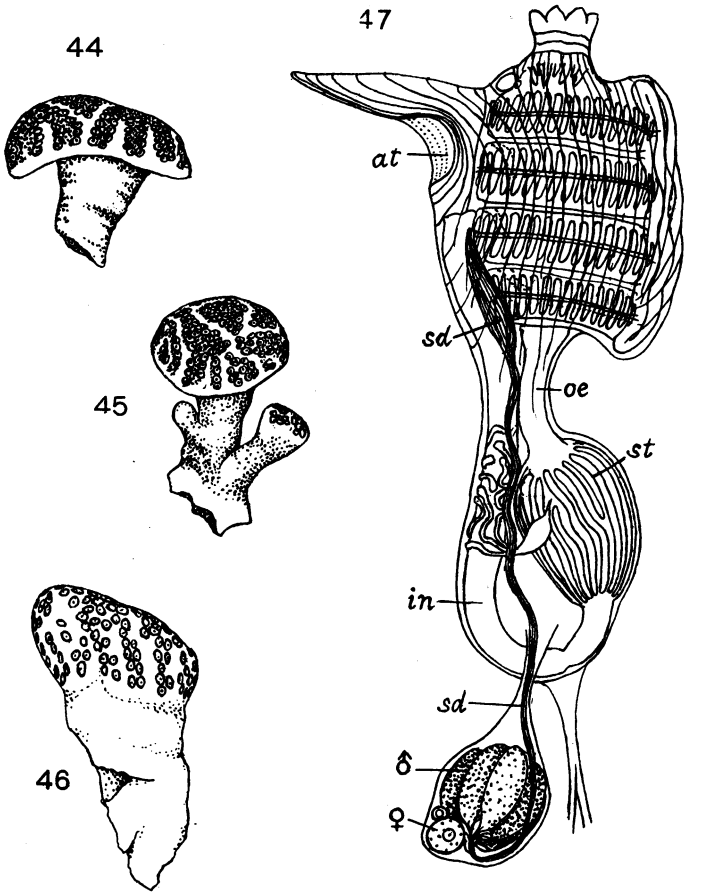
Figures 44–47

The best-developed colonies in the collection exactly resemble ordinary mushrooms in shape, consisting of a broad head, convex above and slightly concave below, mounted on a thick pedicel approximately equaling or exceeding the diameter of the head in height. Size of one of the largest heads 17 mm. in greatest diameter and 15 mm. in height, inclusive of the pedicel, which is not complete at the base; the pedicel enlarges toward the top and has an average diameter of 6 to 7 mm. Several of the colonies have one or two smaller heads arising from the lower part of the pedicel where it is more or less expanded into a base for attachment. Some of the heads exhibit the mushroom form only imperfectly, having nearly the capitate shape seen in many other compound ascidians (Fig. 46); sometimes this appears to be due to immaturity of the colony.

The zooids are arranged in the central part of the upper surface of the heads in several small, irregularly formed systems; branches from these systems extend radially toward the margin of the heads. In most of the specimens the test is of a light yellowish-brown color and rather opaque, the parts occupied by the zooids and common cloacal cavities and canals showing darker brown in conspicuous contrast to the other parts of the colony, but in one lot of specimens (from Station 2136) the test is a dark grayish brown and the systems are inconspicuous. In many places in the test (both of the heads and pedicels) are minute white grains which appear to be intracellular deposits. They dissolve in acids.

The zooids have a rather short but wide thorax, connected by a moderately long thick neck with the abdomen; arising from the latter is

a pear-shaped or oval sac-like post-abdomen, containing the reproductive organs and much resembling the post-abdomen of *Polyclinum*. Apparently, however, it does not contain the heart. It is connected with the abdomen by a very narrow and often considerably elongated neck, which



Figs. 44–47. *Holozoa bursata* new species

Figs. 44–46. Colonies, × 1.3. (Fig. 44 is the type.) Fig. 47. Right side of zooid, × 55.

arises from the right posterior part of the abdomen and extends either in nearly direct prolongation of the main axis of the body of the zooid, or makes more or less of an angle with it. The zooids average small in size; even including the above-described pouch the total length in the somewhat contracted preserved material often does not exceed 2 mm.

Branchial aperture on a short tube; provided with six well-developed simple lobes; atrial region of very delicate structure, the aperture with a very thin and easily torn margin, so that its natural form is very hard to determine and is probably in fact variable according to the relations of the zooid to the common cloacal cavity or canal. In some zooids it appears to be produced in a tubular form, in others only the anterior margin appears to be much extended, forming a broad thin languet. The mantle is very delicate and transparent; on the thorax on each side there are numerous (over 20) very slender but well-defined muscle bands, quite regularly spaced and mainly longitudinal in direction. There is no distinct sphincter about the atrial orifice.

The normal number of tentacles appears to be sixteen, larger and smaller alternating, but the small ones are often wanting in some of the intervals.

Three dorsal languets are present, arising slightly to the left of the median dorsal vessel.

The branchial sac has four rows of stigmata; there are, as is characteristic of this genus, additional slender vessels crossing all the stigmata of each row at their middle point. They lie on the internal aspect of the sac and are not always easy to demonstrate. Fifteen stigmata in the anterior rows and thirteen in the last rows were present on each side in one zooid in which an exact count could be made, some individuals apparently having a few more than this (at least eighteen in the anterior rows). The loop formed by the alimentary tract is not twisted. The stomach is of the ovoid shape usual in this genus and has about eighteen or twenty slightly irregular longitudinal plications which are distinct, though not very deep. A little way posterior to its anterior end the stomach is joined by the duct from the tubular gland that surrounds the ascending branch of the intestine. This duct may be expanded into a fusiform vesicle between the intestine and the stomach; the tubules of the gland itself are crooked with more or less enlarged tips. The intestine often exhibits a more or less distinct constriction a short distance beyond the stomach.

The post-abdomen described above is completely filled by the reproductive organs. There are about six large pyriform testes situated in a circular group filling the proximal three-fourths of the post-abdomen; their sperm ducts arise from their distal (posterior) ends and immediately join to form the common duct which, passing forward beside the testes and through the neck into the abdomen, crosses on the right of the posterior part of the intestinal loop and follows the ascending branch of the

latter, lying along its right ventral aspect. In some individuals the terminal part of the sperm duct (alongside the rectum) is much distended with spermatozoa. The ovary consists of a group of a few eggs in different stages in the extreme end of the post-abdomen. An oviduct accompanying the sperm duct was not satisfactorily demonstrated. The reason for this may, however, have been the poor development of the ovaries, which were small and in some individuals were not found at all. The male organs, on the other hand, were well developed and evidently functional. Neither was an incubatory pouch for the development of the embryos found in the specimens studied, but it may be developed at certain stages, as in other members of the genus.

The specimens, about ten in number, are from three localities, as follows: Marco, Florida, "on beach," collected by Henry Hemphill (includes type); Key West, Florida, Steamer Albatross, April 15–27, 1884; and from southeast of Jamaica (Station 2136, Steamer Albatross, 17° 43′ 40″ N., 75° 38′ 25″ W., 52 fathoms, coral and broken shells). The specimens labeled "on beach" were very likely washed up from deeper water. Type in U. S. National Museum.

It is evident from the above description that this species differs considerably from the typical members of the genus *Holozoa*, such as *H. bermudensis* just described, even though we must regard the post-abdomen of the present species merely as a diverticulum of the abdomen and not as homologous with the post-abdomen of the Synoicidæ, which contains, besides the reproductive organs, the heart, pericardium and epicardium. A very similar species is *H. mikropnoa* (Sluiter) of the Australian and Malayan region (see Hartmeyer, 1920, p. 130). That form has, however, among other differences, only nine or ten stigmata in a row on each side and appears to have the sexes separate, while many, if not all, individuals of the present species are hermaphroditic.

PHLEBOBRANCHIATA Lahille
[= Diktyobranchia Seeliger]

A rather well-defined, though heterogeneous, group of simple and compound ascidians having a system of internal longitudinal vessels (though in a few cases these are rudimentary or lost), but no large folds in the branchial sac. Tentacles always simple, gonads on one side only, in immediate vicinity of digestive tract.

Diazonidæ Garstang, 1891

A small family, having the body divided, as usual in compound forms, into thorax and abdomen and the dorsal lamina replaced by a row of languets, but distinguished by possessing internal longitudinal vessels (usually well developed) and many rows of stigmata in the branchial sac.

RHOPALÆA Philippi, 1893

[=*Rhopalæa*+*Rhopalopsis* Herdman, 1890]

The two genera are united on the ground that they differ in no essential character, except that *Rhopalæa* is said not to reproduce by budding. *Rhopalopsis* is, however, apparently more often found solitary than compound and never forms colonies of more than a few slightly connected individuals, while evidence that *Rhopalæa* never buds is very insufficient. The genus is distinguished by the large, completely or nearly completely separated zooids and the thick, hard test.

Rhopalæa abdominalis (Sluiter), 1898

Figures 48–51

1898. *Ciona abdominalis* Sluiter, Mém. Soc. Zool. France, XI, p. 8, Pl. 1, figs. 3–8.
1909–1911. *Ciona abdominalis* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1414, 1630.

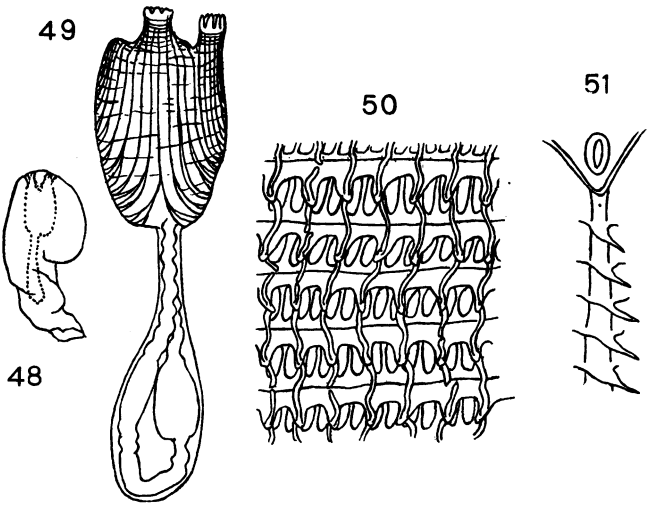
Of the few specimens of this species that were collected, only one shows any evidence of budding, consisting of several small individuals united by their basal portions into an irregular group; the other specimens each consist of a single individual only.

Though the body of the animal when removed from the test has the form usual in compound ascidians, consisting of a thoracic and an abdominal part united by a constricted neck, the external form is exceedingly variable and usually quite irregular, owing to the great and uneven thickness of the test. The normal form is evidently club-shaped, with the anterior end large and rounded; the posterior part of the body is usually narrower, though irregularities in the thickness and outline of the test may alter these relations. The attachment is in most cases by the greater part of one side, leaving, however, the anterior part of the body more or less free. External length of largest individual 24 mm., greatest width about 10.5 mm.; when removed from the test, the body in its somewhat contracted state may be only from one-half to two-thirds of the external length.

Test free from incrusting foreign matter and smooth externally, except for a few slight wrinkles, which are probably due to shrinkage in preservation. It is semitransparent, slightly cartilaginous in character, and not very tough, though a thin inner layer of a much tougher consistency immediately incloses the abdominal part of the body of the animal. The color of the alcoholic specimens is carmine pink or somewhat violet-pink, shading toward a deep carmine on the anterior part of the body, especially about the apertures; the color is in part diffused in

the test, but also largely due to pigment cells and corpuscles of a deep carmine color in the mantle, in the vessels of the branchial sac, and elsewhere in the tissues of the zooids, especially on the anterior part of the body.

The apertures are on short, stout, anteriorly directed tubes, the branchial is rather irregularly lobed, the atrial has six deep rounded lobes.



Figs. 48–51. *Rhopalæa abdominalis* (Sluiter), 1898

Fig. 48. Outline of individual including test, slightly enlarged. **Fig. 49.** Individual removed from test, showing muscle bands on mantle, × 5.6. **Fig. 50.** Piece of the branchial sac, × 56. **Fig. 51.** Dorsal tubercle and anterior part of median dorsal vessel with five of the dorsal languets, × 56.

Mantle thin, with little musculature except the sphincters of the orifices and about twenty distinct and strong longitudinal bands on each side of the thorax; toward their posterior ends these bands curve toward the median dorsal or ventral line (according to whether they are nearer to the dorsal or ventral aspect), so that they become nearly transverse, and at the same time they divide into several narrower, somewhat diverging bands. The abdominal walls are thin and without conspicuous muscle bands.

Tentacles rather few in number, though several different sizes or orders are represented.

Orifice of dorsal tubercle oval, longitudinally elongate.

Dorsal lamina represented by narrow, triangular, transversely expanded languets arising directly from the median dorsal vessel.

Branchial sac with about forty rows of very small and numerous stigmata; the rows are separated by transverse vessels bearing small triangular papillæ which support a well-developed system of internal longitudinal vessels. These vessels connect with the supporting papillæ a little below the tips of the papillæ, so that the tips project into the branchial cavity a very little beyond the level of the internal longitudinal vessels. There are over forty of these vessels on each side. With the transverse vessels they form meshes which appear to usually contain only two stigmata.

The intestinal loop is rather long and narrow; the stomach is oval; definite plications in its wall were not demonstrated.

The reproductive organs are situated beside the intestinal loop and consist of a saccular ovary containing a large number of small eggs and of very numerous, small, pear-shaped testes, the common duct from which accompanies the ascending branch of the intestine.

The specimens are from the following localities:

Station 2413, Steamer Albatross, March 19, 1885, 26° N., 82° 57′ 30″ W., 24 fathoms, fine sand and broken shells. Three specimens (one consisting of several zooids; whether or not the others were part of the same colony is uncertain).

Station 2138, Steamer Albatross, February 29, 1884, 17° 44′ 05″ N., 75° 39′ W., 23 fathoms, coral and broken shells. One individual.

Station 7511. Steamer Fish Hawk, off Cape Florida, in Gulf Stream, 2⅞ miles SSE. of Fowey Rocks Light. Rocky, 45 fathoms. One individual.

All the above in the National Museum collection.

There does not seem to be much question that these specimens are of Sluiter's species which clearly belongs to this group of ascidians and not to *Ciona*. His type was larger than any of them, being 35 mm. long, and it lacked the pink or carmine coloration of the present specimens, but it may have become faded. It was obtained at Tortugas Island in 45 meters. Whether it is a valid species or identical with some Old World form seems open to question.

Phallusiidæ (proposed *nomen conservandum* Ascidiidæ)

[=Ascidiidæ, s. Phallusiidæ *auct. omn.*+Perophoridæ Giard, 1872]

Body not divided into thorax and abdomen. The digestive and reproductive organs lie beside the branchial sac on the left side of the body.

Branchial aperture most frequently with eight or seven lobes, the atrial aperture with six.

Tentacles simple and filiform.

Dorsal lamina a continuous (often toothed) membrane, or replaced by a series of languets.

Branchial sac with internal longitudinal vessels (which often bear papillæ), but no large folds.

Reproductive organs in, or spreading over the surface of, the intestinal loop.

For reasons for uniting the Phallusiidæ and Perophoridæ, see p. 292. The question of whether the family Cionidæ Lahille, 1887, should not also be included need not be considered here, as it has not yet been proved to inhabit this region. Its typical genus *Ciona* approaches the Diazonidæ in some characters, rather than the Phallusiidæ.

PEROPHORA Wiegmann, 1835

Compound ascidians with small zooids having only four rows of stigmata. In our species the zooids are entirely separate, connected only by a branching stolon. Dorsal lamina represented by languets.

Perophora viridis Verrill, 1871

Figure 52

1871. *Perophora viridis* Verrill, Amer. Journ. Sci., (3) II, p. 359.
1872. *Perophora viridis* Verrill, Amer. Journ. Sci., (3) III, p. 212.
1873. *Perophora viridis* Verrill and Smith, 'Rept. on Invert. Animals of Vineyard Sound,' pp. 702, 388, 401.
1879. *Perophora viridis* Verrill, 'Preliminary Check-list of Marine Invertebrata,' p. 27.
1889. *Perophora viridis* MacDonald, Rep. U. S. Comm. Fish and Fisheries for 1886, p. 858.
1891. *Perophora viridis* Herdman, Journ. Linn. Soc. London, Zool., XXIII, p. 602.
1897. *Perophora viridis* Lefevre, Anat. Anzeiger, XIII, p. 474.
1898. *Perophora viridis* Lefevre, Journ. Morphology, XIV, p. 369.
1898. *Perophora* species, Davenport, Science, new series, VIII, p. 687.
1898. *Perophora viridis* Bumpus, Science, new series, VIII, p. 853.
1900. *Perophora viridis* Wilson, Amer. Naturalist, XXXIV, p. 354.
1900. *Perophora viridis* Metcalf, Zool. Jahrbücher, Anat., XIII, p. 508, Pl. XXXIV, fig. 14 (ganglion, neural gland, etc.).
1900. *Perophora viridis* Herdman, Trans. Biol. Soc. Liverpool, V., pp. 158, 159.
1902. *Perophora viridis* Van Name, Trans. Conn. Acad. Sci., XI, p. 337, Pl. XLVII, fig. 8.
1905. *Perophora viridis* Seeliger, Bronn's 'Tier-reich,' III, suppl., p. 981 (budding).
1909–1911. *Perophora viridis* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1410, 1633.
1910. *Perophora viridis* Van Name, Proc. Boston Soc. Nat. Hist., XXXIV, p. 357, text fig. 3.
1913. *Perophora viridis* Miner, Amer. Museum Journ., XIII, p. 91.
1913. *Perophora viridis* Sumner, Osburn and Cole, Bull. U. S. Bureau of Fisheries, XXXI, pp. 155, 158–160, 730, 731; chart 193.
1916. *Perophora viridis* Pratt, 'Manual Common Invert. Animals,' p. 668.

The small ovoid bodies of the zooids of this species, which measure from 2.5 to 3.5 mm. in greatest diameter (length), are borne on the tips of the branches of a slender stolon which grows like a vine over shells, algæ, other ascidians, or other submerged objects in shallow water. The zooids have a thin, transparent covering of test; their tissues are usually transparent and colorless, except for some yellowish or greenish pigment

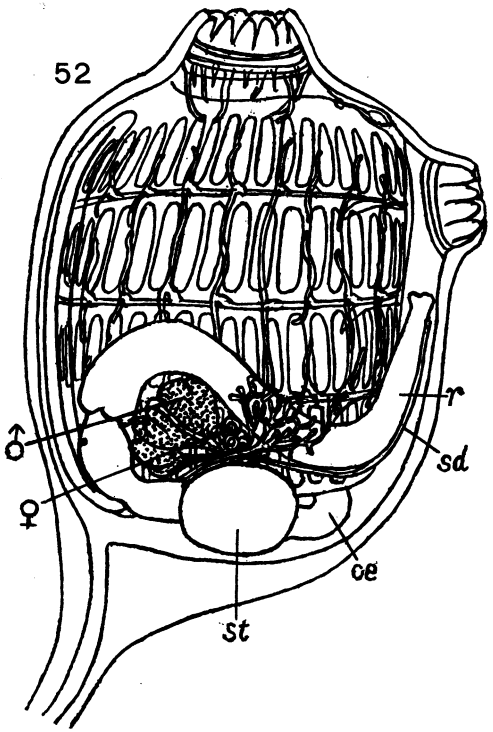


Fig. 52. *Perophora viridis* Verrill, 1871
Left side of zooid, × 27.

contained in branching vessels in the mantle, which, aside from the sphincters of the apertures, has only a few slender longitudinal and oblique muscle bands. Apertures with a variable number of lobes.

Tentacles about twenty-four, of three sizes or orders.

Three languets represent the dorsal lamina.

Branchial sac with four rows of long stigmata; over twenty in a row on each side. Transverse vessels provided with inwardly projecting papillæ which support an incompletely developed system of internal

longitudinal vessels. These are separated by the width of about two stigmata.

Digestive tract forming a fairly large loop lying beside the branchial sac on the posterior part of the left side of the body, as in most simple ascidians. Stomach small, ellipsoidal.

Reproductive glands lying in the intestinal loop. Male glands pear-shaped or cuneate; arranged in a fan-like manner about the origin of the common sperm duct with which they communicate by small individual ducts. Their number varies in different individuals; in some zooids some or most of the individual glands are fused together into a large mass, though this may be incompletely divided by clefts into lobes representing the individual glands. The common sperm duct accompanies the rectum. Ovary situated beside the origin of the common sperm duct.

This animal is common on the southern New England coast, at Beaufort, North Carolina, and also at Bermuda. Hartmeyer (1908) reports a member of this genus (presumably this species) at Tortugas, Florida. At Porto Rico it was collected at Ponce along the shore and off Point Brea in 9½ fathoms.

P. banyulensis Lahille, 1887, is a closely allied, if really distinct, Mediterranean form.

ECTEINASCIDIA Herdman, 1880

Differs from *Perophora* chiefly in the elongated branchial sac with many rows of stigmata.

Ecteinascidia turbinata Herdman, 1880

Figure 54

?1823. *Ascidia claviformis* Lesueur, Journ. Acad. Nat. Sci. Philadelphia, III, p. 5, Pl. I, fig. 3.

1880. *Ecteinascidia turbinata* Herdman, Proc. Royal Soc. Edinburgh, X, p. 724.

1882. *Ecteinascidia turbinata* (? part) Herdman, 'Rept. Voy. Challenger, Zool.,' VI, p. 243, Pl. XXXVI, figs. 1–6.

1886. *Ecteinascidia turbinata* Sluiter, Natuurk. Tijdschr. Nederl. Ind., XLV, pp. 169, 171.

1887. *Ecteinascidia turbinata* van Beneden, Bull. Acad. Roy. Soc., Belgique, (3) XIV, p. 28.

1890. *Ecteinascidia turbinata* Herdman, Trans. Biol. Soc. Liverpool, V, pp. 148, 160.

1891. *Ecteinascidia turbinata* Herdman, Journ. Linn. Soc. London, Zool., XXIII, p. 602.

1897. *Ecteinascidia turbinata* Lefevre, Anat. Anzeiger, XIII, p. 474, figs. 1–6 (budding).

1897. *Ecteinascidia turbinata* Lefevre, Science, new series, V, p. 433.

1900. *Ecteinascidia turbinata* Verrill, Trans. Conn. Acad. Sci., X, p. 588.
1900. *Ecteinascidia turbinata* Metcalf, Zool. Jahrbücher, Anat., XIII, pp. 507, 588, Pl. XXXIV, fig. 12; Pl. XXXVIII, fig.65.
1902. *Ecteinascidia turbinata* Van Name, Trans. Conn. Acad. Sci., XI, p. 338, Pl. XLVII, figs. 4, 6; Pl. LIX, fig. 116. (Young individuals.)
1906. *Ecteinascidia turbinata* Rennie and Wiseman, Proc. Zool. Soc. London, p. 905, Pl. LXV, fig. 12.
1909–1911. *Ecteinascidia turbinata* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1412, 1614, 1633.
1918. *Ecteinascidia turbinata* Michaelsen, Jahrb. Wiss. Anst., Hamburg, XXXV, suppl. 2, pp. 65, 67, 68.

The colony in this species consists of a dense group or cluster of elongate, somewhat club-shaped zooids, each with its own separate covering of test, which are connected by their tapering bases with a network of stolons that adheres to the surface of the object on which the colony grows. Mangrove roots and turtle grass are among the most frequent bearers of such colonies; in such cases the colony generally entirely surrounds the root or the grass, not infrequently for a length of 12 or 15 cm.

Zooids ordinarily about 20 mm. long or less, but occasionally larger. They are of oblong form, truncate at the anterior end where the two apertures are situated, and rather abruptly tapered at the other end to a narrow pedicel containing the vessel that connects the individual with the rest of the colony.

Test transparent and colorless, thicker on the ends of the body. Mantle and internal organs also very transparent, but in the living zooids and in specimens not too long preserved, this shades into yellow, orange, or pinkish orange on the anterior part of the body, the color being largely due to pigment in cells in branching vessels in the mantle. The intestinal loop is colored yellow or orange. A large colony of this species that the writer collected on mangrove roots at Plantation Key, Florida, had the zooids almost entirely bright orange during life, but most of this color quickly faded out on preservation, remaining only on the anterior part of the body.

Apertures on short tubes or slight elevations which often do not project beyond the surface of the thick layer of test covering this end of the body. Margin of apertures thin; when expanded it varies from practically plain to quite deeply and irregularly sinuate. In contraction it is always more or less sinuate. The branchial aperture is larger and a little farther forward than the atrial, though both are usually directed straight forward.

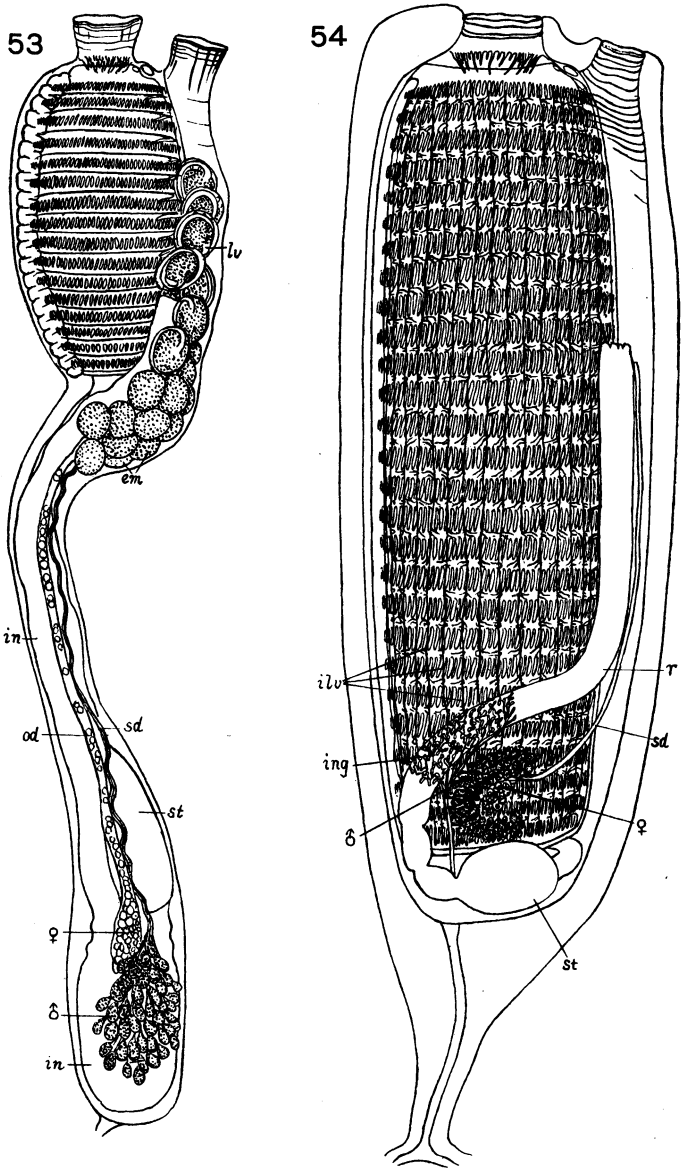


Fig. 53 *Clavelina oblonga* Herdman, 1880
Left side of zooid (branchial sac contracted; embryos and larvæ in peribranchial cavity), × 10.5.

Fig. 54. *Ecteinascidia turbinata* Herdman, 1800
Left side of zooid, × 7.2.

Mantle musculature slight. The sphincters of the apertures consist of slender slightly separated bands, and numerous very narrow transverse bands cross the dorsal region and extend down the sides, but are wanting on the ventral regions.

Tentacles filiform, quite numerous and of three sizes in large individuals, and arranged with considerable regularity. A specimen 20 mm. long had between thirty and forty tentacles.

Dorsal tubercle elongate oval.

Dorsal lamina a continuous membrane which is extended into a well-developed languet at each transverse vessel. Or it may be described as a series of languets connected by a basal membrane. It lies turned over toward the right side of the body.

Branchial sac long, barrel-shaped, with about twenty-seven rows of small oval or elongate stigmata. They are rather irregular in width and to some extent also in length. There are about sixty in a row. At intervals of about three or four stigmata the transverse vessels bear small papillæ which support on their tip a system of exceedingly slender yet in most parts of the sac completely developed internal longitudinal vessels. The supporting papillæ have their bases broad in a direction parallel to the transverse vessels. Along the sides of the endostyle and the median dorsal vessel, the first internal longitudinal vessel may be incompletely developed, or represented only by its supporting papillæ.

Stomach elliptical, intestinal loop open dorsally, rectum long and straight, lying along the dorsal border of the branchial sac on the left side and ending about opposite the tenth row of stigmata from the anterior end in a slightly lobed aperture. Intestinal gland well developed. It encloses the ascending part of the intestinal loop for a considerable distance and consists of crooked branching tubules ending in minute bulbs. These tubules unite to a number of slender ducts which leave the intestine and converge to form a stout common duct that enters the intestine just beyond the pylorus, as in *Perophora*.

Reproductive organs in the bend of the intestinal loop. The male portion consists of a C-shaped or horseshoe-shaped group of small oval or lobed glands which lie more or less concentrically with the curvature of the intestine. The common sperm duct accompanies the rectum almost to the anus. The ovary consists of a cluster of eggs in the bend of the C-shaped group of testes. No oviduct was demonstrated.

Young zooids have the body shorter and more oval, the apertures more prominent and relatively farther apart, and the rows of stigmata less numerous than in the adult. They much resemble individuals of the genus *Perophora* in their appearance.

This animal is common and widely distributed, and is one of the most conspicuous ascidians of the West Indian region, on account of the large size and bright color of the colonies. It occurs in the shallowest situations; its habit of growing on mangrove roots and turtle grass has already been mentioned.

It is common at Bermuda (the type locality); southern Florida, (Plantation Key, Grassy Key, very abundant also on flats near Rabbit Key, Bay of Florida); and in the Bahamas (Andros Island). Lefevre (1897) collected it at Jamaica, the Steamer Albatross at St. Thomas (shore), Rennie and Wiseman (1906) report specimens from the Cape Verde Islands, and examples from Alexandria, Egypt, are mentioned by Herdman, 1882, though the last may belong to another species (see Michaelsen, 1918, p. 67). This animal may be identical with *Ascidia claviformis* Lesueur, 1823, from St. Vincent, but Hartmeyer, 1912a, has expressed a different opinion, identifying (doubtfully) *Clavelina oblonga* with Lesueur's species. Herdman (1906, p. 299) gives the present writer as authority for the statement that *Ecteinascidia thurstoni*, an Indian Ocean species, occurs at Bermuda. Professor Herdman must have had the present species (*E. turbinata*) in mind, as no other is known from Bermuda.

PHALLUSIA Savigny, 1816

[=*Ascidia auct. plur.* Proposed *nomen conservandum, Ascidia*]

Simple ascidians, often of large size, with characters as given above for the family. Papillæ present on internal longitudinal vessels. Dorsal lamina a continuous (often more or less toothed) membrane.

Phallusia nigra Savigny, 1816

[*Ascidia nigra* under proposed system of *nomina conservanda*]

Figures 55–58

1816. *Phallusia nigra* Savigny, 'Mém. s. l. animaux sans vertèbres,' II, part 1, p. 163, Pl. II, fig. 2; Pl. IX, fig. 1.

1820. *Phallusia nigra* Savigny-Oken, Isis, p. 803, figs. on Pls. IX and XI.

1823. *Ascidia atra* Lesueur, Journ. Acad. Nat. Sci. Philadelphia, III, part. 1, p. 2, Pl. I; fig. 2.

1852–1856. *Phallusia violacea* Gould, 'U. S. Exploring Exp.,' XII, p. 495, Atlas, p. 16, Pl. LII, fig. 610.

1878. *Ascidia nigra* Heller, Sitzungsber. Akad. Wiss. Wien, math.-nat. Kl., LXXVII, p. 92.

1880. *Ascidia nigra* Herdman, Proc. Roy. Soc. Edinburgh, X, p. 466.

1882. *Phallusia atra* Traustedt, Vidensk. Meddel. natur. For. Kjöbenhavn, ann. 1881, pp. 278, 286, Pl. IV, fig. 6; Pl. V, fig. 17.

1882. *Ascidia nigra* Herdman, 'Rept. Voy. Challenger, Zool.,' VI, p. 210.

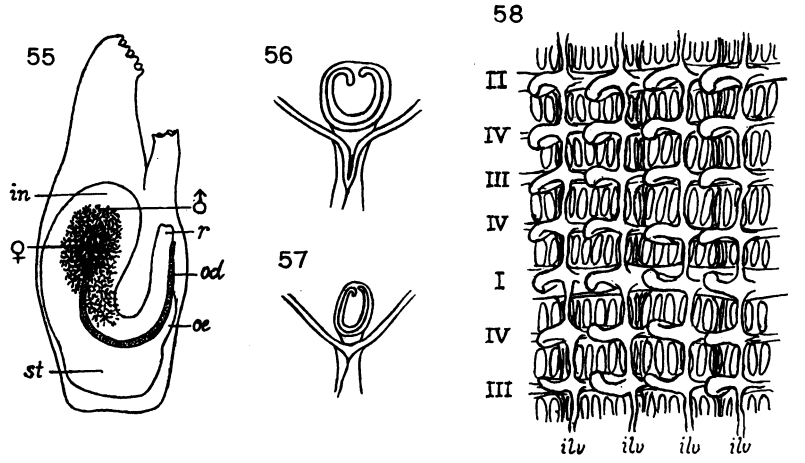
1884. *Ascidia nigra* von Drasche, Denk. Akad. Wiss. Wien, XLVIII, p. 383, Pl. VIII; figs. 5–7.
1891. *Ascidia atra* Herdman, Journ. Linn. Soc. Zool., XXIII, p. 592.
1897. *Ascidia atra* Metcalf, Zool. Bulletin, I, p. 143, figs. 1–4.
1898. *Ascidia atra* Sluiter, Mém. Soc. Zool. France, XI, p. 7.
1900. *Ascidia nigra* Verrill, Trans. Conn. Acad. Sci., X, p. 588.
1900. *Ascidia atra* Metcalf, Zool. Jahrbücher, Anat., XIII, pp. 500, 502, text figs. A–D.
1902. *Ascidia atra* Van Name, Trans. Conn. Acad. Sci., XI, p. 398, Pl. LXIII, figs. 138, 139.
1905. *Ascidia nigra*+*A. obocki*+*A. somaliensis* Sluiter, Bull. Mus. Hist. Nat. Paris, XI, pp. 100, 101; 1905*a*, Mém. Soc. Zool. France, XVIII, pp. 6–8, Pl. I, figs. 1–1*c*, 2–2*b*.
1908. *Thallusia nigra* Hartmeyer, Year Book of Carnegie Inst., Washington, No. 6, ann. 1907, p. 111.
1909–1911. *Phallusiopsis nigra* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1408, 1630, 1632–1634.
1912. *Phallusiopsis nigra* Hartmeyer, 'Deutsch. Tiefsee-Exp.,' XVI, pp. 361, 363.
1913. *Tunica nigra* Hilton, Zool. Jahrbücher, Anat., XXXVII, p. 113.
1916. *Phallusia nigra* Hartmeyer, Sitzungsber. Gesell. naturf. Freunde, Berlin, ann. 1915, p. 408, figs. 5–9.
1916. *Ascidia atra* Hecht, Journ. Exper. Zool., XX, p. 429.
1916. *Ascidia atra* Pratt, 'Manual Common Invert. Animals,' p. 667.
1918. *Ascidia atra* Hecht, Journ. Exper. Zool., XXV, pp. 229–299, figs. 1–6, 9, 10, 12; Amer. Journ. Physiol., XLV, pp. 157–187.
1918. *Phallusia nigra* Michaelsen, Jahrb. Hamburg. Wiss. Anst., XXXV, suppl. 2, p. 60.
1919. *Phallusia nigra* Michaelsen, Denk. Akad. Wiss. Wien, XCV, pt. 10, p. 113.

Body oval or somewhat elongate, usually more or less curved or distorted, broad and often inflated at the posterior end, but tapering toward the anterior end where the branchial aperture is situated, and more or less compressed laterally, especially in the anterior part, or sometimes throughout its whole extent. Atrial aperture usually on a short anteriorly directed tube or prominence, a little way back from the anterior end. The whole anterior part of the body is very commonly curved dorsally so as to bring the two apertures quite near together. This seems to be more or less characteristic of this species. Attachment by an area on the posterior or left posterior part of the body, sometimes by much of the left side.

Test thick and firm but not very tough. Color blue-black; surface smooth and shiny, with the exception of a few shallow furrows. The color, which pervades many of the internal structures as well as the test, is retained in preserved specimens. Very young specimens are colorless, but the dark pigment usually begins to appear when they are still very small.

The largest specimen in the Porto Rico collection measures even in a strongly curved condition 95 mm., and 45 mm. in transverse (dorso-ventral) diameter. A specimen from Bermuda 92 mm. by 47 mm. is in the American Museum, and Sluiter (1898) records one 110 mm. long.

Mantle dark colored, provided with many narrow longitudinal muscle bands crossed by slenderer and more closely placed transverse and oblique bands forming a fine network. On the right side the musculature extends the whole length of the body; on the left side the muscles disappear on the region covering the stomach and intestine.



Figs. 55–58. *Phallusia nigra* Savigny, 1816

Fig. 55. Left side of body slightly reduced. Figs. 56 and 57. Dorsal tubercles of two individuals, × 12. Fig. 58. Part of branchial sac, × 32.

Tentacles of three or four sizes or orders, often arranged with some degree of regularity. The number is very variable (reaching 50 to 90 in fairly large specimens) and depends largely on the extent to which the small tentacles are developed, these being often almost or entirely wanting in some parts of the circle.

The dorsal tubercle was small and simple, usually with a U-shaped or horseshoe-shaped orifice, having the open interval directed forward with the horns more or less incurved, in the Bermuda and West Indian specimens in which this character was studied by the writer. Metcalf (1907) found numerous minute accessory openings leading from, and situated along, the neural duct in two large specimens from Jamaica; the orifice of the dorsal tubercle itself was of the normal form in these specimens. The ganglian and neural glands are very far back from the

dorsal tubercle in this species, and the neural duct is, in consequence, very long.

Dorsal lamina with transverse ribs along its left side and with small sharp serrations on its free margin. These are best developed on the posterior part.

Branchial sac with the minute undulations or plications characteristic of this genus well developed. Rather long, curved papillæ are borne on the internal longitudinal vessels at their intersections with the transverse vessels; intermediate papillæ are not present. Transverse vessels near together, of several sizes or orders, arranged with a variable degree of regularity in a different individuals. Stigmata in each mesh usually 5 to 10, depending on the amount of plication which is present. The branchial sac extends a little way posterior to the stomach.

Digestive tract rather large and strongly curved; stomach large. The whole tract covers more than half the area of the left side.

Reproductive organs only indistinctly visible through the mantle on account of the dark color of the latter. Some of the convoluted branches of the ovary are visible in the anteriorly extending loop of the intestine; the branching tubules of the male gland ramify over the visible parts of the ovary and the portions of the intestines adjacent to the ovary and proximal part of the oviduct.

This is one of the largest and certainly the most conspicuous of the simple ascidians found in West Indian waters, and is easily recognizable by its blue-black color and smooth surface, which appears to afford no secure basis of attachment for other organisms. It is widely distributed and common in shallow water, and has been reported from Bermuda, Tortugas, Florida, Jamaica, St. Croix, St. Thomas, St. Vincent, Guadaloupe, and the east coast of South America at the mouth of the Amazon, and Rio Janeiro. At Porto Rico it was found very common in Guanica Harbor on piles and mangrove roots. Several specimens were collected by Mr. Barnum Brown at Paradones, near Cienfuegos, Cuba, some of them growing in a cluster with *Pyura momus* form *pallida*. The National Museum collection contains specimens from other Cuban localities, from Curaçao and from off the west coast of Florida (21 fathoms).

The identity of the West Indian form with Savigny's *Phallusia nigra* from the Red Sea and Gulf of Oman (probably incorrectly reported also from the Cape of Good Hope by Herdman, 1882), which was for a long time in doubt, has been established by Hartmeyer (1909–1911, p. 1632; 1916, p. 413) by a direct comparison of specimens. Specimens recently received by the American Museum from the Bay of Djibouti appear to fully confirm this conclusion.

The physiology of this species is the subject of recent important papers by Hecht (1916, 1918) based on the study of specimens at Bermuda.

Phallusia hygomiana Traustedt, 1882

[*Ascidia hygomiana* under proposed system of *nomina conservanda*]

Figures 59–61

?1878. *Ascidia interrupta* Heller, Sitzungsber. Akad. Wiss. Wien, math.-nat. Kl., LXXVII, p. 89, Pl. II, fig. 9.

1882. *Phallusia hygomiana* Traustedt, Vidensk. Meddel. natur. For. Kjöbenhavn, ann. 1881, pp. 280, 286, Pl. IV, fig. 7; Pl. V, fig. 18.

?1860. *Ascidia* species Stimpson, Amer. Journ. Sci., (2) XXIX, p. 443.

1891. *Ascidia hygomiana* Herdman, Journ. Linn. Soc. London, Zool., XXIII, p. 594.

1898. *Ascidia hygomiana* (?+*A. interrupta*) Sluiter, Mém. Soc. Zool. France, XI, p. 6.

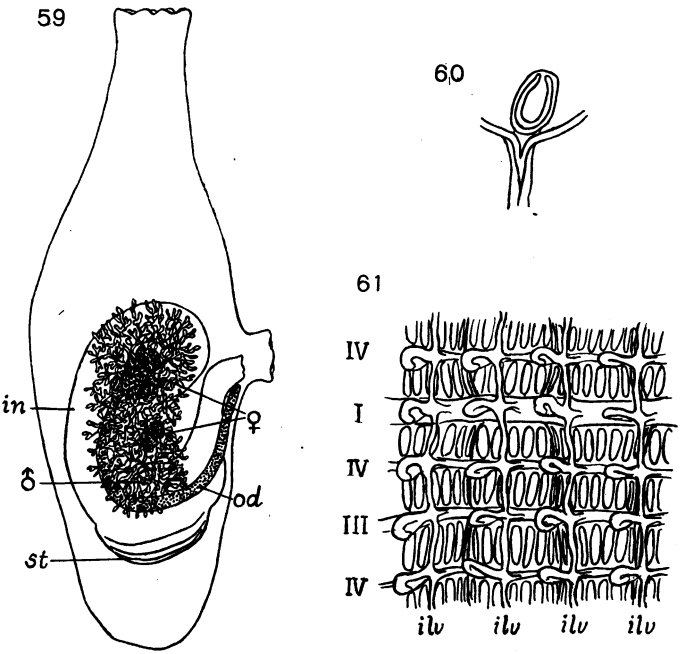
?1900. *Ascidia* species Wilson, Amer. Naturalist, XXXIV, p. 354.

1908. *Ascidia hygomiana* Hartmeyer, Year Book Carnegie Inst., Washington, No. 6, p. 111.

1909–1911. *Phallusia hygomiana* (?+*Ph. interrupta*) Hartmeyer, Bronn's 'Tierreich,' III, suppl., pp. 1402, 1630.

External shape and appearance very variable; form usually rather elongate, the branchial aperture terminal on the somewhat narrowed anterior part of the body, the atrial aperture rather far back (often near the middle of the dorsal border) on a short tube which usually extends out at a considerable angle from the long axis of the body. Body usually considerably compressed laterally; in the more regularly shaped specimens the dorsal, ventral, and posterior borders are thick and rounded, but the body is very liable to distortion, or to irregular depressions, folds, or furrows which often greatly disturb its symmetry and baffle all attempts to give a description which would cover all the variations. Attachment usually by the left ventral region, but individuals vary greatly in this respect. Some of the above irregularities in form and point of attachment are evidently due to the pressure of other individuals, for the species often grows in clumps or groups of individuals of its own or of other species, but in many cases they seem to be merely manifestations of individual variation. Many of the specimens from Fort Macon, North Carolina, are of fairly regular elliptical outline, but as a rule the anterior part of the body is considerably elongated and narrower than the posterior half; this character is still more pronounced on removing the animal from the test, as the latter is proportionally thicker on the anterior half of the body.

Size of the larger specimens usually from 40 to 50 mm. long, and from 20 to 25 mm. in dorso-ventral diameter; the amount of lateral compression is very variable. From Andros Island, Bahamas, there are several that are very large. The three largest measure 105 mm. by 38 mm., 106 mm. by 37 mm., and 77 mm. by 32 mm., respectively. The Porto Rican specimens average small.



Figs. 59–61. *Phallusia hygomiana* Traustedt, 1882

Fig. 59. Left side of body, × 3. Fig. 60. Dorsal tubercle, × 10. Fig. 61. Part of branchial sac, × 36.

Test usually rather thick (thinner in many of the Porto Rican specimens), firm, and rigid in the alcoholic material yet rather easily broken; its outer surface often fairly even but generally not shiny, often having a slightly rough, fibrous texture. It is often discolored by a very thin coating of fine mud, and in old and large specimens it may be somewhat incrusted with calcareous algæ or other foreign bodies, but usually not to any great extent. General color of the test quite variable, most commonly a rather characteristic yellowish gray or yellowish brown, but among the numerous specimens are a few with a smoky bluish cast and others of a pinkish gray. The test has but little transparency; even in

very young individuals it has a cloudy character; in older ones usually little or nothing can be seen through it.

Mantle musculature in most respects rather similar to that of *Ph. nigra* but the greater part of the left side is almost entirely free from muscles; a few longitudinal bands extend back a little way from the anterior end, though in most individuals they do not reach far. On the right side there are a small number of long longitudinal bands and a very much larger number of narrow, irregularly transverse or somewhat oblique bands forming an irregular network.

Tentacles numerous, apparently fully 100 in some individuals. They are of at least four orders and often show considerable regularity in their arrangement.

Dorsal tubercle having a horseshoe-shaped orifice with the open interval turned more or less directly forward, and the horns incurved.

Dorsal lamina with transverse ribs along its left side; the free edge is rolled over to the right and is plain anteriorly and denticulate farther back. It extends a long distance past the œsophageal opening.

Branchial sac usually narrow and tapering in the anterior part. The posterior part extends back a considerable distance beyond the stomach, and is also usually somewhat narrowed, its extreme posterior end being usually truncate or extended into a rather narrow rounded apex, but there is great variation in its shape in different individuals. Intermediate papillæ are wanting, a minute plication of the sac is developed to an extent very similar to the condition in *Ph. nigra*, and the number of stigmata in a mesh (generally from 5 to 10, depending on the amount of plication) is about the same. The transverse vessels are of several orders; the papillæ at the intersections of the transverse and internal longitudinal vessels are, however, narrower and more strongly falciform than in that species. Another difference distinguishing it from *Ph. nigra* is that the alimentary tract is smaller, covering in most individuals a smaller proportion of the left side, though the intestinal loop is bent a little more than in that species and its anteriorly extending loop is opened out a little more. Near the end the rectum often makes an abrupt dorsal bend, conforming to the dorsal direction of the atrial tube. Most of the Bahaman specimens have the part of the intestine between the apex of the anterior loop and the commencement of the rectum greatly distended with mud into a saccular enlargement. Stomach small, its wall with a few obscure plications.

A part of the ovary is visible in the opening of the anteriorly extending loop of the intestine; in some specimens a part of it is also visible in

the other loop near the bend where the intestine turns from a posterior to a dorsal direction. The tubules of the male glands ramify over most of the anteriorly extending loop of the intestine and over the proximal half (or even more) of the oviduct, and over the part of the intestine that the above portion of the oviduct accompanies.

Small renal sacs, each containing a small round brown concretion are also abundantly scattered in the region between the intestine and the adjacent body wall, but in many specimens the small size of the concretions prevents these from being very conspicuous.

This species may be the same as Heller's (1878) *Ascidia interrupta* from Jamaica. If so, his name has priority. Heller's description is, however, too incomplete for certain identification. There is also a possibility that this species is identical with Lesueur's (1823) incompletely described *Ascidia ovalis*, found on a ship's bottom at Philadelphia, doubtless brought from some other more southern locality.

The numerous specimens in the collections I have studied show it to be a common shallow-water species in the West Indian region from North Carolina (Fort Macon near Beaufort, collected by Dr. H. C. Yarrow, specimens in Yale University Museum) to Cuba (Cienfuegos, Cabañas), the Bahamas (Andros Island), and St. Thomas (on piles). It was obtained in great abundance on the piles and stringpieces of the wharves in Guanica Harbor, Porto Rico, by the American Museum expeditions. Most of the specimens were growing in densely crowded clumps and clusters containing several other kinds of ascidians, mussels, worm tubes, etc., besides numbers of its own species, and the individuals were much compressed and distorted, owing to this crowding and pressure. Records for it from the Florida coast include Key West (collected by Prof. A. S. Packard, Yale University Museum) and Cedar Keys (U. S. National Museum). There are no records from Bermuda. There is not any reason to suppose any of the above specimens were from water more than a few feet in depth.

Phallusia sydneiensis (Stimpson), 1855

[*Ascidia sydneiensis* under proposed system of *nomina conservanda*]

Figures 62–65

1855. *Ascidia sydneiensis* Stimpson, Proc. Acad. Sci. Philadelphia, VII, p. 387.

1878. *Ascidia canaliculata* Heller, Sitzungsber. Akad. Wiss. Wien, math.-nat. Kl., LXXVII, p. 84, Pl. I, fig. 1.

1882. *Phallusia longitubis* Traustedt, Vidensk. Meddel. natur. For. Kjöbenhavn, ann. 1882, pp. 283, 286, Pl. IV, figs. 11, 12; Pl. V, figs. 20–22.

1885. *Phallusia longitubis* Traustedt, Vidensk. Meddel. natur. For. Kjöbenhavn, ann. 1884, p. 16.
1891. *Ascidia longitubis*+*A. canaliculata*+*A. sydneiensis* Herdman, Journ. Linn. Soc. London, Zool., XXIII, pp. 593–595.
1894. *Phallusia longitubis* Traustedt and Weltner, Arch. f. Naturgesch., LX, p. 10.
1898. *Ascidia longitubis* Sluiter, Mém. Soc. Zool. France, XI, p. 8, Pl. 1, figs. 1, 2.
1899. *Ascidia sydneiensis* Herdman, 'Descr. Cat. Tunicata Australian Mus.,' p. 15.
1909–1911. *Phallusia longitubis*+*Ph. canaliculata*+*Ph. sydneiensis*, Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1402, 1630, etc.
1911. *Phallusia canaliculata* (part) Hartmeyer, 'Deutsch. Südpol.-Exp.,' XII, p. 576.
1918. *Ascidia canaliculata* Michaelsen, Jahrbuch Wiss. Anst., Hamburg, XXXV, suppl. 2, p. 59.
1919. *Ascidia sydneiensis* (part) Hartmeyer, Kungl. Svensk. Vetensk. Akad. Handl., LX, No. 4, p. 98.
1921. *Ascidia canaliculata* Michaelsen, Arkiv för Zoologi, XIII, No. 23, p. 5.

The body is moderately elongate (this being in part due to the large and long branchial tube into which the anterior end tapers) and moderately compressed; the posterior end broad and rather truncate, or slightly rounded. The atrial tube is well developed, situated far back, and is often directed obliquely backward or bent in that direction. Attachment by a considerable part of the left side. Branchial aperture with seven or eight lobes, the atrial with six lobes. Test colorless and quite transparent, of rather firm rigid consistency (in alcoholic specimens at least) and in the specimens at hand it is quite smooth externally and free from incrusting foreign matter. Size of largest individual (from Cabañas, Cuba): total length, 53 mm.; dorso-ventral diameter, 27 mm.; thickness, 12 mm.

The species is most readily recognized by the characteristic musculature of the mantle. The large branchial and atrial tubes have conspicuous and numerous circular muscle bands and a few longitudinal ones. Longitudinal muscles are insignificant elsewhere on the body. The whole left side is nearly free from muscles, the mantle being thin, colorless and transparent. The greater part of the right side is in the same condition, but all around the dorsal, ventral, and posterior margins of the right side there is a wide border of short stout muscle bands extending inward from the margin for a varying distance. They lie for the most part parallel to each other and at right angles to the margin, but curve and cross each other irregularly to a slight extent.

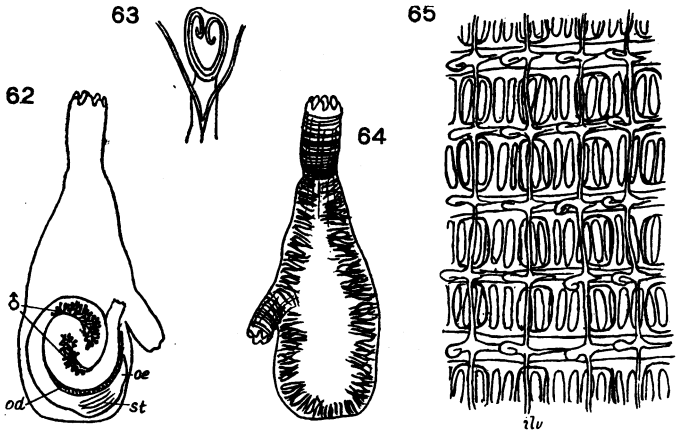
The following notes on the internal structure are based on the larger of the two Porto Rican specimens (see below); they agree sufficiently well with Traustedt's description.

Tentacles numerous, probably 60–70, of several sizes.

Dorsal tubercle heart-shaped, long and very narrow, open interval forward, horns inrolled.

Dorsal lamina with a nearly plain edge rolled over toward the right side. (Sluiter, 1898, mentions and figures a few denticulations on the posterior part.)

Branchial sac not extended much beyond the digestive tract posteriorly, its anterior part narrow, the posterior part broad. Transverse vessels of at least three or four orders, but even the smallest are fairly stout. None of them take any part in the minute plication of the



Figs. 62–65. *Phallusia sydneiensis* (Stimpson), 1855

Fig. 62. Left side of body, × 1.6. Fig. 63. Dorsal tubercle, × 12. Fig. 64. Right side of body showing arrangement of muscles in the mantle, × 1.6. Fig. 65. Part of branchial sac, × 42.

sac which is characteristic of the genus. This plication, therefore, assumes the appearance (when seen from the interior of the sac) of numerous small deep oblong pits or depressions instead of a series of ridges and furrows. Internal longitudinal vessels regular and complete but very delicate. At their intersections with the transverse vessels they bear small, narrow, much bent or hooked papillæ. Intermediate papillæ (between transverse vessels) are wanting. The internal longitudinal vessels are separated by an interval equal in width to four or five stigmata in most places; the intervening number of stigmata is, however, actually greater, owing to the minute plication above mentioned, but it is difficult to determine exactly.

Digestive tract fairly large, covering most of the posterior half of the left side. Stomach rather small, its wall apparently somewhat plicated longitudinally. Intestinal loop large but strongly convoluted into a compact mass so that the parts overlap each other more or less. This is quite different from the condition in *Ph. nigra* and *Ph. hygomiana*.

Reproductive organs almost entirely concealed by the intestine when viewed from the left side. Some of the ramifications of the testes appear upon its surface from between the coils. Of the female organs only the oviduct can be seen; it accompanies the rectum in the usual manner.

This is one of the rarer ascidians of the West Indies and but four specimens have been available for study; two small ones dredged by the American Museum expedition in Guanica Harbor, Porto Rico, 10 to 25 feet, mud, and in Condado Bay, San Juan, Porto Rico, 16 to 22 feet, sand and mud; a large one (see above) from Cabañas, Cuba, and one found on piles at St. Thomas, the two latter in the National Museum collection.

Traustedt described this species from St. Thomas and Crab Island. He reports it also (1885) from Japan. Sluiter (1898) records it from Santa Marta, Colombia; Traustedt and Weltner (1894) report it from Zanzibar. In more recent works (1911, 1919) Hartmeyer identifies Traustedt's species with a widely distributed Pacific and Indian Ocean form that has received several different specific names, *Ph. sydneiensis* (Stimpson), 1855, having the priority and *Ph. canaliculata* (Heller), 1878, being also one of its synonyms. Traustedt's identification of specimens from Japan and Zanzibar with his West Indian species supports this view, which is here adopted, although I have not myself had any opportunity of comparing West Indian and Old World specimens.

Phallusia curvata Traustedt, 1882

[*Ascidia curvata* under proposed system of *nomina conservanda*]

Figures 66–68

1882. *Phallusia curvata* Traustedt, Vidensk. Meddel. natur. For. Kjöbenhavn, ann. 1881, pp. 281, 286, Pl. IV, figs. 8–10; Pl. V, fig. 19.

1891. *Ascidia curvata* Herdman, Journ. Linn. Soc. London, Zool., XXIII, p. 592.

1898. *Ascidia curvata* Sluiter, Mém. Soc. Zool. France, XI, p. 6.

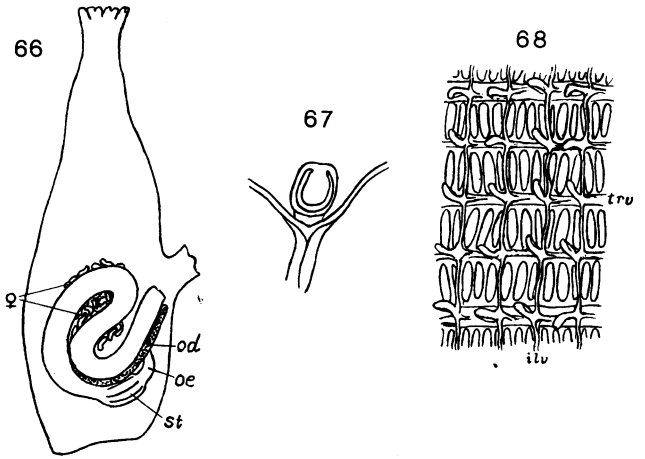
1902. *Ascidia curvata* Van Name, Trans. Conn. Acad. Sci., XI, p. 400, Pl. LVI, figs. 80–82; Pl. LXIII, figs. 145, 146.

1908. *Ascidia curvata* Hartmeyer, Year Book Carnegie Inst., Washington, No. 6, p. 111.

1909–1911. *Phallusia curvata* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1401, 1633.

The following description is based chiefly on specimens collected by the writer at Bermuda.

Body long and narrow, tapering to the branchial aperture at the anterior end and more or less truncate at the posterior end; usually attached by a large part of the left side, the tubes being turned more or less to the right or exposed side. Atrial tube far back, often beyond the middle of the body, usually rather short. Test very thin on attached side, thicker on the other, pale gray or colorless, and sometimes very transparent; markings of light orange-brown about the apertures are present in many living specimens. Some individuals have the external surface smooth and clean; others are wrinkled, or more or less completely cov-



Figs. 66–68. *Phallusia curvata* Traustedt, 1882

Fig. 66. Left side of body, × 2.2. Fig. 67. Dorsal tubercle, × 16. Fig. 68. Part of branchial sac, × 42.

ered with small shell fragments rather loosely adherent or slightly imbedded.

Mantle delicate and transparent. The sphincters of the tubes consist of a number of slender circular bands separated by slight intervals and crossed by some narrow longitudinal bands, which do not however extend much onto the sides of the body. Body musculature weak and mainly confined to the right side, where it consists of a delicate and rather open network of transverse and oblique fibers or very narrow bands crossing each other at various acute angles. These muscles have rather crooked courses. The network is rather denser along the dorsal and

ventral regions, owing to the somewhat stouter and more numerous transverse bands present there, but these do not encroach much if at all upon the left side of the body. Apertures prominently lobed. Length of largest specimen 50 mm.

Tentacles only moderately numerous; of several sizes arranged with some regularity according to the usual scheme. Dorsal tubercle simple, U-shaped or horseshoe-shaped with the open interval forward in the specimens studied.

Dorsal lamina with a toothed margin and conspicuous transverse membranes along its sides.

Branchial sac of a simple type, the small plications or areolations conspicuous in many allied species being comparatively little developed in this form, though not altogether wanting. Transverse vessels of several sizes. Internal longitudinal vessels slender and separated in most places by only three or four, seldom five, stigmata. They bear rather long curved papillæ at their crossings with the transverse vessels. No intermediate papillæ. The branchial sac extends a varying distance posterior to the stomach in different specimens.

Alimentary loop proportionately rather small, and considerably bent, forming a fairly compact mass chiefly or entirely in the posterior half of the body. Stomach small with a few longitudinal plications.

The reproductive organs, both male and female, lie between the branchial sac and the alimentary tract, mostly concealed by the latter, but visible in one of the best preserved specimens along the anterior edge of the anterior loop of the intestine as well as between the branches of the loops formed by the latter. The male glands did not appear to spread over the surface of the intestine next to the branchial sac to any considerable extent in the specimens studied.

This species was described by Traustedt from St. Thomas. I found it one of the commonest simple ascidians at Bermuda in shallow water along the shore, attached to stones, shells, etc. Hartmeyer (1908) reports it from Tortugas, but I have no other records from Florida. The American Museum collection contains a specimen from rocks in San Juan Harbor, Porto Rico.

[NOTE.—*Ascidiella styeloides* (Traustedt), 1882, p. 277, Pl. IV, fig. 5; Pl. V, fig. 16, from St. Croix and St. Thomas, W. I., represents another genus of this family. See p. 483.]

Rhodosomatidæ Hartmeyer, 1908

A small but widely distributed and varied family of simple ascidians, characterized (in many cases at least) by the course of the intestine, which bends ventrally after leaving the stomach, instead of dorsally as in most ascidians, thus coming to lie more or less on the right side of the body beside the branchial sac. Internal longitudinal vessels commonly present, though sometimes rudimentary or lost; no large folds in the branchial sac.

Rhodosoma Ehrenberg, 1828

Anterior of the body modified into a valve or cover which can close upon and protect the apertures. Stigmata straight.

Rhodosoma pellucidum (Stimpson), 1855

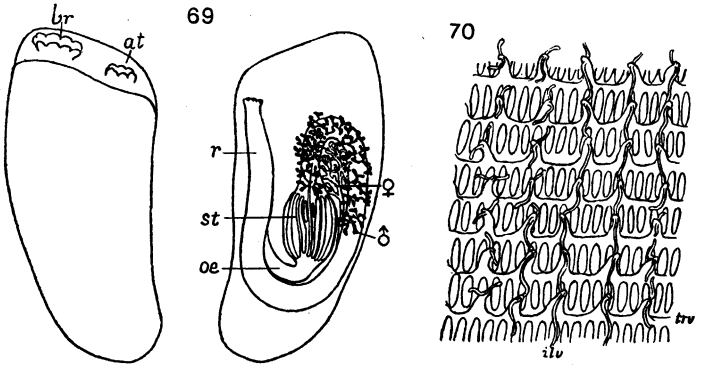
Figures 69 and 70

1855. *Schizascus pellucidus*+*S. papillosus* Stimpson, Proc. Philadelphia Acad. Sci., VIII, p. 377.
1878. *Rhodosoma seminudum* Heller, Sitzungsber. Akad. Wiss. Wien, math.-nat. Kl., LXXVII, p. 91 , Pl. I, fig. 5.
1882. *Rhodosoma pyxis* Traustedt, Vidensk. Meddel. natur. For. Kjöbenhavn, ann. 1881, pp. 274, 285; Pl. IV, fig. 4; Pl. V, figs. 15*a*, 15*b*.
1885. *Rhodosoma papillosum* Traustedt, Vidensk. Meddel. natur. For. Kjöbenhavn, ann. 1884, p. 9.
1891. *Rhodosoma pyxis* + *R. seminudum* + *R. papillosum* + *R. pellucidum* Herdman, Journ. Linn. Soc. London, Zool., XXIII, p. 598.
1898. *Rhodosoma seminudum* Sluiter, Mém. Soc. Zool. France, XI, p. 10.
1901. *Rhodosoma seminudum* + *R. papillosum* + *R. pellucidum* Hartmeyer, Arch. f. Naturgesch., suppl., XLVII, pp. 151, 158, 161; Pl. IV, figs. 2, 7, 9–11.
1904. *Rhodosoma seminudum* Sluiter, 'Siboga-Exped.,' LVIa, p. 26, Pl. I, fig. 2; Pl. IV, figs. 4–6.
1906. *Rhodosoma seminudum* Hartmeyer, Zool. Anzeiger, XXXI, p. 25.
1906. *Rhodosoma seminudum* Herdman, Rept. Ceylon Pearl Oyster Fisheries, No. 39, suppl., p. 302.
1907. [*Rhodosoma*] *papillosum* Seeliger, Bronn's 'Tier-reich,' III, suppl., p. 1077.
1909–1911. *Rhodosoma seminudum* + *R. papillosum* + *R. pellucidum* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1390, 1630, 1624, 1645.
1918. *Rhodosoma papillosum* + *R. pellucidum* Van Name, Bull. U. S. Nat. Museum, No. 100, I, p. 113, figs. 68–71.
1919. *Rhodosoma papillosum* Hartmeyer, Kungl. Svensk. Vetensk. Akad. Handl., LX, No. 4, p. 95.

The following description was prepared from a moderately large West Indian specimen.

Body oblong, not much compressed laterally, tapering toward the posterior end and attached to a shell by an area on the posterior part of the right side. Anterior end of body obliquely truncated. Just be-

hind the anterior margin a deep, obliquely transverse cleft partially separates the anterior wall of the body, which thus forms a hinged lid or cover, so that the two edges of the cleft may be brought together or separated. In this cleft the two apertures are situated near together, but the branchial a little nearer the anterior end than the atrial. The former has about eight obscurely defined lobes, and is somewhat more prominent than the atrial, which has but six lobes. Test rather transparent, nearly colorless, as usual in preserved specimens; free from foreign matter and smooth externally, except for numerous minute conical points or projections arising from the surface on the anterior end of the body and in the vicinity of the above-mentioned cleft. (Occasionally the surface is incrusted with foreign matter, or overgrown with other organisms.) Test not very thick, but firm and rigid, particularly



Figs. 69 and 70. *Rhodosoma pellucidum* (Stimpson), 1855
Fig. 69. Left and right sides of the body, × 2. Fig. 70. Part of branchial sac, × 38.

the portion constituting the lid and the margins of the cleft (which are somewhat thickened); the part lining the cleft is softer and quite flexible, permitting the lid to close tightly and entirely conceal the apertures. Size 30 mm. long by 18 mm. wide (near the anterior end). The species attains, however, a length of 50 mm. or more.

Mantle thin and almost devoid of muscles on most parts, except in the vicinity of the tubes and in the portion of the body which serves as a hinge for the lid. Here, at each end of the hinge, is a group of very short, thick bands by which the lid is moved and held closed.

The tentacles and dorsal tubercle were damaged in dissecting out the animal. According to Traustedt (1882) there are about 50 tentacles of three sizes, and the dorsal tubercle is horseshoe-shaped.

Dorsal lamina replaced by a series of rather long, narrow, triangular languets corresponding in number to the transverse vessels.

Branchial sac without folds or minute plications. Transverse vessels very numerous, alternately larger and smaller, but these are not greatly different in size in most parts of the sac. They bear at intervals equal to about four or five stigmata rather broad but thin triangular supporting papillæ which sustain a system of slender internal longitudinal vessels, the latter connecting with the papillæ not quite at their tips, thus leaving the extreme ends of the papillæ to project slightly beyond the internal longitudinal vessels. A narrow membrane connects the bases of adjacent papillæ arising from the same transverse vessel; indeed, the papillæ might be described as large serrations or triangular projections of the border of such a membrane. The system of internal longitudinal vessels is imperfectly developed and interrupted between the supporting papillæ in many parts of the sac, rudiments of the vessels being usually present as blindly ending lateral branches of the papillæ.

Alimentary tract forming a large oblong loop on the right side of the body. As is the rule in this family, the intestine passes the stomach on the ventral, instead of the dorsal, side of the latter. Stomach small, oblong, with about twenty longitudinal folds and a well-marked typhlosole, which can also be traced throughout much of the digestive tract. Intestine slender; rectum long and straight; its aperture distinctly lobed. The intestinal gland surrounds the duodenal part of the intestine for a short distance a little way beyond the stomach; its tubules are very minute and end in small bulbs.

Ovary of branching form situated in the intestinal loop anterior to the stomach. Its duct can be traced along the distal part of the intestine. Testis an extensive ramifying organ, spreading over the part of the intestine lying anterior and ventral to the stomach on the side of the intestine next to the mantle. Its minute branches end in small wedge-shaped or pear-shaped glands similar to those occurring in the genus *Phallusia*.

Having examined a number of specimens of each, I can find no sufficient characters upon which to maintain the West Indian form distinct from Stimpson's species, which is widely distributed in the Malay Region and western Pacific. Stimpson (1855) described two species, *pellucidum* and *papillosum*, from Chinese waters, but, as there is every reason to believe them identical, I employ the name that has page precedence.

In the West Indies it is uncommon, and only single individuals, not groups or clusters, are generally found. Heller's type was from

Jamaica (found with *Phallusia nigra*). Traustedt had specimens from St. Croix and St. Thomas. One specimen from Porto Rico (Condado Bay, San Juan Harbor, 16 to 22 feet, sand and mud) is in the American Museum collection. The National Museum collection has specimens from St. Thomas (piles near the town); from Jamaica; and from Station 2406, Steamer Albatross, off the west coast of Florida (28° 46′ N., 84° 49′ W., 26 fathoms, coarse sand and coral).

CORELLA Alder and Hancock, 1870

No valve or cover for the apertures. Stigmata arranged in small spirals.

Corella minuta Traustedt, 1882

Figures 71 and 72

1882. *Corella minuta* Traustedt, Vidensk. Meddel. natur. For. Kjöbenhavn, ann. 1881, p. 271, 285, Pl. IV, fig. 1.
1891. *Corella minuta* Herdman, Journ. Linn. Soc. London, Zool., XXIII, p. 588.
1909. *Corella minuta* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1393, 1630.

Owing to the poor condition of the material only an incomplete and unsatisfactory description can be given of this species. It is of very delicate structure, with a soft and flexible test which collapses to a shapeless sac in preservation. The mantle and internal parts, moreover, shrink away to a small mass occupying only a fraction of the space within the test, from the inner wall of which they become entirely detached. These difficulties make the original appearance and the correct relation of some of the parts hard to determine but, judging from the material at hand, the normal form of the body is ovate or oblong, obliquely attached by a considerable area on the posterior part of the left side, and more or less produced at the anterior end into a tube or siphon bearing the branchial aperture at its end. The atrial aperture is dorsal, little if at all produced. Both apertures are rather long, oval openings, with the margin scalloped or lobed, but so obscurely that the lobes are difficult to count.

Test thin, flexible, whitish and somewhat transparent, its surface smooth and clean except for numerous wrinkles and folds, many of which, however, are probably caused by shrinking and are not present during life. Size of largest specimen 28 mm. long by 18 mm. in greatest dorso-ventral diameter.

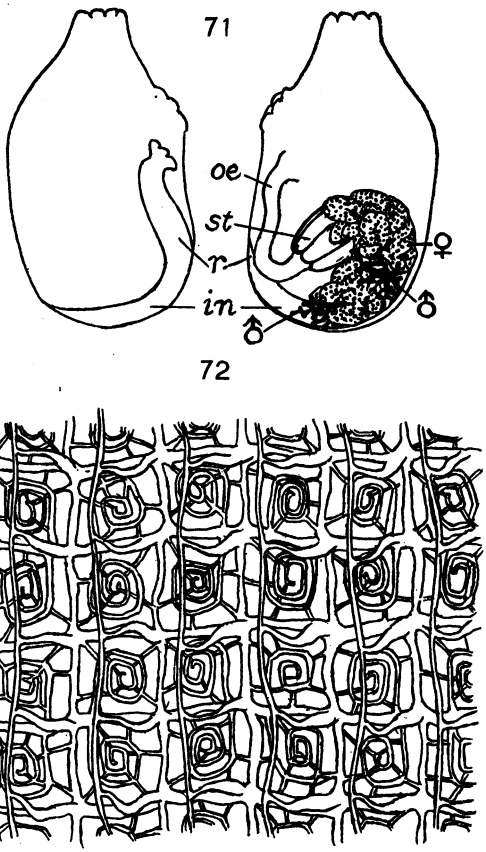
Mantle very thin and transparent, practically free from muscles.

Tentacles long and slender, their number was not determined. (Traustedt gives 26 as the number in the type.)

Dorsal tubercle small, its aperture of simple form.

Dorsal lamina represented by a series of large and rather long and narrow languets.

Branchial sac divided into small square meshes by transverse and longitudinal vessels. In each mesh there is normally a slender spiral vessel making usually from 2 to 4 complete turns. These spirals arise from every alternate transverse vessel. Those which arise opposite each other (extending out from opposite sides of the same transverse vessel)



Figs. 71 and 72. *Corella minuta* Traustedt, 1882

Fig. 71. Left and right side of body, × 2.5. **Fig. 72.** Part of branchial sac, × 45.

coil in opposite directions. These spiral vessels are not usually raised into conspicuously conical infundibula, but are generally nearly flat. By means of these spiral vessels and a few irregularly distributed radial vessels, the square meshes are subdivided. In addition to the above vessels there is a system of slender internal longitudinal vessels, raised on high, tapering supporting papillæ which arise from the transverse

vessels at their junctions with the external longitudinal vessels. These internal longitudinal vessels are smooth, without projecting papillæ. In the present specimens they appear to be complete and uninterrupted in most parts of the sac.

The alimentary tract lies chiefly on the right and posterior aspect of the body (the rectum extends forward on the dorsal aspect, or a little on the left side). The œsophagus is long and curved and opens into the oval stomach whose wall has a few deep plications. Extending forward from the stomach, the intestine curves ventrally instead of dorsally as in most ascidians, thus passing the stomach on the ventral and posterior side, where it curves forward to form the rather long rectum whose aperture has a reflexed and distinctly lobed margin.

The ovary forms a broad, flattened layer composed actually of thick branching lobes, but these divisions are so closely crowded when the organ is distended with eggs that the ovary forms an almost continuous sheet covering that aspect of the pyloric part of the stomach and of parts of the intestinal loop (except the rectum) which lies toward the mantle. The testis is likewise a branching organ; its branches and lobes are narrower and smaller than those of the ovary (at least when the latter is well developed), among and between which they ramify.

Nine poorly preserved specimens, most of them very small, were dredged by the 'Albatross' at Station 2406 off the West Coast of Florida (28° 46′ N., 84° 49′ W., 26 fathoms, coarse sand and coral), attached to calcareous worm-tubes, and so forth.

Traustedt's (1882) type of this species was from St. Thomas. He had but one small specimen. In structure it is close to *Corella borealis* Traustedt, 1886, but, as that is an arctic species only once recorded from any point as far south as Cape Ann, Massachusetts, the two can hardly be identical.

[NOTE.—A larger species (*Corella eumyota* Traustedt, 1882) with much better developed mantle musculature, widely distributed in the antarctic and subantarctic region, ranges north to Bahia on the eastern South American coast, according to Traustedt. (See below, p. 483.)]

STOLIDOBRANCHIATA Lahille

[=Ptychobranchia Seeliger]

The most highly specialized order of ascidians. It contains both compound and simple forms. Body never divided into thorax and abdomen; the digestive tract and reproductive organs always lie beside the branchial sac, which has internal longitudinal vessels and a few large longitudinal folds or plications (rudimentary or lost in a few forms). Tentacles sometimes compound.

Botryllidæ Verrill, 1871

A small but widely distributed group of compound ascidians, probably to be regarded as degenerate descendants of the same stock as the compound Styelidæ, from which they differ in having systems and common cloacal cavities (not found elsewhere in the Stolidobranchiata). Branchial folds wanting; only three internal longitudinal vessels on each side of the body. Dorsal lamina a continuous membrane.

Botryllus Gaertner and Pallas, 1774

As here employed, co-extensive with the family Botryllidæ.

Subgenus **Botryllus**

Systems small, circular or oval, containing few zooids.

Botryllus schlosseri (Pallas), 1766

Figure 73

1766. *Alcyonium schlosseri* Pallas, Elench. Zoophyt., No. 208.
1816. *Botryllus schlosseri* Savigny, 'Mém. s. l. animaux sans vertèbres,' pt. 2, p. 200, Pl. xx, fig. 5.
1871. *Botryllus gouldii* Verrill, Amer. Journ. Sci., (3) I, pp. 211, 212; figs. 14–19.
1873. *Botryllus gouldii* Verrill and Smith, 'Rep. on Invert. animals of Vineyard Sound,' pp. 702, 375, etc., Pl. xxxii, figs. 252, 253.
1903. *Botryllus schlosseri* Bancroft, Proc. California Acad. Sci., Zool., (3) III, p. 137, Pl. xvii, figs. 1–3.
1910. *Botryllus schlosseri* Van Name, Proc. Boston Soc. Nat. Hist., XXXIV, p. 350, Pl. xxxix, fig. 10, text fig. 1.
1915. *Botryllus schlosseri* (*nomen conservandum*) Apstein, Sitzungsb. Gesell. naturf. Freunde, Berlin, ann. 1915, p. 185.
1916. *Botryllus schlosseri* Hartmeyer, Sitzungsber. Gesell. naturf. Freunde, Berlin, ann. 1915, p. 252.

For other references and synonyms see Van Name (1910).

This species forms incrusting colonies of variable extent, sometimes several centimeters across, and is subject to many of the same color variations described for *Botryllus niger*, though red or orange varieties do not occur, and the colonies differ from those of that species in having the zooids arranged in small circular or oval systems, usually containing only from five to twenty zooids. The zooids average a little larger and proportionately shorter than in *Botryllus niger;* they have only nine or ten rows of stigmata and the internal longitudinal vessels are separated by about four stigmata. These characters will suffice to distinguish the two species. A more detailed description will be found in Van Name, 1910.

The distribution of this species on the coasts of the Middle and Southern Atlantic States requires further investigation. It is widely distributed on the European coasts and is very common in shallow water

on the shores of southern New England and Long Island, often growing on eel grass. I have no records between New Jersey and Florida, though I cannot suppose it is absent from that part of the coast, as the National Museum collection contains flourishing colonies from Cedar Keys and off Gasparilla Light (7 fathoms) on the west coast of Florida. I failed to find it in my collecting at Bermuda and in southeastern Florida.

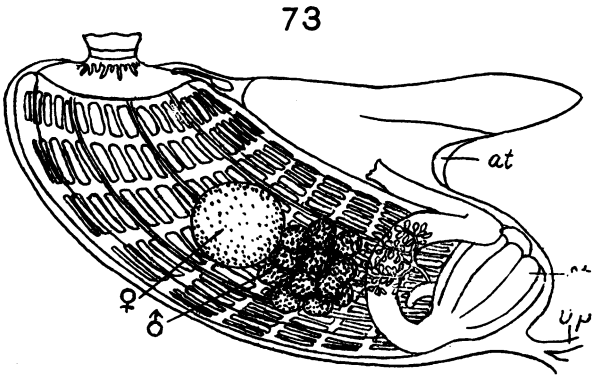


Fig. 73. *Botryllus schlosseri* (Pallas), 1766
Left side of zooid, × 45.

Subgenus **Botrylloides** (Milne-Edwards), 1841

Systems more extensive than in the subgenus *Botryllus*, elongate or branching in outline.

Though this group has until lately been almost universally recognized as a genus, the characters separating it are of no more than specific rank, and its recognition as a subgenus can only be justified on the ground of deference to established custom and to avoid the confusion that its sudden entire abandonment might cause.

Botryllus (Botrylloides) niger (Herdman), 1886

Figure 74

1886. *Botrylloides nigrum* Herdman, 'Rep. Voy. Challenger, Zool.,' XIV, p. 50, Pl. I, fig. 8; Pl. III, figs. 19–21.
1891. *Botrylloides nigrum* Herdman, Journ. Linn. Soc. London, Zool., XXIII, p. 608.
1897. *Botrylloides nigrum* Sluiter, Zool. Jahrb., Syst., XI, 1897, p. 49.
?1898. *Botrylloides chazaliei* Sluiter, Mém. Soc. Zool. France, XI, p. 10.
1899. *Botrylloides leptum* Herdman, 'Descr. Cat. Tunicata Australian Mus., 'p. 102, Pl. Botr. I, figs. 1–4.
1902. *Botrylloides nigrum*+varieties Van Name, Trans. Conn. Acad. Sci., XI, pp. 374–378, Pl. LIII, figs. 53–55; Pl. LIX, fig. 110; Pl. LXI, fig. 125.

?1906. *Botrylloides nigrum* Herdman, 'Rept. Ceylon Pearl Oyster Fisheries,' V, p. 333, Pl. VII, fig. 25.

1909–1911. *Botrylloides nigrum*+varieties Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1380, 1633, etc.

1912. *Botrylloides nigrum* Hartmeyer, 'Deutsch. Tiefsee-Exp.,' XVI, p. 270, Pl. XLI, fig. 10.

1915. [*Botryllus niger*] form *typica* Michaelsen, 'Beitr. Meeresfauna Westafrikas,' I, pp. 419, 420.

1916. *Botrylloides nigrum* Pratt, 'Manual Common Invert. Animals,' p. 669.

1918. *Botryllus niger* Michaelsen, Jarhb. Wiss. Anst., Hamburg, XXXV, suppl. 2, p. 45, fig. 6.

1919. *Botryllus niger* Michaelsen, Denk. Akad. Wiss. Wien, XCV, pt. 10, p. 105 fig. 19.

1921. *Botryllus niger* Michaelsen, Arkiv för Zoologi, XIII, No. 23, p. 9.

Colony flat and expanded when growing on extended surfaces; when growing on branching algæ, corals, etc., it may entirely surround the branches. It reaches a diameter of 100 mm. or more (in one case 180 mm); different specimens vary greatly in thickness; some are so thin and flattened that the zooids have to lie flat and are more or less compressed dorso-ventrally, others are so thick and fleshy that the zooids have more than room enough to be placed vertically (at right angles to the surface of the colony). These differences seem to be merely individual or caused by varying conditions of environment, and are without significance in classification. The same is true of variations in color. In preserved specimens the test is usually more or less transparent and nearly colorless or slightly pervaded with a purplish tint, while the zooids and bulbs of the test vessels are some shade of purple, reddish, or brown, sometimes so dark as to be almost black, in other cases very pale. The pigment is in part diffused through the tissues of the zooid, but is chiefly contained in round or oval cells in the mantle, parts of the branchial sac, and bulbs of the test vessels.

In life the colors are much more brilliant. I am familiar chiefly with the color varieties of this species which occur at Bermuda, but in that limited region many very striking and beautiful varieties can be found. Most of them have the zooids of some brown, purple, or blackish shade, as in preserved specimens, but this tint pervades also the test substance to a greater extent than after death. Sometimes the purple shades are replaced by a light bluish gray, but in preservation this changes to purple. In addition to the ground color the zooids are usually marked during life with some light-colored pigment, pure white, pale green, light yellow, or even bright orange, which usually forms a ring or star-shaped area about the branchial orifice. This pigment is likewise contained in

the mantle of the zooids, the bulbs of the test vessels, etc., but, unlike the dark pigment, it disappears almost immediately upon the death of the animal. In a few colonies the zooids were entirely of a bright orange color during life; this color pervaded the test to some extent also. On preservation the zooids in these colonies became a dull reddish, and the test practically colorless. In some specimens the adult zooids exhibit one combination of colors and the immature ones an entirely different

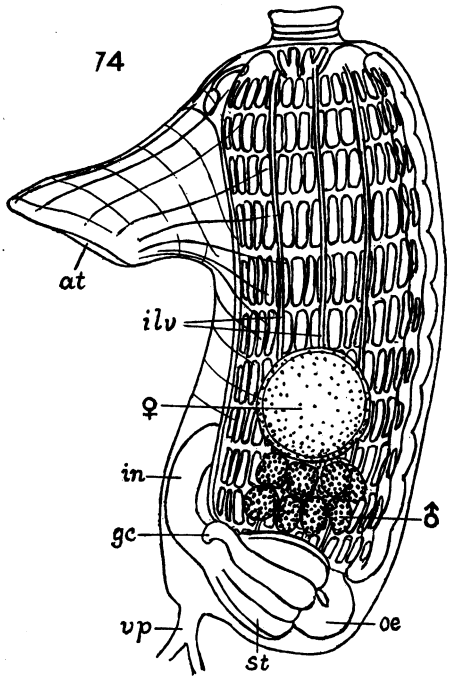


Fig. 74. *Botryllus* (*Botrylloides*) *niger* (Herdman), 1886
Left side of zooid, × 40.

combination. Sometimes two colonies entirely different in coloration will be found growing close together, attached to the same object. Several specimens dredged by the Steamer Fish Hawk near Bahia Honda Key in 11 fathoms are in the preserved condition practically without pigment, except for a conspicuous ring (dark purplish brown in the alcoholic material) about the anterior end of the thorax of each zooid.

Zooids small (in contracted preserved material often only 1.5 to 2 mm. long) and arranged in extensive branching systems. In thick

colonies they are usually closely crowded and are placed with their long axes at nearly right angles to the upper and lower surfaces of the colony. In thinner colonies their position is necessarily more or less oblique or, when the colony is very thin, nearly horizontal.

Body of zooid normally of somewhat curved, moderately elongate cylindrical form. Branchial orifice without distinct lobes; the atrial orifice large, situated at the end of a short broad tube which arises from the dorsal side of the body some distance from the anterior end and extends obliquely back. Its anterior lip is often extended to form a large languet. The form, size and position of the tube and orifice are, however, very variable. Mantle musculature moderately developed, especially in the dorsal region.

Tentacles usually of two sizes placed alternately, eight in all. Additional third-order tentacles are sometimes present.

Dorsal lamina plain.

Branchial sac with three internal longitudinal vessels on each side. They are separated by about three stigmata; next to the endostyle and median dorsal vessel there are about five stigmata before the first vessel is reached, Porto Rico specimens have eleven or possibly twelve rows of stigmata; some of the Bermuda specimens appear to have one or two more rows, while in some Florida specimens there are sometimes as many as sixteen rows, though in other specimens only eleven or twelve.

Stomach with nine principal longitudinal folds, one or two small incomplete ones, and a well-developed pyloric cæcum.

A group of small oval testes is present on each side of the body near the posterior end. Directly in front of these there is sometimes a single large egg on each side, or occasionally two. In the older zooids male organs only are found, this species being markedly protogynous (see Michaelsen, 1919, p. 107).

It will be clear from the above description that the specimens assigned to this species exhibit great variation, not only in colors but other characters, including considerable differences in the number of rows of stigmata. Nevertheless, after the study of many specimens from various localities, I have entirely failed to find any tangible basis for dividing them into more than one species. In my account of the Bermuda ascidians (1902), I attempted to give recognition to several of the more striking variations by naming three varieties (*planum*, *concolor*, and *sarcinum*) but, were all the observable differences to be accounted for, it would be necessary to greatly multiply such varieties, and there is no evidence that they represent true races. The variations seem rather to

be individual or due in part to age, stage of growth, and the immediate effect of the conditions under which the colony grows.

This species is common and widely distributed, at least in the northern part of the West Indian region, and occurs both along the shore near low-water mark and on corals, gorgonians, etc., on the reefs and in deeper water to 11½ fathoms (near Bahia Honda Key, Florida) and 21 fathoms (near the northern coast of Yucatan), according to specimens in the National Museum. It is common at Bermuda (the locality of the type, which was obtained by the Challenger Expedition), and at many points on both the east and west coasts of Florida. At Porto Rico, specimens were collected by the American Museum Expedition in Guanica Harbor and east of Caribe Cayo (5½ to 8¾ fathoms) on the south coast, and in Condado Bay, San Juan Harbor, 16 to 22 feet, on the north coast. The National Museum contains a specimen from Green Bay, Bahamas.

It is also widely distributed in the Red Sea, Indian Ocean, Malay region, and Australia (see Michaelsen, 1919, p. 106), and Herdman, 1906, reports a *Botrylloides nigrum* from Ceylon, designating it, however, as a new species, so that it is not clear whether he really intended to refer his specimen here or had forgotten that he had already applied the name *nigrum* to a member of this genus. The very brief description and the illustration he gives shed no light on this question. A variety of this species (variety *magnicœcum*) has also been described by Hartmeyer (1912*a*, p. 271, Pl. XLI, fig. 11) from the Cape of Good Hope, but is regarded by Michaelsen (1919, 1921) as a distinct species.

Sluiter (1908) described a species, *B. chazaliei* from Margarita Island, Venezuela, which agrees well with the present one in all important characters except the number of internal longitudinal vessels which Sluiter gives as four on each side. This number is often very hard to determine with certainty, unless the zooids are well expanded, and the possibility that *B. chazaliei* is a synonym of the present species does not seem to be excluded.

Styelidæ Sluiter, 1905

[=Tethyidæ Hartmeyer, 1909–1911, not Huntsman, 1912]

A large family found in all parts of the world and including both compound and simple forms. Usually they have both apertures square or four-lobed, simple filiform tentacles, a continuous dorsal lamina and four (or less) longitudinal folds on each side of the branchial sac, which always has straight longitudinal stigmata. The compound forms never have the zooids arranged in systems with common cloacal cavities.

SYMPLEGMA Herdman, 1886

[=*Diandrocarpa* Van Name, 1902]

Branchial sac with no folds and only four internal longitudinal vessels on each side. Only one gonad on each side of the body.

Herdman, 1886, described as *Symplegma viride*, new genus and species, a peculiar compound ascidian collected by the Challenger Expedition in shallow water near Bermuda. In spite of the extensive collecting since done in Bermuda waters, no such ascidian has been found again, either there or elsewhere. Michaelsen (1904, pp. 21, 22) offered the suggestion that *Symplegma* and *Diandrocarpa botryllopsis* Van Name, 1902, also from Bermuda, are identical, and made out a strong case in favor of this view. Such a possibility had indeed occurred to me in describing *D. botryllopsis*, but had been dismissed, as the discrepancies between Herdman's description and the real structure of *Diandrocarpa* seemed too great and too numerous to have been overlooked by so experienced an observer as Professor Herdman. Nevertheless, it seems certain that Michaelsen was right and that Herdman's specimen was too poor to give him a correct idea of its structure; the name *Symplegma viride* is accordingly used here instead of *Diandrocarpa botryllopsis*.

Other species and varieties of the genus (see Michaelsen, 1904, 1919; Herdman, 1906) have been since described, showing it to be very widely distributed in the tropical regions; the distinctions separating these additional forms from the Bermuda species and from each other do not, however, appear to be of a kind likely to prove very constant or reliable. (Cf. Michaelsen, 1918, pp. 39, 40; 1919, pp. 104, 105.)

Symplegma viride Herdman, 1886

Figure 75

1886. *Symplegma viride* Herdman, 'Rept. Voy. Challenger, Zool.,' XIV, p. 144, Pl. XVIII, figs. 7–14.

1891. *Symplegma viride* Herdman, Journ. Linn. Soc. London, Zool., XXIII, p. 606.

1902. *Diandrocarpa botryllopsis*+*Symplegma viride* Van Name, Trans. Conn. Acad. Sci., XI, p. 383, Pl. LIV, fig. 68; Pl. LIX, figs. 120, 121; Pl. LX, fig. 123; p. 378, Pl. L, fig. 22.

1904. *Diandrocarpa botryllopsis* (?+*Symplegma viride*) Michaelsen, Jahrb. Wiss. Anst., Hamburg, XXI, suppl. 2, pp. 21, 22, 42, 43.

1907. *Diandrocarpa botryllopsis*+*Symplegma viride* Seeliger, Bronn's 'Tier-reich,' III, suppl., pp. 1132, 1145, text fig. 214.

1909–1911. *Diandrocarpa botryllopsis*+*Symplegma viride* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1371, 1633.

1918. *Symplegma viride* Michaelsen, Jahrb. Wiss. Anst., Hamburg, XXXV, suppl. 2, p. 40.

1919. *Symplegma viride* Michaelsen, Denk. Akad. Wiss. Wien, XCV, pt. 10, p. 105.

Colony thin and incrusting, usually not averaging over 2 mm. thick, but sometimes 60 mm. across; commonly of very irregular form, owing to the irregular objects (often branching algæ, corals, etc.) on which it grows. Test transparent and gelatinous in preserved specimens, darker and more opaque in living colonies. Surface of colony somewhat raised over the position of each zooid.

Zooids irregularly scattered, not arranged in systems; each with two independent apertures on the surface of the colony. They lie on their ventral side; the branchial aperture is close to the somewhat upturned anterior end of the body; the atrial is near the middle of the body. Both have slightly prominent margins, not lobed but sometimes minutely denticulate. Both are elliptical in outline (elongated longitudinally), and the atrial when expanded is much the larger of the two. Size of largest zooids 2.5 to 2.8 mm. long and about 1.3 mm. wide.

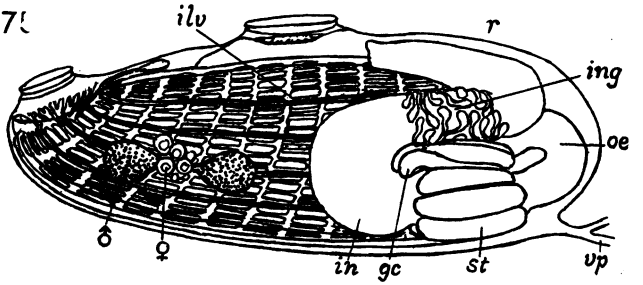


Fig. 75. *Symplegma viride* Herdman, 1886.
Left side of zooid (specimen from Bermuda; ovaries poorly developed), × 35.

Zooids oval when seen from above, broad and rounded at the posterior end, narrower in front; blackish, brownish, or purplish, or occasionally olive or greenish in color, due chiefly to pigment cells contained in the mantle and vessels of the branchial sac. During life an area of light-colored pigment, greenish white, pale yellow, or pale salmon, surrounds the branchial aperture. The whole appearance and pigmentation is strongly suggestive of the family Botryllidæ. Branching vessels arising from the posterior ends of the zooids extend through the common test connecting the zooids and end in the marginal regions of the colonies in bulbs containing pigmented corpuscles similar to those occurring in that family.

Mantle musculature slight, chiefly transverse.

Normal number of tentacles apparently 24, of which six are very large; some of the small ones are often rudimentary or wanting. Many minute, slender, atrial tentacles are present.

Dorsal tubercle oval, its opening narrow and elongate.

Dorsal lamina a plain membrane.

Branchial sac without folds. There are four internal longitudinal vessels on each side. Transverse vessels all of one size. Those of opposite sides of the body do not meet the medial dorsal vessel exactly opposite each other. Stigmata in about thirteen rows. About four stigmata intervene between adjacent internal longitudinal vessels. In the meshes along the median dorsal vessel and endostyle there are five or six stigmata, or somtimes more. Branchial sac large and broad, extending nearly to the posterior end of the body.

Stomach and intestine lying chiefly on the left side of the body. Œsophagus short and curved; wall of stomach with rather few (ten to twelve) well-marked longitudinal folds, and a large curved cæcum near the pyloric end. Proximal part of the intestine large, extending forward and dorsally, then posteriorly beside the stomach (this part is surrounded by branching glandular tubules with dilated ends). The intestine then bends abruptly forward to form the rectum, which is of smaller diameter. Margin of anus not lobed.

One gonad on each side; that on the left side farther forward than the other. Each gonad consists of two pear-shaped testes with the small ends near together and an ovary attached to the mantle walls. A short individual duct from each testis unites with that from the other to form a common duct, but it is very short. The ovary, when small, lies between the testes and is bridged over by the sperm ducts. This is a vestige of the condition found in members of this family having more complex gonads, where the individual sperm ducts run on to the inner (free) surface of the ovary and there unite to form a large common sperm duct. No oviduct was demonstrated. When the eggs become large, though they are not very numerous, the ovary spreads over a considerable space on each side of the body. Testes not divided by clefts into lobes or divisions in any of the specimens studied, though a slight notching of their margins, evidently indicating an incipient tendency toward that result, was several times noted. Specimens collected in spring (April and May) have in many cases fairly well-developed testes, but the eggs and ovaries are small.

Locality, Bermuda; common on stones, corals, etc., in shallow water. The typical form has not been recorded from anywhere else, but *S. brakenhielmi* (Michaelsen), 1904 (see below), as well as certain forms from the Red Sea, North Australia, the Indian Ocean, Philippines, etc., appear to be separable from it only as subspecies or varieties, so that the

species as a whole is evidently of very wide distribution in tropical waters (see Michaelsen, 1919, pp. 104, 105).

Symplegma viride brakenhielmi (Michaelsen), 1904

Figure 76

1904. *Diandrocarpa brakenhielmi* Michaelsen, Jahrb. Wiss. Anst., Hamburg, XXI, suppl. 2, p. 50.

1909–1911. *Diandrocarpa brakenhielmi* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1371, 1630.

Having examined a considerable amount of material of this genus from Florida and West Indian localities, I find it very variable and believe that there is such complete gradation between the Bermuda and the West Indian forms that the rank of a subspecies is all that can be claimed

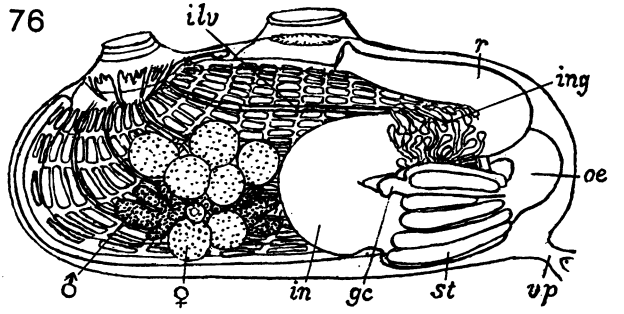


Fig. 76. *Symplegma viride brakenhielmi* (Michaelsen), 1904
Left side of zooid (individual with developing eggs), × 35.

for the latter, especially as the Bermuda specimens were perhaps not very mature and might later have become more like the West Indian ones. Michaelsen (1919, pp. 104, 105) has arrived independently at a similar conclusion.

As compared with the Bermuda specimens, the colonies are larger (in one case measuring over 90 mm. across) and the zooids reach a larger size (4 mm. or more long); the test is tougher and generally less transparent, and in the preserved material often has, particularly on the parts covering the zooids, a suggestion of a pearly grayish luster, due to the character of its surface, not to any pigmentation. Over the body of each zooid it is more or less raised into a low convex or dome-like elevation, usually separated by a distinct depressed line or furrow from the areas covering adjacent zooids; this causes the surface of the colony to be more or less closely covered with these small raised areas which are of oval

outline (or, where the zooids are close together, often conspicuously polygonal, as a result of this crowding); in each one the two minute, slightly prominent apertures of the zooid appear.

Some colonies have the zooids somewhat more convex and broader in proportion to their length than in the Bermuda specimens, and have the branchial aperture situated a little way back from the anterior end, but there is much variation and no constant difference between the two forms in this respect.

Specimens from Porto Rico and Florida in which the oral tentacles could be accurately observed showed in each case six very large and long ones, of which three were larger than the other three with which they alternated. The extent to which smaller tentacles are present in the intervals between these large ones seems to be subject to much individual variation and of no significance in classification. In the Porto Rico colony two additional orders, bringing the total number up to twenty-four, were present and were quite well developed; in the Florida colony small tentacles were few and rudimentary, though the six large ones were well developed. A circle of numerous, very minute, thread-like atrial tentacles on the edge of a circular membrane or velum at the base of the low conical elevation bearing the atrial aperture were demonstrated in some specimens; there appeared to be some additional more or less rudimentary ones scattered between this circle and the aperture.

A larger number of stigmata than in the Bermuda specimens (up to six or seven between the internal longitudinal vessels and as many as ten or eleven between the dorsal lamina and the first internal longitudinal vessel) were demonstrated in some of the Florida and West Indian material; the number seems in some degree dependent on the size of the zooids.

The number of plications of the stomach wall appears to vary from eleven to fourteen in these specimens (Michaelsen gives the number as fourteen or fifteen).

The material at hand indicates that the gonads may afford a more constant difference, in that the two testes in the present subspecies are each more or less deeply cleft into three to six lobes or divisions, but the extent of such cleavage is very variable and even in the Bermuda specimens a slight notching of the border of the pear-shaped testes evidently indicates a tendency to such a division.

The specimens studied are from Porto Rico (Guanica Harbor in shallow water); the east coast of Jamaica (piles near low-water mark); Biscayne Bay, Florida (banks near Soldier's Key); Tortugas, Florida;

and from localities off the west coast of Florida, in depths down to 27 fathoms.

Michaelsen's type was from Vera Cruz, Mexico. Michaelsen (1904) and Herdman (1906) described varieties of it from the western part of the Indian Ocean and Ceylon respectively, which should now be regarded as varieties of *S. viride* (see above).

POLYANDROCARPA Michaelsen, 1904

Characters practically those of *Polycarpa* (see p. 420), except that it produces buds and forms colonies. Gonads, though small, similar to those of that genus.

Subgenus POLYANDROCARPA

Several or many testes in each gonad.

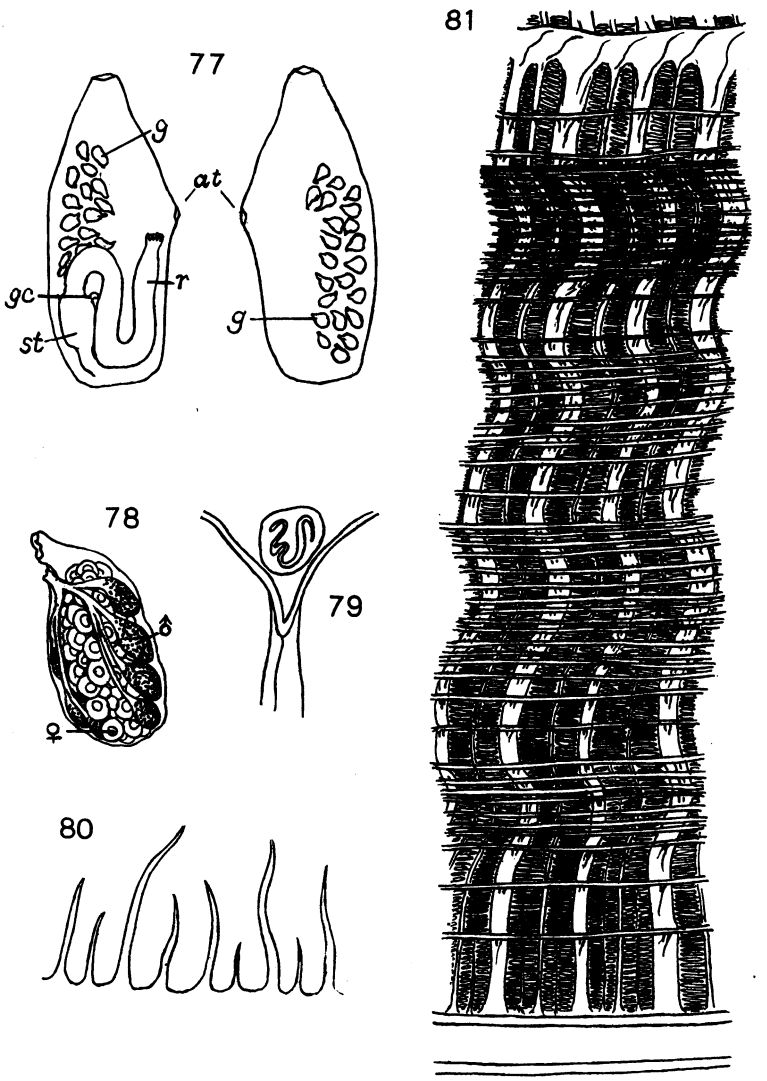
Polyandrocarpa sabanillæ, new species

Figures 77–81

Except for the fact that this species grows in irregular groups or clusters which appear to have been formed by budding, it has no characters differentiating it from the genus *Polycarpa*. The individuals are of very irregular, rather elongate form, attached by a large part of the ventral region and more or less closely united to adjacent individuals of the group or colony by a larger or smaller part of the body surface but not so firmly that they cannot usually be torn apart without much injury. The groups or colonies contain only about six to ten individuals (the exact number is not readily distinguishable without separating the individuals), but may have been parts of larger groups. Several separate individuals that were with them were probably originally part of the groups. Vascular connection between individuals was not found and would be difficult to demonstrate on account of the tough, opaque test; it may exist only in the early stages of a colony. Test tough and leathery, opaque, somewhat pearly within, the outer surface rough and wrinkled, of a dirty brownish color, more or less covered with mud and overgrown with foreign matter.

Size of largest individuals about 22 mm. long and 11 mm. in transverse diameter. Though some were considerably smaller than this, all those examined appeared to be adult, having well-developed gonads.

Mantle thick and opaque, its muscles forming continuous sheets or layers. Color light brown, deeper and somewhat purplish about the apertures, which are four sided.



Figs. 77–81. *Polyandrocarpa sabanillæ*, new species

Fig. 77. Left and right sides of body, × 2.2. Fig. 78. Gonad, × 32. Fig. 79. Dorsal tubercle, × 18. Fig. 80. Part of the circle of tentacles, × 32. Fig. 81. Part of branchial sac, × 24.

Oral tentacles slender, of about three orders arranged with a moderate degree of regularity. The total normal number appears to be 32. The interior of the low conical projection bearing the atrial aperture is provided at its base with a circular membrane or velum, on which, as well as on the interior of the cone between the velum and the aperture, many very small slender atrial tentacles are irregularly distributed.

Dorsal tubercle large and rounded, but not very prominent. Its orifice is a slit having a different curvature in each specimen examined; some modification of the C or V form seems to be the normal form.

Dorsal lamina a rather narrow, plain-edged membrane.

Branchial sac with four complete folds, of which the first and third are the best developed. Transverse vessels numerous and stout; of three orders (in the ventral region four orders) quite regularly arranged. Small vessels crossing the stigmata are wanting on most parts of the sac. Internal longitudinal vessels numerous but slender, their distribution in a large individual was about as follows:

Left side
dl 2 (17) 2 (9) 3 (15) 3 (8) 2 en

Right side
dl 4 (17) 3 (10) 2 (13) 2 (7) 3 en

On the flat parts of the sac the meshes contain 6 to 10 or more stigmata, the large meshes along the endostyle sometimes 18 to 20 or more.

Digestive tract rather large. Stomach oval and provided with a small pyloric cæcum; its outer surface shows but little indication of plication. The intestine runs forward from the stomach, then backward beside the stomach, then bends forward, forming a rather long rectum. Margin of anus with about ten to twelve rather conspicuously developed lobes. Gonads numerous on each side of the body in the ventral region along near the endostyle. On the left side they are confined to the region not occupied by the alimentary organs. Each gonad is a small oval sac of the usual *Polycarpa* type containing many eggs and a few small, pear-shaped or elongate testes. Many small endocarps are present among the gonads and on the dorso-lateral parts of the body wall.

The specimens (several small groups and some detached individuals) were collected at Sabanilla, Colombia, March 16–22, 1884, by the Steamer Albatross. One of the colonies is attached to a shell. From their condition they appear to have come from a muddy bottom. With them was a specimen of *Microcosmus exasperatus* Heller, 1878. Vascular connection between the individuals of the clusters was not successfully

demonstrated, so that there still remains a possibility that this species belongs in *Polycarpa*. I have not been able to identify it with any of the species of that genus described by Sluiter (1898).

The type is in the U. S. National Museum collection.

Polyandrocarpa maxima (Sluiter), 1904

Figures 82 and 83

1904. *Gynandrocarpa maxima* Sluiter, 'Siboga-Exped.,' LVIa, p. 93, Pl. xv, figs. 5–7.
1909. *Polyandrocarpa maxima* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1370, 1644.
1918. *Polyandrocarpa maxima* Van Name, Bull. U. S. Nat. Mus., No. 100, I, p. 103, Pl. xxxi, fig. 33, text figs. 56, 57.

The only specimen forms an irregularly ovoid mass about 18 mm. by 14 mm. in diameter, yellowish white in color in the preserved specimen, but probably red when alive, having a deeply wrinkled and more or less verrucose surface. It resembles a single simple ascidian in appearance except for the more numerous, four-lobed apertures, which, though raised on small papillæ, are not very conspicuous on account of the rough and wrinkled surface. When cut open it is seen to be composed of a dense cluster of four individuals of different sizes (the largest about 11 mm. long) separated only by thin lamellæ of test substance. The test between and close to the bodies of the zooids contains vessels, except where the separating lamella of test is very thin, yet, owing to the tough opaque character of the test, actual vascular connection between the zooids could not be demonstrated. The largest zooid has well-developed gonads and is apparently adult, though perhaps not of the maximum size that may be attained. The following description of the anatomy is chiefly based upon it.

Body oval, not much elongated; both apertures dorsal.

Mantle thin, free from conspicuous muscle bands or pigmentation except on the tubes.

Tentacles about 22, apparently representing three orders; rather irregular in their arrangement, the small ones being wanting in many of the internals.

Dorsal tubercle not demonstrated.

Dorsal lamina a plain, rather narrow membrane.

The branchial sac has four well-developed, though rather low folds, separated by wide flat intervals. Transverse vessels slender and rather widely spaced, so that the stigmata are long. These vessels are of four orders, quite regular in their course and arrangement; the smallest cross, without dividing, the stigmata. Internal longitudinal vessels slender and

rather closely placed, generally separated by four or five stigmata on the flat parts of the sac; even in the largest meshes immediately adjacent to the dorsal lamina and endostyle the number ranges only from about six to nine, rarely ten. Approximate distribution of the internal longitudinal vessels:

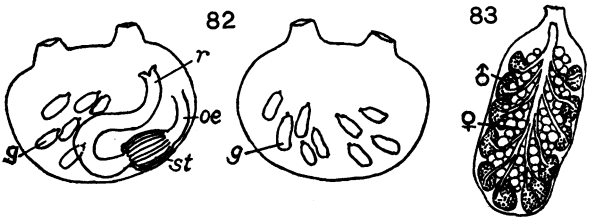
Left side

dl 4 (14) 7 (16) 6 (18) 5 (13) 5 en

Right side

dl 6 (14) 6 (16) 5 (19) 6 (13) 7 en

The rows of stigmata commence close to the dorsal lamina and endostyle.



Figs. 82 and 83. *Polyandrocarpa maxima* (Sluiter), 1904

Fig. 82. Left and right sides of body, × 2.6. Fig. 83. Gonad (side next to branchial sac), × 22.

The alimentary tract forms a rather narrow loop, the œsophagus is long and narrow, the stomach is oval with twenty or more conspicuous plications, the rectum is of moderate length, with a two-lipped, somewhat lobated aperture. Gonads oblong or flask-shaped, of the usual *Polycarpa* type, very loosely attached to the mantle. They are about sixteen in all, irregularly distributed on both sides of the body.

The above-described specimen was from Station 7271, Steamer Fish Hawk (West Channel, entrance to Key West, Florida, 7¼ fathoms, coral sand). No differences appear to exist sufficient to separate this specimen specifically from Sluiter's species from the East Indies (Salibabu Island and the Philippines).

Subgenus **Eusynstyela** (Michaelsen), 1904

As this group appears to differ from *Polyandrocarpa* only in the smaller zooids and the reduction of the testes to two in each gonad, the rank of a subgenus of *Polyandrocarpa* seems sufficient for it.

Polyandrocarpa (Eusynstyela) tincta (Van Name), 1902

Figures 84–86

1902. *Michaelsenia tincta* Van Name, Trans. Conn. Acad. Sci., XI, p. 381, Pl. LIV, figs. 61, 63; Pl. LIX, fig. 109.

1904. *Eusynstyela tincta* Michaelsen, Jahrb. Wiss. Anst., Hamburg, XXI, suppl. 2, p. 37.

1907. *Michaelsenia tincta* Seeliger, Bronn's 'Tier-reich,' III, suppl., p. 1147, fig. 215.

1909–1911. *Eusynstyela tincta* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1370, 1633.

1918. *Eusynstyela tincta* Michaelsen, Jahrb. Wiss. Anst., Hamburg, XXXV, suppl. 2, p. 38.

1919. *Symplegma viride* form *brakenhielmi* Michaelsen, Denk. Akad. Wiss. Wien, XCV, pt. 10, p. 105.

1919. *Eusynstyela tincta* Michaelsen, Denk. Akad. Wiss. Wien, XCVII, pt. 9, p. 96.

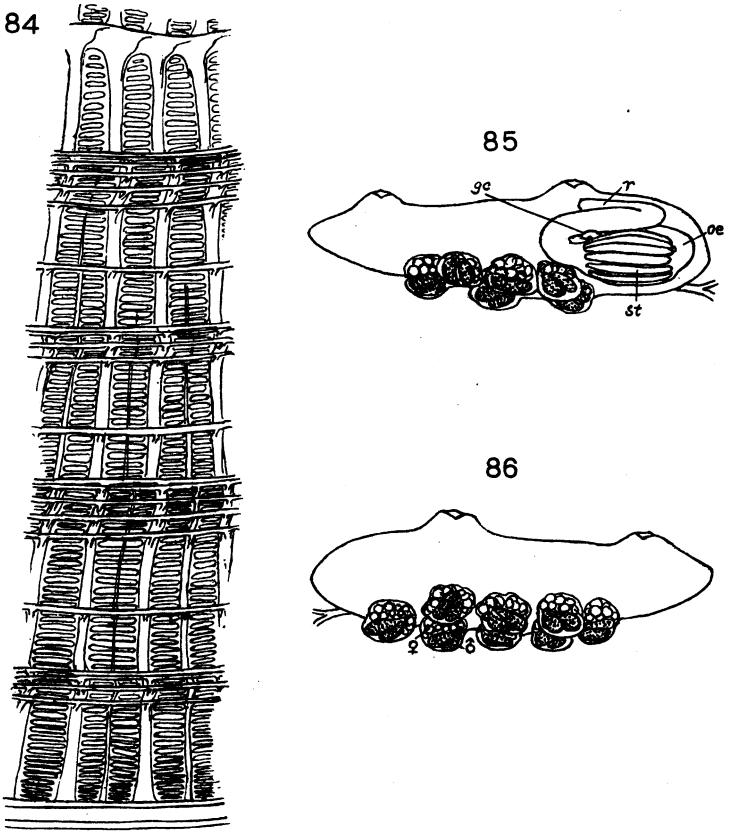
Colony ordinarily of the flattened incrusting type and commonly of small size, often consisting only of from half a dozen to a dozen zooids. Such colonies measure 25 to 35 mm. in greatest thickness and 15 to 20 mm. in greatest diameter; they commonly have a rather thick, rounded border and uneven upper surface. The specimens usually found on stones, etc., along the shore are of this character. It forms, however, under favorable conditions (especially when growing in water a few feet in depth), much more extensive colonies containing one hundred individuals or over. When these grow on some branching object, as a gorgonian, they may entirely surround the branch or two or more adjacent branches and form a much thicker mass of irregular shape, having all or nearly all its surface exposed and bearing zooids on all its aspects, as well as in such clefts or depressions as may exist in its contour. One such colony in the National Museum collection, dredged on the banks off Cedar Keys, Florida, in about 10 fathoms, forms an irregular ovoid mass 55 mm. by 37 mm. by 28 mm. in diameter.

Surface of colony very slightly rough and finely wrinkled; generally the number and position of the zooids is indicated chiefly by the pairs of small rough papillæ on which their apertures are situated.

Test very tough and leathery and very opaque, so that neither the zooids nor the branching vessels which ramify in the test and end in elongate club-shaped bulbs are visible through it. Color of test during life varying from rose pink to carmine red, deepest about the apertures of the zooids, but fading to pink or yellowish in the marginal and basal parts of the colony in many cases. Test substance yellowish in the interior of the colony. The red color soon fades out in preserved material.

Zooids few in most of the colonies and not at all equal in size. In most colonies none of them exceed about 6 mm. long and 2.4 mm. wide,

but the largest may reach 8 or 9 mm. in length. They lie with the ventral surface down, often quite closely crowded together or overlapping each other to some extent, and are strongly flattened dorso-ventrally. Both apertures on the dorsal surface, more or less prominent on the surface of the colony and rather widely separated; the branchial near the anterior



Figs. 84–86. *Polyandrocarpa* (*Eusynstyela*) *tincta* (Van Name), 1902
Fig. 84. Part of branchial sac, × 45. Fig. 85. Left side of zooid, × 9. Fig. 86. Right side of zooid, × 9.

end, the atrial behind the middle of the body. Both are square when expanded. The test is roughened and irregularly granular immediately about them in many colonies.

Mantle more or less carmine in color, due to pigment grains contained in its cells. It is not very muscular; the fibers form a thin sheet and are not gathered into bands.

Tentacles numerous (over 30), slender, of at least three sizes. A circle of minute atrial tentacles is present.

Dorsal tubercle oval, orifice generally elongated in an antero-posterior but sometimes in an oblique direction.

Branchial sac with four folds on each side, of which the first and third are the highest. Transverse vessels of two or three sizes. The smallest are generally stout enough to interrupt the stigmata, but in some places they cross them without doing so. Internal longitudinal vessels slender on the folds; those on the flat parts of the sac are thicker. The following scheme shows their distribution in a rather large zooid:

Left side
dl 0 (9) 1 (4) 1 (7) 1 (4) 0 en

Right side
dl 0 (8) 1 (5) 1 (8) 1 (4) 0 en

In the meshes on the flat parts of the sac there are generally about eight stigmata. On the right side the first fold is quite far from the median dorsal vessel, and about fifteen stigmata intervene in some places before the first internal longitudinal vessel is reached. The fold is nearer the median dorsal vessel on the left side. The meshes along the endostyle are also wide, containing often ten or twelve stigmata.

Stomach rather long and narrow with about thirteen or fourteen well-defined longitudinal folds and a small curved pyloric cæcum. The stomach is yellow or brown during life. Rectum rather long and straight, its orifice with two well-marked lips, each slightly lobed.

Gonads especially well developed in some of the Florida specimens. Each is a small, rounded sac containing two large, elongate testes and a varying number of eggs. The testes are in the part of the gonad next to the mantle. In most specimens they are of simple, elongate oval form but sometimes one or both of them may be deeply cleft into two lobes. Occasionally there appear to be three or four separate testes in a gonad; that this never occurs it would be unsafe to assert, yet in several such cases a careful examination showed that the appearance was due to a deep lobation of one or both of the two which are normally present.

The gonads are attached to the inside of the mantle of the ventral region in the usual way. They are present on both sides of the body and may form more than one row on each side of the median line. They often project out into the test beyond the general surface of the ventral regions inclosed in small knob-like or rounded evaginations of the body wall, which may be more or less constricted at their connection with the body. Some endocarps are usually present.

At Bermuda, the type locality, this species is found attached to stones at many points along the shore near low-water mark, though nowhere in great abundance. On the Florida coast I have found it in Biscayne Bay on stones along the shores of Ragged Keys, and on calcareous algæ on the banks near Soldier's Key. All the specimens from the above localities were small. The National Museum contains specimens, some of them as mentioned above of considerable size, from deeper water (10½ feet to about 10 fathoms) at stations off the west coast of Florida from the latitude of Cedar Keys to the Bay of Florida. Its distribution may be very much wider, since Michaelsen, 1919, expresses the opinion that *P.* (*E.*) *hartmeyeri* from the Red Sea and Mozambique, and *P.* (*E.*) *imthurni* from Ceylon are inseparable from it. *P.* (*E.*) *latericia* (Sluiter), 1904 of the Malay region he considers another possible synonym. Specimens from the Philippines, which I have referred (Van Name, 1918, p. 105) to *P.* (*E.*) *latericia*, differ in certain characters from American specimens, notably in the flatter, more expanded colony, the more numerous vessels of the branchial sac, the smaller number of stigmata (usually only two or three) in the meshes between them, and other minor characters. Although these differences may not prove to be of importance, it would seem better to leave the question open until more information is available.

The type of this species is in the Yale University collection.

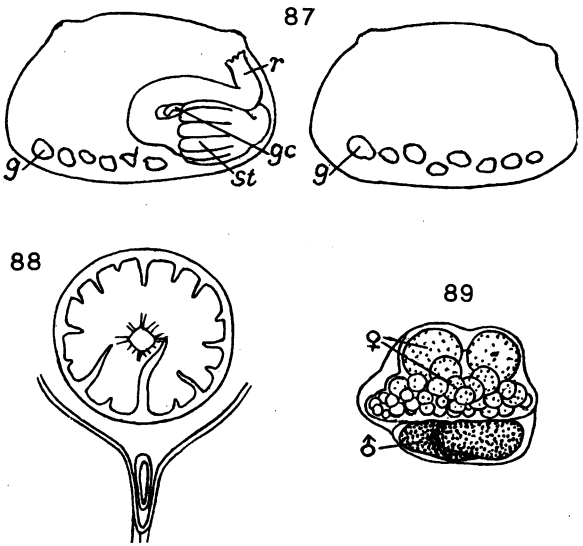
Polyandrocarpa (Eusynstyela) floridana, new species

Figures 87–89

?1852. *Cynthia subcærulea* Stimpson, Proc. Boston Soc. Nat. Hist., IV, p. 231.

Colony diffuse, consisting of many dome-shaped zooids of different sizes, which often lie some distance apart, connected only by a thin sheet or irregular strands of test substance. Zooids of elliptical outline, when seen from above, and sometimes sufficiently convex on the upper surface to form one-half (or even a slightly greater part) of a sphere, but in most cases they are of lower, more flattened form. In some parts of the colony they may lie so close together as to be in contact, but there is always a distinct furrow of demarkation between them and usually they may be easily pulled apart. Size of the largest (type) colony about 55 mm. by 40 mm. across. Test thin, tough, rather opaque, showing a fibrous structure when torn, its outer surface quite smooth. Color in alcohol yellowish white, becoming bluish gray with a slight pearly lustre on the parts covering the zooids; in some places it shows a pinkish or reddish tinge even in the preserved specimens, indicating that the colonies are red or reddish during life.

Zooids covered by a thin, practically smooth layer of test. They lie on their flattened ventral surface; the two apertures are on the dorsal surface quite far apart and both well removed from the ends of the body; they are but very slightly, if at all, prominent in most specimens and are four-sided, though showing in the contracted condition little evidence of this shape. Size of the largest zooids in any of the specimens 8 mm. long by 5 mm. across, but these, though containing some well-developed gonads, may not have reached the maximum size.



Figs. 87–89. *Polyandrocarpa* (*Eusynstyela*) *floridana*, new species
Fig. 87. Left and right sides of zooid, × 6. Fig. 88. Circle of tentacles and dorsal tubercle, × 32. Fig. 89. Gonad, × 50.

Mantle thin, musculature slightly developed.

Oral tentacles about sixteen in number, large and smaller alternating, the larger very unequal in size, one or more of those in the posterior part of the circle often especially large and long. Around the inside of the base of the low conical eminence on which the atrial aperture is situated is a circle of very numerous and very minute and slender atrial tentacles. Others are scattered irregularly between this circle and the orifice.

Dorsal tubercle longitudinally elongate, its orifice a similarly elongate slit or cleft.

Dorsal lamina rather wide, with a slightly sinuous edge.

Branchial sac with four folds, of which the first and third are the highest. Transverse vessels numerous, only two orders placed alter-

nately can be recognized in most parts of the sac. Small vessels crossing the stigmata were not noted. Approximate distribution of the internal longitudinal vessels in two rather large zooids:

(*a*)

Left side

dl 0 (11) 3 (6) 2 (15) 2 (6) 1 en

Right side

dl 2 (11) 2 (6) 2 (16) 2 (6) 1 en

(*b*)

Left side

dl 1 (13) 3 (7) 3 (14) 2 (8) 1 en

Right side

dl 2 (14) 2 (9) 3 (15) 3 (8) 1 en

The meshes formed by the vessels are small; those on the flat parts of the sac contain (except immediately along the endostyle or dorsal lamina) usually only two to four stigmata.

Œsophagus short and curved; stomach short, with about twelve deep plications and a small curved pyloric cæcum. Intestine large; it loops back beside the stomach and then bends abruptly forward and dorsally into a very short rectum whose orifice is very slightly lobed.

Gonads few and small in the specimens studied, attached on the inside of the mantle along each side of the median ventral line. They are small oval or irregular sacs containing a few large eggs and many small ones, and two elongate oval testes. No more than two testes were demonstrated in any of a number of gonads dissected out for careful examination.

The type of this species is from the west coast of Florida (Station 7151, Steamer Fish Hawk, 29°43′40″ N., 83°49′45″ W., 5¼ fathoms, coral). The remaining specimens, five in number, were dredged in the same region, at some distance off the west coast of Florida from the vicinity of Anclote Keys northward, in depths from 21 to 27 fathoms. Several of them, including the type, were growing on a large simple ascidian, *Polycarpa circumarata*, that is common in that region. It is apparently not a littoral species.

This is a near ally of *P.* (*E.*) *tincta*, described above, and *P.* (*E.*) *latericia* (Sluiter), 1904, from the Malay Archipelago, but in those forms the colony consists of a thick incrusting sheet of test in which the zooids are deeply imbedded. Superficially, at least, it agrees well with Stimpson's (1852) *Cynthia subcærulea* from Oak Island Beach, North Carolina, but his description is too insufficient to warrant identifying the two in the absence of any specimens of this form from the North Carolina coast.

POLYCARPA Heller, 1877

[=*Pandocia auct. mult.*]

Simple ascidians with the characters as given above for the family, having a number of compact sac-like or short tubular hermaphroditic gonads on each side of the body. In the typical species the gonads are small, oval or oblong sacs, and are very numerous.

Polycarpa obtecta Traustedt, 1883

Figure 90

?1878. *Polycarpa tumida* Heller, Sitzungsber. Akad. Wiss. Wien, math.-nat. Kl., LXXVII, p. 103, Pl. II, fig. 15.

1883. *Polycarpa obtecta* Traustedt, Vidensk. Meddel. natur. For. Kjöbenhavn, ann. 1882, pp. 126, 134, Pl. V, figs. 7, 8; Pl. VI, fig. 15.

1891. *Polycarpa obtecta* (?+*P. tumida*) Herdman, Journ. Linn. Soc. London, Zool., XXIII, p. 584.

1898. *Styela* (*Polycarpa*) *obtecta* Sluiter, Mém. Soc. Zool. France, XI, p. 11.

1900. *Polycarpa multiphiala* Verrill, Trans. Conn. Acad. Sci., X, p. 591; idem, 1901, XI, Pl. IX, fig. 7.

1902. *Polycarpa obtecta* Van Name, Trans. Conn. Acad. Sci., XI, p. 386, Pl. XLVII, figs. 88, 89, 92–94; Pl. LXIII, figs. 140, 144; Pl. LXIV, figs. 151, 153.

1908. *Polycarpa obtecta* Hartmeyer, Year Book Carnegie Inst., Washington, No. 6, p. 111.

1909–1911. *Pandocia obtecta* (?+*P. tumida*) Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1364, 1630, 1633.

1915. *Polycarpa obtecta* Michaelsen, 'Beitr. Meeresfauna Westafrikas,' I, pp. 412, 413.

1918. *Pandocia obtecta* Van Name, Bull. U. S. Nat. Mus., No. 100, I, p. 103.

Body rounded-oblong, often with the dorso-ventral diameter exceeding the length; when not distended with water the flexibility of the test permits the sides to collapse so that it is quite narrow from side to side. The apertures, which may be raised on conical elevations, or in contracted specimens may be nearly flush with the external surface, are both conspicuously four-sided; the branchial aperture is situated at or close to the anterior end; the atrial is forward of the middle of the dorsal region. Body usually attached by a small area on the posterior or ventral part of the body, where the test may be produced into a sort of rudimentary peduncle, or may develop some root-like processes or irregular projections to assist in the attachment. Size of the largest specimens studied, about 50 mm. long by 45 mm. in dorso-ventral diameter, exclusive of the short tubes.

Test rather thin except in the dorsal region where it becomes very thick. Color of the outer surface dirty yellowish or brownish gray, usually more or less stained with mud, darkening to red, brown, or

purplish brown about the apertures in fresh specimens. Some individuals have the entire surface or parts of it incrusted with sand and shell fragments, but in a majority of the specimens it is practically bare, fairly smooth in some parts, but with more or less extensive areas which are rough, wrinkled, and warty, or it may even develop patches of short irregular moss-like processes. Other specimens may have the entire surface wrinkled. Internally the test is grayish with a slight pearly cast. Test substance strong, yet soft and flexible when fresh, and even in material long preserved in alcohol it has less tendency to become hard and rigid than in many other allied ascidians.

Mantle smooth and often of a somewhat gelatinous appearance, conspicuously brown in color in most individuals, and provided with a rather weak musculature consisting of longitudinal, transverse, and

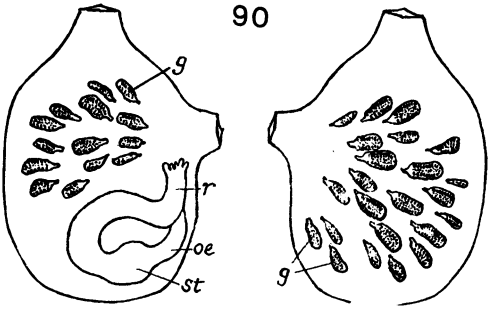


Fig. 90. *Polycarpa obtecta* Traustedt, 1883
Left and right sides of body, natural size.

oblique fibers, of which only the longitudinal ones radiating from the bases of the tubes are gathered into bands of any size. The brown coloration just mentioned pervades many of the internal organs as well as the mantle, and is in part due to granules of pigment in some of the cells.

The tentacles are rather numerous, often forty to sixty in large individuals (55 and 58 respectively were counted in two large specimens) and represent four or more orders in respect to their size and length; only the larger ones show any degree of regularity in their distribution, the small ones being few and irregularly placed.

Dorsal tubercle rather large but not very prominent above the surface of the prebranchial region. It varies in relative size and shape in different individuals, as its orifice does also. The latter is a very narrow cleft usually bent in a C or sometimes an S-shape; in the former case with the open interval forward or more or less to the left and the horns unequally curved (both in, or one in and one out).

Dorsal lamina a plain-edged membrane; endostyle very wide and thick.

Branchial sac peculiar in that many (though not all) individuals have an additional more or less distinct fold on the right side, besides the four which are characteristic of this family of ascidians. This fifth fold lies between the dorsal lamina and the first regular fold and is small, seldom bearing more than three or four internal longitudinal vessels. The remaining folds (as also all those of the left side) are much higher and better developed, bearing from ten to seventeen vessels in the specimens studied, the third fold from the dorsal side (not counting the above-mentioned extra fold) being usually the highest. Although in other families of ascidians the number of folds is variable (sometimes increasing with the age and size of the individual), in the Styelidæ the number four on each side is so rarely exceeded as to make such cases of especial interest. Less than four folds, by the reduction and disappearance of one or more of them, are, however, found in many Styelidæ.

This extra fold is not morphologically comparable to the other four folds, which must have been inherited from some remote ancestor of the whole family; it may be produced by some secondary cause, possibly largely mechanical in its nature. A peculiarity in the test has been alluded to above. On the sides and ventral part of the body it is very soft and flexible so that the body collapses when the water is expelled from the branchial sac, but over the dorsal part, in the immediate region of the extra fold, it becomes suddenly much thicker and more rigid.

The consequent frequent bending of the body wall at this point may have its bearing upon the development of the extra fold. Why it appears on the right side and not on both is perhaps to be explained by the fact that in this, as in many other members of the Styelidæ, the first fold on the left side is usually comparatively close to the dorsal lamina while on the right side there is a much broader flat interval.

Aside from the extra fold, the structure of the branchial sac presents nothing remarkable; the folds are sharply defined and, conformably to the short deep body, very much curved. The transverse vessels are of several orders arranged with a varying degree of regularity; small vessels crossing without dividing the stigmata are not usually present. Internal longitudinal vessels close together on the folds but separated by varying (often rather wide) intervals on the flat parts of the sac. The number of stigmata in the larger meshes is usually from seven to twelve; in the ventral regions of the sac, especially in the meshes along the endostyle, the number is often still greater. Different individuals show some

variation in the number of internal longitudinal vessels, in the regularity of their distribution, and in the number of stigmata that intervene between them. The number of vessels is usually greater in large than in small individuals, but is not altogether dependent on the size. In two large individuals over 50 mm. long, from Florida, the following counts of these vessels were made:

(*a*)
Left side
dl 3 (12) 4 (13) 4 (13) 4 (11) 3 en
Right side
dl 0 [3] 1 (10) 4 (13) 4 (12) 4 (10) 3 en

(*b*)
Left side
dl 3 (14) 3 (13) 3 (14) 4 (12) 3 en
Right side
dl 0 [3] 2 (9) 1 (14) 3 (14) 4 (8) 3 en

An individual from Porto Rico, though smaller, has more vessels:

Left side
dl 2 (13) 3 (13) 3 (17) 4 (11) 3 en
Right side
dl 0 [3] 0 (11) 3 (15) 3 (17) 5 (11) 3 en

An example about 40 mm. long from off the west coast of Florida has still more:

Left side
dl 3 (19) 3 (21) 5 (23) 6 (19) 6 en
Right side
dl 0 [5] 3 (17) 5 (22) 5 (24) 6 (19) 4 en

Irregularities in the branchial sac, especially in the height of the folds or in the width of the flat intervals, which may be increased at the expense of the adjoining folds, or in the transverse vessels, which may branch or run obliquely, joining an adjacent vessel, are frequent in some individuals; others show great regularity in such details.

Stomach small and short; oval. The intestine forms a small open loop which does not extend much, if at all, forward of the middle of the body. Margin of anus irregularly lobed. A large endocarp connected both with the mantle and the branchial sac is commonly present in the bend of the intestinal loop.

Gonads oblong or flask-shaped, produced into a short neck with the ovarian opening at its end; the opening of the sperm duct is on a small

papilla beside the neck. The number of gonads varies, and is commonly greater in large than in small individuals. In ordinary sized individuals there may be twenty or more on the right side irregularly scattered, but with their necks turned more or less directly toward the base of the atrial tube, while on the left side, where they are confined to the region anterior to the intestinal loop, the number is somewhat less. In very large examples the number on the right side may reach one hundred or more.

As usual in this group of ascidians, the male glands in each gonad are small and often cleft into two or three lobes; they lie against the mantle more or less covered by the ovarian part of the gonad around which their individual sperm ducts curve to join the main branches of the common duct.

Traustedt's type of this species was from St. Thomas, and Hartmeyer (1908) records it from Tortugas, Florida. It is fairly common at Bermuda (see Van Name, 1902, p. 388); one was obtained at Paradones near Cienfuegos, Cuba, by Mr. Barnum Brown of the American Museum, and several were collected by the American Museum expeditions at Porto Rico (Guanica Harbor on piles; one dredged in eighteen feet of water). Those in the National Museum collection, excepting specimens from Eleuthera Island, Bahamas, and Cabañas, Cuba, are from Florida (Tortugas, Key West, and points off the west coast). It ranges from shallow water to a depth of 37½ fathoms, and appears to be commoner in water at least a few feet deep than along the shore.

That this species is distinct from *P. tumida* (Heller), 1878, from Jamaica seems very doubtful, but Heller's description is very incomplete. Among the long list of species of this group that Sluiter (1898) has described from the West Indian region, there appear to be several that are very near to this species, especially *P. friabilis* from Jamaica, *P. brevipedunculata* from Curaçao, and *P. seminuda* from Tortugas Island. It is, therefore, probably of very wide distribution in the West Indian region. *P. arnoldi* (Michaelsen), 1914, from Annobon Island, West Africa, and *P. ovata* Pizon, 1908 (see Van Name, 1918, p. 103) from Amboina, are very close allies, if really distinct from it.

Polycarpa spongiabilis Traustedt, 1883

Figures 91–95

1883. *Polycarpa spongiabilis* Traustedt, Vidensk. Meddel. natur. For. Kjöbenhavn, ann. 1882, pp. 125, 134, Pl. v, fig. 9.

1891. *Polycarpa spongiabilis* Herdman, Journ. Linn. Soc. London, Zool., XXIII, p. 583.

1909–1911. *Pandocia spongiabilis* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1364, 1630, 1634.

Though in its internal anatomy this species closely resembles *P. obtecta* just described, I believe that Traustedt was well justified in describing the two as distinct. The sponge-like appearance of the present species readily explains its specific name. It is due to the rough fibrous surface of those parts of the body free from foreign matter, the rigid yet easily broken test and the non-contractile character of the tubes and apertures, which gives them, in the alcoholic specimens at least, a resemblance to the oscula of sponges.

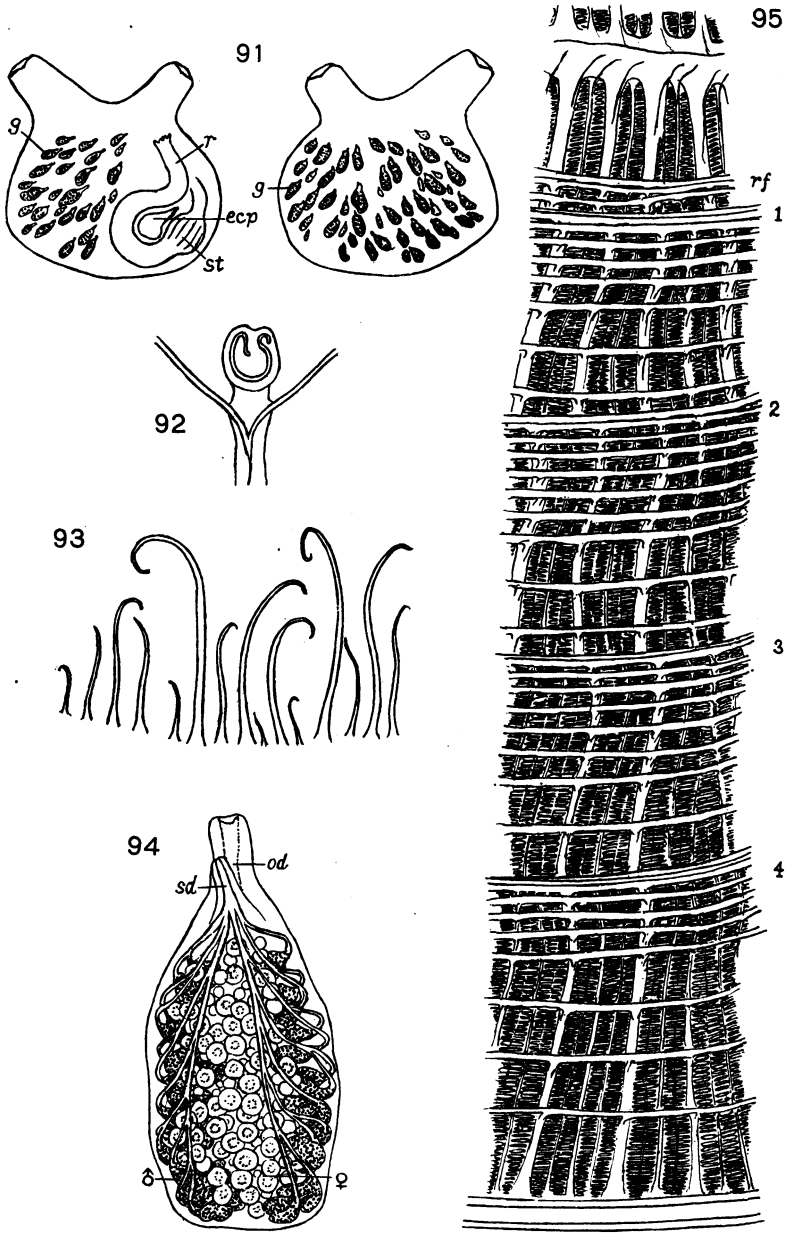
Shape of body very variable in the specimens available for study, which were collected at Porto Rico; strongly compressed from side to side in the small ones, but tumid in the larger ones. Tubes of varying length, mere conical eminences in two of the individuals, large, cylindrical and very long in other cases. Orifices somewhat square, not contracted in any of the specimens. The tubes arise near together on the dorsal part of the body, but curve apart so as to form a widely diverging angle (in one case nearly 180 degrees). Largest specimen 40 mm. long, 35 mm. in dorso-ventral diameter, and about 28 mm. wide, exclusive of the tubes. Color of test yellowish or brownish, becoming reddish or purplish on the tubes.

Test in the alcoholic specimens opaque; its surface rough, uneven and fibrous, but not greatly incrusted with foreign matter on the upper half of the body or on the tubes, though in the two larger specimens some minute bivalve mollusks are imbedded in its substance. Upon the ventral half of the body there may, however, be a tangled growth of hair-like processes to which sand grains, shell fragments, mud, etc., adhere, and which evidently serve to anchor the animal.

The internal structure of two of the specimens, one large and one small immature one, was examined. The mantle and test are adherent in the alcoholic specimens.

Mantle rather thick; brownish in color, with an external layer of transverse and an internal layer of longitudinal fibers.

Tentacles 78 in number of the large specimen, less than 50 in small one; of various sizes down to very minute ones (the latter not very numerous and occurring only here and there). No regularity in the arrangement of the different sizes in most parts of the circle. The tubes in these specimens were exceptionally well expanded, permitting an unusually accurate count of the tentacles, even the very smallest. Had they been more contracted, a considerable number of the smaller



Figs. 91–95. *Polycarpa spongiabilis* Traustedt, 1883

Fig. 91. Left and right sides of body, × .75. Fig. 92. Dorsal tubercle, × 12. Fig. 93. Part of circle of tentacles, × 12. Fig. 94. Gonad, × 18. Fig. 95. Part of branchial sac, × 11.5.

tentacles would doubtless have been overlooked and the number would have seemed lower.

Dorsal tubercle horseshoe-shaped with the open interval forward, both horns bent back, one inward, one outward (both to the left) in each of the two specimens examined.

Dorsal lamina plain, rather narrow.

Branchial sac very similar to that of *P. obtecta*. The rudimentary extra fold on the right side between the dorsal lamina and first true fold is present in the large individual, but not in the small one. Internal longitudinal vessels stout, not very numerous. The four true folds are of variable height in different parts of the sac.

Internal longitudinal vessels distributed approximately as follows:

Left side
dl 1 (11) 2 (14) 2 (15) 3 (12) 4 en

Right side
dl 0 [3] 0 (12) 3 (14) 2 (15) 2 (11) 3 en

Five or even six orders of transverse vessels are recognizable in some parts of the sac. Their distribution is, for the most part, fairly regular; the very smallest, crossing without interrupting the stigmata, are present in some places only. The stigmata are rather long and narrow; owing to irregularities in the distribution of the internal longitudinal vessels on the flat parts of the sac, the number of stigmata in a mesh is very variable, but it is often large, ten to twelve or more in many cases. Along the endostyle and median dorsal vessel there are meshes containing many stigmata (fifteen to twenty or more).

The above description is taken from the branchial sac of the largest individual. That of the small one is similar but there are somewhat fewer internal longitudinal vessels on the folds.

Stomach small, its wall with a few indistinct plications. Intestine forming a small rounded loop. Rectum very short in the small specimen, proportionately longer in the large one. Anus margin with about ten small lobes. In the large individual a large endocarp lies in the bend of the intestinal loop.

Gonads as in *P. obtecta*. On the right side they number over 50 in the large specimen, and on the left side, where they are confined to the part of the mantle anterior to the intestinal loop, there are about 30. In the small individual the gonads are but poorly developed, though numerous.

Traustedt (1883) gives the localities of his specimens as West Indies and Brazil. A total of six specimens were dredged by the American Museum expeditions at Porto Rico, as follows: entrance to Guanica Harbor, 10–25 feet, mud, 1 specimen; Condado Bay, San Juan Harbor, 16–22 feet, sand and mud, 3 specimens (large); Salinas Cove (east of Parguera) off Don Luis Cayo, 5–4½ fathoms, coral, mud, 2 specimens.

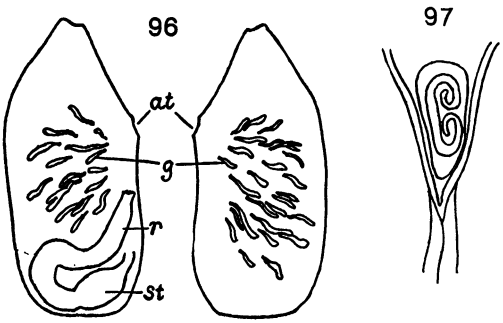
Polycarpa circumarata (Sluiter), 1904

Figures 96 and 97

1904. *Styela circumarata* Sluiter, 'Siboga-Exped.,' LIVa, p. 70, Pl. I, fig. 4; Pl. IX, fig. 1.

1909. *Pandocia circumarata* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., p. 1363.

1918. *Pandocia circumarata* Van Name, Bull. U. S. Nat. Mus., No. 100, I, p. 92, fig. 46; Pl. XXVI, figs. 7, 8.



Figs. 96 and 97. *Polycarpa circumarata* (Sluiter), 1904

Fig. 96. Left and right sides of body, natural size. Fig. 97. Dorsal tubercle, × 6.

Though subject to great individual variation in shape and manner of attachment, the body in this species is usually elongate, oblong, somewhat abruptly tapered at the front end and strongly flattened from side to side. It is usually extended at the posterior end or in the posterior ventral region into a very short, broad, laterally compressed peduncle for attachment; this peduncle may break up into, or be replaced by, a number of root-like processes. Less often the body is sessile and directly adherent to the object on which it grows; in a few of the specimens there is no lateral compression of the body.

Test moderately thick, tough and very opaque; its substance white with a pearly lining; the outer surface yellowish brown to brassy yellow in color. Its surface is wrinkled or furrowed; these furrows are rather few and mainly longitudinal in most individuals, being separated by

rounded ridges irregularly broken by short transverse or oblique furrows into small rounded elevations; in some individuals, however, the wrinkles are closer together and mainly transverse. Some have parts of the surface lightly incrusted with foreign matter (sand grains, shell fragments, etc., or compound ascidians), but usually not to any great extent except on the peduncle or the processes into which it branches. Largest individual from the West Indian region 52 mm. long and 40 mm. in dorso-ventral diameter.

Mantle thick and opaque, the muscular layers forming thick continuous sheets. It is light colored, as on the other internal organs also.

Normal number of tentacles apparently 32, representing three orders, but some, especially those of the smallest order, are often poorly developed or wanting in some of the positions where they should occur according to the scheme.

Dorsal tubercle large and elongate; the typical form of its orifice seems to be C-shaped, with the open interval to the left and the horns inrolled, but some irregular variation of this form very often occurs instead of the above typical one.

Dorsal lamina a plain membrane widest in its posterior portion.

Branchial sac with four well-defined and moderately high folds separated by wide flat intervals. Transverse vessels very numerous and close together; in some places five or six orders arranged with some degree of regularity may be recognized. Often, however, the large ones are distributed at irregular intervals separated by a considerable but varying number of small ones which may be fairly uniform in size for considerable distances, except for the occasional presence of still smaller ones that cross without interrupting the stigmata. Internal longitudinal vessels also exceedingly numerous and on the folds very closely crowded; on the flat part of the sac they are usually separated by from five to eight stigmata, except along the endostyle and dorsal lamina, where there are more stigmata in the meshes.

Distribution of the internal longitudinal vessels in a specimen 36 mm. long:

Left side

dl 6 (37) 7 (37) 8 (33) 9 (26) 5 en

Right side

dl 5 (38) 8 (34) 8 (34) 6 (28) 5 en

In one 48 mm. long:

Left side
dl 5 (40) 9 (36) 8 (39) 9 (29) 6 en

Right side
dl 8 (42) 8 (36) 8 (38) 7 (32) 4 en

Œsophagus short; stomach oval, rather short, its exterior surface showing but little plication. No pyloric cæcum. Intestine of large diameter but forming a rather narrow compact loop lying somewhat transversely to the body axis. No very abrupt bend at the beginning of the rectum, which is rather short. Margin of anus with many minute, rather inconspicuous lobes.

Gonads hermaphroditic, small and numerous, irregularly distributed on both sides of the body, but so deeply buried in the tissues of the body wall, and so much less prominent than the numerous small endocarps which arise between them and partially conceal them, that they are readily overlooked. They are elongate or phial-shaped, often irregularly curved, and sometimes forked or branched. They contain a variable number of small, ovoid or pear-shaped testes and many still smaller, rounded eggs.

In spite of the difference of locality, there do not appear to be any characters separating the specimens here described from Sluiter's species from the Philippines, where it is recorded from depths from 16 meters to 20 fathoms.

It is represented in the National Museum collection by about thirty specimens of various sizes, all dredged in the Gulf of Mexico off the west coast of Florida, by the Steamers Albatross and Fish Hawk, at stations from Deadman's Bay to near Sarasota Point, in depths from 5¾ to 30 fathoms on sandy and coral bottom. Most of the specimens were obtained at Station 2405 by the Steamer Albatross (28° 45′ N., 85° 02′ W., 30 fathoms, gray sand and broken coral), where a large number of examples of *P. obtecta* were also dredged. Several of the individuals of this species are partially overgrown with colonies of *Polyandrocarpa floridana*, a new species of compound ascidian.

Styela Fleming, 1822

Simple ascidians with characters as given above for the family and a small number (often only one or two on each side) of elongate gonads having in the typical species the male glands alongside of but slightly removed from the ovaries.

Styela partita (Stimpson), 1852

Figures 98–101

1852. *Cynthia partita* Stimpson, Proc. Boston Soc. Nat. Hist., IV, p. 231.
1868. *Styela variabilis* Hancock, Journ. Linn. Soc. London, Zool., IX, p. 318.
1873. *Cynthia partita* Verrill and Smith, 'Rept. on Invert. Animals of Vineyard Sound,' pp. 311, 701, etc., Pl. XXXIII, fig. 246.
1877. *Styela canopoides* Heller, Denk. Akad. Wiss. Wien, XXXVII, p. 254, Pl. VI, figs. 1–3.
1878. *Cynthia partita* Coues and Yarrow, Proc. Acad. Nat. Sci. Philadelphia, 1878, p. 304.
1891. *Cynthia partita*+*C. canopoides* + *C. variabilis* + *C. stellifera* Herdman, Journ. Linn. Soc. London, Zool., XXIII, pp. 581, 586.
1898. *Cynthia partita* Bumpus, Science, new series, VIII, p. 853.
1900. *Styela partita*+*S. canopoides* Verrill, Trans. Conn. Acad. Sci., X, pp. 588, 589; idem, 1901, XI, Pl. IX, figs. 8*a*, 8*b*, 8*c*.
1902. *Styela partita* Van Name, Trans. Conn. Acad. Sci., XI, p. 388, Pl. LV, fig. 69; Pl. LVI, figs. 76–78; Pl. LXIV, figs. 147, 149.
1905. *Cynthia* (*Styela*) *partita* Conklin, Journ. Acad. Nat. Sci. Philadelphia, (2) XIII, pp. 1–118, Pls. I–XII (Embryology).
1906. *Styela partita* Rennie and Wiseman, Proc. Zool. Soc. London, p. 34, figs. 7, 9.
1909–1911. *Tethyum partitum* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1359, 1619.
1912. *Tethyum partitum* Hartmeyer, Denk. Akad. Wiss. Wien, math-nat. Kl., LXXXVIII, p. 191.
1912. *Tethyum partitum* Van Name, Proc. Boston Soc. Nat. Hist., XXXIV, p. 556, Pl. LIX, figs. 94, 95; Pl. LX, fig. 97; Pl. LXIX, fig. 141; Pl. LXXI, fig. 153; text fig. 32.
1913. *Styela partita* Sumner, Osburn and Cole, Bull. U. S. Bureau of Fisheries, XXXI, pp. 155, 158–160, 729, 730; chart 192.
1913. *Styela partita*+ *S. variabilis* Huntsman, Zool. Anzeiger, XLI, pp. 488–490, text figs. 4, 9.
1915. *Styela partita* Michaelsen, 'Beitr. Meeresfauna Westafrikas,' I, pp. 385–388.
1916. *Styela partita* Hartmeyer, Sitzungsber. Gesell. natur. Freunde, Berlin, ann. 1915, pp. 398, 399.
1916. *Styela partita* Pratt, 'Manual Common Invert. Anim.,' p. 666, text fig. 1009.
1918. *Styela partita* Michaelsen, Jahrb. Wiss. Anst., Hamburg, XXXV, suppl. 2, pp. 33, 34, 35.

For other references and synonyms see Van Name, 1912, p. 556; Hartmeyer, 1912, p. 191.

Form of body largely dependent on whether the animal is attached singly or in a crowded group of several or many individuals. In the former case, the body may be attached by much of the ventral surface and the branchial aperture situated on the dorsal surface slightly back from the anterior end; in the latter case, the body is often attached by only a small area near the posterior end and the branchial aperture is

situated at the anterior end. The atrial aperture is on the dorsal surface rather near the branchial aperture in either case. When so situated as to grow symmetrically, the body is ovoid, smaller at the anterior end and not much compressed laterally; the apertures are on conical papillæ. Body surface more or less rough and wrinkled, and raised into minute irregular elevations. The surface becomes rougher and the furrows coarser and more conspicuous toward the anterior end. On and about the papillæ bearing the apertures, the furrows usually become replaced by rounded wart-like elevations. Color dirty yellowish or grayish brown, more or less tinged during life with red, red-brown, or purplish, especially toward the anterior end and about the apertures, which may exhibit radial white markings; some specimens are red or reddish all over. Test coriaceous, usually of a somewhat fibrous texture, rather thin on the posterior part of the body, thicker on the anterior part.

On the New England coast it reaches a length of 30 mm., but the specimens from southern localities (Florida and Porto Rico) appear to average smaller, rarely exceeding 20 mm. in length.

Mantle thin, its musculature light; the superficial muscles form an almost continuous sheet; the deeper muscles are gathered into imperfect bands radiating from the bases of the tubes.

Tentacles 40 to 50 in large individuals; of several sizes arranged with a varying degree of regularity.

Dorsal tubercle quite variable; of some modification of the U or horseshoe form; the open interval forward or more or less to the left, and one or both of the horns usually incurved but not spirally coiled.

Dorsal lamina plain-edged.

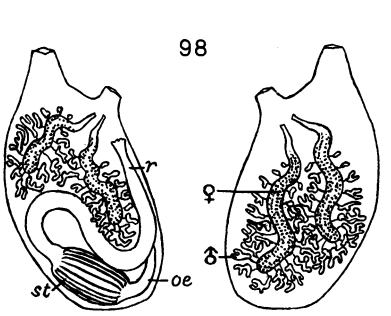
Branchial sac with four folds on each side separated by rather broad flat intervals. The first and third folds are the highest. Transverse vessels slender, of four, in some places five orders, often quite regularly distributed, the smallest crossing without interrupting the stigmata. Internal longitudinal vessels slender, quite close together on the folds, but separated by from five to eight stigmata (near the endostyle by still larger numbers) on the flat intervals between folds. Distribution of the internal longitudinal vessels in a fairly large individual:

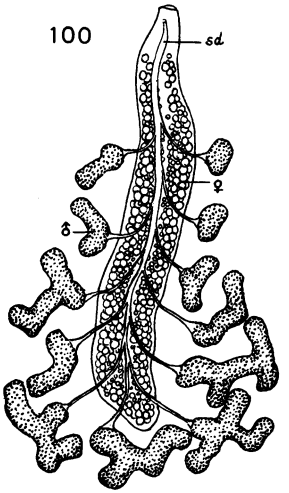
Left side

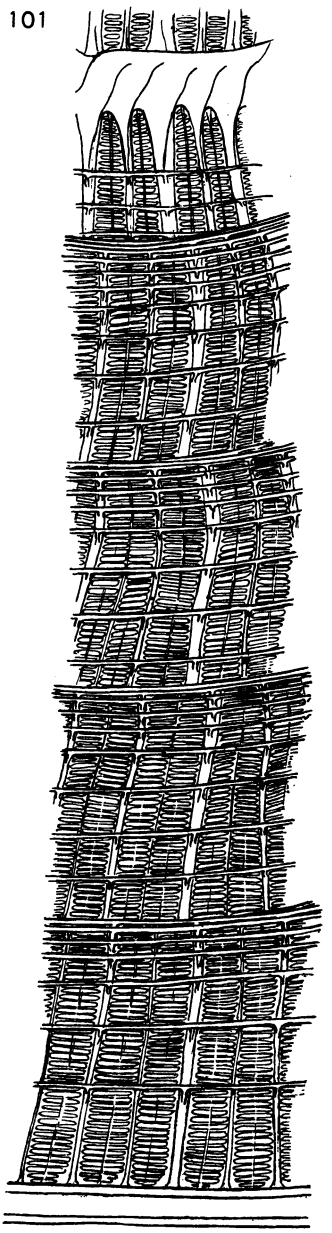
dl 2 (18) 3 (14) 3 (16) 4 (10) 2 en

R'ght side

dl 4 (17) 4 (13) 4 (15) 4 (8) 2 en







Figs. 98–101. *Styela partita* (Stimpson), 1852

Fig. 98. Left and right sides of body, × 2. Fig. 99. Dorsal tubercle, × 12. Fig. 100. Gonad of a small individual, × 20. Fig. 101. Part of branchial sac, × 14.

Stomach only moderately elongate, its wall with about 20 to 30 longitudinal folds. Margin of anus lobed to a varying extent in different individuals; sometimes merely sinuous.

The best distinguishing character of the species is furnished by the gonads which, owing to the thinness of the mantle, are usually distinctly visible when the animal is removed from its test. There are two on each side, each consisting of a tubular more or less sinuous ovary, narrowed to a neck at its dorsal end, where the opening for the discharge of the eggs is situated. Each ovary is surrounded by a varying number of small male glands which are distributed around the ventral end of the ovary and along its sides, except toward the dorsal end. The male glands lie attached to the mantle a little way removed from the ovary (Fig. 100). Each one, when large, is of elongate and generally irregularly bent form and more or less branched; small ones are of simpler outline. A slender sperm duct leads from each to the unattached surface of the ovary, where those of the several male glands unite to a common sperm duct running along the free surface of the ovary and ending in a papilla beside the neck of the latter. Toward the dorsal ends of the ovaries the male glands become smaller, fewer, and simpler in outline. Often they are wanting entirely along the dorsal half of the ovaries.

This is a well-known and widely distributed form which has been described under several different names. It is a close ally of *S. canopus* Savigny, 1816. On the American coast it ranges from Massachusetts Bay to Florida and the West Indies (Cuba and Porto Rico); on the other side of the Atlantic it ranges from the British Islands to the tropical part of West Africa (specimens in American Museum), including the Cape Verde Islands (Rennie and Wiseman, 1906), and occurs in the Mediterranean and Adriatic. At Bermuda it is represented by a local race (see below). It is an inhabitant of very shallow water, all the material examined being from depths of not more than 15 fathoms.

By the American Museum expeditions to Porto Rico, it was collected from the piles of wharves and mangrove roots in Guanica Harbor, growing in large clumps with mussels, barnacles, bryozoans, ascidians of other species, etc. It was also obtained at Santurce near San Juan, and off Tallaboa Bay where it was dredged in 6 to 11 fathoms (one small specimen). Examples from the South Carolina coast, both coasts of Florida, and from Cuba (Cienfuegos and Las Arroyas) were also in the collections studied.

Styela partita bermudensis Van Name, 1902

1901. *Styela partita*+*S. canopoides* Verrill, Trans. Conn. Acad. Sci., X, pp. 588, 589; XI, Pl. IX, figs. 8*a*, 8*b*, 8*c*.

1902. *Styela partita* variety *bermudensis* Van Name, Trans. Conn. Acad. Sci., XI, p. 388, Pl. LV, figs. 70–75; Pl. LXIII, figs. 142, 143.

1909–1911. *Tethyum partitum* variety *bermudense* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1359, 1633.

Bermuda specimens of *partita* do not present any differences in internal structure from the typical form. The test is usually thicker and of a more cartilaginous character, and more translucent; the colors are generally brighter, usually a warm brownish yellow or reddish yellow, becoming rich brown or red on the upper surface, especially about the apertures, which may exhibit radial white striping such as sometimes occurs also in the typical variety. These distinguishing characters are certainly not of great importance but, considering its isolated habitat, the form may possibly be worthy of recognition as a geographical race.

The type is in the Yale University collection.

Styela plicata (Lesueur), 1823

Figures 102–105

1823. *Ascidia plicata* Lesueur, Journ. Acad. Nat. Sci. Philadelphia, III, p. 5, Pl. III, fig. *b*.

1843. *Ascidea plicata* DeKay, 'Zool. New York,' V, 'Mollusca,' p. 259.

1877. *Styela gyrosa* Heller, Sitzungsber. Akad. Wiss. Wien, XXXVII, p. 255, Pl. III, figs. 7–12; Pl. IV, figs. 1–8.

1881. *Styela gyrosa* Herdman, Proc. Royal Soc. Edinburgh, XI, p. 76.

1882. *Styela gyrosa* Herdman, 'Rep. Voy. Challenger, Zool.,' VI, p. 155.

1883. *Styela plicata* Traustedt, Vidensk. Meddel. natur. For. Kjöbenhavn, ann. 1882, pp. 123, 134, Pl. V, fig. 6; Pl. VI, fig. 16.

1883. *Styela plicata* Traustedt, Mitt. Zool. Stat. Neapel, IV, p. 478, Pl. XXXVI, fig. 12.

1885. *Styela plicata* Traustedt, Vidensk. Meddel. natur. For. Kjöbenhavn, ann. 1884, p. 44.

1891. *Styela plicata* Herdman, Journ. Linn. Soc. London, Zool., XXIII, p. 581.

1900. *Styela plicata* Metcalf, Zool. Jahrbücher, Anat., XIII, p. 516, Pl. XXXVI, figs. 24, 25.

?1900. *Styela* species, Wilson, Amer. Naturalist, XXXIV, p. 354.

1905. *Styela plicata* Hartmeyer, Zool. Jahrbücher, Syst., VIII, suppl., p. 384.

1909–1911. *Tethyum plicatum* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1359, 1630.

1912. *Tethyum plicatum* Hartmeyer, Denk. Akad. Wiss. Wien, math.-nat. Kl., LXXXVIII, p. 192.

1912. *Tethyum plicatum* Van Name, Proc. Boston Soc. Nat. Hist., XXXIV, p. 569, Pl. LXII, figs. 104, 105; Pl. LXIII, fig. 108; Pl. LXVIII, fig. 136, text fig. 36.

1912. *Styela plicata*, Huntsman, Contrib. Canadian Biol., p. 149.
1913. *Styela plicata* Huntsman, Zool. Anzeiger, XLI, pp. 489, 497, text fig. 13.
1916. *Styela plicata*, Redikorzew, 'Faune Russ., Tunicata,' part I, p. 197, Pl. v, figs. 1, 2, text figs, 37, 38.
1918. *Styela plicata* Van Name, Bull. U. S. Nat. Mus., No. 100, I, p. 88.
1918. *Styela plicata* Michaelsen, Jahrb. Wiss. Anst., Hamburg, XXXV, suppl. 2, p. 36.

For other synonyms and references see Hartmeyer, 1905.

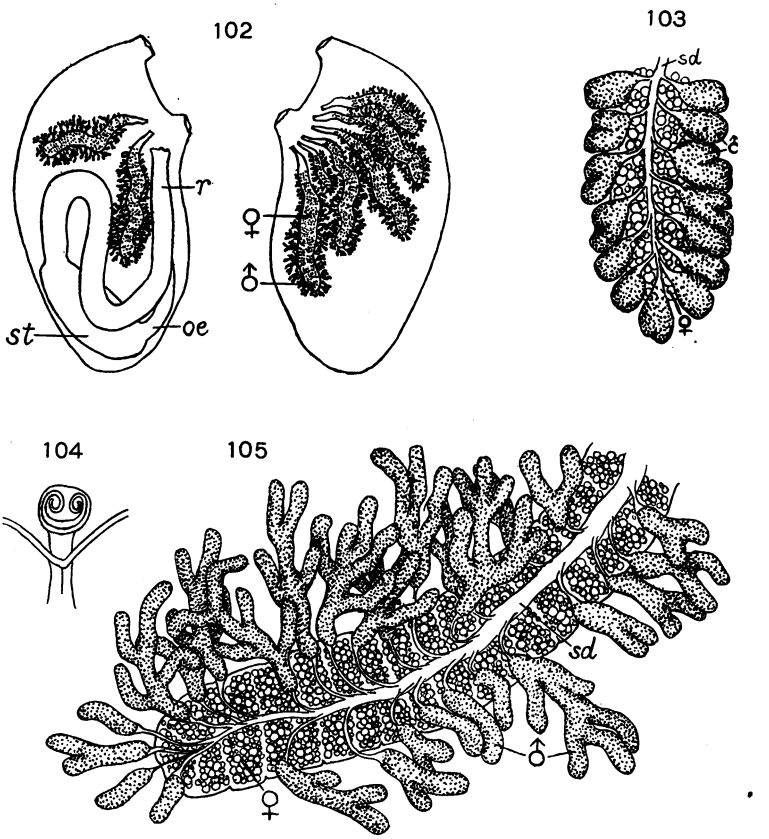
This is a much larger species than S. *partita* and is very variable in external appearance. Sometimes the body is broader in the anterior part or near the middle and narrowed toward the posterior end by which it is attached; the test at this end of the body may be so produced that it may be described as forming a short stout pedicel. Some specimens are strongly compressed laterally, others scarcely at all. In other examples, the general outline of the body is merely oval or rounded and attached by one side or near the posterior end.

The branchial orifice is terminal or nearly so, the atrial a little way back on the dorsal side; both are usually surrounded by four rounded eminences corresponding to the four sides of the square aperture, which lies in the depression between them. In many individuals there is a conspicuous curvature of the long axis of the body by which the apertures are brought towards each other and the ventral side of the body becomes more convex.

The most conspicuous external characters of the species are furnished by the test and the body surface. The test when not discolored is of a dull white color, quite opaque in alcoholic material, but more or less translucent in formaldehyde. It is said to be whitish in living specimens also. Except for a trifling amount of mud, frequently no more than sufficient to discolor the surface, the latter is usually free from foreign matter, though ascidians of the same or other species and other organisms sometimes grow upon it. In some individuals the surface is merely irregularly furrowed; or there are a few conspicuous, rather widely separated furrows whose direction is longitudinal and which are separated by broad, rounded ridges running toward the apertures and ending in the eminences surrounding the latter, which have already been mentioned. In many individuals the ridges are broken, especially in the anterior part of the body, into low but rather large dome-shaped elevations, giving the body surface, or parts of it, an appearance suggesting a coarse unevenly laid cobblestone pavement. Such specimens are very characteristic and easily recognized.

A number of the largest specimens measured ranged from 45 to 72 mm. long and from 25 to 38 mm. in greatest dorso-ventral diameter.

Mantle of only moderate thickness; in some individuals quite thin. The outer layer of muscles encircles the body and its fibers form a nearly continuous sheet. The deeper muscles extend from the tubes toward the



Figs. 102–105. *Styela plicata* (Lesueur), 1823

Fig. 102. Left and right sides of body, slightly enlarged. Fig. 103. Terminal part of a gonad of an individual having the gonads compact and the testes of simple form, × 16. Fig. 104. Dorsal tubercle, × 6. Fig. 105. Terminal part of the gonad of an individual with highly developed branching testes, × 12.

posterior end of the body and are gathered into distinct, rather closely placed bands.

Tentacles difficult to count in the material studied on account of the contraction of the strong sphincter muscles. The number mentioned in Traustedt's (1883) description (25 to 30) seems to be exceeded in many

of the Porto Rican specimens, these apparently having a total of 40 or more, of at least three or four orders, the smaller ones being irregular in their distribution and wanting in many of the intervals.

Dorsal tubercle C-shaped with the open interval forward and the horns strongly inrolled in all the specimens in which this character was studied.

Dorsal lamina plain-edged.

Branchial sac with four quite sharply defined folds separated by rather wide flat intervals. The first three folds do not differ greatly in height and bear over 20 internal longitudinal vessels in most individuals. The ventral fold is somewhat lower. Transverse vessels numerous, of at least five orders in the ventral parts of the sac, the smallest crossing without interrupting the stigmata. They are stout and rather closely placed, and so prominent upon the inner surface of the sac that the meshes containing the stigmata are quite deeply depressed. The presence of two second-order vessels instead of one between two first-order vessels and other similar irregularities may be observed in some parts of the sac in many individuals. Internal longitudinal vessels of rather broad flattened cross-section; they are noticeably stouter on the flat intervals between folds than upon the upper parts of the folds.

Distribution of these vessels in two moderately large individuals:

	Left side	
(*a*)	dl 2 (25) 5 (24) 7 (20) 6 (14) 5 en	
	Right side	
	dl 5 (20) 6 (20) 8 (22) 7 (17) 6 en	
	Left side	
(*b*)	dl 2 (22) 6 (20) 5 (22) 4 (19) 3 en	
	Right side	
	dl 5 (24) 7 (22) 6 (25) 5 (17) 4 en	

The meshes on the flat portions of the sac between the folds contain, for the most part, from six to nine stigmata.

Stomach large, more elongate than in *S. partita*, its walls with from thirty to forty longitudinal folds, which do not, however, show very conspicuously on the exterior surface. Intestinal loop large but proportionately narrow, its middle part extending back so as to lie beside the stomach. Margin of anus irregularly lobed in some individuals, but only slightly sinuous in others.

Gonads usually two in number on the left side, one anterior to the intestine, the other extending down between the rectum and the descend-

ing part of the intestine. A third gonad on the left side may occasionally be found. On the right side the number of gonads is variable; usually there are from four to seven. They are placed with their necks converging toward the base of the atrial tube. The individual gonads vary greatly in size in the same individual, even when fully mature. Sometimes one or more of them divides into two branches. Specimens obtained at Porto Rico afford excellent material for studying the details of the structure of the gonads and confirm the statement of Huntsman (1913, p. 489) that this species is a typical *Styela* related to *S. partita*. Each gonad consists of a central, elongate, more or less sinuously curved ovary, along each side of which the small male glands are arranged. The sperm ducts follow a similar course to that described above in *S. partita* and the individual male glands have, as in that species, a branching form if well developed. There is, however, this difference in the arrangement: the individual sperm ducts leading from the testes are comparatively short, so that the testes, instead of lying attached to the mantle at a little distance from the ovary, lie close against or more or less upon the latter. The testes are of about the same actual size as in *S. partita* but much more numerous.

Fig. 105 represents part of a gonad of a large specimen in a very well-developed condition. The reader must not expect to find the testes always so numerous or of such elongate and lobate form as in the example there shown. In many specimens, even when the reproductive organs are adult and evidently functional, the testes are merely small oval glands not much divided into lobes, lying close upon and against or even more or less imbedded in the ovary (see Fig. 103). All intermediate conditions will also be found.

This is a well-known species, widely distributed on the coasts of the warmer parts of the Atlantic, Pacific, and Indian Oceans, including the Mediterranean. Lesueur's type specimen was from Philadelphia from the bottom of a ship that must doubtless have come from some more southern port, as the water at Philadelphia is too fresh for it, and there, are moreover, no other records from the American coast north of Fort Macon, near Beaufort, North Carolina. From there it ranges through Florida (where it is very common on the west coast) and the West Indies (St. Thomas, St. Croix, St. Vincent, Cuba, and Porto Rico) to Rio Janeiro and Montevideo (Traustedt, 1883). It is a shallow-water species; in Guanica Harbor it was found abundantly on wharf piles in clusters containing other ascidians as well. The greatest depth recorded for any of the specimens I have examined is 15 fathoms (off the South Carolina

coast). Wilson (1900) reports a large *Styela*, "doubtless *Cynthia vittata* of Stimpson's list," from Beaufort, North Carolina. The number of branchial folds given by Stimpson shows that *C. vittata* Stimpson is not a *Styela*. Wilson's species, if a *Styela*, was probably the present one.

I am now able to extend the recorded range of this species to Bermuda on the basis of a specimen in the National Museum collected at Hamilton in 1882.

Styela (Botryorchis) atlantica (Van Name), 1912

Figure 106

1885. *Cynthia partita* ("apparently") Verrill, Rept. U. S. Comm. Fish and Fisheries for 1883, p. 529.

1912. *Tethyum atlanticum*, Van Name, Proc. Boston Soc. Nat. Hist., XXXIV, p. 552, Pl. LIX, figs. 92, 93; Pl. LX, fig. 96; Pl. LXVIII, fig. 135, text fig. 31.

1913. *Botryorchis atlanticus* Huntsman, Zool. Anzeiger, XLI, pp. 498, 499, text fig. 4.

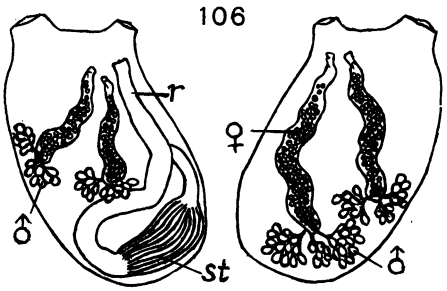


Fig. 106. *Styela atlantica* (Van Name), 1912
Left and right sides of body, × 1.3.

This species much resembles *Styela partita* in external characters, but averages larger, often 40 mm. or more in length, and has a rougher, more deeply wrinkled test. In internal structure it is distinguished from that species by the very much more numerous internal longitudinal vessels, these being sometimes 40 on a fold and 10 or more on some of the flat intervals; also by the arrangement of the gonads. The ovaries, numbering two on each side, are similar to those of *S. partita*, but the male glands are small, rounded or pyriform bodies, forming several compact clusters grouped around the dorsal or ventral ends of the ovaries, instead of arranged along a considerable part of the sides of the latter.

Other details given in the original description will not be repeated here, as this species is only known from moderately deep water (62 to 397 fathoms) far off the coast of southern New England and the Middle States, chiefly between 38° and 40′ N., and 69° and 73° W.

It has been made the type of a genus (*Botryorchis*) by Huntsman (1913) but, while his group is a natural one, the rank of a section of *Styela* would seem sufficient recognition to give it on account of the small differences distinguishing it from the more typical members of that genus.

For further particulars see Van Name, 1912. Additional stations for this species not recorded in that article are:

Station 2198, Steamer Albatross (39° 56′ 30″ N., 69° 43′ 20″ W., 84 fathoms, sand and broken shells) and

Station 2031, Steamer Albatross (39° 29′ N., 72° 19′ 55″ W., 74 fathoms, gray mud and black and white sand).

Pyuridæ Hartmeyer, 1908

[=CYNTHIIDÆ, HALOCYNTHIIDÆ *auct. plur.* and TETHYIDÆ Huntsman, 1912]

Simple ascidians having the branchial sac with longitudinal folds (usually five to eight or more on each side) and generally with compound tentacles and straight stigmata. No kidney. Dorsal lamina variable, usually replaced by a row of languets.

TETHYUM Bohadsch, 1761

[Proposed *nomen conservandum, Halocynthia*]

In the most recent classification this is restricted to those species of the former genus *Halocynthia* having the gonads with several separate, more or less parallel flask-shaped ovaries, the external body surface more of less minutely spiny, and the stigmata longitudinal. Dorsal lamina replaced by a row of languets.

Tethyum microspinosum, new species

(*Halocynthia microspinosa* under proposed system of *nomina conservanda*)

Figures 107–111

The following description is based on only one specimen.

Body irregularly oval, not much compressed laterally, somewhat contracted in the ventral region where it is attached by a small area to a piece of coralline; the apertures, both four-lobed, are widely separated (8 mm. apart), both situated on the dorsal aspect, and scarcely prominent on the external surface. Dimensions 17 mm. long, 17 mm. in dorso-ventral diameter, 9 mm. from side to side. Test yellowish brown, opaque,

its surface free from adherent matter, but uneven with many small and low, rounded elevations, scarcely prominent enough to be termed papillæ except on the dorsal region, where they become small wart-like prominences about 2 mm. in diameter and nearly as much in height in some cases. Everywhere the test is covered with spiny projections so minute as to be visible only on magnification. They are short and stiff and taper to a sharp point, giving the surface a rough, coarse, velvety appearance; about the apertures there are larger ones that bear a few lateral branches, also pointed, but these are very short. In many places these minute spines arise from the surface in small circular tufts of about half dozen; they are not, however, borne on regular rounded elevations as in the case of the allied species *T. pyriforme* Rathke, 1806, of arctic waters. These tufts have no central or axial spine, and in some

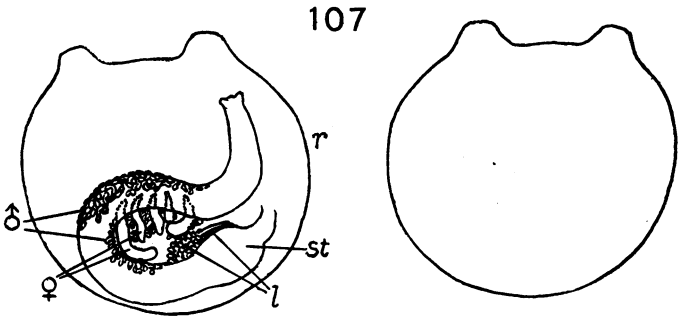


Fig. 107. *Tethyum microspinosum*, new species
Right and left sides of body, × 3.2.

cases, particularly on the papillæ of the dorsal region, they are raised on a short, thick pedicel, from whose summit they radiate out like the tentacles of a minute actinian. It must be understood that all these spines, with the exception of the larger branched ones about the apertures, which attain in a few cases a length of nearly 1 mm., are exceedingly minute. At the inner margin of the apertures the large spines cease abruptly, and are replaced by small, simple, appressed, sharp thorns with the point directed outward, which cover the test lining the distal part of the tubes. These decrease in size from the outer toward the inner end of the tube.

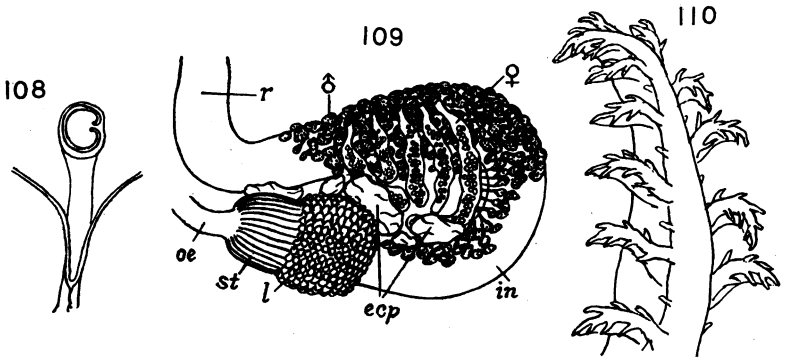
Mantle rather thin; many strong muscle bands extend down on the side of the body from the base of the tubes, those from the two tubes crossing each other on the sides to form a network with small, nearly square meshes. This network is crossed by an external loosely formed

layer of slender fibers, not gathered into very well-defined bands, whose direction is mainly longitudinal.

Tentacles rather few; the large ones number about 12 and are twice pinnate; the branches are rather few and short, their tips not enlarged; smaller sizes of tentacles are also present but are not numerous.

Dorsal tubercle C-shaped, the open interval narrow and directed toward the left; the horns are incurved but not inrolled.

Dorsal lamina replaced by a series of narrow languets.



Figs. 108–110. *Tethyum microspinosum*, new species

Fig. 108. Dorsal tubercle, × 16. Fig. 109. Intestinal loop and gonads seen from side next to branchial sac, × 5. Fig. 110. One of the larger tentacles, × 25.

Branchial sac of very delicate structure, with nine folds on each side. Folds very high, bearing numerous very thin internal longitudinal vessels, the folds are separated by narrow, flat intervals which they entirely conceal when lying flat. Transverse vessels of four or five orders quite regularly placed. Internal longitudinal vessels distributed about as in the following scheme:

Right side

dl 2 (15) 2 (21) 2 (24) 3 (25) 3 (23) 3 (21) 3 (18) 3 (16) 2 (12) 1 en

In this, when a vessel is at the base of a fold, it has been counted as belonging to the fold, not to the flat part of the sac. There are many cases where either course would seem equally well justified. On the left side the arrangement is similar except for the last fold, which is much reduced and bears but few vessels. There are about eight or nine stigmata in the larger meshes on the flat parts of the sac. The stigmata are crossed in most places, without being interrupted, by very minute transverse vessels.

Digestive tract forming a rather small but fairly wide loop; the distal branch bends down so as to nearly touch the stomach, then turns

abruptly dorsally, forming a rather short rectum ending in an inconspicuously lobed aperture; œsophagus short and curved; stomach short; on the aspect toward the branchial sac it bears an extensive hepatic organ consisting of about 25 leaf-like longitudinal folds. On the pyloric part of the stomach these folds are plain-edged; on the cardiac half of the stomach their projecting edges bear small papilla-like or short tubular projections. The organ has thus a very different appearance on the two parts of the stomach.

Gonads very well developed on the left side but wanting on the right side of the body. Whether their absence there is a normal character or merely an individual peculiarity cannot be determined until more specimens are available. In view of the close correspondence of the animal to the other species of the genus *Tethyum*, which have gonads on both sides, I am not inclined to attribute too much importance to their absence in this form, even should it prove to be a normal character of the species.[1] In this specimen there are five crooked tubular or flask-shaped ovaries whose blind ventral ends lie within the intestinal loop; their dorsal ends leave the mantle and lie across and attached to the distal branch of the intestinal loop on the inner aspect of the latter, that is, on the side toward the branchial sac. The testes are very numerous. They are small, oval or pear-shaped, or in some cases lobed or branched bodies; they lie between the ovaries and spread also over the adjacent parts of the intestinal loop, some of them extending around to the external aspect of the intestine (the side next to the mantle). There are several small endocarps in the area inclosed by the intestinal loop.

The type and only example in the collection (Cat. No. 305, Amer. Mus. Nat. Hist.) was found in a jar with a mixed lot of specimens of various classes or animals. No locality was recorded, but from other material in the jar it seems most probable that all the specimens in the lot came from Andros Island, Bahamas. Under these circumstances, it can be only doubtfully included in the West Indian list, although the presence of a member of this genus (*T. papillosum* Linnæus, 1767) in the Mediterranean and another, *T. spinosum* (Sluiter), 1905, in the Red Sea, would seem to render its representation in the West Indies probable.

It is not impossible, in view of their close correspondence in many characters, and of the several species common to the Red Sea and the West Indies, that are already known, that this species may prove to be identical with the above-mentioned one from the Red Sea, but until

[1]Michaelsen, 1919, p. 20 records a similar instance in the Red Sea species.

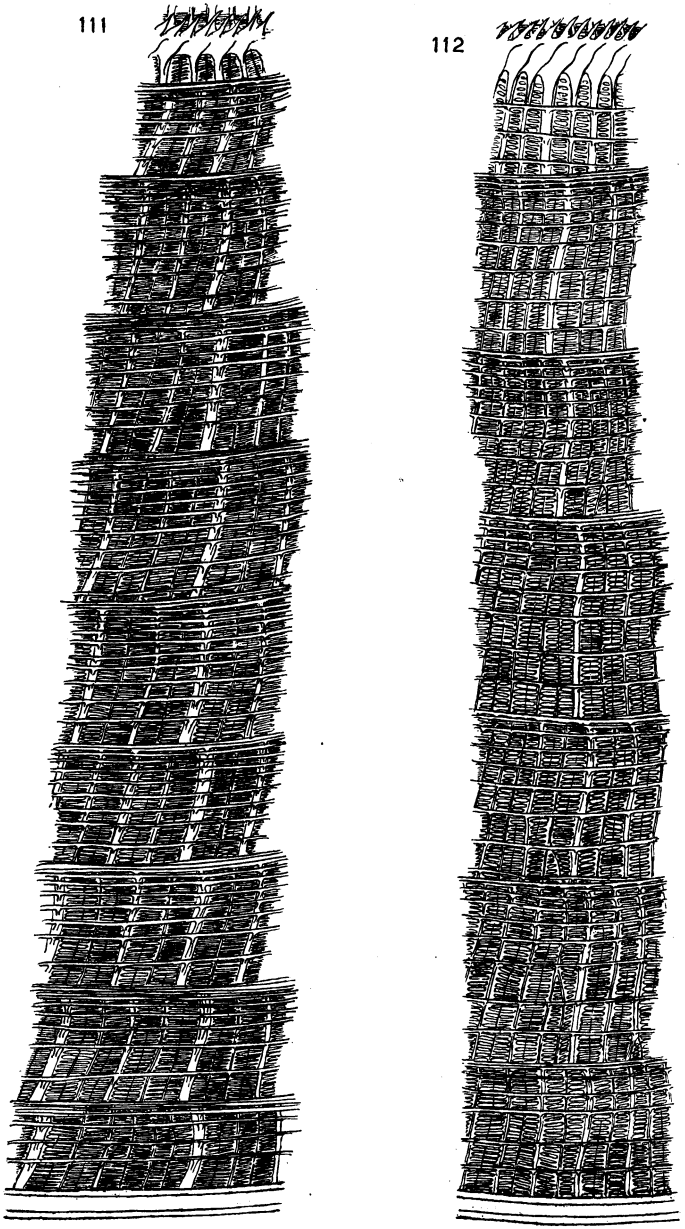


Fig. 111. *Tethyum microspinosum* new species
Part of branchial sac, × 10.

Fig. 112. *Pyura vittata* (Stimpson), 1852
Part of branchial sac, × 7.5.

more material becomes available, that question cannot be definitely decided (see Michaelsen, 1919, p. 10, for description of *T. spinosum*).

PYURA, Molina, 1782

[=*Cynthia* s. *Halocynthia* (part) *auct. plur.*]

This is the largest genus of the family, separable from *Tethyum* by the elongate, longitudinally placed gonads, usually one (less often two) on each side of the body. Dorsal lamina replaced by a row of languets. External body surface rough but usually not spiny.

Pyura vittata (Stimpson), 1852

Figures 112–122

1852. *Cynthia vittata* Stimpson, Proc. Boston Soc. Nat. Hist., IV, p. 230.
1860. *Cynthia vittata* Stimpson, Amer. Journ. Sci., (2) XXIX, p. 443.
1878. *Cynthia lævigata* Heller, Sitzungsber. Akad. Wiss. Wien, math.-nat. Kl., LXXVII, p. 93, Pl. II, fig. 11.
1883. *Cynthia riiseana* Traustedt, Vidensk. Meddel. natur. For. Kjöbenhavn, ann. 1882, pp. 118, 132, Pl. v, fig. 13; Pl. VI, fig. 19.
1891. *Cynthia lævigata*+*C. riisiana* Herdman, Journ. Linn. Soc. London, Zool., XXIII, p. 577.
1898. *Cynthia lævigata* (?) Sluiter, Mém. Soc. Zool. France, XI, p. 20, Pl. II, fig. 24.
1900. *Halocynthia rubilabia*+*H. riiseana* Verrill, Trans. Conn. Acad. Sci., X, pp. 589, 590, fig. 7.
1902. *Halocynthia rubilabia*+*H. riiseana* variety *munita* Van Name, Trans. Conn. Acad. Sci., XI, pp. 393, 394, Pl. LVI, figs. 83, 84; Pl. LVII, figs. 85–87, 90; Pl. LXII, fig. 133; Pl. LXIII, fig. 141; Pl. LXIV, figs. 150, 152.
1906. *Halocynthia rubilabia* Rennie and Wiseman, Proc. Zool. Soc. London, ann. 1906, p. 404, Pl. LXIV, figs. 1–6, 8.
1908. *Halocynthia riiseana* Hartmeyer, Year Book Carnegie Inst., Washington, VI, p. 111.
1909–1911. *Pyura lævigata*+*P. riiseana*+*P. rubrilabia* Hartmeyer, Bronn's 'Tierreich,' III, suppl., pp. 1340–1342, 1629, 1633.

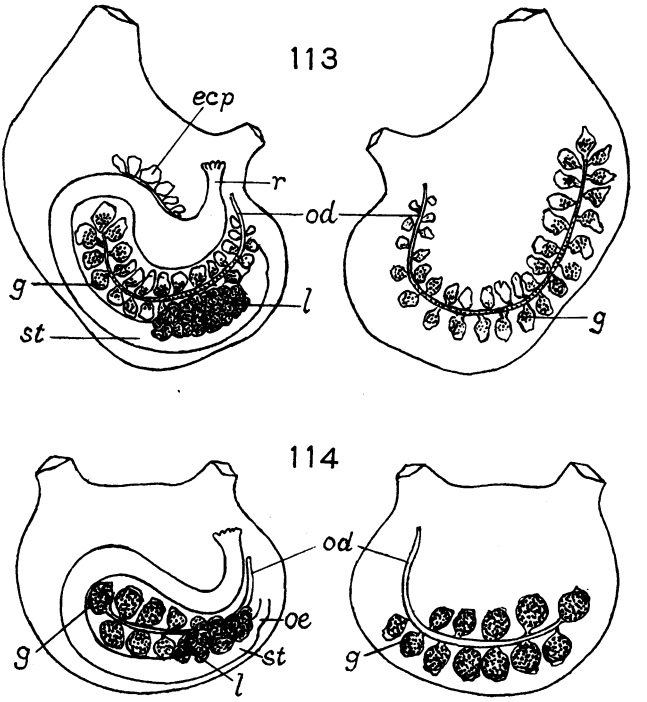
See also note on the *C. vittata* Stimpson reported by Wilson (1900), on p. 440 of this article.

After the study of a considerable amount of material from a wide range of localities, I have come to the conclusion that all the above forms, if not also some others, should be regarded as representing one species, which, though exceedingly variable, does not seem to be divisible upon the basis of any constant and reliable characters.

External form and characters so varied that it is practically impossible to give any description covering them; often the species can be recognized only on dissection. Body more or less oval, but often very irregularly so, sometimes laterally compressed, sometimes not. Attachment variable, occasionally by the whole of the ventral surface, in other examples by a larger or smaller area at or near the posterior end (which

may be produced into a very short extension or peduncle), or by an area on one side. Apertures square, generally rather far apart, raised on papillæ which in some specimens are produced into more or less elongate tubes.

Test, especially in old specimens, tough and opaque, sometimes remarkably so, and often much wrinkled. The wrinkles and folds, though separated by narrow sharply defined furrows, generally have the upper

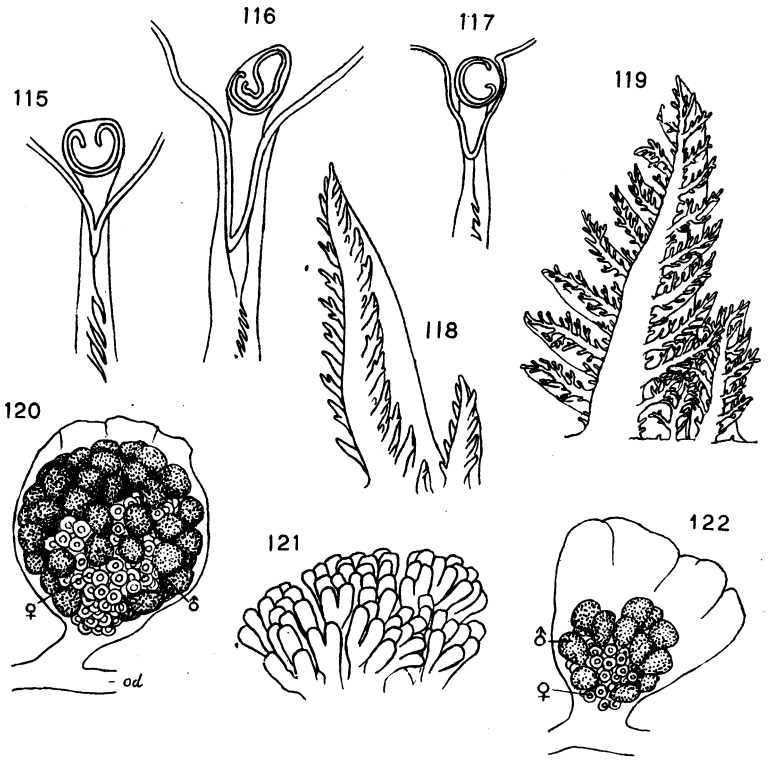


Figs. 113 and 114. *Pyura vittata* (Stimpson), 1852

Fig. 113. Left and right sides of a large individual, slightly enlarged. Fig. 114. Same, small individual from Bermuda (cotype of variety *munita* Van Name), 1902, × 1.6.

edge rounded. The outer body surface may be incrusted with sand or shell fragments, or overgrown by other organisms, or be nearly clean; around the apertures the surface is usually more or less nodulose. The fresh specimens I have seen are generally reddish or reddish brown, the color becoming more intense (often bright red) near the apertures; the color is often obscured or concealed by the incrusting material. In preservation in alcohol the colors fade to a dirty yellowish or yellowish brown; one small alcoholic specimen from Pensacola, Florida, in the

National Museum collection is a bright brassy yellow externally. The inner surface of the test is more or less pearly. This species reaches a large size; a specimen from Porto Rico measures 49 mm. long and 35 mm. dorso-ventrally; one in the Yale University collection from Fort Macon, North Carolina, collected by Dr. H. C. Yarrow is 65 mm. long and 48 mm. in dorso-ventral diameter.



Figs. 115–122. *Pyura vittata* (Stimpson), 1852

Figs. 115–117. Dorsal tubercles showing variation in different individuals, × 20. Fig. 118. Tentacles of an individual from Bermuda, cotype of *P. rubrilabia* (Verrill), 1901, × 22. Fig. 119. Tentacles of a large individual, × 12. Fig. 120. Genital sac fully distended by the reproductive glands, × 14. Fig. 121. Part of liver, × 18. Fig. 122. Genital sac only partly filled by reproductive glands, × 14.

In its internal characters it is also subject to individual variation to an unusual degree.

Mantle with numerous narrow, closely placed muscle bands which extend down on the sides of the body from the bases of the tubes; those from the two tubes cross each other obliquely on the flanks. These are

crossed by more superficial longitudinal muscles not gathered into such definite and conspicuous bands.

Tentacles rather numerous, usually about a dozen large ones and several orders of smaller and less branched ones. They may be arranged with some degree of regularity. Usually the large ones are two or three times compound in a rather regularly pinnate manner; the tips of the small branches were little if at all enlarged in the examples studied. In some individuals the tentacles are less well developed, even the largest being mostly of simply pinnate tapering form.

Dorsal tubercle normally with a U-shaped or C-shaped aperture, the open interval straight or obliquely forward, the horns incurved or more or less spirally rolled, or sometimes one curved inward and the other outward, but in large and old individuals the aperture may have the form of some more complex and often very irregular curve.

Dorsal lamina represented by a series of rather narrow pointed languets.

Branchial sac normally with six folds on each side. The transverse vessels are of four or five orders, the smallest crossing the stigmata. They are slender and numerous. The degree of regularity in the distribution of the several orders varies in different individuals and in different parts of the sac of the same specimen. The internal longitudinal vessels are very slender, and generally not especially numerous in moderate-sized individuals, but there is much individual variation in this respect.

In a fairly large specimen they had this distribution:

Left side

dl 4 (17) 4 (16) 5 (18) 5 (17) 4 (14) 4 (11) 5 en

Right side

dl 5 (17) 5 (17) 4 (18) 5 (19) 5 (16) 5 (11) 5 en

In an extremely large one:

Left side

dl 4 (28) 5 (26) 5 (32) 6 (26) 4 (18) 4 (14) 3 en

Right side

dl 5 (25) 4 (28) 5 (31) 5 (26) 6 (18) 5 (12) 3 en

The stigma are large and regular, the interstigmatic vessels slender. The number of stigmata in the meshes bounded by the transverse and internal longitudinal vessels averages larger in large than in young and small specimens, but aside from this, it appears to vary individually to an unusual degree. On the flat parts of the sac there are only four or five (sometimes only three) in some individuals, while in others there are often six or eight, or even nine, stigmata in a mesh.

Digestive tract in the form of a simple loop the branches of which are more opened out in some specimens than in others. The distal branch of the intestine, near where it passes the stomach, often becomes distended with mud into a saccular enlargement. Rectum usually short, its orifice with a variable number of rounded lobes which are not always well marked. Stomach long and narrow, tapering gradually into the intestine at the pyloric end. Its dorsal and lateral aspects are covered for a considerable distance by the liver, a massive organ consisting of several main lobes, each comprising many rounded lobules built up of numerous short, thick, blunt-ended, radially disposed secreting tubules, some of which divide into two nearly parallel branches (Fig. 121).

There is a large gonad on each side, that of the left side lying within the intestinal loop. Each consists of an elongated oviduct having a curved course and terminating near the base of the atrial tube. Along this (on each side of it and connecting with it by very short lateral branches) small reproductive sacs are located. These sacs vary in number from forty to fifty on each side (there are usually more on the right than on the left) to a dozen or less on each side; when fully developed they contain a central ovary surrounded by numerous small testes. If partially or wholly empty, the sacs resemble endocarps in their character and irregular shape; if fully distended by the development of the eggs and the male glands, they assume a more nearly spherical form, but may bear even then a distal endocarp-like prolongation. In many individuals there is, in addition, on the dorsal side of the intestinal loop, a conspicuous row of endocarps, some of which may develop into genital sacs similar to those of the gonads just described, but usually neither eggs nor male glands can be found in them.

This species is widely distributed. Stimpson's type was from North Carolina (Oak Island Beach, near Smithville); Heller's from Jamaica; Traustedt's from Saint Thomas; Sluiter (1898) reports specimens from Gairaca and Santa Marta, Colombia, and Hartmeyer (1908) from Tortugas, Florida. In the Yale Museum there are large specimens from Fort Macon, North Carolina, collected by Dr. H. C. Yarrow. It is common at Bermuda on stones, corals, etc. At Porto Rico (where it does not appear to be very common, as only four specimens were collected), it was found in shallow water along the shore in Guanica Harbor and at Parguera, and one was dredged in 5 fathoms off Guanica Harbor. The National Museum collection adds Cabañas, Cuba, the Snapper Banks off Pensacola, Florida, in 80 feet depth, and the Bahamas to the list of localities. Stimpson's description is very brief, but there does not appear to be any

other species on the North Carolina coast to which it can possibly apply. The variety *munita* described from Bermuda does not seem to be a valid subspecies; similar specimens occur in West Indian localities. It was based on small individuals covered externally with shell fragments and having but few genital sacs. Verrill's *rubrilabia*, also from Bermuda, was based on individuals with a thick, tough test, with the internal longitudinal vessels close together, and the tentacles poorly developed (mostly simply pinnate), but the differences appear to be within the range of the great individual variation to which this species is subject.

Pyura antillarum, new species

Figures 123–128

Body in the only specimen oblong when seen from one side, somewhat compressed laterally; both apertures on the dorsal surface, the branchial near the anterior end, the atrial near the middle of the body.

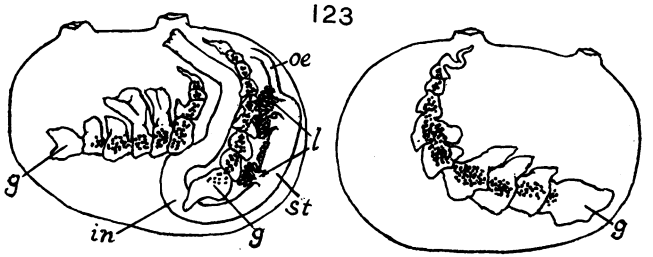
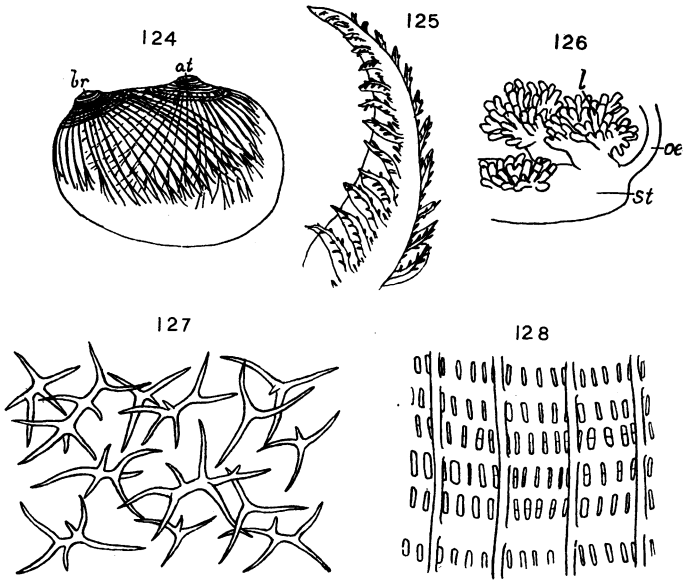


Fig. 123. *Pyura antillarum*, new species
Left and right sides of body, × 1.4.

Both are four-lobed and raised on low elevations; between them a large, irregular ridge of test substance crosses from one side of the body to the other, rising to a much greater height than the papillæ bearing the apertures. Whether this is an individual peculiarity or abnormality, or is more or less characteristic of the species, cannot be determined from the single specimen. Attachment of the body apparently by a small area on the middle of the ventral surface. Length 40 mm., dorso-ventral diameter (exclusive of the above-mentioned transverse ridge) 28 mm. Test yellowish gray, fairly thick, tough and opaque, with many narrow, deep, sharply defined wrinkles on the outer surface; these are mainly longitudinal on the dorsal half of the sides of the body, but elsewhere very irregular. Body surface covered with sand and shells of foraminifera. Internally the test is slightly pearly.

No spicules were found in fragments of the test that were examined, but spicules are present in large numbers in the mantle and vessels of the branchial sac. They are of different form from those of *P. pallida* and other species sometimes separated off as the genus *Rhabdocynthia*, being branched, and having their surface apparently smooth, even under considerable magnification. Spicules having only three or four branches are usually of more or less stellate form, the branches arising from a common central point; in the case of those with more branches there is often a



Figs. 124–128. *Pyura antillarum*, new species

Fig. 124. Body removed from test, showing muscle bands on mantle, slightly enlarged. Fig. 125. Large tentacles, × 9. Fig. 126. Part of stomach and liver, × 3.5. Fig. 127. Spicules from mantle and vessels of branchial sac, × 125. Fig. 128. Small piece of branchial sac from flat part between two folds, × 22.

short central stem or trunk from which branches arise at each end and at intermediate points. The branches are slender and tapering, and suggest in appearance those of a deer's antlers. The largest spicules that were measured were 0.15 to 0.18 mm. in extreme diameter to the tips of the branches.

The mantle is remarkable for its conspicuous network of rather narrow but prominent muscle bands. About fifty of these bands radiate from each of the tubes, extending down on the sides; those from the two tubes cross each other, forming square or diamond-shaped meshes of

considerable size, the bands radiating from the branchial aperture being superficial, and crossing outside those from the atrial aperture. A number of narrow but strong circular bands surround each tube and the area about its base; these are superficial to the radiating bands. The latter fork and break up on the lower part of the flanks into smaller bands which taper rapidly off, and end without extending across or on to the ventral region; there the mantle is thin and practically without muscles.

About ten tentacles of unequal sizes are large enough to be regarded as representing the first two orders. They are long and narrow, gradually tapering, and bear a narrow membrane and a fairly large number of short branches, which are rather sparingly pinnately branched. The tips of the small branches are not swollen. Some smaller and simpler tentacles of various sizes are irregularly distributed in the intervals between these large ones.

Dorsal tubercle scarcely at all developed; the orifice of the duct of the neural gland is merely a minute and inconspicuous cleft. This may, however, be only an individual peculiarity or abnormality of the specimen.

Dorsal lamina represented by a series of rather long narrow languets.

Branchial sac with six rather high folds on the left, and six, or possibly seven, on the right side. The folds diminish fairly regularly in height from the dorsal to the ventral one. Approximate distribution of vessels on the left side:

dl 1 (23) 3 (22) 4 (26) 4 (22) 5 (19) 5 (15) 5 en

From five to seven stigmata generally intervene between adjacent internal longitudinal vessels on the flat parts of the sac. Though in the arrangement of its vessels the branchial sac conforms to the general type found in *P. vittata* and other allied species, it is, as in many other deep-water ascidians, of very delicate structure. The transverse vessels are of three or four orders, additional very slender vessels crossing the stigmata are present only in a few places and for short distances. The transverse and interstigmatic vessels, though wide, are very flat in cross-section; the stigmata are small and narrow in most parts of the sac, and the appearance of the wall of the sac is rather that of a delicate membrane pierced by the stimgata, not of a structure built up of vessels. The internal longitudinal vessels are also of very flattened cross-section, and are not raised on supporting papillæ; one edge is in close contact with the inner surface of the sac.

The digestive tract forms a small, somewhat transversely placed, rather narrow loop, situated in the posterior part of the body. Œsophagus rather long and narrow. Stomach elongate, tapering gradually off into the intestine; it bears on its dorsal and median aspects five rather loose and irregular tufts of branching, blunt-ended hepatic tubules. Rectum moderately long, its aperture with eight bluntly rounded lobes.

On the left side there are two elongate curved gonads partially divided by transverse constructions into eight or ten rather distinct segments that are irregular in outline and prolonged at the edges into saccular extensions of the nature of endocarps. The genital glands occupy the central portions of the segments, but when in a more active functional condition they would no doubt fill them more completely. The glands contain both eggs and testes. The eggs are discharged at the posterior end of the gonad, which is prolonged into a short oviduct or neck curved so as to be directed toward the atrial tube. The ducts from the small oval or pear-shaped testes can be seen upon the free surface of the ovary, where they unite (or at least many of them do) to form a stout common sperm duct which accompanies the oviduct. One of the gonads of the left side lies in the intestinal loop, the other dorsal to it. On the right side there is but one gonad, but it is larger and stouter than those of the left side.

The only specimen was dredged by the Steamer Albatross at Station 2750 near the north end of the chain of the Lesser Antilles (18° 30′ N., 63° 31′ W., 496 fathoms, fine gray sand). This depth seems to be the greatest thus far recorded for this genus, though, except for the delicate structure of the branchial sac, the species differs little from the shallow water forms.

Pyura (Rhabdocynthia) momus form **pallida** (Heller), 1878

Figures 129–136

1878. *Cynthia pallida* Heller, Sitzungsber. Akad. Wiss. Wien, math.-nat. Kl., LXXVII, p. 96, Pl. III, figs. 17, 18.

1881. *Cynthia pallida* Herdman, Proc. Roy. Soc. Edinburgh, XI, p. 60.

1882. *Cynthia pallida* Herdman, 'Rep. Voyage Challenger,' Zool., VI, p. 143, Pl. XVII, figs. 17–21.

1883. *Cynthia pallida* Traustedt, Vidensk. Meddel. natur. For. Kjöbenhavn, ann. 1882, pp. 119, 133, Pl. v, fig. 12.

1885. *Cynthia pallida* variety *billitonensis* Sluiter, Natuurh. Tijdschr. Neder. Ind., XLV, p. 183, Pl. I, fig. 6; Pl. II, figs. 1–11.

1885. *Cynthia pallida* Traustedt, Vidensk. Meddel. natur. For. Kjöbenhavn, ann. 1884, p. 35.

1886. *Cynthia pallida* (+*C. pallida* variety *billitonensis*) Herdman, 'Rep. Voy. Challenger,' Zool., XIV, App. A., pp. 405, 406.

1890. *Cynthia pallida* variety *billitonensis* Sluiter, Natuurh. Tijdschr. Neder. Ind., L, p. 331.
1891. *Rhabdocynthia pallida* (part) +*R. pallida* variety *billitonensis*+*R. mauritiana* Herdman, Journ. Linn. Soc. London, Zool. XXIII, p. 575.
1898. *Rhabdocynthia pallida* Sluiter, Mém. Soc. Zool. France, XI, p. 25.
1904. *Rhabdocynthia pallida* Sluiter, 'Siboga-Exped.,' LVIa, p. 54.
1905. *Halocynthia pallida typica*+*H. mauritiana* Michaelsen, Zool. Jahrb., suppl., VIII, p. 83.
1905. *Halocynthia pallida* Hartmeyer, Zool. Jahrb., suppl., VIII, p. 384.
1905. *Rhabdocynthia pallida* Sluiter, Bull. Mus. Hist. Nat. Paris, 1905, p. 102.
1905. *Rhabdocynthia pallida* Sluiter, Mém. Soc. Zool. France, XVIII, p. 14.
1906. *Rhabdocynthia pallida* Herdman, 'Rept. Ceylon Pearl Oyster Fisheries,' V, p. 308, Pl. II, figs. 36–39.
1906. *Halocynthia pallida* Hartmeyer, Zool. Anzeiger, XXXI, p. 4, text fig. 2.
1908. *Pyura pallida* (form *typica*) Michaelsen, Jahrb. Wiss. Anst., Hamburg, XXV, suppl. 2, pp. 269, 270.
1909–1911. *Pyura pallida* (form *typica*) Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1340, 1629.
1912. [*Pyura*] *pallida* Hartmeyer, Denk. Akad. Wiss. Wien, math.-nat. Kl., LXXXVIII, p. 17.
1912. *Pyura pallida* Hartmeyer, 'Deutsch. Tiefsee-Exp.,' XVI, pp. 361, 363.
1913. *Pyura pallida* Hartmeyer, Zool. u. anthropol. Ergeb. Forsch., Südafrika, V, p. 128.
1918. *Pyura pallida* Van Name, Bull. U. S. Nat. Mus., No. 100, I, p. 76, Pl. XXXII, figs. 36–38; text figs. 19–25.
1918. *Pyura momus* form *pallida* Michaelsen, Jahrb. Wiss. Anst., Hamburg, XXXV, suppl. 2, p. 10.
1919. *Pyura momus* form *pallida* Michaelsen, Denk. Akad. Wiss. Wien, math.-nat. Kl., XCVII, pt. 10, pp. 34, 53.
1921. *Pyura momus* var. *pallida* Michaelsen, Arkiv för Zoologi, XIII, No. 23, p. 1.

Usual form of the body rounded or oblong somewhat compressed laterally, and attached by a small ventrally or more or less laterally situated area. Apertures on the dorsal side, rather widely separated, often raised on papillæ.

Test moderately thick, opaque, rather soft though tough in fresh material, and remaining soft in formalin, but becoming harder in alcoholic specimens. Surface varying from uneven and wrinkled to rather smooth, occasionally overgrown with other organisms. Color of external surface and interior of test usually a dull white (sometimes tinged with pink about the apertures) when not stained or incrusted with mud or other substances. Size sometimes very large; 55 by 45 mm. in longitudinal and dorso-ventral diameter is, however, not usually exceeded in the West Indies.

The species is most readily recognized by the characteristic spicules, present chiefly in the mantle and large blood vessels of the branchial sac.

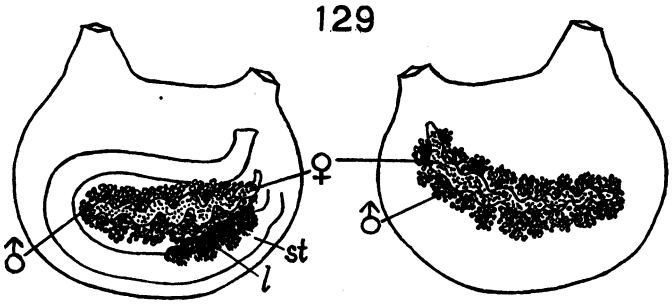
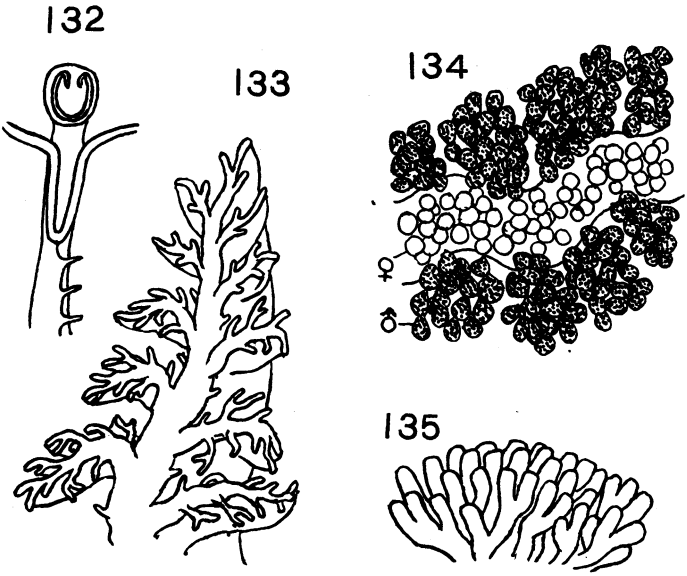


Fig. 129. *Pyura momus* form *pallida* (Heller), 1878
Left and right sides of body, natural size.



Figs. 130–135. *Pyura momus* form *pallida* (Heller), 1878
Fig. 130. Small part of a spicule, × 420. Fig. 131. Spicules. The large group is from the mantle and vessels of the branchial sac, the small group from the test, × 35. Fig. 132. Dorsal tubercle, × 8. Fig. 133. Tentacle, × 25. Fig. 134. Part of a gonad, × 8. Fig. 135. Part of liver, × 20.

These are rod-like or needle-like, very variable in size and proportions, but sometimes 2 mm. or more long in large individuals. They taper toward one or both ends and are usually slightly curved. Under magnification, their surface is seen to be covered with minute appressed points or spines arranged in transverse rings. Somewhat similar spicules are found, though less abundantly, in the test, where they are usually very short, stout and straight, and often have one end enlarged into a head, the other being either blunt or pointed. The presence of these spicules has led some writers to make this species the type of a genus or subgenus, *Rhabdocynthia*.

Mantle thin, with rather weak musculature except for some stout bands extending from the bases of the tubes down on the sides. Tentacles irregular in size and arrangement; the larger ones, which are of unequal size and may number from eight to a dozen, are two or three times compound and bear broad membranes. Their branches are not very numerous.

Dorsal tubercle rather small, U-shaped, heart-shaped, or horseshoe-shaped, with the open interval forward (sometimes obliquely to the left), and both horns usually incurved or inrolled.

Dorsal lamina replaced by a series of languets.

Branchial sac with high, sharply defined folds separated by narrow flat intervals. The number of folds is variable; in West Indian specimens usually eight or nine on a side.

Transverse vessels of four or five orders, often quite regular in their arrangement, the smallest often crossing the stigmata. There are from six to ten stigmata in the large meshes on the flat parts of the sac.

Internal longitudinal vessels only moderately numerous; they were distributed about as follows in a fully adult and fairly large specimen, though in small individuals they will be found considerably less numerous:

Left side

dl 2 (15) 3 (19) 3 (22) 2 (23) 2 (21) 2 (19) 2 (16) 2 (11) 3 en

Right side

dl 4 (16) 3 (20) 2 (22) 2 (23) 2 (22) 3 (18) 2 (14) 2 (10) 1 (5) 0 en

Digestive tract curved in a simple, broad loop. Stomach elongated, bearing a large and dense mass of short hepatic tubules which are crooked and often slightly branched. Rectum short; margin of its aperture not conspicuously lobed in the specimens studied.

One long, horizontally or obliquely placed gonad on each side, each consisting of a central, sinuously curved ovary bordered by numerous small testes. On the left side the gonad lies in the intestinal loop.

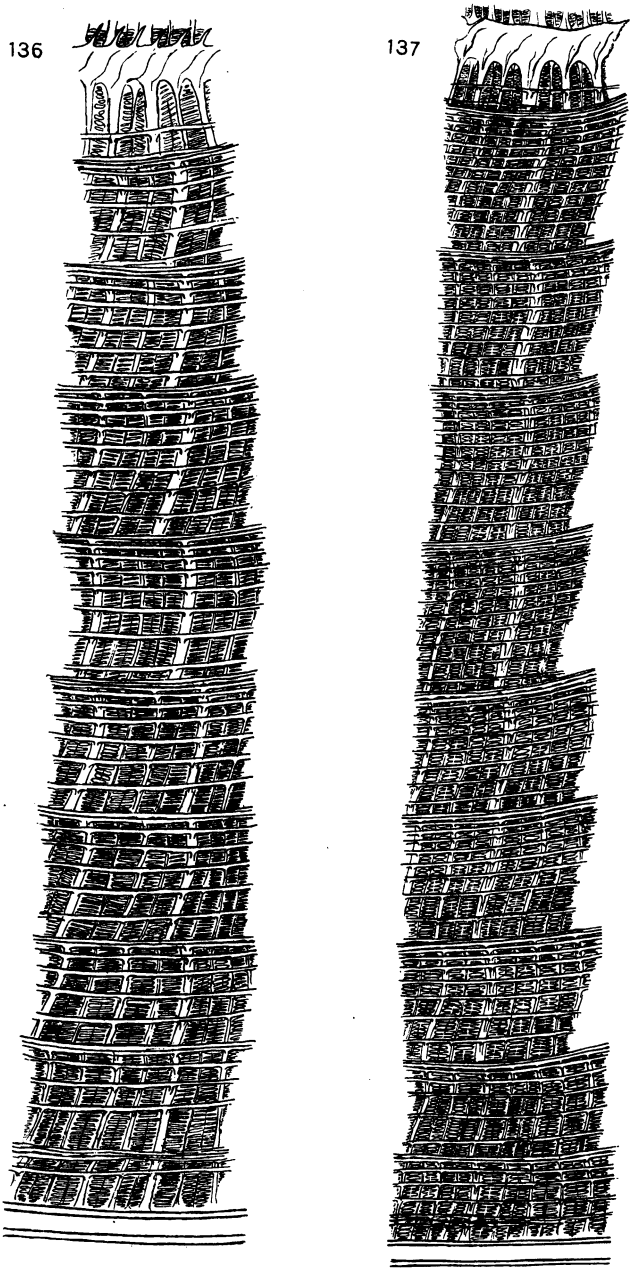


Fig. 136. *Pyura momus* form *pallida* (Heller), 1878
Part of branchial sac, × 8.

Fig. 137. *Microcosmus exasperatus* (Heller), 1878
Part of branchial sac, × 6.

This ascidian is widely distributed in tropical and subtropical seas, ranging from shallow water to a considerable depth. According to Michaelsen, 1918, it is a form or subspecies of *Cynthia momus* Savigny, 1816, from the Red Sea. A number of varieties, subspecies, and allied species of this group have been distinguished, but their characters need not be discussed here, as West Indian specimens are quite typical of the form *pallida* (see Michaelsen, 1908, p. 270; 1919, pp. 30–54.)

It has been recorded by Heller (1878), Traustedt (1883, 1885), and Sluiter (1898) from Jamaica, Curaçao, St. Croix, and St. Thomas; the American and National Museum collections add several localities in Cuba (Paradones near Cienfuegos, Bahia Honda and Cabañas), and Colon, Isthmus of Panama, to the list. The specimens from Paradones were growing in dense clusters with *Phallusia nigra*.

Microcosmus Heller, 1877

Distinguished from *Pyura* chiefly by the possession of a continuous dorsal lamina instead of a row of languets. A further distinction is the narrower intestinal loop, whose branches lie partly in contact with each other.

Microcosmus exasperatus Heller, 1878

Figures 137–144

1878. *Microcosmus exasperatus*+*M. variegatus*+*M. distans* (part) Heller, Sitzungsber. Akad. Wiss. Wien, math.-nat. Kl., LXXVII, pp. 99, 100, Pl. III, figs. 19, 20; Pl. v, fig. 27.

1883. *Microcosmus variegatus* Traustedt, Vidensk. Meddel. natur. For. Kjöbenhavn, ann. 1882, pp. 122, 134, Pl. v, figs. 10, 11; Pl. VI, fig. 17.

1885. *Microcosmus variegatus* Traustedt, Vidensk. Meddel. natur. For. Kjöbenhavn, ann. 1884, p. 42.

1891. *Microcosmus exasperatus*+*M. variegatus*+*M. distans* Herdman, Journ. Linn. Soc. London, Zool., XXIII, p. 574, 575.

1898. *Microcosmus distans*+*M. exasperatus*+*M. variegatus* Sluiter, Mém. Soc. Zool. France, XI, pp. 6, 26, Pl. II, fig. 35.

1900. *Microcosmus miniatus* Verrill, Trans. Conn. Acad. Sci., X, p. 590, fig. 8.

1902. *Microcosmus miniatus* Van Name, Trans. Conn. Acad. Sci., XI, p. 396; Pl. LVI, fig. 79; Pl. LVII, figs. 91, 95; Pl. LXII, figs. 129, 130; Pl. LXIV, fig. 148.

1908. *Microcosmus exasperatus* (subspecies *typicus*) Michaelsen, Jahrb. Wiss. Anst., Hamburg, XXV, suppl. 2, p. 271, Pl. II, figs. 11–13.

1909–1911. *Microcosmus exasperatus* (subspecies *typicus*) Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1345, 1630, 1633.

1913. [*Microcosmus*] *exasperatus* Hartmeyer, Denk. Akad. Wiss. Wien, math.-nat. Kl., LXXXVIII, p. 180.

1918. *Microcosmus exasperatus* (subspecies *typica*) Michaelsen, Jahrb. Wiss. Anat., Hamburg, XXXVI, suppl. 2, p. 11.

1918. *Microcosmus exasperatus* Van Name, Bull. U. S. Nat. Mus., No. 100, I, p. 81, figs. 30–32, Pl. XXXII, fig. 39.

1919. *Microcosmus exasperatus* Michaelsen, Denk. Akad. Wiss. Wien, math.-nat. Kl., XCV, pt. 10, p. 63, fig. 9.

This widely distributed species has been often described and figured, and a comparatively brief account of it will suffice for its identification. For further details in regard to its structure, variations, and relationships, the reader is referred to Michaelsen, 1908 and 1919.

Body irregularly elongate ovate, generally attached by considerable area on the ventral or posterior ventral side. Apertures on the dorsal side, widely separated, generally on rather low papillæ, which, however, are sometimes produced into tubes of conspicuous length. Size of largest specimen about 55 mm. by 35 mm. by 27 mm. Body surface very rough and uneven with irregular folds, furrows, and ridges, the latter often with rough angular edges. Though often overgrown to some

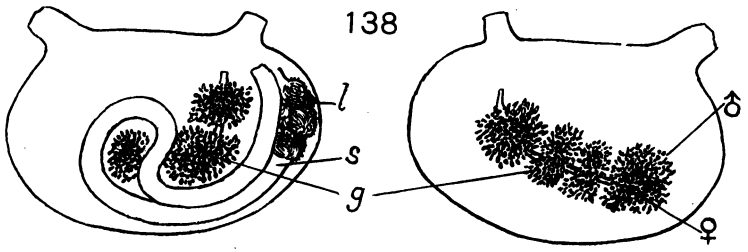


Fig. 138. *Microcosmus exasperatus* Heller, 1878
Left and right sides of body, × 1.2.

extent with algæ, compound ascidians, or other organisms, it is generally not much incrusted by sand or shell fragments. Color of test in life, some shade of red or pink externally and pearly gray or whitish internally. Test fairly thick and tough, often becoming hard and rigid in alcoholic specimens.

Mantle with many very conspicuous muscle bands radiating from the bases of the tubes and extending down onto the sides of the body, where they cross each other nearly at right angles; there are also conspicuous but less regular muscles crossing the ventral region.

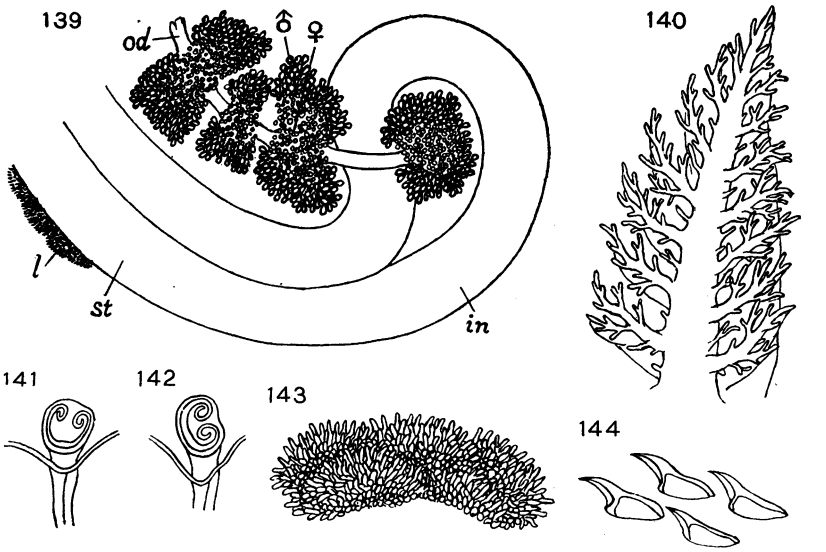
Tentacles of tapering form, the larger ones about eight or ten in number, pinnately branched, and two or three times compound. A variable number of smaller, more or less branched tentacles occupy the intervals between them. Considerable variation was found in the number and length of the primary and secondary branches of the large tentacles in different specimens. In some large specimens from Porto Rico they were found very numerous, and many third-order branches

were present. The tips of the small branches may or may not be slightly enlarged.

Dorsal tubercle generally C-shaped with inrolled horns, the open interval directed forward and more or less obliquely to the left.

Dorsal lamina rather wide, plain-edged.

Branchial sac with about nine (sometimes eight or ten) folds on each side; the folds diminish in height, and in the number of internal longitudinal vessels they bear, fairly regularly from the dorsal to the ventral



Figs. 139–144. *Microcosmus exasperatus* Heller, 1878

Fig. 139. Intestinal loop and gonad of left side, seen from side next to the branchial sac, × 6. Fig. 140. Tentacle, × 15. Figs. 141 and 142. Dorsal tubercles of two individuals, × 7. Fig. 143. Part of liver, × 10. Fig. 144. Minute spines from lining of distal part of branchial tube, × 280.

region, the ninth fold being often much reduced and fading out before the posterior end of the body is reached, or it may be wanting entirely. A small rudiment of a tenth fold is often present on the right side or on both sides, but it extends only a short distance and bears very few vessels. The second fold is often somewhat lower than the third. The folds in this species are ordinarily not very high, and portions of the intervening flat parts of the sac are exposed even when the folds lie flat against the sides. Transverse vessels quite numerous; at least five orders can be recognized in some parts of the sac, those of the first order being very large. The smallest vessels often cross without interrupting the stigmata. The following scheme shows the distribution of the internal longitudinal vessels in a fairly large and typical example:

Left side

dl 4 (25) 4 (22) 5 (24) 4 (20) 3 (19) 4 (16) 3 (12) 3 (9) 2 (6) 1 en

Right side

dl 5 (24) 4 (20) 3 (24) 3 (22) 4 (18) 3 (15) 3 (11) 3 (9) 2 (6) 0 (3) 0 en

Five to eight stigmata ordinarily intervene between internal longitudinal vessels on the flat parts of the sac between the folds.

Intestinal loop narrow, its branches lying close together except at the anterior end, where it opens out into a small loop and is at the same time strongly bent in a dorsal direction. Stomach long and narrow; its wall bears two large hepatic glands near the œsophageal end. The surface of these glands exhibits convolutions which under low magnification suggest those of the human brain. Under high power they are seen to be composed of compacted masses of blindly ending tubules, whose tips project irregularly above the surface.

One gonad on each side of the body. It consists of several masses or segments arranged along a curved oviduct which passes through them in succession. Generally there are three or four segments in the left, and four or five in the right gonad. Each mass or segment consists of a central ovary more or less completely surrounded by the male glands, which are of the usual small pyriform type. When highly developed, the masses may become so large as to obliterate the intervals or clefts between them wholly or in part, so that the gonad may appear continuous or nearly so. The anterior end of the left gonad lies in the open part of the loop formed by the intestine.

This species, which is one of the commonest ascidians of the West Indian region, is widely distributed in tropical and warm-temperate seas, being known from various parts of the West Indies (St. Thomas), Cuba, Porto Rico, Venezuela, Colombia (Santa Marta), Bermuda, East Africa, the Malay region and Formosa, while on the Australian coasts it is represented by a variety (see Traustedt, 1883; Michaelsen, 1908). It grows in shallow water attached to piles, corals, stones, and mangrove roots, as well as in depths to 23 fathoms or more. Many specimens were collected in the vicinity of Guanica Harbor and Parguera, Porto Rico, by the American Museum expeditions; these were mostly found in shallow water along the shore, but several were dredged in depths from 3 to 7 fathoms. Among the numerous specimens in the National Museum collection is one from Sabanilla, Colombia, and one from Station 2617, Steamer Albatross (33° 37′ 30″ N., 77° 36′ 30″ W., 14 fathoms), off the South Carolina coast.

Microcosmus helleri Herdman, 1881

Figures 145, 146

1881. *Microcosmus helleri* Herdman, Proc. Royal Soc. Edinburgh, XI, p. 54.
1882. *Microcosmus helleri* Herdman, 'Rept. Voy. Challenger, Zool.,' VI, p. 121, Pl. XIV, figs. 1–4.
1885. ?*Microcosmus gleba*+*M. helleri* Traustedt, Vidensk. Meddel. natur. For. Kjöbenhavn, ann. 1884, p. 41, Pl. III, figs. 23–25.
1891. *Microcosmus helleri*+?*M. gleba* Herdman, Journ. Linn. Soc. London, Zool., XXIII, p. 574.
1905. *Microcosmus helleri* Sluiter, Denkschr. med.-nat. Gesell. Jena, VIII, p. 184, Pl. X, figs. 8, 9 (*fide* Hartmeyer).
1906. ?*Microcosmus manaarensis*+?*M. longitubis* Herdman, 'Rept. Ceylon Pearl Oyster Fisheries,' V, pp. 311, 312, Pl. II, figs. 23–25.
1909. *Microcosmus helleri*+?*M. gleba* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1345, 1642, 1644.
1918. *Microcosmus goanus*+*M. helleri*+?*M. gleba* Michaelsen, Jahrb. Wiss. Anst., Hamburg, XXXV, suppl. 2, p. 12, text figs. 1, 2.
1919. *Microcosmus helleri*+?*M. gleba* Hartmeyer, Kungl. Svensk. Vetensk. Akad. Handl., LX, No. 4, p. 19, Pl. I, figs. 6–9.

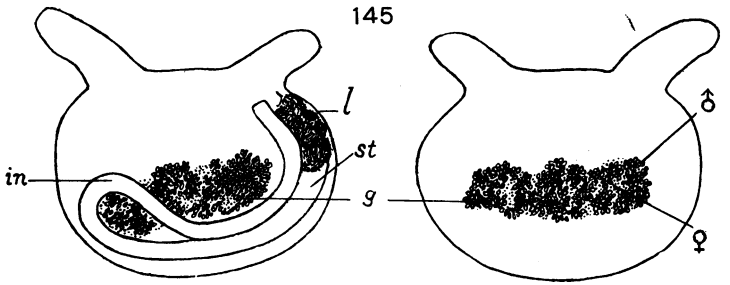


Fig. 145. *Microcosmus helleri* Herdman, 1881
Left and right sides of body, × 1.5.

Body irregularly spheroidal, longer than broad, and usually not laterally compressed, though sometimes slightly compressed in a dorso-ventral direction. Tubes arising from the dorsal surface at a varying distance apart; they are long, narrow, and diverging in most specimens, and often very crooked. In some specimens, however, they are quite short, perhaps because of contraction. Size of the largest specimen, 45 mm. long, 32 mm. in dorso-ventral and 29 mm. in lateral diameter, exclusive of the tubes. These arise more than 10 mm. apart; the branchial tube is about 16 mm. long, the atrial about 11 mm. long.

Body surface rough and raised into small, sharp, irregular ridges and small irregular processes. It is so completely incrusted with sand grains, shell and coral fragments, etc. (which are imbedded in the test of the body and in the substance of the processes, as well as firmly at-

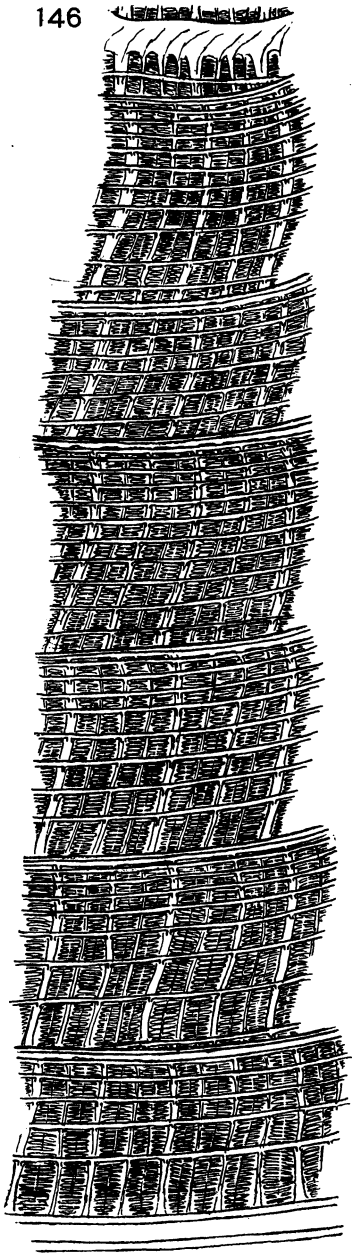


Fig. 146. *Microcosmus helleri* Herdman, 1881
Part of branchial sac, × 10.

tached to their surfaces) and so plastered with loosely adherent mud that the surface is generally entirely concealed and the animal often looks like a ball of mud and débris. Most of the specimens had evidently lived buried in the mud, the long tubes (probably capable of greater extension during life) enabling them to breathe and feed when so situated. (One specimen, from off Guanica Playa, was attached to an oyster shell, and evidently grew in a more exposed position; some algæ were growing upon its surface, which is otherwise only lightly incrusted with foreign matter; its tubes are little more than papillæ, and arise very near together.) The test is tough but only moderately thick; its lining is slightly nacreous. The test extends into and forms a thin lining to the branchial tube; the terminal or posterior margin of this lining is produced into four large, rigid, somewhat spoon-shaped or obtusely pointed lobes that project in a convergent manner into the lumen of the branchial tube anterior to the circle of tentacles. In spite of the most careful search I was unable to demonstrate any small spines in the lining of either the branchial or atrial tube, such as are present in *M. exasperatus*.

Mantle rather thin, but with strong, rather closely spaced muscle bands on many parts of its surface, the most conspicuous of them, as in other species of this genus, being long narrow bands composed of several fibers side by side, which extend down on the flanks from the tubes, those from

one tube crossing those from the other so as to form small square or obliquely four-sided meshes.

Tentacles of rather regular pinnate form, the largest ones larger and more extensively branched than in most individuals of *M. exasperatus*, being three times (on some of the branches four times) compound. The minute branches end in blunt, somewhat swollen tips. The larger tentacles are not all of uniform size and number only eight or less; smaller and less complex tentacles are present in the intervals, but are not very numerous. In some individuals several tentacles (two to four or more) are very much larger than the rest, but these are not necessarily symmetrically placed in the circle.

Dorsal tubercle C-shaped, the open interval directed forward and the horns spirally rolled inward. Neither the dorsal tubercle nor the tentacles appear to differ sufficiently from those of *M. exasperatus* to require illustration.

Dorsal lamina a plain membrane, rather narrow.

Branchial sac very regular in structure, with six well-developed folds on each side of the body. Additional rudimentary folds were not observed in any of the specimens studied (five individuals). The folds are for the most part so high as to cover the intervening flat part of the sac and a part of the fold above when in their normal position. Transverse vessels of at least five orders can be recognized, the smallest crossing without interrupting the stigmata. They are usually quite regularly arranged (except that the fifth-order vessels are wanting in many places), according to the usual scheme:

1 5 4 5 3 5 4 5 2 5 4 5 3 5 4 5 1.

Internal longitudinal vessels narrow, numerous, and rather near together on the folds, but considerably more widely and unevenly spaced on the intervening flat parts of the sac. It is often hard to decide whether certain of the vessels should be counted as belonging to the flat portion or to the basal part of one of the adjacent folds. Approximate distribution of the internal longitudinal vessels in a moderately large individual:

Left side

dl 3 (24) 2 (19) 2 (25) 4 (22) 3 (16) 3 (13) 1 en

Right side

dl 4 (23) 3 (18) 2 (26) 4 (23) 3 (17) 3 (14) 0 en

Several others examined showed about the same distribution. Stigmata very narrow and very regular in their arrangement. The meshes formed by the transverse and internal longitudinal vessels are quite variable

in size on the flat portions of the sac on account of irregular spacing of the latter vessels, but there are commonly at least nine or ten and sometimes twelve or fifteen stigmata in a mesh.

Stomach long and narrow, tapering off into the intestine. A part of its wall near the œsophageal end bears a hepatic gland. Intestinal loop long and narrow, its branches lying close together except for a short distance at the anterior end (the closed end), where they are spread apart to form a small open space in which part of the gonad lies. The anterior part of the intestinal loop is much less sharply bent up dorsally than in *M. exasperatus*. As the intestine is visible through the mantle, this character is of convenience in distinguishing the two species.

One gonad of elongate outline is present on each side of the body. Each consists of a layer of small pyriform male glands attached to the inner surface of the mantle. These in turn are covered by the ovarian portion of the gonad, which lies in contact with the branchial sac. On the left side the anterior end of the gonad lies chiefly within the above-mentioned loop formed by the intestine. A tendency to division of the gonads into two or three segments by narrower necks is noticeable in many cases, but this was rarely carried to such an extent as to break the continuity of the mass in any of the specimens studied.

The specimens of this species were all dredged off the coast of Porto Rico in the vicinity of Guanica and Tallaboa by the American Museum expeditions. Their localities are as follows:

East of Caribe Islands, 5½ to 8¾ fathoms, 27 specimens; off Guanica Playa, 18 feet, sand and algæ, 1 specimen; between Ratones and Caribe Islands, 6 to 11 fathoms, 1 specimen.

This is a species very widely distributed in the warm parts of the world. Herdman's type was from Torres Strait, Sluiter reports it from Amboina, and Michaelsen (1918) redescribed it under the name *goanus* from Delagoa Bay, Portuguese East Africa, though doubtful of its distinctness from Herdman's species. The identity of the two seems to have been satisfactorily established by Hartmeyer (1919). I am inclined to go farther than that author and regard *M. gleba* Traustedt, 1885, from Banka, as another synonym, and *M. manaarensis* and *M. longitubis* Herdman, 1906, from Ceylon, as only very doubtfully distinct.

[NOTE. An additional, apparently entirely distinct species of this genus (*M. anchylodeirus*) is described by Traustedt (1883, p. 121, Pl. VI, fig. 18) from St. Thomas, W. I. It has seven folds on each side and a branchial sac with very irregular vessels. See also p. 485.]

Molgulidæ Lacaze-Duthiers, 1877

[=Cæsiridæ *auct. mult.*]

Simple ascidians, usually having the tentacles compound and the branchial sac with longitudinal folds, more or less spirally arranged stigmata, and a kidney (in the form of a single completely closed sac in which concretions form) situated on the right side of the body. Dorsal lamina continuous but often toothed.

Molgula Forbes and Hanley, 1848

[=*Cæsira auct. mult.*]

The largest genus of the family. The branchial sac is provided with folds (usually six or seven on each side), each bearing a number of internal longitudinal vessels and usually a row of infundibula with spiral stigmata along its summit; the spirals are more or less imperfect and interrupted. A gonad is usually present on each side of the body.

Molgula occidentalis Traustedt, 1883

Figures 147–152

?1860. *Molgula* species, Stimpson, Amer. Journ. Sci., (2) XXIX, p. 443.

1883. *Molgula occidentalis* Traustedt, Vidensk. Meddel. natur. For. Kjöbenhavn, ann. 1882, pp. 113, 128, Pl. v, figs. 4, 5; Pl. vi, fig. 14.

1891. *Molgula occidentalis* Herdman, Journ. Linn. Soc. London, Zool., XXIII, p. 567.

1909–1911. *Cæsira occidentalis* Hartmeyer, Bronn's 'Tier-reich,' III, suppl., pp. 1323, 1624, 1629.

1914. *Molgula occidentalis* Hartmeyer, Sitzungsber. Gesell. naturf. Freunde, Berlin, p. 7.

Body of rounded or oval outline; the depth may or may not exceed the length. It is not much compressed laterally. Apertures on the dorsal side, usually situated not far apart, sometimes sunk in the depressions between rounded prominences of the test that are present on that part of the body, in other cases raised on low papillæ. Size of largest specimen examined, 44 mm. long, 45 mm. in dorso-ventral diameter, and nearly 25 mm. wide from side to side when distended.

Test rather thin, though tough, on most parts of the body; on the dorsal region it becomes quite abruptly very thick and hard. The surface is sometimes roughened by rather fine wrinkles and much incrusted with mud, sand, shell fragments, etc., these materials being in part imbedded in the test and in part adherent to short fibrous processes with which parts of the surface are provided, but some specimens have much of the body bare of foreign matter and fairly smooth. The color is usually that of the incrusting sand or mud; where the surface is exposed it is of a dingy yellowish or gray color. Mantle thin and semitransparent, some-

times dark colored. There are a few stout muscle bands radiating from the tubes and extending part way down the sides, and, as shown in Traustedt's figures, there are rows of short transverse bands on many parts of the sides and ventral region, and well-developed circular muscles about the apertures.

About a dozen large tentacles are present in the largest specimens beside some additional smaller tentacles. These structures are difficult to count because of their crowded condition, and it is often difficult to distinguish some of the closely placed smaller tentacles from the basal

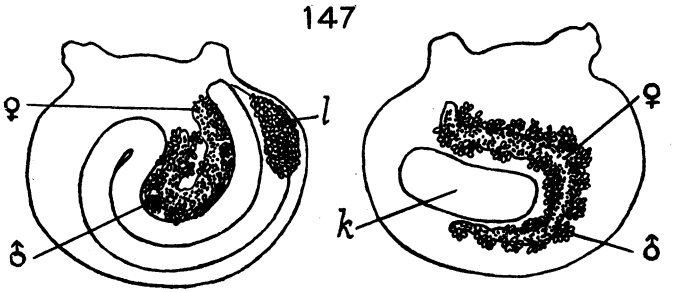


Fig. 147. *Molgula occidentalis* Traustedt, 1883
Left and right sides of body, × 1.5.

branches of the larger ones. The large tentacles are three times pinnate, the small branches ending in slightly enlarged rounded tips.

Dorsal tubercle C-shaped; open interval more or less directly to the left in all of a number of specimens in which this character was examined; horns inrolled.

Dorsal lamina plain-edged.

Branchial sac with six well-developed folds on each side; they are broad and sharply defined, and bear many internal longitudinal vessels. Traustedt's description, probably based on a single specimen, gives seven folds on each side, the first fold being incomplete. I have found a more or less well-developed plication between the dorsal lamina and the first true fold in many individuals (including examples from different localities) on one or both sides of the body, and this is probably what Traustedt counted as the first fold. It bears a few somewhat irregular internal longitudinal vessels, but I cannot consider it homologous with the remaining six. In many examples it is so slight as to be readily overlooked; in many it is wanting completely on one or both sides. This extra fold seems to be of the same nature as that present in *Polycarpa obtecta*, and *P. spongiabilis* (see p. 422) and is very probably due to a mechanical cause, as suggested in the description of *P. obtecta*.

Distribution of the internal longitudinal vessels in a medium sized individual:

Left side

dl [5] 1 (11) 0 (12) 0 (11) 0 (10) 1 (9) 1 (7) 0 en

Right side

dl [6] 0 (12) 0 (12) 1 (10) 1 (10) 0 (8) 0 (6) 0 en

In a larger example, 39 mm. long, which was without any trace of the extra fold, they were distributed as follows:

Left side

dl 8 (15) 1 (17) 1 (16) 2 (14) 1 (11) 1 (9) 0 en

Right side

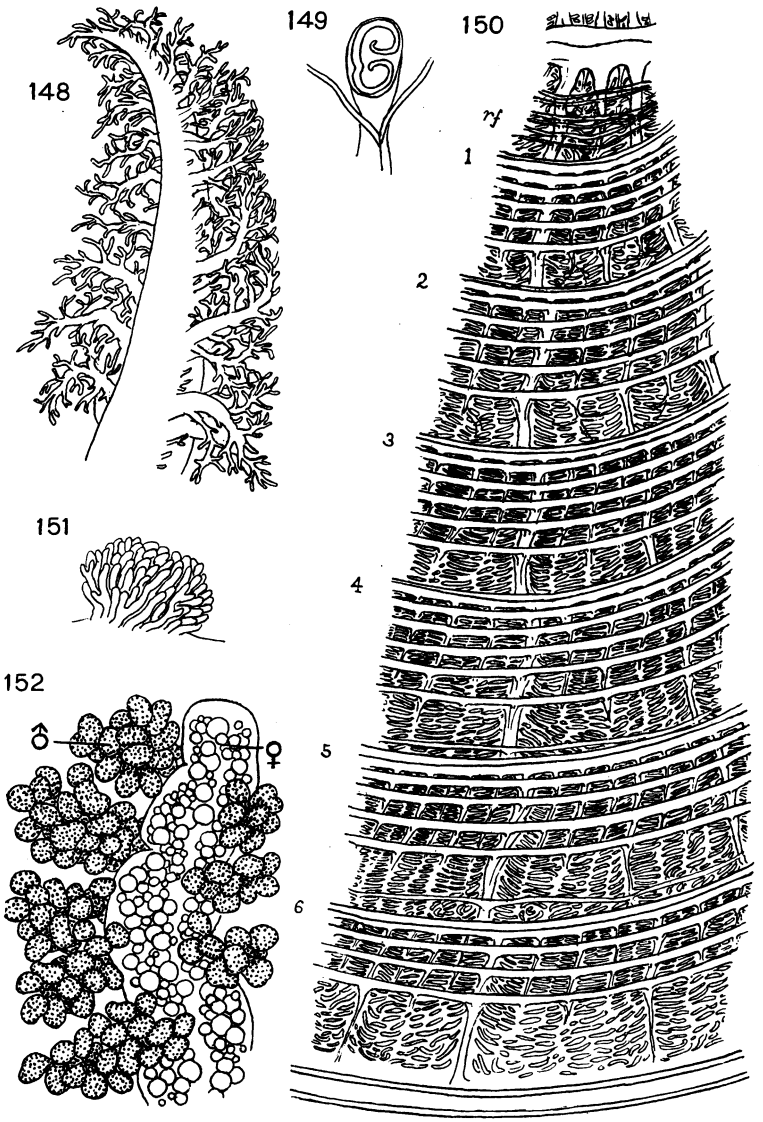
dl 7 (17) 1 (16) 1 (14) 2 (12) 2 (10) 1 (7) 1 en

Four (in the ventral parts of the sac often five) orders of transverse vessels are recognizable on the folds, where they are quite regularly arranged. On the flat spaces between folds the smaller ones become irregular and often disappear. Stigmata very numerous, mostly straight or but little curved; never very long and narrow. They are mainly longitudinal and arranged in transverse columns separated by the transverse vessels of the smaller orders. The small interstigmatic vessels branch and curve a good deal, and this, as well as the irregularity of the smaller transverse vessels, disturbs or obscures their arrangement in columns in many places, but in others their regularity is quite striking. No definitely formed infundibula with spirally arranged stigmata were demonstrated even on the folds, whose knife-like sharpness would hardly allow of their presence. On the flat intervals between folds, especially in the ventral region of the sac, a tendency to a spiral arrangement of the stigmata is present in a few places. A considerable number of irregularly branching vessels ramify on the inner surface of the sac.

Intestinal loop very narrow (its branches in contact for practically the whole length). It is bent into about three quarters of a circle. Stomach with a large, greenish hepatic gland consisting of an immense number of very minute, short, sparingly branched tubules.

Kidney large and broad, elongate-oblong in shape; usually not much curved.

A large gonad is present on each side of the body. Each gonad consists of an elongate curved tubular ovary bordered along its sides with clusters of small oval or pear-shaped male glands. Right gonad very long and narrow, and bent around the kidney so as to surround all except the posterior part of it. The dorsal end of the ovary, where the aperture



Figs. 148–152. *Molgula occidentalis* Traustedt, 1883

Fig. 148. Large tentacle, × 9. Fig. 149. Dorsal tubercle, × 12. Fig. 150. Part of branchial sac, × 12. Fig. 151. Part of liver, × 6. Fig. 152. Closed end of left gonad, × 15.

for the discharge of the eggs is situated, is bent dorsally toward the base of the atrial tube. Left gonad situated in the curve formed by the dorsal side of the digestive tract. The ovary is bent into a U-shaped loop, with the open end dorsal; the small groups of male glands lie, in the specimens studied, chiefly along the outside of the curve (hence between the ovary and intestine), but some are in the bend of the loop formed by the ovary. When well developed the left ovary and testes form a compact group, broad below and narrow above (that is, in the dorsal part), the bend of the loop being completely filled.

The form of the gonads just described seems to be characteristic of this species and furnishes the best means of recognizing it, as the gonads are usually easily seen through the mantle as soon as the animal is removed from the test.

This species ranges from North Carolina (Fort Macon, near Beaufort, and the mouth of the Cape Fear River) to the West Indies (Porto Rico, off Guanica Playa, 18 fathoms; Guanica and San Juan Harbors), but appears to be especially common on the Florida coasts, where it is the principal representative of the family. It ranges in depth from low-water mark, often growing on mangrove roots, to 21 fathoms (off the west coast of Florida). Traustedt's type was from the West Indies (probably from the former Danish possessions).

Molgula manhattensis (De Kay), 1843

Figures 153 and 154

1843. *Ascidea manhattensis* De Kay, 'Zoology of New York,' V, 'Mollusca,' p. 259.
?1852. *Molgula sordida* Stimpson, Proc. Boston Soc. Nat. Hist., IV, p. 229.
1873. *Molgula manhattensis* Verrill and Smith, 'Rep. on Invert. Animals of Vineyard Sound,' pp. 699, 311, 445, etc., Pl. XXXIII, fig. 250.
1898. *Molgula manhattensis* Metcalf, Anat. Anzeiger, XVI, p. 469.
1900. *Molgula manhattensis* Wilson, Amer. Naturalist, XXXIV, p. 354.
1905. *Molgula manhattensis* Mayer, 'Seashore Life,' p. 170, fig. 119.
1912. *Cæsira manhattensis* Van Name, Proc. Boston Soc. Nat. Hist., XXXIV, p. 471, Pl. XLV, figs. 11–13, Pl. LXXI, figs. 151, 152, text figs. 4, 5.
1912. *Cæsira papillosa* Huntsman, Trans. Canadian Inst. (1911), pp. 112, 139. (Not *Molgula papillosa* Verrill, 1871.)
1913. *Molgula manhattensis* Sumner, Osburn and Cole, Bull. U. S. Bureau of Fisheries, XXXI, pp. 155, 157–160, 729; 730; chart 191.
1913. *Molgula manhattensis* Miner, Amer. Museum Journal, XIII, p. 91, text fig.
1914. *Molgula manhattensis* Hartmeyer, Sitzungsber. Gesell. naturf. Freunde, Berlin, p. 7.
1915. *Molgula manhattensis* Hartmeyer, Mittheil. Zool. Mus. Berlin, VII, p. 313.
1916. *Molgula manhattensis* Pratt, 'Manual Common Invert. Animals,' p. 665, text fig. 1007.

Additional references and synonyms and a more detailed description are given in Van Name, 1912 (see above).

Body usually nearly globular when distended, except for some degree of lateral compression. The tubes are diverging and often curved. They arise on the dorsal region either a little way apart or quite close together. The test is firm, tough, and moderately thick, with an irregularly roughened surface, and provided in places with short, irregular hair-like processes, which would not be conspicuous were it not for the sand grains, shell fragments, bits of eel grass and other débris which adhere to them. The maximum diameter usually does not exceed 20 to 25 mm. The general color, when fresh, is a dingy yellowish or greenish gray, or olive.

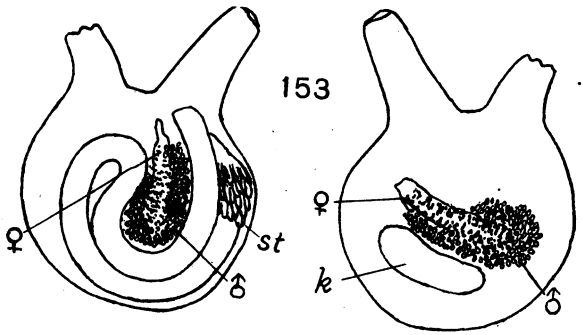


Fig. 153. *Molgula manhattensis* (De Kay), 1843
Left and right sides of body, × 1.8.

On removal from the test, this animal is readily distinguishable from *M. occidentalis* by the branchial sac and gonads. There are six branchial folds on each side. These are low and bear a maximum of six or seven internal longitudinal vessels. The stigmata are usually quite long and narrow, and irregularly curved, and form well-defined spirals on the folds and here and there also on the flat parts of the sac, especially in the ventral regions. On the left side, the ovary is flask-shaped and the intestinal loop is bent in a more circular shape than in *M. occidentalis*; on the right side, the gonad is shorter than in that species, and its ovary is practically straight. It is situated dorsal to the kidney, and does not bend around it. The kidney is smaller and shorter than *M. occidentalis*, and is bean-shaped. The dorsal tubercle is similar to that of the latter species, but usually has the open interval to the rear.

This species ranges from St. Andrews, New Brunswick (Huntsman, 1912), to Louisiana (Shell Island, Mussel Bayou, Drum Bay, etc.). It

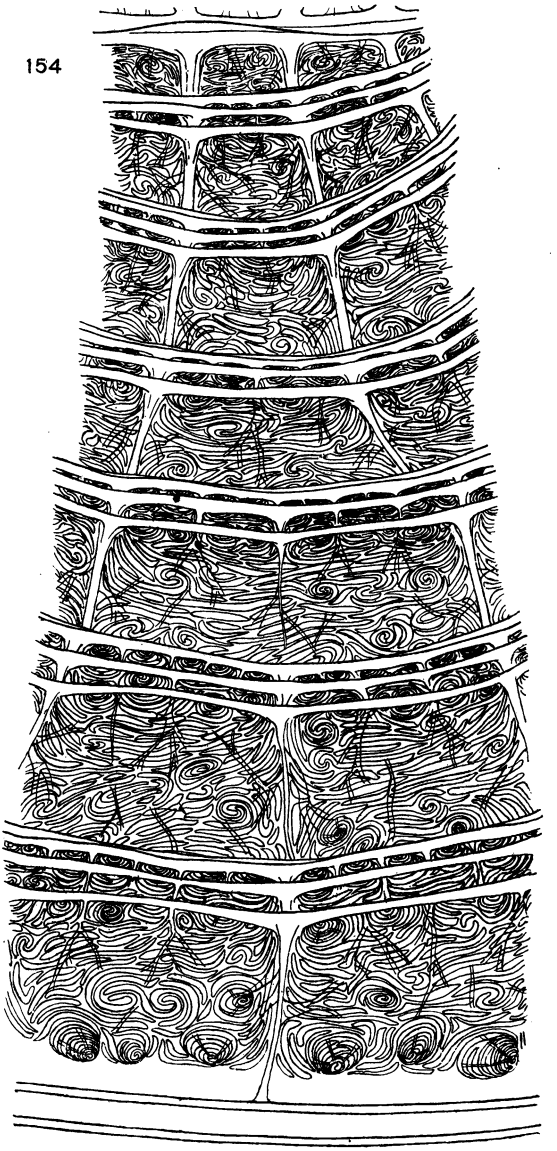


Fig. 154. *Molgula manhattensis* (De Kay), 1843
Part of branchial sac, × 15 (from Proc. Boston Soc. Nat. Hist., XXXIV).

is a shallow-water form, often growing abundantly on eel grass, piles, stakes, etc., but is recorded to depths of 16 fathoms on the New England coast and 27 fathoms in Chesapeake Bay. From Cape Cod to North Carolina it is the commonest of the larger simple ascidians. The dredgings of the Steamer Fish Hawk in 1915 indicate that in most of the deeper parts of Chesapeake Bay it is not only the commonest but practically the only species of ascidian. I have no records from Florida, and failed to find it in my collecting on the southern part of the coast of that State, though there are several stations for it from the South Carolina coast. Its distribution may, therefore, be discontinuous and interrupted by the Florida peninsula.

The National Museum collection contains several small specimens from the back of a large blue crab (*Callinectes*) supposed to have been caught in Chesapeake Bay. It is apparently rare to find ascidians on a crab of such active habits.

Molgula lutulenta (Van Name), 1912

Figure 155

1912. *Cæsira lutulenta* Van Name, Proc. Boston Soc. Nat. Hist., XXXIV, p. 468, Pl. XLV, figs. 7–10; Pl. LXXIII, fig. 168; text figs. 2, 3.

1914. *Molgula lutulenta* Hartmeyer, Sitzungsber. Gesell. naturf. Freunde, Berlin, p. 7.

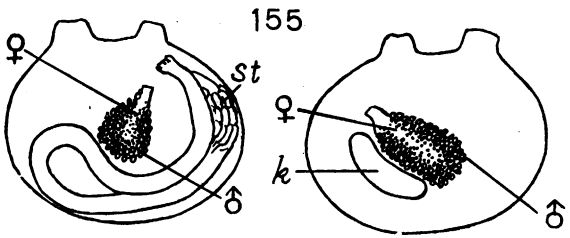


Fig. 155. *Molgula lutulenta* (Van Name), 1912
Left and right sides of body, × 3.

This species does not require more than a brief mention here, as it is only known from rather deep water (67 to 142½ fathoms) far off the coast of southern New England and the Middle States, in the vicinity of 40° N. and 70° and 71° W.

It is a small species of elliptical outline, not exceeding about 15 mm. in greatest diameter, though it is densely covered externally with long moss-like fibrous processes to which sand and mud adhere, making it appear larger. Internally, it differs from *M. manhattensis* in the large

infundibula, on which the stigmata form very regular spirals, the much less bent intestinal loop, and in the gonads of both right and left sides being short, broad, and flask-shaped. There are as in that species, six branchial folds on each side.

[NOTE. *Molgula eugyroides* Traustedt (1883, p. 112, Pl. v, figs. 1–3) from Bahia, Brazil, and *M. contorta* Sluiter (1898, p. 28, Pl. II, figs. 39, 40) from Colombia, are species entirely distinct from any of the above. See p. 486.]

BOSTRICHOBRANCHUS Traustedt, 1883

In this genus the folds of the branchial sac have disappeared and are indicated only by seven broad, flat, internal longitudinal vessels on each side. Stigmata on internally projecting and often very high conical infundibula, on each of which they form a perfect double spiral interrupted only at the summit. Infundibula very numerous and irregularly distributed in adult individuals. A gonad is normally present on the left side only.

Bostrichobranchus pilularis Verrill, 1871

Figures 156–159

1871. *Molgula pilularis* Verrill, Amer. Journ. Sci., (3) I, p. 58, fig. 4*c*.

1872. *Eugyra pilularis*+*Molgula pellucida* Verrill, Amer. Journ. Sci., (3) III, pp. 211, 289, Pl. VIII, figs. 2, 3.

1873. *Eugyra pilularis*+*Molgula pellucida* Verrill and Smith, 'Rept. on Invert., Animals of Vineyard Sound,' pp. 509, 699, 700, etc., Pl. XXXIII, fig. 249.

1878. *Molgula pellucida* Coues and Yarrow, Proc. Acad. Nat. Sci. Philadelphia, 1878, p. 303.

1883. *Bostrichobranchus manhattensis* Traustedt, Vidensk. Meddel. natur. For. Kjöbenhavn, pp. 109, 128.

1885. *Bostrichobranchus manhattensis* Traustedt, Vidensk. Meddel. natur. For. Kjöbenhavn, ann. 1884, p. 22, Pl. I, figs. 10–12.

1912. *Bostrichobranchus pilularis* Van Name, Proc. Boston Soc. Nat. Hist., XXXIV, p. 458, Pl. XLIII, figs. 1–4; Pl. XLIV, figs. 5, 6; Pl. LXIX, fig. 137; text fig. 1.

1913. *Eugyra pilularis*+*Bostrichobranchus molguloides*+*Molgula pellucida*+*Eugyra glutinans* Sumner, Osburn and Cole, Bull. U. S. Bureau of Fisheries, XXXI, pp. 75, 157, 186, 729; Chart 190.

1916. *Eugyra pilularis*+*Bostrichobranchus molguloides*+*Molgula pellucida* Pratt, 'Manual Common Invert. Animals,' p. 665.

Not *Molgula pellucida* MacDonald, 1859, from Australia.

This species has occasionally been confused with *Molgula manhattensis* (De Kay), 1843, described above. Additional synonyms and a detailed description, with special reference to the remarkable arrangement of the branchial stigmata, have been given in a previous paper (Van Name, 1912), so that only the more important characters will be mentioned here.

As usually found, this animal resembles a small ball of mud or sand; the body is globular or ellipsoidal, and is more or less covered externally with short, minute fibers to which fine sand and mud adhere. This foreign material is, however, rather easily rubbed off, and sometimes specimens are found in which the surface is nearly smooth and bare. Tubes elongate, equalling or exceeding the body diameter in length when extended, tapering, straight or slightly curved, and arising near together from the dorsal side of the body. These tubes, as well as a small definitely circumscribed area on the surface of the body, within which they both have their bases, are free from adhering sand or mud. They can usually be entirely retracted, and are ordinarily found so in preserved material, but in some specimens the test about their bases is thick

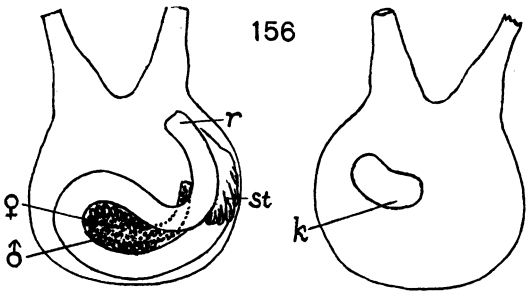


Fig. 156. *Bostrichobranchus pilularis* (Verrill), 1871
Left and right sides of body, tubes extended, × 1.3.

and tough, and it is doubtful whether they can be drawn in to any great extent. (*Molgula pellucida* Verrill, 1872, appears to be based on specimens having little adhering mud or sand, and such non-retractile siphons. With the information at present available it does not appear to be valid, even as a true variety.)

Branchial aperture six lobed; atrial aperture square.

Test over most of the body thin and, when the foreign matter is rubbed off, transparent and colorless, or with a bluish or greenish tint. The body is usually unattached, the animal living buried in the sand or mud. It sometimes reaches a considerable size (25 to 35 mm. in maximum diameter), but is commonly much smaller, often only 8 to 10 mm., even when adult.

Excepting the tubes, which have conspicuous circular and longitudinal muscle bands, the mantle is thin and in most parts without muscles. The longitudinal bands of the tubes extend out on to the body but a very short distance, ending abruptly only a little way from the

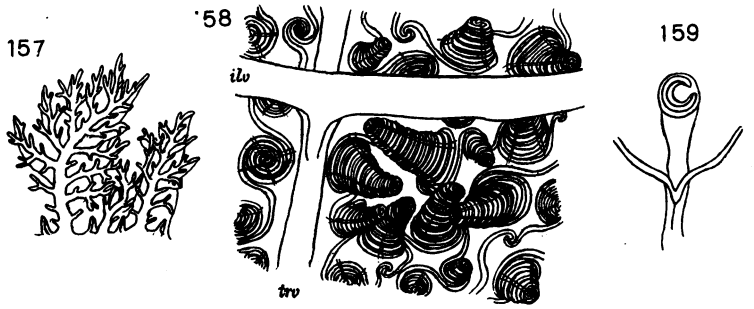
base of the tubes; along each side of the mid-ventral line there is a row of many very short but stout bands transverse to that line and parallel to each other. None of these reach to or extend across the mid-ventral line.

Tentacles rather numerous, of four orders; the largest two or, to some extent, three times compound.

Dorsal tubercle C-shaped; open interval to the left.

Dorsal lamina plain-edged.

Branchial sac entirely without folds. There are seven very wide but thin and flat internal longitudinal vessels, and five transverse vessels on each side. The walls of the sac are occupied by internally projecting infundibula, very tall and numerous, and distributed without apparent



Figs. 157–159. *Bostrichobranchus pilularis* (Verrill), 1871

Fig. 157. Tentacles, × 24. Fig. 158. Small piece of branchial sac (inner aspect), × 32. Fig. 159. Dorsal tubercle, × 18.

regularity in old individuals. On each infundibulum a stigma winds uninterruptedly from the base to the summit, where it ends; another begins there and winding to the base between the coils of the first it crosses the flat part of the sac to an adjacent infundibulum on which it winds to the summit, so that the stigmata form chains of connected spirals occupying several or many adjacent infundibula.

Alimentary tract forming a rather narrow, moderately bent loop. Stomach elongate; a part of its wall is differentiated into a hepatic organ.

One gonad, consisting of a flask-shaped or elongate ovary bordered by numerous small testes which are oval or two- or three-lobed. It lies in, more or less overlapped or covered by, the intestinal loop; the ovary is prolonged into a short, stout tube or oviduct, extending posteriorly and dorsally. No gonad on the right side (see exception noted below).

Kidney situated on the right side, posterior to the middle of the body.

This genus is represented along the Atlantic coast of North America from the Gulf of St. Lawrence, if not from farther north, to the west coast of Florida. It occurs in depths of from ½ to 120 fathoms (the latter depth in 39° 57′ N., 70° 56′ W. This wide distribution and the variability exhibited by the specimens would suggest that there is more than one species, but I can find no sufficient basis for such a conclusion. It is much commoner than is generally known, as it lives buried in the sand or mud and is therefore usually only to be obtained by digging or dredging. Thus far, the only record from the Southern States has been from Fort Macon, North Carolina (collected by Coues and Yarrow), but the National Museum contains two small specimens from the Gulf coast of Florida, from the banks near 28° 56′ N. and 83° W., and from St. George's Sound, respectively. The St. George's Sound specimen is unique in having a gonad on each side of the body. Though I have dissected many examples of this species from various localities, I have never found more than one gonad except in this case and therefore regard it as merely an individual abnormality, perhaps a sporadic case of reversion, as this genus is doubtless derived from ancestors having a gonad on each side.

If sought for by the proper methods, this species will probably be found to be much more numerous and widely distributed along our southeastern coast than has been supposed, but it is not unlikely that its distribution is discontinuous and interrupted by the southern part of the Florida peninsula, as appears to be the case with *Molgula manhattensis*.

Local Lists of Species

A.—Ascidians from Porto Rico (26 species and forms).

Polyclinum constellatum Savigny, 1816
Aplidium lobatum Savigny, 1816
Trididemnum savignii (Herdman), 1886
Trididemnum savignii form *porites* (Van Name), 1902
Trididemnum solidum (Van Name), 1902
Leptoclinum macdonaldi (Herdman), 1886
Didemnum candidum Savigny, 1816
Polycitor (*Eudistoma*) *olivaceus* (Van Name), 1902
Clavelina oblonga Herdman, 1880
Holozoa bermudensis (Van Name), 1902
Perophora viridis Verrill, 1871
Phallusia nigra Savigny, 1816
Phallusia hygomiana Traustedt, 1882

Phallusia sydneiensis (Stimpson), 1855
Phallusia curvata Traustedt, 1882
Rhodosoma pellucidum (Stimpson), 1855
Botryllus (*Botrylloides*) *niger* (Herdman), 1886
Symplegma viride brakenhielmi (Michaelsen), 1904
Polycarpa obtecta Traustedt, 1883
Polycarpa spongiabilis Traustedt, 1883
Styela partita (Stimpson), 1852
Styela plicata (Lesueur), 1823
Microcosmus exasperatus Heller, 1878
Microcosmus helleri Herdman, 1881
Pyura vittata (Stimpson), 1852
Molgula occidentalis Traustedt, 1883

B.—Ascidians from the former Danish West Indies (26 species and forms).

Aplidium lobatum Savigny, 1816
Aplidium (*Amaroucium*) *bermudæ* (Van Name), 1902
Tridemnum solidum (Van Name), 1902
Didemnum candidum Savigny, 1816
Leptoclinum macdonaldi (Herdman), 1886
Lissoclinum fragile (Van Name), 1902
Polycitor (*Eudistoma*) *olivaceus* (Van Name), 1902
Polycitor (*Eudistoma*) *olivaceus* form *obscuratus* (Van Name), 1902
Polycitor (*Eudistoma*) *hepaticus*, new species
Clavelina oblonga Herdman, 1880
Holozoa bermudensis (Van Name), 1902
Ecteinascidia turbinata Herdman, 1880
Phallusia nigra Savigny, 1816
Phallusia hygomiana Traustedt, 1882
Phallusia sydneiensis (Stimpson), 1855
Phallusia curvata Traustedt, 1882
[*Ascidiella styeloides* (Traustedt), 1882]
Rhodosoma pellucidum (Stimpson), 1855
Corella minuta Traustedt, 1882
Polycarpa obtecta Traustedt, 1883
Styela plicata (Lesueur), 1823
Microcosmus exasperatus Heller, 1878
[*Microcosmus anchylodeirus* Traustedt, 1883]
Pyura momus form *pallida* (Heller), 1878
Pyura vittata (Stimpson), 1852
Molgula occidentalis Traustedt, 1883

C.—Ascidians from the coasts of Florida and adjacent banks (43 species and forms).

Polyclinum constellatum Savigny, 1816
Aplidium (*Amaroucium*) *bermudæ* (Van Name), 1902
Aplidium (*Amaroucium*) *pellucidum* form *constellatum* (Verrill), 1871
Aplidium (*Amaroucium*) *exile* (Van Name), 1902. (Identification not certain.)

Trididemnum savignii (Herdman), 1886
Trididemnum savignii form *porites* (Van Name), 1902
Didemnum candidum Savigny, 1816
Didemnum fusiferum, new species
Didemnum (*Polysyncraton*) *amethysteum* (Van Name), 1902
Leptoclinum macdonaldi (Herdman), 1886
Echinoclinum verrilli Van Name, 1902
Polycitor (*Eudistoma*) *olivaceus* (Van Name), 1902
Polycitor (*Eudistoma*) *olivaceus* form *obscuratus* (Van Name), 1902
Polycitor (*Eudistoma*) *convexus* (Van Name), 1902
Polycitor (*Eudistoma*) *hepaticus*, new species
Clavelina oblonga Herdman, 1880
Clavelina gigantea (Sluiter), 1919
Cystodytes dellechiaiæ (Della Valle), 1877
Holozoa bermudensis (Van Name), 1902
Holozoa bursata, new species
Rhopalæa abdominalis (Sluiter), 1898
Perophora viridis Verrill, 1871
Ecteinascidia turbinata Herdman, 1880
Phallusia nigra Savigny, 1816
Phallusia hygomiana Traustedt, 1882
Phallusia curvata Traustedt, 1882
Rhodosoma pellucidum (Stimpson), 1855
Corella minuta Traustedt, 1882
Botryllus schlosseri (Pallas), 1766
Botryllus (*Botrylloides*) *niger* (Herdman), 1886
Symplegma viride brakenhielmi (Michaelsen), 1904
Polyandrocarpa maxima (Sluiter), 1904
Polyandrocarpa (*Eusynstyela*) *floridana*, new species
Polyandrocarpa (*Eusynstyela*) *tincta* (Van Name), 1902
Polycarpa obtecta Traustedt, 1883
Polycarpa circumarata (Sluiter), 1904
Styela partita (Stimpson), 1852
Styela plicata (Lesueur), 1823
Microcosmus exasperatus Heller, 1878
Pyura vittata (Stimpson), 1852
Molgula manhattensis (De Kay), 1843
Molgula occidentalis Traustedt, 1883
Bostrichobranchus pilularis (Verrill), 1871

D.—Ascidians from Bermuda (31 species and forms. The second column gives the name used for the species in my previous article (1902) on the Bermuda ascidians).

Aplidium (*Amaroucium*) *bermudæ* (Van Name), 1902	*Amaroucium bermudæ*
Aplidium (*Amaroucium*) *exile* (Van Name), 1902	*Amaroucium exile*
Trididemnum savignii (Herdman), 1886	*Didemnum savignii*+*D. atrocanum*
Trididemnum savignii form *porites* (Van Name), 1902	*Didemnum porites*+*D. lucidum*

Present Name	Van Name, 1902
Tridemnum solidum (Van Name), 1902	*Didemnum solidum*
Tridemnum orbiculatum (Van Name), 1902	*Didemnum orbiculatum*
Didemnum candidum Savigny, 1816	*Leptoclinum speciosum* (+ varieties)
Didemnum (Polysyncraton) amethysteum (Van Name), 1902	*Polysyncraton amethysteum*
Leptoclinum macdonaldi (Herdman), 1886	*Diplosoma macdonaldi*+*D. lacteum*+*D. atropunctatum*
Lissoclinum fragile (Van Name), 1902	*Diplosomoides fragile*
Echinoclinum verrilli Van Name, 1902	*Echinoclinum verrilli*
Polycitor (Eudistoma) olivaceus (Van Name), 1902	*Distoma olivaceum*
Polycitor (Eudistoma) olivaceus form *obscuratus* (Van Name), 1902	*Distoma obscuratum*
Polycitor (Eudistoma) convexus (Van Name), 1902	*Distoma convexum*
Polycitor (Eudistoma) clarus (Van Name), 1902	*Distoma clarum*
Polycitor (Eudistoma) capsulatus (Van Name), 1902	*Distoma capsulatum*
Clavelina oblonga Herdman, 1880	*Clavelina oblonga*+*Rhodozona picta*
Cystodytes dellechiaiæ (Della Valle), 1877	*Cystodytes draschii*+*C. violaceus*
Holozoa bermudensis (Van Name), 1902	*Distaplia bermudensis*
Perophora viridis Verrill, 1871	*Perophora viridis*
Ecteinascidia turbinata Herdman, 1880	*Ecteinascidia turbinata*
Phallusia nigra Savigny, 1816	*Ascidia atra*
Phallusia curvata Traustedt, 1882	*Ascidia curvata*
Botryllus (Botrylloides) niger (Herdman), 1886	*Botrylloides nigrum* (+varieties)
Symplegma viride Herdman, 1886	*Diandrocarpa botryllopsis* + *Symplegma viride*
Polyandrocarpa (Eusynstyela) tincta (Van Name), 1902	*Michaelsenia tincta*
Polycarpa obtecta Traustedt, 1883	*Polycarpa obtecta*
Styela partita bermudensis (Van Name), 1902	*Styela partita* var. *bermudensis*
Styela plicata (Lesueur), 1823	Not recorded
Microcosmus exasperatus Heller, 1878	*Microcosmus miniatus*
Pyura vittata (Stimpson), 1852	*Halocynthia rubrilabia* + *H. riiseana* var. *munita*

Alphabetical List of Ascidians (Including Synonyms) Reported From The West Indian and Neighboring Regions

The synonyms included are those referring to the species as inhabitants of the region covered by this article.

Varieties and subspecies are not included (except those that have at some time been treated as full species), but are dealt with in the systematic part of this article under the species to which they belong.

Full titles of works referred to will be found in the bibliography at the end of this article.

Amarœcium. Syn. of *Amaroucium*.

Amaroucium. In this article treated as a subgenus of *Aplidium*. See species listed under *Aplidium*.

Amouroucium. Syn. of *Amaroucium*.

Aplidium lobatum. See p. 303.

" *crassum* Herdman, 1886, p. 207, Pl. xxv, figs. 15, 16. From Bahia, Brazil, in shallow water.

" (subgenus *Amaroucium*) *bermudæ*. See p. 305.

" " " *constellatum*. See p. 310.

" " " *exile*. See p. 311.

" " " *pellucidum*. See p. 309.

" " " *stellatum*. See p. 308.

Ascidea. Syn. of *Ascidia*.

Ascidia albeola Lesueur, 1823, p. 3, Pl. II, fig. 1. From Guadeloupe. A minute, probably immature form. Genus uncertain. Hartmeyer, 1909–1911, p. 1630, assigns it to the genus *Ecteinascidia*.

" *atra* = *Phallusia nigra*.

" *cavernosa* Lesueur, 1823, p. 2, Pl. I, fig. 1. From St. Bartholomew Id. Genus uncertain. Hartmeyer (1909–1911, p. 1630) assigns it to the genus *Pyura*.

" *claviformis*. Probably either *Ecteinascidia turbinata* or *Clavelina oblonga*. See p. 379.

" *curvata* = *Phallusia curvata*.

" *interrupta*. Perhaps = *Phallusia hygomiana*. See p. 386.

" *lobifera* Lesueur, 1823, p. 7. No locality given, perhaps not West Indian. Genus uncertain.

" *longitubis* = *Phallusia sydneiensis*.

" *manhattensis* = *Molgula manhattensis*.

" *monstrans* = *Phallusia monstrans*.

" *multiformis* Lesueur, 1823, p. 3, Pl. II, figs. 2–4. From Guadeloupe. Genus uncertain. Hartmeyer (1909–1911) assigns the species *Cæsira* (syn. of *Molgula*).

" *nigra* = *Phallusia nigra*.

" *ovalis* Lesueur, 1823, p. 6, Pl. III, fig. *a*. From the bottom of a vessel, Philadelphia. Genus uncertain. Possibly it may be *Phallusia hygomiana*.

" *plicata* = *Styela plicata*.

" *proboscidea* Lesueur, 1823, p. 6, Pl. I, figs. 4, 5. From Florida. Probably not an ascidian.

Ascidia prostrata = *Phallusia prostrata*.
" *styeloides* = *Ascidiella styeloides*.
" *sydneiensis* = *Phallusia sydneiensis*.
" *variabilis* Lesueur, 1823, p. 4, Pl. II, fig. 5. From St. Thomas. Identity uncertain. 'Hartmeyer (1909–1911, p. 1630) assigns it to the genus *Pyura*, but it may be *Microcosmus exasperatus*.

Ascidiella styeloides. This is evidently the correct genus for *Phallusia styeloides* Traustedt (1882, pp. 277, 286, Pl. IV, fig. 5; Pl. V, fig. 16) from St. Croix and St. Thomas, as it is described as having no papillæ on the internal longitudinal vessels and the intestinal loop little bent, both characters marking the genus *Ascidiella* Roule, 1883.

Boltenia coacta = *Pyura legumen*.
" *coarcta* = " "
" *legumen* = " "

Bostrichobranchus pilularis. See p. 475.

Botrylloides. In this article treated as a subgenus of *Botryllus*. See species listed under *Botryllus*.

Botryllus gouldi = *B. schlosseri*.
" *gouldii* = *B. schlosseri*.
" *schlosseri*. See p. 398.
" (subgenus *Botrylloides*) *chazaliei* Sluiter, 1898, p. 10. From Marguerita Island (lagoon). Perhaps not distinct from *B. niger*.
" (subgenus *Botrylloides*) *niger*. See p. 399.
" " " *perspicuus* var. *rubicundus* (*Botrylloides perspicuum* var. *rubicundum* Herdman, 1886, p. 48, Pl. I, figs. 6, 7; Pl. III, figs. 15–18). Philippines. Listed from Bermuda by Hartmeyer, 1909–1911, p. 1633, probably by mistake.

Botryorchis atlanticus = *Styela atlantica*.

Cæsira. Syn. of *Molgula*. See species listed under *Molgula*.

Cellulophana collectrix = *Holozoa collectrix*.

Chondrostachys oblonga = *Clavelina oblonga*.
" *claviformis* = *Ascidia claviformis*.
" *picta* = *Clavelina oblonga*.

Ciona abdominalis = *Rhopalæa abdominalis*.

Clavelina gigantea. See p. 358.
" *oblonga*. See p. 354.
" *picta* = *Clavelina oblonga*.

Clavellina. Misprint for *Clavelina*.

Colella sigillinoides = *Sycozoa sigillinoides*.

Corella eumyota Traustedt, 1882, p. 273, Pl. IV, figs. 2, 3; Pl. V, figs. 13, 14. From Bahia, Brazil, and Valparaiso, Chile, Patagonia, etc. Also South Africa, Sluiter, 1897, p. 40, Pl. V, fig. 14, and West Africa, Michaelsen, 1915, p. 423.

Corella minuta. See p. 395.

Cynthia amphora Gould, 1852, p. 495, Pl. LII, fig. 609. Rio Janeiro, Brazil, 4–5 fathoms. Genus doubtful.
" *chazaliei* = *Pyura chazaliei*.
" *claudicans* = *Microcosmus claudicans*.
" *discrepans* = *Pyura discrepans*.

Cynthia dura = *Pyura squamulosa* variety *dura*.
" *lævigata* = *Pyura vittata*.
" *nodulosa* von Drasche, 1884, p. 375. Not West Indian; = *Pyura socialis* (Troschel) 1852, from Chile and Peru.
" *pallida* = *Pyura momus* form *pallida*.
" *partita* = *Styela partita*.
" *plicata* = *Styela plicata*.
" *riiseana* = *Pyura vittata*.
" *subcærulea* Stimpson, 1852, p. 331. From Oak Id. Beach, North Carolina. A small and perhaps immature form. Genus doubtful. See p. 419.
" *torpida* = *Pyura torpida*.
" *vittata* = *Pyura vittata*.
Cystodites. Syn. of *Cystodytes*.
Cystodytes dellechiaiæ. See p. 360.
" *dellechiajei* = *C. dellechiaiæ*.
" *draschei* = *C. dellechiaiæ*.
" *draschii* = *C. dellechiaiæ*.
" *violaceus* = *C. dellechiaiæ*.
Diandrocarpa botryllopsis = *Symplegma viride*.
" *brakenhielmi* = *Symplegma viride brakenhielmi*.
Diazona picta = *Clavelina oblonga*.
" *geayi* Caullery, 1914, Bull. Soc. Zool. France, XXXIX, p. 204, figs. 1, 2. From French Guiana. Perhaps a *Clavelina*.
Didemnopsis inerme = *Didemnum inerme*.
Didemnum amethysteum. See p. 333.
" *annectens* (*Leptoclinum annectens* Herdman, 1886, p. 280, Pl. XXXIV, fig. 14; Pl. XXXVIII, figs. 5–9). From Bahia, Brazil, shallow water. Perhaps not distinct from *D. candidum*.
" *atrocanum* = *Trididemnum savignii*.
" *candidum*. See p. 323.
" *cineraceum* (*Leptoclinum cineraceum* Sluiter, 1898, p. 30, Pl. II, figs. 41 41a; Pl. III, fig. 48). Kingston, Jamaica.
" *conchyliatum* (*Leptoclinum conchyliatum* Sluiter, 1898, p. 29, Pl. III, fig. 47). From Curaçao and Jamaica (Kingston).
" *fusiferum*. See p. 331.
" *inerme* Herdman, 1886, p. 265, Pl. XXXIV, figs. 6, 7. From Bermuda. Described from very poor specimens. Genus and family very doubtful.
" *lucidum* = *Trididemnum savignii* form *porites*.
" *lutarium* = *D. candidum lutarium*. See p. 323.
" *orbiculatum* = *Trididemnum orbiculatum*.
" *porites* = *Trididemnum savignii* form *porites*.
" *solidum* = *Trididemnum solidum*.
" *savignii* = *Trididemnum savignii*.
" *savignyi* = *Trididemnum savignii*.
" *speciosum* = *D. candidum*.
" *studeri*. Not West Indian. See p. 331.
" *tenue* (*Leptoclinum tenue* Herdman, 1886, p. 281, Pl. XXXIX, figs. 8–11; Pl. XL, figs. 3–5). Sluiter, 1898, p. 31, reports this from Los Testigos Islands. It would seem much more likely that Sluiter's specimens were *D. candidum*.

Didemnum (subgenus *Polysyncraton*) *amethysteum*. See p. 333.
Diplasoma. Misprint for *Diplosoma*.
Diplosoma atropunctatum = *Leptoclinum macdonaldi*.
" *lacteum* = *Leptoclinum macdonaldi*.
" *macdonaldi* = *Leptoclinum macdonaldi*.
Diplosomoides. Syn. of *Lissoclinum*. See species under *Lissoclinum*.
Distalium. Misprint for *Distaplia*.
Distaplia. Syn. of *Holozoa*. See species under *Holozoa*.
Distoma. Syn. of *Polycitor*. See species under *Polycitor*.
Echinoclinum verrilli. See p. 340.
Ecteinascidia albeola. = *Ascidia albeola*.
" *thurstoni*. Not West Indian. See p. 379.
" *turbinata*. See p. 375.
Eudistoma. Subgenus of *Polycitor*, sometimes given rank of a genus. See species under *Polycitor*.
Eusynstyela. Here treated as a subgenus of *Polyandrocarpa*. See species under *Polyandrocarpa*.
Halocynthia microspinosa = *Tethyum microspinosum*.
" *pallida* = *Pyura momus* form *pallida*.
" *riiseana* = *Pyura vittata*.
" *rubrilabia* = *Pyura vittata*.
Holozoa bermudensis. See p. 363.
" *bursata*. See p. 366.
" *collectrix* (*Cellulophana collectrix* O. Schmidt, 1870, p. 25). See p. 365.
Leptoclinum annectens = *Didemnum annectens*.
" *atropunctatum* = *L. macdonaldi*.
" *cineraceum* = *Didemnum cineraceum*.
" *conchyliatum* = *Didemnum conchyliatum*.
" *lacteum* = *L. macdonaldi*.
" *macdonaldi*. See p. 335.
" *speciosum* = *Didemnum candidum*.
" *tenue* = *Didemnum tenue*.
Lissoclinum fragile. See p. 338.
" *molle*. See p. 339.
Michaelsenia tincta = *Polyandrocarpa* (*Eusynstyela*) *tincta*.
Microcosmus anchylodeirus Traustedt, 1883, pp. 121, 133, Pl. VI, fig. 18. From St. Thomas. Michaelsen, 1919, pp. 58, 62 considers this possibly identical with *M. pupa* Savigny, 1816, from the Red Sea. See p. 466.
" *biconvolutus* Sluiter, 1898, p. 26, Pl. II, figs. 36–38. From Curaçao.
" *claudicans* (*Cynthia claudicans* Savigny, 1816, p. 150, Pl. II, fig. 1). Reported by Heller, 1878, pp. 83, 84, as probably occurring in the Antilles. It is more likely that his specimens were *M. exasperatus*.
" *distans* = *M. exasperatus*.
" *exasperatus*. See p. 459.
" *helleri*. See p. 463.
" *miniatus* = *M. exasperatus*.
" *pupa*. See under *M. anchylodeirus*.
" *variegatus* = *M. exasperatus*.

Molgulina contorta = *Molgula contorta*.

" *eugyroides* = *Molgula eugyroides*.

Molgula contorta Sluiter, 1898, p. 28, Pl. II, figs. 39, 40. From Rio Hacha, Goajira, Colombia. Related to *M. eugyroides*.

" *eugyroides* Traustedt, 1883, p. 112, Pl. V, figs. 1–3. From Bahia, Brazil. Hartmeyer (1914) has made this species the type of a genus, *Molgulina*, the branchial sac showing an approach to the condition found in the genus *Eugyra*, having large regularly placed infundibula with long spiral stigmata.

" *koreni*. Credited to the West Indies by mistake (Herdman), 1891.

" *lutulenta*. See p. 474.

" *manhattensis*. See p. 471.

" *multiformis* = *Ascidia multiformis*.

" *occidentalis*. See p. 467.

" *pellucida*. See p. 476.

" *sordida* Stimpson, 1852, p. 229. From rocks off the breakwaters of Charleston, S. C., Harbor. Insufficiently described, but probably = *M. manhattensis*. Not *M. sordida* Sluiter, 1904, which is from the Malay region.

" *tenax* = *M. papillosa* Verrill, 1871. Credited to the West Indies by Herdman, 1891, by mistake.

Pandocia. Syn. of *Polycarpa*. As used by Sluiter, it ranks as a subgenus of *Styela*. See species under *Polycarpa*.

Perophora viridis. See p. 373.

Phallusia atra = *Ph. nigra*.

" *atrales*. Misprint for *Ph. atra*.

" *canaliculata* = *Phallusia sydneiensis*.

" *curvata*. See p. 389.

" *interrupta* (*Ascidia interrupta*, Heller, 1878, p. 89, Pl. II, fig. 9). From Jamaica. Perhaps the same as *Ph. hygomiana*.

" *hygomiana*. See p. 383.

" *longitubis* = *Ph. sydneiensis*.

" *monstrans* (*Ascidia monstrans* Gould, 1852, p. 496, Pl. LII, fig. 611). From near entrance of harbor, Rio Janeiro, Brazil, in 3 fathoms, attached to old shells, etc.

" *nigra*. See p. 379.

" *prostrata* (*Ascidia prostrata* Heller, 1878, p. 90, Pl. I, fig. 4). From Jamaica.

" *styeloides* = *Ascidiella styeloides*.

" *sydneiensis*. See p. 386.

Phallusiopsis nigra = *Phallusia nigra*.

Polyandrocarpa maxima. See p. 412.

" *sabanillæ*. See p. 409.

" (subgenus *Eusynstyela*) *floridana*. See p. 417.

" " " *tincta*. See p. 414.

Polycarpa appropinquata (*Styela*, subgenus *Polycarpa*, *appropinquata* Sluiter, 1898, p. 18, Pl. I, figs. 19–21). From La Tortuga Id., Venezuela.

" *asiphonica* (*Styela*, subgenus *Polycarpa*, *asiphonica* Sluiter, 1898, p. 17, Pl. I, figs. 16–18). From Goajira, Rio Hacha, Colombia, 6–7 meters.

" *brevipedunculata* (*Styela*, subgenus *Polycarpa*, *brevipedunculata* Sluiter, 1898, p. 15, Pl. I, fig. 12). From Curaçao.

Polycarpa cartilaginea (*Styela*, subgenus *Polycarpa*, *cartilaginea* Sluiter, 1898, p. 16, Pl. I, figs. 13–15). From Gairaca and Santa Marta, Colombia. Apparently related to *P. obtecta*.

" *circumarata*. See p. 428.

" *fibrosa*. See p. 296.

" *friabilis* (*Styela*, subgenus *Polycarpa*, *friabilis* Sluiter, 1898, p. 13, Pl. I, fig. 11). From Jamaica (Kingston). Apparently related to *P. obtecta*.

" *fuliginea* (*Styela*, subgenus *Polycarpa*, *fuliginea* Sluiter, 1898, p. 12, Pl. I, fig. 10; Pl. III, fig. 45). From near the Tortugas Ids., 45 meters. (Probably La Tortuga, Venezuela is meant.)

" *insulsa* (*Styela*, subgenus *Polycarpa*, *insulsa* Sluiter, 1898, p. 14, Pl. III, fig. 43). From Los Testigos Ids.

" *nivosa* (*Styela*, subgenus *Polycarpa*, *nivosa* Sluiter, 1898, p. 12, Pl. I, fig. 9; Pl. III, fig. 46). Santa Marta, Colombia, 30 meters.

" *obtecta*. See p. 420.

" *pilella* Herdman, 1881, p. 73; 1882, p. 174, Pl. XXII, figs. 11–15. From Bahia, Brazil, 7–20 fathoms. (Not *P. pilella* Herdman, 1899, from Australia, according to Michaelsen, 1912).

" *rugosa* von Drasche, 1884, p. 380, Pl. VII, figs. 3, 4. From Rio Janeiro, Brazil. Apparently related to *P. obtecta*.

" *seminuda* (*Styela*, subgenus *Polycarpa*, *seminuda* Sluiter, 1898, p. 19, Pl. II, figs. 22, 23). From La Tortuga Id., Venezuela. 45 meters. Apparently related to *P. obtecta*.

" *spongiabilis*. See p. 424.

" *tumida* Heller, 1878, p. 103, Pl. II, fig. 15. Probably the same as *P. obtecta*.

Polycitor (*Eudistoma*) *capsulatus*. See p. 352.

" " *clarus*. See p. 350.

" " *convexus*. See p. 346.

" *giganteus* = *Clavelina gigantea*.

" (*Eudistoma*) *mayeri* = *P. convexus*.

" " *hepaticus*. See p. 348.

" " *obscuratus* = *P.* (*E.*) *olivaceus* form *obscuratus*. See p. 345.

" " *olivaceus*. See p. 343.

Polyclinum constellatum. See p. 299.

Polysyncraton amethysteum = *Didemnum* (subgenus *Polysyncraton*) *amethysteum*.

Psammaplidium funginum Sluiter, 1898, p. 31. From La Tortuga Id.

Puyra. Misprint for *Pyura*.

Pyura amphora = *Cynthia amphora*.

" *antillarum*. See p. 451.

" *cavernosa* = *Ascidia cavernosa*.

" *chazaliei* (*Cynthia chazaliei* Sluiter, 1898, p. 22, Pl. II, figs. 29, 30. From Santa Marta, Colombia.

" *coacta* = *P. legumen*.

" *discrepans* (*Cynthia discrepans* Sluiter, 1898, p. 23, Pl. II, figs. 31–34; Pl. III, fig. 44). From Gulf of Cariaco, Santa Maria, Colombia, and Kingston, Jamaica.

" *dura* = *P. squamulosa* variety *dura*.

" *lævigata* = *P. vittata*.

Pyura legumen (Lesson), 1830; Hartmeyer (1909–1911, pp. 1629–1632), indicates that *Boltenia coacta* Gould, 1852, p. 496. Atlas, p. 16, Pl. LII, fig. 212, which is evidently identical with this species, was from the Gulf of Mexico. Gould, however, gives the locality Orange Harbor (Terra del Fuego). The species is sub-antarctic in distribution, and its occurrence in the Gulf of Mexico seems very improbable.

" *momus* form *pallida*. See p. 454.

" *pallida*. = *P. momus* form *pallida*.

" *riiseana* = *P. vittata*.

" *rubrilabia* = *P. vittata*.

" *squamulosa* variety *dura* Heller, 1878, p. 83 (probably incorrectly) reports this Mediterranean form from the Antilles and New Zealand under the name *Cynthia dura*.

" *torpida* (*Cynthia torpida* Sluiter, 1898, p. 21, Pl. II, figs. 25–28). From Santa Marta, Colombia.

" *variabilis* = *Ascidia variabilis*.

" *vittata*. See p. 446.

Pyuræ. Misprint for *Pyura*.

Rhabdocynthia pallida = *Pyura momus* form *pallida*.

Rhodosoma pellucidum. See p. 392.

" *pyxis* = *Rh. pellucidum*

" *seminudum* = *Rh. pellucidum*

Rhodozona picta = *Clavelina oblonga*.

Stereoclavella oblonga = *Clavelina oblonga*.

Styela atlantica. See p. 440.

" *appropinquata* = *Polycarpa appropinquata*.

" *asiphonica* = *Polycarpa asiphonica*.

" *brevipedunculata* = *Polycarpa brevipedunculata*.

" *canopoides* = *Styela partita*.

" *cartilaginea* = *Polycarpa cartilaginea*.

" *friabilis* = *Polycarpa friabilis*.

" *fuliginea* = *Polycarpa fuliginea*.

" *insulsa* = *Polycarpa insulsa*.

" *nivosa* = *Polycarpa nivosa*.

" *partita*. See p. 431.

" *plicata*. See p. 435.

" *seminuda* = *Polycarpa seminuda*.

Stygela. Misprint for *Styela*.

Sycozoa sigillinoides (Lesson), 1870. A colony of this species reported floating off the coast of Rio Grande del Norte, Brazil, by Michaelsen, 1907, p. 47. It had doubtless drifted from much farther south, and cannot be regarded as belonging to the fauna of this region.

Symplegma viride. See p. 404.

" *brakenhielmi* = *Symplegma viride brakenhielmi*. See p. 407.

Tethyum atlanticum = *Styela atlantica*.

" *canopoides* = *Styela partita*.

" *microspinosum*. See p. 441.

" *partitum* = *Styela partita*.

Tethyum plicatum = *Styela plicata*.
Thallusia. Misprint for *Phallusia*.
Tolycitor. Misprint for *Polycitor*.
Tridemnum atrocanum = *T. savignii*.
" *lucidum* = *T. savignii* form *porites*.
" *orbiculatum*. See p. 320.
" *porites* = *T. savignii* form *porites*. See p. 317.
" *savignii*. See p. 314.
" *savignyi* = *T. savignii*.
" *solidum*. See p. 318.
Tunica nigra = *Phallusia nigra*.

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