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Transactions of the Connecticut Academy of Arts and Sciences.

New Haven :Published by the Academy,1866-

<http://www.biodiversitylibrary.org/bibliography/7541>

v. 11:pt. 1 (1901-1902): <http://www.biodiversitylibrary.org/item/48122>

Article/Chapter Title: Ascidians from Bermudas

Author(s): Van Name

Subject(s): Ascidian taxonomy

Page(s): Page 325, Page 326, Page 327, Page 328, Page 329, Page 330, Page 331, Page 332, Page 333, Page 334, Page 335, Page 336, Page 337, Page 338, Page 339, Page 340, Page 341, Page 342, Page 343, Page 344, Page 345, Page 346, Page 347, Page 348, Page 349, Page 350, Page 351, Page 352, Page 353, Page 354, Page 355, Page 356, Page 357, Page 358, Page 359, Page 360, Page 361, Page 362, Page 363, Page 364, Page 365, Page 366, Page 367, Page 368, Page 369, Page 370, Page 371, Page 372, Page 373, Page 374, Page 375, Page 376, Page 377, Page 378, Page 379, Page 380, Page 381, Page 382, Page 383, Page 384, Page 385, Page 386, Page 387, Page 388, Page 389, Page 390, Page 391, Page 392, Page 393, Page 394, Page 395, Page 396, Page 397, Page 398, Page 399, Page 400, Page 401, Page 402, Page 403, Page 404, Page 405, Page 406, Page 407, Page 408, Page 409, Page 410, Page 411, Text, Text, Text, Text, Illustration, Text, Text, Text, Text, Text, Text, Text, Text, Text, Text, Text, Text, Text, Text, Text, Text, Text, Text, Text

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IX.—THE ASCIDIANS OF THE BERMUDA ISLANDS.

BY WILLARD G. VAN NAME, PH.D.

IN preparing the account of the Bermuda ascidians which is presented in the following pages, the writer has hoped that it would not be of local interest only. The waters about these islands are remarkably rich in animals of this class, including many new species and several new genera, and the Tunicata of the part of the world in which the Bermuda Islands are situated are only slightly known.

The species which have been described from the Atlantic coast of North America are for the most part northern forms, from the British Provinces and the New England States. Concerning those of the Southern States but little is recorded. A large number of species of Simple Ascidians from the West Indies and the adjacent parts of tropical America have been described in the works of Heller (4, 5), Traustedt (16), and Sluiter (15), though these writers had only preserved, and often very insufficient, material as a basis for their descriptions and figures. Only one of these writers (Sluiter) describes any Compound Ascidians from this region, and he describes only a very few.

Our knowledge in regard to the Tunicata of the Bermuda Islands themselves was until very recently confined to the six species obtained there by the Challenger Expedition, and described by Herdman (6) in the reports of that voyage.

In the spring of 1898, Prof. A. E. Verrill, of Yale University, and a party of students under his direction, made a general collection of the invertebrates of the Bermuda Islands, and among them a considerable number of ascidians were obtained, though particular attention was not directed to this class of animals. But few Simple Ascidians were comprised in this collection. Most of these were described by Prof. Verrill in these Transactions (Vol. x, 1900), as well as one new Compound Ascidian. He also mentioned four genera of the latter which had not been previously recorded from there, though he did not describe or identify the species.

Prof. Verrill has turned over to the writer the entire collection of Tunicata obtained by that expedition, and this paper is in part the result of a study of those specimens. In the spring of 1901, Prof. Verrill and Mr. A. Hyatt Verrill made another trip to Bermuda and obtained an even larger collection of Tunicata than in 1898, and the

writer himself spent some time during the months of April and May of that year at Bermuda, part of the time in company with Prof. Verrill, and has consequently been able to collect and study nearly all the species in a living state and in their natural surroundings. The writer has also examined some specimens obtained by Prof. G. Brown Goode in the years 1876 and 1877, though there proved to be no forms among them which were not also obtained by the Yale parties.

The fauna of the Bermuda Islands is exceedingly rich in Compound Ascidians, not only in the number of species, but in individuals also, many of the forms being very abundant and generally distributed about the islands. There may be other localities of no greater extent where an equal variety of species and abundance of individuals may be found, but there are probably few places where all the generally recognized families of this group are so fully represented. A very large proportion of the more important genera of the Compound Ascidians are also present, and a study of the Bermuda forms comes very near to giving a complete and comprehensive idea of this group of animals.

With the Simple Ascidians the case is different. The genera and species are few, and though some of the species are common, none are conspicuously abundant. One large and important family, the Molgulidæ, does not appear to be represented at all.

No examples of the free-swimming Tunicata, the Pyrosomidæ, Thaliacea, and Larvacea were obtained, but no collecting of a kind likely to result in finding them was attempted, owing to lack of time. Unquestionably representatives of all these groups occur in the vicinity of the islands and will be found when sought for.

The following are the Bermuda Tunicata described by Herdman in the Challenger Reports :—

Symplegma viride.

Didemnum (?) *inerme.*

Botrylloides nigrum.

Ecteinascidia turbinata.

Clavelina oblonga.

Ascidia nigra Savigny,
(= *A. atra* Lesueur).

All but the last of these were new species. With the exception of *Symplegma viride* and perhaps *Didemnum* (?) *inerme* they are represented in the Yale collections.

Didemnum inerme is a form described by Herdman from a single small specimen in such a poor state of preservation that nothing could be made out in respect to the structure of the zoöids, and he is

consequently uncertain in regard to the genus and even of the family in which it should be placed. Considering the difficulty of recognizing most species of Compound Ascidians even when an abundance of well preserved material is at hand, the practice of describing new species from such wretched specimens need not be commented on. The writer does not believe that the animal in question is a *Didemnum*. It may or may not be identical with one of the forms described in this paper, but the description does not warrant devoting time and space to conjectures concerning it.

The following are the additions to this list made in Prof. Verrill's paper (17) above alluded to:

<i>Styela partita</i> (Stimpson).	<i>Microcosmus miniatus</i> .
<i>Styela canopoides</i> Heller.	<i>Polycarpa multiphiala</i> .
<i>Halocynthia rubrilabia</i> .	<i>Diazona picta</i> .
<i>Halocynthia riiseana</i> (Traustedt).	

Of these, four were new species. All save the last named are Simple Ascidians. Prof. Verrill also mentions the occurrence of the following genera, *Leptoclinum*, *Distaplia*, *Distoma* and *Amaroucium*, though naming no species.

One of these, *Styela canopoides* Heller, is, I think, included on insufficient evidence, while the Bermuda representatives of two of the others, *Styela partita* (Stimpson) and *Halocynthia riiseana* (Traustedt) differ sufficiently from the types to be considered as new subspecies.

Omitting *Styela canopoides* and the doubtful *Didemnum inerme*, there remain a total of eleven species recorded from the islands. Of these six are Simple and five Compound Ascidians, according to the classification I have adopted in this paper, in which the Clavelinidæ and Perophoridæ are regarded as Compound Ascidians. Only one of these, *Symplegma* (unfortunately the most interesting of them), is wanting from the Yale collections.

This is no inconsiderable number if the small geographical area under consideration is taken into account, yet a study of the collections made in 1898 and 1901 enables me to increase it to no less than 38 species, one of which is represented by at least six well-marked varieties and another by three, in addition to the type. As these varieties differ sufficiently to constitute species if intermediate forms did not occur, we have 46 as the total number of kinds of tunicates known to occur at Bermuda. They are distributed as follows in 23 genera (4 new) and 9 families.

COMPOUND ASCIDIANS.

Clavelinidæ.

- Clavelina* (*Stereoclavella*) *oblonga* Herdman.
Rhodozonia picta (Verrill).

Perophoridæ.

- Perophora viridis* Verrill.
Ecteinascidia turbinata Herdman.

Distomidæ.

- Distoma capsulatum*, n. sp.
Distoma convexum, n. sp.
Distoma obscuratum, n. sp.
Distoma olivaceum, n. sp.
Distoma clarum, n. sp.
Cystodytes draschii Herdman.
Cystodytes violaceus, n. sp.
Distaplia bermudensis, n. sp.

Polyclinidæ.

- Amaroucium bermudæ*, n. sp.
Amaroucium exile, n. sp.

Didemnidæ.

- Didemnum solidum*, n. sp.
Didemnum savignii Herdman.
Didemnum atrocantum, n. sp.
Didemnum porites, n. sp.
Didemnum lucidum, n. sp.
Didemnum orbiculatum, n. sp.
Leptoclinium speciosum Herdman, represented at Bermuda by six new subspecies: *bermudense*, *pageti*, *hamiltoni*, *harringtonense*, *acutilobatum*, and *somersi*.
Polysyncraton amethysteum, n. sp.
Diplosoma macdonaldi Herdman.
Diplosoma lacteum, n. sp.
Diplosoma atropunctatum, n. sp.
Diplosomoides fragile, n. sp.
Echinoclinium verrilli, n. sp.

Botryllidæ.

Botrylloides nigrum Herdman, represented by three new subspecies: *concolor*, *planum*, and *sarcinum* in addition to the typical form.

Symplegma viride Herdman.

Polystyelidæ.

Michaelsenia tinctoria, n. sp.

Diandrocarpa botryllopsis, n. sp.

SIMPLE ASCIDIANS.**Halocynthiidæ.**

Polycarpa obtecta Traustedt.

Styela partita (Stimpson) var., *bermudensis*, nov.

Halocynthia rubrilabia Verrill.

Halocynthia riiseana (Traustedt) var., *munita*, nov.

Microcosmus miniatus Verrill.

Asciididæ.

Ascidia atra Lesueur.

Ascidia curvata Traustedt.

The writer does not believe that this list by any means exhausts the number of forms really found there. The collections were made during the spring months. Collecting at other seasons would probably result in finding new species and larger and better specimens of many of those which are here described. Moreover, different methods of collecting might further increase the number.

A few words in defense of the somewhat appalling number of new species (21) are probably called for. The writer believes that our knowledge of certain families, notably the Didemnidae, Halocynthiidæ, and Botryllidæ, has been retarded rather than advanced by the practice of many authors of describing as a new species nearly every faded and shrunken specimen that comes into their hands, because it cannot be made to agree perfectly with descriptions of other authors, made in many cases from similarly poor and scanty material. Such specimens had far better be left undescribed, unless they present characters so marked, that there is not likely to be much difficulty in identifying the form again, and characters of

such a nature that it is reasonably certain that they are not merely individual peculiarities of the specimen.

Minute and careful description cannot make up for insufficiency of material. Indeed it often decreases rather than increases the possibility of positively recognizing the species again if the individual peculiarities of the specimen be described as specific characters, and if no indication is given in regard to the directions in which individual variation (which is vastly greater in the ascidians than most writers give credit for) may be expected to manifest itself.

In the case of some Bermuda forms, the amount of material available has not been as great as could be desired, yet in nearly all cases I have had several specimens collected at different times and places. In two cases only have I ventured to describe a species on the strength of a single colony (*Didemnum solidum* and *Diplosoma atropunctatum*), and these only where there were well-marked specific characters, and when I had examined the specimen in a living state. In fact, there are only two or three of the forms which I have not myself collected and studied in a fresh condition.

The almost total neglect of the Compound Ascidians of this part of the world by previous collectors and investigators sufficiently explains, I think, the large number of new species in that group.

Methods of Collecting.

Most of the species may be found attached to stones along the shores of the bays and harbors, at low water. They grow chiefly on the under sides of stones of sufficient size to resist the movement of the waves and currents to which they are exposed. In such situations, as well as in narrow crevices in the rocks, they are safe from the attacks of the fishes and larger animals of other kinds which would otherwise destroy them.

The limestone rock, of which the islands are composed, contains numerous caverns to which the sea water has access through narrow passages where there is always a current of water when the tide is rising and falling. About the mouths of these passages (as at Waterloo, on Castle Harbor) are the best collecting places, not only for ascidians but for many other forms of invertebrates as well, as the constant currents of water carry an abundant supply of the minute organisms on which they feed. In such places it is not uncommon to find five or six different species of ascidians attached to the under side of the same stone. Sometimes several forms of Compound Ascidians may be found attached to an individual of one of the larger Simple Ascidians (Fig. 130).

A few species are seldom to be found along the shore, but grow chiefly on the corals, sponges, gorgonians, etc., on the reefs or in water deep enough to escape the effect of the waves and tides. These were obtained in collecting the corals and gorgonians by diving or by means of the nippers, attached to a long pole, which are used for that purpose.

Rhodozona picta (Verrill), *Distoma olivaceum*, *Cystodytes draschii* Herdman, *Distaplia bermudensis*, *Amaroucium bermudæ*, *A. exile*, and *Botrylloides nigrum* var. *concolor* are among the forms which are partial to such situations.

As far as I know, no ascidians are to be found on the white shell sand which covers large areas of the bottom in the sounds and harbors about the islands. So rough and rocky is the bottom in most other places that but little dredging was done, and this did not add any new forms to the list of tunicates.

It is possible that in the vicinity of the outer reefs there may be bottoms where a dredge can be used to advantage, and would probably disclose the existence of other species, particularly of the Polyclinidæ, which are partial to deeper water and are but poorly represented in our collections. Moreover, owing to the strong winds and rough water prevailing during the spring season (when all the collections were made), no collecting was done on the outer reefs. As many forms of invertebrates occur there which are seldom found on the reefs near shore, there are probably other kinds of ascidians there also.

NOTE.—The names of places, given as the localities where the specimens were found, are those of places about the Bermuda Islands, unless otherwise stated.

Methods of Preservation and Study.

Most of the specimens were preserved in formalin of from 2 to 4 per cent. This preserves the form and to some extent the color of the specimens better than any other method, but for anatomical study alcoholic specimens are usually better, though more contracted.

The specimens were studied microscopically by dissecting out the zooids or parts and staining and clearing in glycerine; also by means of paraffin sections of the zooids, or of the colonies, or parts of the same. Generally the specimens must first be decalcified. Owing to the absence of silicious sand at Bermuda, no trouble was met with in cutting the sections.

New Genera.

Diazona picta Verrill requires a new genus, which I have termed *Rhodozonia*. It is in many respects intermediate between *Diazona* and *Clavelina*. In the general shape of the colony it is not unlike *Stereoclavella australis* Herdman (8) from Australia, but only the anterior portions of the zooids project from the common test, and the colony has the beautifully transparent and gelatinous character of a *Diazona*. The branchial sac resembles *Clavelina* in the absence of internal longitudinal bars, but the strong longitudinal muscle bands along each side of the dorsal lamina, and the many transverse muscle bands in the mantle are very different from any species of that genus with which I am familiar.

The genus *Echinoclinum* is also an intermediate form, serving to unite more closely the genera *Didemnum* and *Diplosoma*, and furnishes an additional argument for uniting the Didemnidæ and Diplosomidæ in one family. In its zooids and in the gelatinous nature of the colony, it resembles the last named genus or family. The large cavities present in the test in that genus are however wanting, and the large tetrahedral spicules, though peculiar in their shape and arrangement, are more suggestive of the former genus.

The two new genera of the Polystyelidæ, *Michaelsenia* and *Diandrocarpa*, appear to be connecting forms linking that family with the Halocynthiidæ and Botryllidæ respectively. In the latter genus one or more of the forms included by Michaelsen (12) in his genus *Gynandrocarpa* may also be placed, though the Bermuda form approaches the genus *Botryllus* more closely in the general character and pigmentation of the colony than any of the other species.

Classification.

The classification employed is based upon that of Herdman, but with a number of modifications, such as separating the Perophoridæ from the Clavelinidæ, and uniting the Diplosomidæ with the Didemnidæ, as many writers have done. Moreover, I include the Clavelinidæ and Perophoridæ among the Compound Ascidiæ, because they are compound. They reproduce by budding and form colonies, and are by no means so closely related to the Simple Ascidiæ as some of the Polystyelidæ are, though Herdman includes these among the Compound Ascidiæ.

I have made free use of Herdman's diagnoses of families and genera, as given in his Revised Classification (7), with many changes and omissions, and wish to acknowledge my obligations to that author.

Before proceeding to the description of the species, I wish to express my thanks to Prof. A. E. Verrill for the use of his material and for much valuable advice and assistance. I am also indebted to Prof. H. C. Bumpus and Prof. H. M. Smith, of the United States Fish Commission, for the opportunity of working at the Fish Commission laboratory at Wood's Hole, where a portion of this work was done, and also to Prof. S. I. Smith and Dr. W. R. Coe of Yale University, and Mr. T. Goodwin Gosling of Hamilton, Bermuda.

WILLARD G. VAN NAME.

New Haven, Conn., December, 1901.

Descriptions of Species.

ASCIDIÆ COMPOSITÆ.

Fixed ascidians which reproduce by gemmation, forming colonies the individuals of which remain united together by stolons or by being more or less completely buried in the common test. This group is usually regarded as a sub-order.

Family **CLAVELINIDÆ** Forbes, 1853.

Body attached by the posterior end or more or less entirely buried in a creeping basal stolon or common stolonial mass, from which the young zoöids form by gemmation. Test usually gelatinous, apertures simple, or (rarely) lobed.

Branchial sac not folded, with or without longitudinal bars.

Dorsal lamina represented by or provided with languets.

Alimentary canal extending beyond the thorax to form a distinct abdomen.

Reproductive organs in or beside the intestinal loop.

Genus *Clavelina* Savigny, 1816.

Zoöids oblong or club-shaped, nearly independent, each enveloped in its own test and connected by stolons arising from the posterior end.

Apertures not lobed. Mantle muscles mainly longitudinal.

Branchial sac with straight stigmata, with no internal longitudinal bars or papillæ, but with horizontal membranes.

The Bermuda species of this genus belongs in Herdman's sub-genus *Stereoclavella*, which differs from the typical *Clavelina* in having the stolons united in a basal thickening or mass of test.

Clavelina (Stereoclavella) oblonga Herdman.

Clavelina oblonga Herdman, Prelim. Rep. Proc. Roy. Soc. Edin., 1879-80, p. 724.

Clavelina oblonga Herdman, Report Voy. Challenger, Zoöl., vol. vi, pt. xvii, p. 246, plate xxxv, figs. 6-10.

Stereoclavella oblonga Herdman, Trans. Biol. Soc. Liverpool, vol. v, pp. 160-161, also Jour. Linn. Soc. Zoöl., vol. xxiii, p. 603.

PLATE XLVI. FIGURE 1.

PLATE XLVII. FIGURE 7.

PLATE LXII. FIGURE 130a.

Individual animals club-shaped, the anterior end rounded, the body tapering gradually into the very short stalk. The colony consists of a number of such individuals quite closely grouped together, united by the expanded bases of the stalks.

The total length of the largest individuals (including the short stalk) is about 30^{mm}. Removed from the test the zoöid ordinarily measures less than half this length, but large ones fully expanded measure about 20^{mm} in length.

The test is thick but perfectly transparent and colorless; the lower part may be slightly incrustated with fine sand. It is gelatinous in consistency, firmer near the base. The zoöids themselves are nearly colorless. The stomach and intestine in life are brownish. There are often spots of very pure opaque white on the thorax, and always about the edges of the orifices.

The musculature of the mantle consists of a rather small number of slender bands, most distinct on the thorax. Beneath there are very delicate transverse muscles placed close together. These form an almost continuous but very thin layer about the thorax, but the longitudinal muscles are much the stronger and the animals contract greatly in length in preservation. The thorax contracts more than the abdomen. In life when the animal is expanded the branchial sac is fully half the length of the body.

There are 15 or more rows of stigmata, and sometimes 50 in a row. The stigmata begin close beside the dorsal lamina.

According to Herdman, the dorsal languets are short, conical and tentacular, and separated by about their own length. The tentacles are short and stout, about 20 in number, of two sizes placed alternately. The dorsal tubercle is small and irregularly oval.

In all the specimens obtained the reproductive organs were small, but a large number of embryos in various stages were contained in the atrial cavities of some of the zoöids.

This is a common species. It was obtained both in 1898 and 1901, also by Prof. Goode, as well as by the Challenger Expedition. The writer has collected it in Castle Harbor and on the north shore of Coney Island, where a number of colonies were found under stones a little below low water mark.

Genus **Rhodozonia**, n. gen.

An examination of *Diazona picta* Verrill (17) shows that it differs so materially from the type of *Diazona* that it must be made the type of a new genus, having characters intermediate between *Diazona* and *Distoma* or *Clavelina*.

It differs from the former genus in having the colony divided up into a large number of small lobes, in the absence of internal longitudinal bars from the branchial sac, and in having no lobes to the apertures. It has a smooth-walled stomach, except for a single longitudinal ridge on the inner surface.

Rhodozonia picta (Verrill).

Diazona picta Verrill, Trans. Connecticut Academy, vol. x, pt. 2, pl. lxx, fig. 8, 1900.

PLATE XLVI. FIGURE 3. PLATE XLVII. FIGURE 5.
PLATE LX. FIGURE 122.

“Forms large gelatinous colonies, consisting of a massive main stem from which arise more or less numerous lobes, each lobe often containing 12 to 20 zoöids, which, in expansion, are much exsert above the common mass, the free portion being slender and three or four times as high as broad. Apertures, when expanded, on short terminal tubes, the oral one larger and higher than the atrial.

“General color usually translucent pinkish white; the oral aperture surrounded by a band of bright carmine-red, edged on both sides with flake-white; a stripe of the same carmine color extends from the oral band down the ventral side of each zoöid.

“Height of the larger colonies, 125 to 160^{mm}; breadth about the same; height of free part of zoöids, in life, 15 to 20^{mm}; their diameter, 5 to 6^{mm}; diameter of oral tube, about 2^{mm}.” (Verrill 17.)

The test is gelatinous and transparent and of similar character to that of *Diazona*. In young colonies and in newly developing lobes of larger colonies, where the zoöids are still small, they do not project above the surface of the lobe. Such specimens may, however, be readily identified by the color and the great numbers of anasto-

mosing vessels with enlarged ends, which occur in the lower parts of the colonies. These vessels arise from the posterior ends of the zoöids.

The largest zoöids measure, in the preserved condition, about 22^{mm}, or slightly more, in length when removed from the test. In formalin they are of a pale flesh-color. The white contents of the intestine show plainly from the outside.

The mantle is provided with a varying number of rather narrow longitudinal muscle-bands. Beneath these bands there are still narrower transverse bands of different sizes, which are spaced rather far apart, so as to form with the longitudinal muscles square or oblong meshes often of considerable regularity. (Fig. 5.) On the abdomen, the musculature becomes weak and inconspicuous. The siphons have delicate longitudinal and sphincter muscles. The apertures are not lobed, but in contraction their edges become thrown into folds which may easily be mistaken for lobes.

There are fifteen or more rows of stigmata in the branchial sac, each with a great number of short but narrow and closely placed stigmata. The transverse vessels are muscular and have very wide membranes attached along their inner sides. These membranes unite with each other and with the rather long tapering dorsal languets at the dorsal lamina. The dorsal lamina itself is rather broad, and has a thick muscle-band along each side.

There are about a dozen tentacles placed rather far apart and forming a single circle in which large and small ones alternate, but in addition to these there are numerous much smaller ones inserted farther forward and apparently forming more than one circle. In this it resembles the genus *Distoma*. There are no atrial tentacles.

The stomach is smooth-walled and elongated. It is provided with a single internal ridge running longitudinally, and a similar ridge may be traced along a large part of the intestine.

The reproductive glands are poorly developed in the specimens in the collection. The ovary is elongated and situated in the loop of the intestine, and in most cases contains numerous small eggs, but no large eggs or embryos were found. There is a well developed oviduct.

“Harrington Sound and Castle Harbor, just below low-tide, usually attached to gorgoniæ or bryozoa” (Verrill). One or two large colonies, and many small ones, were collected in 1898; but in 1901 only a few small ones were found. It appears to grow chiefly on the gorgonian *Muricea muricata*.

Family **PEROPHORIDÆ** Giard.

Distinguished from the Clavelinidæ chiefly by the absence of an abdomen.

Branchial sac with from four to many rows of stigmata, either plain or with papillæ or longitudinal bars. The dorsal lamina may be a continuous membrane, but languets are usually present.

The stomach and intestine lie on the left side of the branchial sac. Reproductive organs in the intestinal loop.

Genus **Perophora** (Lister, 1834), Wiegman, 1835.

Body short and wide, the branchial sac with but four rows of long, narrow stigmata. Both apertures lobed.

Branchial sac with papillæ (which are often branched) on the transverse vessels, but no internal longitudinal bars. Dorsal lamina with languets.

Perophora viridis Verrill.

Perophora viridis Verrill, American Jour. Science, ser. iii, vol. ii, p. 359, 1871; also Rep. of Comm. Fish and Fisheries, (Invertebrate animals of Vineyard Sound, etc.), p. 702, 1871-72; also Webster's International Dictionary, pp. 1365, 2004 (figures).

See also Lefevre, Budding in *Perophora*, Jour. of Morphology, 1898.

PLATE XLVII. FIGURE 8.

“Colonies composed of nearly sessile individuals about 2.5^{mm} to 3^{mm} high, connected by slender stolons, and thickly covering the surfaces over which they creep. Test compressed; seen from the side, scarcely higher than broad, oval, elliptical or sub-circular, often one sided or distorted, with a short pedicle or subsessile at base. Branchial orifice large, terminal; anal lateral or subterminal, both a little prominent, with about 16 angular lobes, alternately larger and smaller. Test transparent; mantle beautifully reticulated with bright yellowish green; intestine yellow.” (Verrill.)

There are a dozen or more tentacles of two sizes placed alternately. The horizontal bars of the branchial sac bear one papilla for every two stigmata except near the ends. Testis usually consisting of several separate glands.

Specimens of *Perophora* from Bermuda do not appear to differ in internal structure from this well known species of the New England coast. The colonies collected were all small, with but few individuals, and these were lighter colored and rather more transparent

than the average of a large number of specimens collected at Wood's Hole, Massachusetts. They were rather yellower in color during life and appear to be somewhat less compressed laterally, though this may be partly due to the fact that the zooids are in no case crowded together, the colonies being loose and straggling.

The writer collected specimens in May, 1901, under stones at various points, including Waterloo, on Castle Harbor, Coney, and Long Bird Islands, Somerset Island, and Hungry Bay. It is widely distributed, but at that season of the year, at least, it is not very abundant or conspicuous.

Genus *Ecteinascidia* Herdman, 1880.

Body elongated, usually tapering posteriorly, sometimes with a short peduncle; but not divided into thorax and abdomen. Test thin and membranaceous, containing no blood vessels.

Mantle thin, musculature consisting of transverse bands.

Branchial sac with internal longitudinal bars which are not papillated.

Dorsal lamina usually represented by a series of tentacular languets.

Viscera placed on the left side of the branchial sac.

Ecteinascidia turbinata Herdman.

Ecteinascidia turbinata Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., p. 724, 1879-80.

Ecteinascidia turbinata Herdman, Report Voy. Challenger, part xvii, p. 243, pl. xxxvi, figs. 1-6.

See also Lefevre, Budding in *Ecteinascidia*, Anat. Anzeiger, vol. xiii, 1897.

PLATE XLVII. FIGURES 4 and 6. PLATE LIX. FIGURE 116.

Prof. Verrill (17) states that he found this species in 1898. There were, however, no specimens among the ascidians he brought home.

In 1901 the writer found what he considers to be immature specimens of this species, but no adults.

The following is condensed from Herdman's description of the adult:

Shape of each individual elongated, the anterior three-fourths almost cylindrical, the posterior part tapering rapidly to a short, slender stalk. Apertures sessile and minute, both at the right side of the anterior end. They are not lobed.

Length of body 30^{mm}, breadth near the anterior end 10^{mm}. Test thin and membranaceous, transparent. Internal longitudinal bars of

branchial sac narrow and borne on stout connecting ducts. No horizontal membranes present. The meshes between the internal longitudinal bars contain two or three stigmata. On each side of the dorsal lamina (which consists of a row of narrow tentacular languets) there are no internal longitudinal bars for a space of about ten stigmata, but there is a papilla on each transverse vessel at about half this distance.

Tentacles simple and filiform. They are of three lengths placed regularly. Dorsal tubercle elongated and tapering posteriorly. Its aperture is anterior, and the horns are coiled.

Genital glands in the intestinal loop. Ovary alongside and curved parallel to the intestine. Testis in the concavity of the ovary.

The young individuals obtained by the writer do not exceed 6^{mm} in length. Most of them are smaller. The test and mantle are very transparent and the latter contains branching vessels similar to those in *Perophora*.

In life the color is a pale greenish yellow, due to corpuscles of that color in the vessels of the branchial sac and mantle. It becomes brown in preservation.

The body and branchial sac are much shorter than in the adult; none have over 18 or 20 rows of stigmata. There are two sizes of tentacles. The apertures appear lobed, but these may merely be folds produced by contraction of the strong sphincter muscles.

None of the individuals had reproductive organs developed.

The type specimen of this species was obtained by the Challenger Expedition at Bermuda in shallow water. Herdman also states that there are several colonies in the Liverpool Free Public Museum from Alexandria Harbor (3 to 5 fathoms). It also occurs at Jamaica (Lefevre 9).

The young specimens collected at Bermuda by the writer were mostly found under stones along the shores of Castle Harbor and at Coney Island, during the month of May.

Family **DISTOMIDÆ** Giard, 1872.

Colony generally thick and massive, sometimes pedunculated. Systems often wanting. Zoöids usually completely imbedded in the common test.

Zoöids having the body divided into two distinct regions,—thorax and abdomen. From the posterior part of the latter vascular processes usually extend into the test, and upon these the buds form.

Branchial sac without internal longitudinal bars or folds. Dorsal lamina in the form of a series of languets.

Reproductive organs in or on one side of the intestinal loop. Testes consisting of a number of separate pyriform glands. Vas deferens not spirally coiled.

This family is none too well separated from the Clavelinidæ. On the other hand the adult zoöids of this family much resemble those of the Didemnidæ, but the last named family has an entirely different method of budding and is in reality only distantly related.

Genus **Distoma** Savigny, 1816.

Colony generally thick and fleshy. Systems sometimes present. More often both orifices of the zoöids open independently on the surface and the zoöids are irregularly placed. No calcareous spicules.

Branchial orifice normally six-lobed. Atrial orifice also with six lobes and placed at the end of a distinct tubular siphon.

Tentacles often very numerous; in more than one circle.

Stomach globular. Intestinal loop more or less twisted.

Reproductive organs on the left side of the abdomen, which is separated from the thorax by a more or less elongated and narrow peduncle. No incubatory pouch is present, though the embryos develop under the mantle of the parent.

The stomach is smooth-walled in the Bermuda forms.

The zoöids in this genus are quite elongated, but the mantle is strongly muscular, and in preserved specimens they are apt to be so contracted as to give little idea of their natural shape. This must be taken into account in identifying specimens of these animals.

For the purposes of illustrating this paper, individuals were selected which were not much contracted.

Analytical Table of Bermuda species of Distoma, based on the character of the colony.

A.—Incrusting, but thick. Surface uneven, usually slightly raised over the positions of the zoöids. Test firm, colorless but rendered more or less opaque by included sand and shell fragments, which are usually most numerous immediately about the zoöids, forming a sort of capsule. Zoöids large, not pigmented. *D. capsulatum*.

B.—Massive, rounded, attached by most of lower surface. Upper surface smooth and shining. Test soft and gelatinous, with brown or dusky pigment, yet more or less transparent. Much sand included in lower portions of colony. Zoöids rather large with more or less rich brown pigment. *D. convexum*.

C.—Flattened and incrusting but rather thick. Test firm, color greenish black, entirely opaque. Surface smooth. Zoöids rather large, with much black pigment. *D. obscuratum.*

D.—More or less completely divided into heads raised on short peduncles (small colonies consisting of a single head). Color some shade of greenish yellow or olive. Upper surface of heads smooth and glistening. Zoöids of moderate size, somewhat pigmented, and more or less distinctly visible through the test. *D. olivaceum.*

E.—Rounded, attached by most of lower surface. Test very transparent, usually colorless, soft and gelatinous. Zoöids small with the thorax usually pure white and the intestinal loop orange, conspicuously visible through the test. *D. clarum.*

Distoma capsulatum, n. sp.

PLATE XLVI. FIGURE 2.

PLATE LVIII. FIGURE 107.

Forms a small rounded or unsymmetrical colony with an uneven surface, which is often slightly raised over the anterior ends of the zoöids. Size of largest colony; 17^{mm} by 11^{mm} across, and 5 to 7^{mm} in thickness.

Test colorless, rather tough and firm, containing many included grains of sand and shell fragments, so that it may become entirely opaque. The zoöids lie in the test inclined at various angles, and are often so surrounded by sand grains or shell fragments, that each appears to be inclosed in a tubular calcareous capsule. In some specimens the whole of the colony is so crowded with included material that no such arrangement is noticeable. Some sand generally adheres to the surface of the colony also. The zoöids do not appear to be arranged in systems.

Though all the colonies found were very small, the zoöids were large and few in number. When removed from the test they are light yellow or buff with the stomach and part of the intestine orange. They often reach 6^{mm} or more in length in the preserved specimens, which are of course somewhat contracted.

The mantle is well provided with longitudinal muscles, which are gathered on the thorax into a rather small number of broad but not very compact or solid bands. These may also be traced some distance back from the thorax, but gradually break up into narrow bands or individual fibers toward the posterior end of the zoöids. Beneath these longitudinal muscles on the anterior half of the body there are fairly strong transverse muscles, which are, however, not

collected into definite bands. The sphincters of the siphons are well developed. The lobes of the branchial opening are often somewhat bifid.

The branchial sac has four rows of narrow stigmata with a considerable number in each row. The tentacles are numerous, of several sizes arranged in more than one circle, somewhat after the manner described below in *D. convexum*.

The intestinal loop is twisted bringing the large globular stomach to the dorsal side of the abdomen. The so-called hepatic gland surrounding the intestine is confined to a very short portion of its length and consists of short tubules of rather large diameter with expanded ends closely clasping the intestine. (Fig. 2.)

The pyriform testes are very numerous, often 20 to 30 in number. None of the specimens examined contained large eggs or embryos.

This is not an abundant species. Five small colonies were collected in 1898 attached to the lower part of a mass of coral. The writer also obtained several colonies at Coney Island, Bermuda, in May, 1901, below extreme low water mark, attached to stones. These were in poor condition, with very few and small zoöids.

The species is probably commoner in deeper water than along the shore.

***Distoma convexum*, n. sp.**

PLATE XLIX. FIGURE 16. PLATE LVIII. FIGURE 104. PLATE LIX.
FIGURE 118.

Colony forming a thick, fleshy, rounded mass attached by a large part of the lower surface.

The largest colony obtained measures about 24^{mm} across and fully as much in greatest height. The others are of proportionately less height.

The upper portion of the colony is free from included material and the surface is smooth and glistening, but in the lower parts there are many sand grains and shell fragments. The color of the test is a smoky brown or dusky brown (due to scattered cells containing the pigment), very soft and gelatinous yet transparent, so that the zoöids can be more or less distinctly seen. They are numerous and closely placed, but no systems can be distinguished, at least not in the preserved specimens. Bladder cells appear to be absent from the test.

The zoöids are perceptibly smaller than in the last described species (*D. capsulatum*), the individual figured measuring 4.9^{mm} in

length by 1^{mm} across, when somewhat contracted. Their tissues are yellow, the stomach orange, and in addition many of the cells in the mantle contain brown pigment grains of irregular shape, especially on the anterior part of the thorax.

The musculature (not shown in fig. 16) is similar to that of *D. capsulatum* though the longitudinal bands are rather more numerous, and as in that species, it becomes very weak on the abdomen.

The branchial sac has four rows of stigmata, the number in a row exceeding 20 on each side. The tentacles are evidently arranged much as in *D. adriaticum* (Von Drasche, 3). There is a circle of eight large ones; a little further forward, and alternating with them, eight smaller ones; and still further forward one or more circles of still smaller ones.

The gland surrounding the intestine in this species differs from that of *D. capsulatum*. The tubules of which it consists run lengthwise of the intestine and lie parallel to each other, surrounding the intestine on all sides. As in the last mentioned species, they do not branch. Anteriorly they are of small diameter but increase in size as they follow the intestine backward. After following it some distance they leave it and run toward the stomach. At a point near the latter they converge and unite into the common duct. Along the intestine they are thin-walled tubes composed of an epithelium of flat hexagonal cells with nuclei which do not stain deeply. After leaving the intestine they become suddenly smaller, with thick walls and scarcely visible lumen, close to which the deeply staining nuclei of the cells are placed, and they are provided with a conspicuous basement membrane.

Two colonies were collected in 1898 and several in 1901. The exact localities were not recorded, but they were no doubt taken at points near the eastern end of the group of islands. One of the colonies contained a few larvæ.

***Distoma obscuratum*, n. sp.**

PLATE XLVIII. FIGURE 11.

PLATE LVIII. FIGURES 105 and 106.

Two specimens of this species, which is nearly related to *D. convexum*, but evidently quite distinct from it, were collected in May, 1901, growing on corals in rather shallow water in Castle Harbor. They are of flattened form, measuring between 20 and 30^{mm} across, and are 3 to 4^{mm} in thickness, with rounded edges. They are of a uniform greenish black color, entirely opaque, and of firm semi-cartilaginous consistency.

In external appearance the colonies resemble those of *Cystodytes draschii* so closely that they were taken for that species until they were cut open.

Common cloacal apertures are present. The dark pigment of the test is contained entirely in the numerous test cells. The zoöids are pigmented much as described in the case of *D. convexum*, but the pigment is in this case much more thickly distributed and is of an intense black color, so that the whole thorax appears black. There is also much of the black pigment on the vessels of the branchial sac.

The zoöids average about the same size as those of *D. convexum*, though they appear to be somewhat less stout, and differ from them but very little in structure.

They have between 15 and 20 stigmata in a row on each side.

The tubules of the gland surrounding the intestine do not pursue parallel courses along the intestine as in *D. convexum*, but resemble rather those of *D. capsulatum*, though they are not so crowded together (fig. 11).

The colonies contain some tailed larvæ.

Distoma olivaceum, n. sp.

PLATE XLVIII. FIGURE 9. PLATE LIX. FIGURE 113.

This species is also closely allied to *D. convexum*, but the form of the colony differs. In this species it consists of a flat-topped more or less distinctly pedunculated head of small size, seldom over 5 to 8^{mm} across, and, including the peduncle, not much over 10^{mm} in height. Many of the heads are very small, but usually a number of them are grouped together in a mass which may cover several square centimeters of the stone or coral on which the colony grows, the separate heads being connected by the expanded lower ends of the peduncles. In shape the heads resemble those of *Distaplia*, but average smaller. Common cloacal apertures are probably present. Occasionally no distinct peduncle can be distinguished, the colony being attached by its lower surface, and in such cases it often becomes wider, though of less height than stated above.

The color also differs from that of *D. convexum* and is retained, at least for a considerable time, in specimens preserved in formalin or even in alcohol. It is some shade of olive, or yellowish olive, or in a few specimens a very dark olive-green. The test is moderately firm, the upper surface is smooth and glistening; the peduncle, however, is coated with an outside layer or pellicle containing fine sand

grains. This coating of sand generally ceases abruptly at the top of the peduncle. The interior of the colony is usually nearly free from sand or shell fragments.

The zoöids are light colored, with the stomach and part of the intestinal loop orange. The mantle is less pigmented than in *D. convexum*, the spots are blackish and exceedingly minute, and it is usually only on the anterior end just over the ganglion and over the end of the endostyle that they are sufficiently numerous to conceal the whitish ground-color of the mantle. These two points, however, are in most individuals practically black, so thick is the spotting, and they are visible through the semi-transparent test (especially in light-colored colonies) as black dots, and in many of the specimens are the most conspicuous parts of the zoöids.

In structure the zoöids resemble those of *D. convexum*. This applies also to the structure of the gland surrounding the intestine. They average, however, somewhat smaller and slenderer than those of *D. convexum*, as a comparison of figs. 9 and 16, drawn to the same scale, will show. There are the same number of rows of stigmata (four) but fewer in each row. There are also fewer tentacles. There are a dozen or more quite long slender ones, also some small ones inserted further forward.

None of the zoöids examined contained embryos in advanced stages, or very large eggs.

This species was not among those collected in 1898. In 1901, however, it was abundant, especially on corals in Harrington Sound, but common also under stones along the shore at various places, including Coney Island, Long Bird Island, and Hungry Bay. It appears, though, to prefer deeper water rather than situations near low-water mark.

***Distoma clarum*, n. sp.**

PLATE XLVIII. FIGURE 10.

PLATE LIX. FIGURE 117.

Colony jelly-like, the test usually colorless and transparent in preserved specimens. In life, however, it is slightly opalescent with a greyish, pinkish or sometimes a blue or green cast. The colony is simply a rounded or oval mass without a peduncle, attached by most of the under surface. It seldom exceeds 12^{mm} in width and half that in greatest thickness. The zoöids, which are irregularly placed and lie at all angles to the surface (no systems being discernible), are visible through the test with perfect distinctness.

The mantle of the thorax is pure white, not pigmented, while the stomach and more or less of the intestine is yellow or orange. This color fades out in preserved specimens, becoming yellowish or flesh color. In specimens which are in a degenerate condition, the test often becomes infested with parasitic algæ, giving it a dirty and greenish appearance.

Some specimens preserved in alcohol have the zoöids very dark colored, brownish or blackish. I think this may be due to the action of the alcohol or of something contained in it. I have not seen fresh specimens in which they are so colored.

The zoöids are much smaller than in any of the above species. The longitudinal muscles of the mantle are strong and form distinct bands. In consequence of this development of these muscles the zoöids are nearly always found in a condition of violent contraction. This is true of all the species of this genus, but particularly of this one, and most of the zoöids in preserved specimens are generally contracted into a shapeless condition.

There are four rows of stigmata, but a rather small number in each row. Neither are the tentacles very numerous, but they are of two or three different sizes, the largest ones inserted farther back than the smaller ones. In some colonies seven lobes to the branchial aperture is the rule, in others six. The atrial aperture always has six as far as I have observed. There are fewer testes than in any of the larger species of this genus described above. Six appears to be a common number, but in some colonies it is often considerably exceeded.

Specimens of this species collected in April and May are full of large eggs and embryos in all stages. Four or five large embryos, together at least equalling in bulk the individual which has produced them, may sometimes be found under the mantle of one zoöid. Those of most advanced development are nearest the atrial aperture, the others further back, according to their stage of growth.

This species is abundant and may be found on the under side of stones at every suitable place along the shore, and on corals, etc., on the reefs. It is one of the two or three commonest ascidians at Bermuda.

Genus *Cystodytes* von Drasche, 1883.

Differs from *Distoma* in that the abdomen of each zoöid is surrounded by a capsule of calcareous spicules lying in the test. These spicules have the form of circular disks, thin at the edges and

thicker at a point near the center, and slightly concave on the side toward the zoöid. The capsule is formed by a varying number of such disks placed overlapping each other, sometimes several deep.

The zoöids are shorter than those of *Distoma*, and appear to have no vascular appendages. If this be the case, the method of budding must be somewhat modified from that of *Distoma*.

Cystodytes draschii Herdman.

Cystodytes draschii Herdman, Report Voy. Challenger, pt. xxxviii, p. 137.

PLATE XLIX. FIGURE 17.

PLATE LVIII. FIGURES 99 to 101 inclusive.

The type of this species, described in the above work, was obtained in 400 fathoms off Barra Grande, Brazil, but Bermuda specimens from shallow water agree almost perfectly with Herdman's description and figures.

It forms flat incrusting colonies, about 5^{mm} thick, and reaching 60 or 80^{mm} across. The surface is smooth and the consistency of the test moderately firm. The colonies are usually quite opaque. The color is a deep, uniform, brownish gray. When the colony is cut the white calcareous capsules surrounding the posterior ends of the zoöids are very conspicuous.

Under the microscope the test is shown to contain enormous numbers of bladder cells, so closely packed in most places that their outline becomes polygonal, and the amount of test substance is actually small.

A spicule of ordinary size measures from 0.1 to 0.3^{mm} in diameter and about 0.03^{mm} in thickness at the thickest point, but somewhat larger ones and of course many smaller ones occur. They resemble the larger kind of spicules of *C. violaceus* shown in fig. 14.

The zoöids are pale yellow in color when removed from the capsule, which is not readily done without tearing them unless the capsule is dissolved away. They are distinctly divided into thorax and abdomen, but by a very short peduncle, if indeed there can be said to be any. In life, however, they must be capable of some extension, and their usual contracted condition is due to the great strength of the longitudinal mantle muscles. These form many distinct bands on the sides of the thorax, but in the region of the peduncle these separate bands run together and unite into a single broad, thick band on each side. On the abdomen, the muscles spread out again. The object of these strong bands is no doubt to retract the thorax and bring it more or less completely within the protection

of the calcareous capsule. The mantle contains a few black-pigmented corpuscles.

The tentacles are very slender and numerous, of two sizes, the shorter inserted, as in *Distoma*, in a separate and more anterior circle. There are four rows of stigmata with but a small number in a row. Both apertures are six-lobed.

This species is rather common in Castle Harbor; off Bailey's Bay; and doubtless in other places at Bermuda, on gorgonians, corals, etc.

Cystodytes violaceus, n. sp.

PLATE XLVIII. FIGURES 12, 13 and 14.

Four small colonies of a species of this genus, evidently distinct from *C. draschii*, were obtained in Castle Harbor, at Waterloo, in May, 1901. The largest measures only about 12^{mm} across and not much over 2^{mm} in thickness. They were attached to the under side of a stone.

The test is semi-transparent, allowing the zoöids, or rather their capsules, to be seen, and contains corpuscles with purple pigment, which becomes brown in preserved specimens. The zoöids have the stomach yellow, but no pigment cells in the mantle.

The spicules forming the capsules about the zoöids resemble those of *C. draschii*, and reach a diameter of about .3^{mm}, but the capsules are less perfect, and in addition there are spicules scattered in the lower layers of the test and taking no part in the formation of the capsules. They are most numerous and conspicuous near the edges of the colony. Most of them are of smaller size than those forming the capsules, being usually only about one-fifth or one-sixth of the diameter of the latter, and they are proportionately thicker, with thick rounded edges, and are readily seen to be built up of radially disposed rods or needles. The spicules of the capsules also have radial striations or markings, but they are much less distinct. (Figs. 13 and 14.) Bladder-cells occur in the test, but much less abundantly than is usual in *C. draschii*.

The zoöids are similar to those of that species, but average a little smaller and generally have a smaller number of testes. Many of them contain large eggs in the abdomen.

Sluiter's figures and description (15) show that there is a very striking resemblance, superficially at least, between this species and his *Diplosoma purpureum*, found at Cape Verde, Africa. Though he may have sufficient reason for placing his specimens in the genus

Diplosoma, it must be admitted that he gives nothing, either in the figures or description, which demonstrates or even supports the correctness of his position, and in his figure the numerous bladder-cells and the objects which he considers included "shells of *Globigerinas*" bear a most extraordinary resemblance to the bladder-cells and spicules of *Cystodytes*. Moreover, in his description he indicates the existence of a number of testes. *Diplosoma* has but two.

The European *Cystodytes dellechiaiaæ* Della Valle has also a violet color, and I do not feel very sure that the species here described is really distinct from it.

Genus **Distaplia** Della Valle, 1881.

Colony fleshy, often lobed or pedunculated. Test penetrated by vascular processes of the zoöids. Zoöids arranged in distinct and usually rather simple systems.

Branchial sac large, with four rows of long stigmata.

Atrial aperture with a large languet.

Stomach ovate. Intestinal loop not twisted.

Reproductive organs on the right side of the intestinal loop.

The larvæ in this genus are remarkably large. The eggs are received into an elongated diverticulum of the atrial cavity which is developed for the purpose, the incubatory pouch, where they undergo development. The youngest embryos are always found in that end of the pouch farthest from the body of the parent.

Distaplia bermudensis, n. sp.

PLATE XLIX. FIGURES 15, 18 and 19. PLATE LIX. FIGURES 108 and 111.
PLATE LXII. FIGURE 130b.

Specimens of *Distaplia* from Bermuda are very variable in respect to the form and color of the colony, yet I cannot find ground for believing that more than one species occurs there. Bancroft (1) reports a similar variability in the Pacific species, *D. occidentalis*. There is reason to suspect that the number of species of this genus occurring in European waters has been considerably over-rated, through failure to make allowance for such variations.

I am unable to identify these specimens with any of the species already described. Some of the colonies closely resemble *D. vallii* Herdman (6), but it is doubtful whether that is a good species, and moreover, if the stomach of that species resembles that of *D. magnilarva* Della Valle, as Herdman says, it must be pitted or folded on the inner surface.

The Bermuda form has the stomach smooth-walled within and without, though, when highly magnified, the inner surface is finely granular. No pits or folds are present, except such as may be produced by the contraction of the body, the stomach-wall being very thin and delicate. The smooth-walled stomach is, as far as I know, peculiar to this species.

Some of the specimens have the form of rather flat-topped heads, with more or less abrupt edges, attached by a short peduncle. Such heads are usually 10 or 12^{mm} across the top and (including the peduncle) 12 or 15^{mm} in height, and they often consist of but a single system. Other colonies (figs. 18 and 19) form rather thick but flattened incrusting masses several centimeters across, attached by the greater part of the lower surface. Between these and the heads there is every gradation. The incrusting colonies usually contain several systems, and may be produced into one or more lobes, or more or less distinct heads.

The test is only moderately firm, but the outer layer is somewhat tougher. It is rather opaque, yet the zoöids and the vessels may usually be distinguished. The latter occur chiefly in the peduncle and lower parts of the colonies. They seldom branch or anastomose, and their terminal portions are only slightly enlarged. The test may or may not contain groups or masses of bladder-cells.

No reliance whatever can be placed on the color of the colony as a specific character. Whatever may be the color, it generally becomes darker on the upper surface of the head or colony, especially about the atrial aperture or apertures, and paler on the sides of the colony and on the peduncle, if one is present. Sometimes the upper surface is nearly black, and some white pigment is often present about the orifices. Usually the colonies have a chocolate brown color: this often shades into olive, violet, purple, or rose color in some parts of the colony, or one of these colors may predominate. All these colors turn to a green, blue-green, or yellowish green, or sometimes a deep blue, when the specimen is preserved in formalin.

Two large colonies obtained in 1901 were deep orange-red, almost vermilion, shading to blackish about the atrial orifices. These colonies turned brownish in formalin. Among the specimens obtained by Prof. Verrill in 1898 were a few which were almost white, and others of a dull yellowish olive. These were preserved in formalin, with no notes as to their colors in life.

The zoöids are easily removed from the test. They appear to vary much in size, but this is no doubt largely due to a varying

amount of shrinkage. This is very likely to occur in preserved specimens, as the tissues of the zoöids are exceedingly delicate. Well-expanded individuals are beautiful objects, and the internal structure can be made out with greater ease than in any other of the Bermuda ascidians. The mantle is but slightly muscular, the fibers running chiefly obliquely and transversely. It is often more or less pigmented, at other times nearly colorless. The stomach and duodenum are always orange in fresh specimens. The largest and best preserved zoöids measure over 3^{mm} in length, and about 1.2^{mm} across the thorax.

The branchial sac has four rows of more than twenty long narrow stigmata on each side, which become shorter as the ends of the rows are approached. A very narrow intermediate transverse vessel crosses the stigmata half way between each principal transverse vessel. This is visible even in quite young buds, where the number of stigmata in a row is still much less than in the adult. The structure of the branchial sac agrees exactly with Herdman's (6) description of *D. rosea* and *D. vallii*.

The branchial orifice has an irregularly toothed margin. This is not apparent when the aperture is much contracted. The atrial opening is placed well back from the anterior end and is very large, with the anterior lip produced into a long pointed languet. There are about 16 tentacles of two sizes placed alternately, but their arrangement and number is not always exactly the same.

As already mentioned, the stomach-wall is not pitted nor folded, but is smooth within and without.

The zoöids are usually hermaphroditic, well-developed testes and eggs of considerable size being present at the same time. (Fig. 15.) Some, however, appear to have the organs of only one sex. Some colonies contain great numbers of buds and embryos, the latter usually contained in the long incubatory pouch, which eventually becomes detached from the zoöid. I have not observed more than three embryos in a pouch.

Family **POLYCLINIDÆ** Giard, 1872.

Colony usually massive, sometimes incrusting, sometimes lobed or pedunculated. Systems of various shapes, occasionally irregular or wanting.

Zoöids elongated antero-posteriorly, and usually divided into three distinct regions; the thorax, abdomen, and post-abdomen.

Branchial aperture 6 or 8 lobed, atrial aperture often with a languet.

Branchial sac generally long, with numerous rows of small round or oval stigmata. It may be papillated, but no internal longitudinal bars occur.

Dorsal lamina with languets.

Stomach-wall smooth or variously folded or pitted. Reproductive organs and heart situated in the post-abdomen. Testis represented by a number of small spermatic sacs.

Gemmation by division of the post-abdomen.

Genus *Amaroucium* Milne-Edwards, 1841.

Distinguished by forming massive, often pedunculated colonies, with elongated zoöids having long post-abdomens, usually six-lobed branchial siphons, the atrial aperture placed well forward, and a large atrial languet. The stomach-wall is, usually at least, longitudinally folded, but in one of the Bermuda species this appears to be a very variable character. The post-abdomen is sessile.

This genus, though almost universally accepted by writers on Tunicata, is but poorly distinguished from *Aplidium* Savigny, which in its typical form has a sessile colony, shorter zoöids, often lacks the atrial languet, and has the post-abdomen separated from the abdomen by a more conspicuous constriction or peduncle. The atrial aperture is also said to be placed further back. Most of these differences are very trifling, and many species could be placed in either genus with equal propriety.

Amaroucium bermudæ, n. sp.

PLATE L. FIGURE 20. PLATE LVIII. FIGURES 96 and 97.

The colony is irregular in shape, seldom much over 30^{mm} across, generally less, with rather flat top and abrupt sides tapering into a more or less distinct peduncle. The combined height of the colony and peduncle often reaches 20^{mm} or more.

The test is firm, almost cartilaginous, but softer in the interior of the colony. It is usually quite free from sand grains, grayish and nearly opaque in life, sometimes with a distinct bluish or pinkish tint. In formalin it becomes more transparent and of a yellowish or flesh-color. There are no bladder-cells. The systems are irregular and the number of zoöids in different specimens of the same size is very variable.

The zoöids are rather large and stout. A fair sized specimen measures 2.3^{mm} long without the post-abdomen, which may itself reach 4 or 5^{mm} in length, though in most individuals it is much shorter. In color they vary from orange to bright vermilion red in life, but gradually fade to yellow in preservation. The color is diffused through most of the tissues, but in very red individuals the mantle of the thorax contains an especially large amount of pigment. The mantle, especially near the anterior ends of the thorax, abdomen and post-abdomen, is often studded with rounded cells, much larger than the ordinary epithelial cells.

Usually there are six lobes to the branchial orifice, but some individuals have more. There is a fairly large atrial languet placed a little anterior to the orifice, which is itself provided with distinct though very short lobes. The usual number of rows of stigmata appears to be about eighteen, with more than a dozen in a row on each side. They are small and round and placed rather far apart. The transverse vessels are very muscular. The tentacles are small and difficult to count.

The presence and arrangement of folds or plications in the wall of the stomach have been made the chief characters by which the genera of this family are distinguished. In the present species, however, it is clear that great importance should not be attributed to them. Usually the stomach of this form has distinct longitudinal folds, but often there are transverse folds also over more or less of the surface, or the transverse folds may even predominate and become the principal ones, exceeding the longitudinal folds in prominence. Some individuals show, on some parts of the surface of the stomach, an areolated condition not far removed from that which is typical of the genus *Morchellium* Giard. Others, again, apparently have the stomach entirely smooth-walled in its natural condition, but in this species the stomach-wall is very thin and liable to become folded by the contraction of the animal incident to preservation, and its original condition is not always easy to determine.

In another species of this genus, *A. constellatum* Verrill, from the New England coast, which normally has a longitudinally folded stomach, I have also observed variations from the usual condition, though not to such a great extent.

Many specimens of this species were collected, both in 1898 and 1901. It was found most abundantly on corals in Harrington Sound, in water of moderate depth, and evidently grows better in such situa-

tions than along the shore. The zoöids often contain larvæ in the atrial cavity.

In the Peabody Museum of Yale University there are some specimens of *Amaroucium* from Fort Macon, N. C., which appear to be of this species.

Amaroucium glabrum Verrill, from the coast of Maine, forms colonies of very similar size and shape.

***Amaroucium exile*, n. sp.**

PLATE L. FIGURE 21.

PLATE LVIII. FIGURE 98.

The colony in this species is rounded or button-shaped. It is not pedunculated and adheres by the greater part of the lower surface. The edges are not abrupt as in the last described form, but rounded, and the consistency of the test is not so firm. It does not generally grow more than 5 or 6^{mm} high and 15 or 20^{mm} wide.

The test is often quite densely crowded with coarse sand grains and shell fragments, in the interior of the colony as well as on the surface; in other cases it is entirely free from such inclusions and is very transparent and almost colorless. Such colonies are very beautiful objects, for the zoöids vary from orange to an even more brilliant red than those of *A. bermudæ*, being sometimes bright scarlet.

The zoöids are smaller and slenderer than in *A. bermudæ*. The systems are irregular. The specimen figured measured a little under 4^{mm} long including the post-abdomen, which was short in this individual.

The chief anatomical differences between this and the last described species appear to be that the present one has fewer stigmata, only twelve or fourteen rows (the number in each row may be slightly less also), and that in this species the stomach-wall is thicker and always distinctly folded longitudinally with a variable but not very large number of folds (generally about 9).

This is a less common species than the last, and though found in the same situations, occurs under stones along the shore more frequently than *A. bermudæ* does. The writer collected it at Coney Island; Waterloo; and Somerset Island, among other places. It was obtained both in 1898 and 1901. Many of the specimens contain larvæ, which begin to secrete test-substance even while still contained in the atrial cavity of the adult zoöid.

This species is related to *A. constellatum* Verrill of the New England coast. The more brilliantly colored specimens of that

form are, when small, of rather similar appearance to those of this species; but the somewhat stouter zoöids, with much more numerous and often much less regular plications in the stomach-wall; the very milky appearance of the test; and the tendency to form wedge-shaped or pedunculated colonies, would serve to distinguish the New England species, even if it did not form massive colonies of vastly greater bulk than this species ever attains.

Family **DIDEMNIDÆ** Verrill, 1871.

Colony incrusting, sometimes thick and massive, not pedunculated. Test usually containing bladder-cells and often calcareous spicules, which are generally of stellate form. Zoöids arranged in complex branching systems.

Zoöids of small size, divided into thorax and abdomen, often with a muscular and vascular process extending out into the test from the region of the peduncle connecting the two divisions of the body.

Branchial aperture six-lobed; atrial plain, or with a languet. Three to six rows of stigmata. Dorsal lamina with languets.

Stomach smooth-walled, externally at least. Intestinal loop twisted.

Reproductive organs on the left side of the abdomen, or more or less ventral, or posterior. Testes few, often only one. Vas deferens often spirally coiled about the testis before leaving it to follow the intestine. There is no oviduct.

Budding from the pyloric region (near the peduncle); thorax and abdomen of the new zoöid formed from separate buds.

The genera *Diplosoma* and *Diplosomoides*, which are often regarded as constituting a separate family, the Diplosomidæ, are here included in this family.

Genus **Didemnum** Savigny, 1816.

Colony generally rather thick and fleshy. Test containing bladder-cells and usually stellate calcareous spicules.

Zoöids with a strong muscular process extending into the test from the ventral side of the peduncle connecting the thorax and abdomen. Branchial orifice six-lobed, atrial plain, with no languet.

Branchial sac with three rows of stigmata.

Testis single, more or less conical in form. The vas deferens makes a number of spiral turns about it before proceeding on its

course to the rectum, which it follows to a point near the atrial orifice.

The Bermuda species of this genus differ more in the habit and character of the colony than in the structure of the zoöids or the form of the spicules. They appear to have the following characters in common:

The zoöids vary in length, according to the species, from less than 1^{mm} to 1.6^{mm} in preserved specimens. The musculature of the mantle consists of a moderate number (perhaps twenty or more) distinct, though slender, bands running longitudinally. Transverse muscles (with the exception of the sphincters) are but slightly developed in the mantle.

The transverse vessels of the branchial sac are, however, provided with strong muscles, and each side of the dorsal lamina a strong muscle-band runs longitudinally in the wall of the branchial sac. These two bands, which run ventrally when they reach the posterior end of the thorax, are joined near the posterior end of the endostyle by fibers from different parts of the wall of the thorax, so that they become quite thick, and passing out in a ventral and posterior direction from the upper end of the peduncle, they unite to form the muscle of the muscular process which extends out into the test.

The tentacles appear to be eight in number, four large and four small ones placed alternately, but I am not certain that there are not more in some cases. The stigmata are long and narrow, about 16 in number on each side in the species with the largest zoöids, and somewhat fewer in the smaller species. The upper and lower rows of stigmata do not contain quite as many as the middle row.

The stomach is round or oval and smooth externally, and more or less yellow in color. The gland about the intestine consists of a small number of tubes clasping it. They branch but little, and their terminal portions are not much dilated.

I have found well developed reproductive organs in only two species (*D. savignii* and *D. porites*), but they are probably similar in the others also. The testis, which is single and obtusely conical, is very large, and is situated on the left side of the abdomen, with its base close against the intestine. The vas deferens leaves it at its apex and makes, usually, from eight to a dozen turns about its conical surface, like the string wound around a top. It leaves it finally about opposite the stomach. The ovary is placed between the testis and the stomach.

Analytical Table of Bermuda species of Didemnum, based on the character of the colony.

A.—Massive and irregular, opaque, consistency firm. Surface roughish; apertures far apart and conspicuous. Spicules uniformly and thickly distributed. Color reddish grey or buff, almost flesh colored.

D. solidum.

B.—Moderately thick, opaque, gelatinous. Surface smooth and glistening; apertures inconspicuous. Spicules confined to a stratum in the interior of the colony, invisible from above. Color rich brown.

D. savignii.

C.—Very thin, incrusting, gelatinous; zoöids visible through the test. Surface smooth, apertures inconspicuous. Spicules irregularly distributed. General color blackish and greyish, irregularly mottled, varying in places according to the abundance of the white spicules and of the black pigment in the test and on the zoöids.

D. atrocantum.

D.—Massive, partly opaque, consistency moderately firm, surface slightly rough; apertures prominent. Spicules rather uniformly distributed, only moderately numerous. Color greyish, becoming black on parts of the upper surface.

D. porites.

E.—Thin, incrusting, transparent, gelatinous. Surface smooth; zoöids visible. Spicules in interior parts of the colony, not numerous enough to greatly diminish the transparency of the colony. Little or no dark pigment.

D. lucidum.

F.—Thin, incrusting, translucent. Surface smooth, zoöids more or less concealed by the abundance of spicules, which are so distributed that the surface of the colony shows over the position of each zoöid a circular area, more transparent than the intervening spaces, which latter are white and more opaque, owing to the greater abundance of spicules there. Thorax of zoöids often dark colored. Colony whitish gray.

D. orbiculatum.

NOTE.—The only specimens of species A and D which were found incrusting branching algæ, which no doubt influenced the form of the colony. Colonies growing on smooth surfaces will probably be found thinner and more expanded.

Didemnum solidum, n. sp.

PLATE LI. FIGURES 31 and 36.

PLATE LIX. FIGURE 119.

But one specimen of this species was found. It is a very irregular colony, incrusting a growth of seaweed. In greatest length it measures about 45^{mm}, and reaches 4^{mm} or 5^{mm} in thickness in places. It is entirely opaque and of firm, almost brittle consistency, on account of the abundance of spicules, which are very evenly distributed in all parts of the colony. The surface is, for the same reason, slightly rough to the touch, and the apertures are conspicuous. Bladder-cells are scarce in most points of the colony.

The color is difficult to describe, being a reddish grey or buff, almost a flesh-color, darker above. It fades in preservation. The spicules are very uniform in size and shape, being about .05^{mm} to .07^{mm} in diameter, and have very short and stout, but regular and numerous conical points.

The zoöids are light colored and small, and placed rather far apart. They do not much exceed 1^{mm} in length in preservation, and are rather slender. There are probably not more than 12 stigmata in a row on each side.

None of those examined had well-developed reproductive organs.

The colony was obtained at Coney Island, May 16th, 1901, just below low water mark.

Didemnum savignii Herdman.

Didemnum savignii Herdman, Report Voy. Challenger, pt. xxxviii, p. 261.

PLATE LI. FIGURES 27 and 35.

PLATE LIX. FIGURE 112.

The colony is incrusting but rather thick, and of rather soft, gelatinous consistency. The color is a rich brown, darker above, and the surface is smooth and glossy, the apertures inconspicuous and the spicules and zoöids invisible from the surface.

The largest specimen measures about 16^{mm} across, and is between 3^{mm} and 4^{mm} in greatest thickness.

The test contains great numbers of bladder cells, especially near the surfaces, where they are so abundant that they assume polygonal forms from mutual pressure. The dark color is due to brown pigment contained in the test cells. These pigment cells are most abundant near the upper surface, where they are irregular in form. In the deeper portions of the colony they are oval and less thickly distributed.

The spicules are very large, often $.1^{\text{mm}}$ in diameter, with numerous long conical or somewhat flask-shaped points. They are chiefly confined to a layer lying about $.5^{\text{mm}}$ to 1^{mm} below the upper surface. In this layer they are abundant and placed near together.

The zoöids are placed close together and mostly nearly perpendicular to the surface. They are rather large (the specimen figured (fig. 35) measured 1.6^{mm} long) and rather dark in color, due to brown pigment in the mantle, especially about the branchial aperture, and to a less extent on other parts of the thorax. The lining of the branchial siphon is particularly dark colored.

They have about sixteen stigmata in a row on each side. In several different individuals I found the number of turns in the spiral portion of the oviduct to be about eight. Herdman gives four or five as the number in his specimen.

The locality of the type of this species, described in the Challenger Report, is given as doubtful, but probably just south of the Cape of Good Hope, in 150 fathoms.

Only two specimens of this species were found at Bermuda, neither of them as large as the type specimen. One was obtained in 1898, the other in 1901, but the exact localities are not recorded.

***Didemnum atrocantum*, n. sp.**

PLATE LI. FIGURES 30 and 34.

PLATE LIX. FIGURE 114.

This species forms very thin incrusting colonies. The largest that were obtained measure 2^{mm} thick and from 30^{mm} to 40^{mm} across. In consistency it is gelatinous, and the spicules are not sufficiently abundant to greatly alter the character of the test.

The spicules are of moderately large size, averaging over $.05^{\text{mm}}$ in diameter, but differ somewhat from those of *D. savignii* in having more numerous points, which are generally somewhat shorter and more or less irregularly rounded or split or broken at the extremities, though some have the regular conical or flask-shaped points, as in the last named species. They are irregularly distributed in the interior of the colonies, being thickly crowded in small patches and absent in other places. Where they are dense their white color makes them noticeable against the grey or blackish yet transparent test. Many bladder cells also occur.

The zoöids are not on an average quite as large as those of the last described species (*D. savignii*). In many of the specimens the mantle cells contain so much black pigment that the whole colony

appears quite blackish, for the zoöids are numerous and closely placed; in other cases they have but little dark pigment, and appear lighter than the greyish test, which also contains a greater or less number of black pigment cells.

I have found this form only at Hungry Bay, where it is common. A number of colonies were collected under stones in the latter part of May, 1901. None of the zoöids appear to have reproductive organs developed.

Didemnum porites, n. sp.

PLATE LI. FIGURE 29 and 33.

PLATE LIX. FIGURE 115.

A couple of colonies, the largest about 25^{mm} across and rather thick, were obtained growing on algæ in Bailey's Bay, May 1st, 1901. They differ considerably from *D. atrocantum*, though they are also of a grayish color, becoming black in the upper parts of the colony.

The test is of firm consistency, though bladder-cells are very abundant in some places; the spicules, which exactly resemble those of *D. lucidum* described below, are fairly evenly distributed through the test and come close to the surface, giving it a slightly rough granular character. The apertures of the zoöids on the surface are conspicuous and slightly prominent. The test is opaque.

The zoöids are of good size (1.3^{mm} or 1.4^{mm} long in many cases in the preserved specimen), and have a little black pigment in the mantle walls. In structure they resemble those of *D. savignii*. I have counted ten or eleven turns of the vas deferens in some individuals.

Didemnum lucidum, n. sp.

PLATE LI. FIGURES 26, 28 and 37.

This is a species with very small zoöids (usually less than 1^{mm} in length), which are slightly or not at all pigmented, forming small, fairly transparent, nearly colorless incrusting colonies of slight thickness. Sometimes the anterior end of the zoöid is marked with a little blackish pigment about the aperture and over the ganglion.

The spicules, though varying much in size, are mostly under .04^{mm} or .05^{mm} in diameter. They have long but not very numerous conical points, and are distributed unevenly in the interior parts of the colony, generally not in sufficient abundance to greatly interfere with the transparency of the test. Near the surfaces of the colony they are wanting and there are a good many bladder-cells.

I have not been able to count more than about a dozen stigmata in a row on each side. None of the specimens have reproductive organs in good condition.

One colony of this little species was collected in 1898. In 1901 two or three were obtained in Bailey's Bay and Harrington Sound. One of the specimens grew on a branching alga, the others incrusting coral.

Didemnum orbiculatum, n. sp.

PLATE LI. FIGURES 32 and 38. PLATE LXI. FIGURES 127*a* and 128.

This is a form in many respects intermediate between a true *Didemnum* and a *Leptoclinum*, having the thin colony and abundant spicules characteristic of the latter, yet the large size of the spicules, their form, and the appearance and pigmentation of the zooids show it to be closely related to some of the species just described, and as I have been able to distinguish but three rows of stigmata it seems best to place it in this genus.

The largest specimens found were 25 or 30^{mm} across, and about 2^{mm} thick.

It may be recognized at a glance by the peculiarity in the distribution of the spicules alluded to in the analytical table above. The spicules, which are of fair size (about .04^{mm}), with rather slender conical points, are abundantly and thickly disposed in the test, yet not in such numbers as to give the colony the white, chalky appearance of a *Leptoclinum*, but leaving it a translucent grayish white. The zooids are placed very close together, and there being but a thin layer of spicules over them, each branchial orifice appears in the center of a more transparent circular area of about the diameter of the thorax of the zooid.

The zooids are small (in contraction about 1^{mm} long). They have strong muscle bands in the mantle and contract badly in preservation. The mantle contains much dark pigment on the thorax, so that that part of the body often appears quite uniformly blackish.

This species is common and grows on the underside of stones near low water in company with colonies of *Leptoclinum*, *Diplosomoides* and *Botrylloides* at almost all suitable places along the shores of the islands. I found it especially common at Long Bird Island and at Waterloo, on Castle Harbor, in April and May, 1901. Many of the zooids then contained large eggs, but I did not observe well developed testes in any of the numerous individuals examined.

Genus **Leptoclinum** Milne-Edwards, 1841.

Differs from *Didemnum* in having four rows of stigmata, and in forming a thin incrusting colony, densely crowded with calcareous spicules, so that the test becomes more or less hard and brittle.

Some species are said to have an atrial languet, but probably these should be placed in another genus.

In some cases the testis is deeply lobed, or it may be completely divided into two glands.

This genus is none too well distinguished from *Didemnum*, but is accepted by nearly all writers. The number of rows of stigmata (though apparently a reliable character in the Bermuda forms) is by no means always invariable, even in the same species, and in the character of the colony every gradation is found between the massive colony of a typical *Didemnum* and the thin, brittle crust of a typical *Leptoclinum*.

In this paper the writer has placed all the forms with three rows of stigmata in *Didemnum*, regardless of the thickness of the colony.

True *Leptoclinums*, with four rows of stigmata, occur in abundance at Bermuda, growing on corals, sponges and algæ on the reefs, and on the under side of stones along the shore, up to a point well above low-water mark. It is the most abundantly represented genus of ascidians there.

With only a limited number of specimens at hand, it is easy to classify them into several distinct and well marked species, differing from each other fully as much as some of the forms which are described above as species of the genus *Didemnum*, but with a large number of specimens available for study, the problem is by no means such an easy one, as so many intermediate forms occur. The writer devoted particular attention to collecting examples of this genus during his visit to Bermuda in 1901, but is obliged to confess, after examining a very large amount of material, that he has utterly failed to discover any character or characters by which the Bermuda *Leptoclinums* may be divided into groups worthy of specific rank. Apparently a process of active evolution is going on in the members of this group, at least in the Bermuda representatives of it, and from the hopeless confusion in which the species of this genus generally are involved, it seems not unlikely that this is the case elsewhere as well.

As the differences between the varieties are too great to disregard entirely, the only course open to the writer is to describe the most

striking variations as subspecies. Between these there are an indefinite number of intermediate forms. Nevertheless all these forms appear to have some degree of permanence, and reproduce their peculiarities at least in their immediate descendants, for often a number of colonies attached to the same stone, or growing near together, will have exactly identical characters, indicating a common parentage, while certain others, growing among them, will differ from them, yet agree among themselves.

The relation of these numerous varieties to previously described species of the genus is a difficult question. Naturally their nearest allies would be sought for on the Atlantic coast of the United States and in the West Indies. In neither of these regions has the genus been sufficiently studied.

Sluiter (15) has recently described two new forms, *L. conchyliatum* and *L. cineraceum*, from Jamaica, but these differ from the Bermuda forms, among other things, in the number of stigmata, for he says that they are provided with but from four to six stigmata in a row on each side, while the Bermuda forms have about 12 in those with large zooids, and probably at least 8 or 10 in all cases.

From the Atlantic coast of North America two species only have been described, as far as the writer is aware; *L. albidum* Verrill and *L. luteolum* Verrill, the latter perhaps only a variety of the former. Both of these are found on the New England coast. The Bermuda varieties are quite different from the typical *albidum*, which has spicules of a different type from any of the Bermuda forms (fig. 41), and in most specimens the spicules are much larger than is the case in any of the latter.

Specimens of *L. luteolum*, from Southern New England, however, have spicules more like some of the Bermuda varieties (fig. 40). Yet the correspondence between *L. speciosum* Herdman (6), from Bahia, Brazil, and the commonest Bermuda form is so much closer that it seems best to consider the latter, and consequently the remaining Bermuda varieties, as subspecies of the Brazilian form.

The writer has not ascertained that any of the several varieties here described is confined to any particular locality at Bermuda.

Leptoclinum speciosum Herdman.

Leptoclinum speciosum Herdman, Report Voy. Challenger, pt. xxxviii, p. 274.

The types are from Bahia, Brazil, in 7 to 20 fathoms. I have not found specimens at Bermuda which correspond exactly to the description of the Brazilian examples.

Var. *bermudense*, nov.

PLATE LII. FIGURES 39, 42 and 50. PLATE LXII. FIGURES 130c,
132 and 134.

Colony usually between 2 and 3^{mm} thick (when incrusting irregular objects often very much thicker) and reaching 60 or 70^{mm} in width in some cases. Spicules more abundant in the upper layers of the colony, though generally the extreme upper stratum is free from them, so that the surface is smooth to the touch. The spicules (figs. 39 and 42) are usually rather small (less than 0.025^{mm} in diameter) with a variable but generally very large number of points or rays. Occasional very large spicules occur among the small ones, but this is not peculiar to this variety. In some colonies most of the spicules have their points blunt and broken, in other colonies most of the points are perfect, but generally slightly rounded. As a rule the spicules are not so abundant as to render the test very stiff or brittle. The color is usually pure white, but it often becomes yellowish in preserved specimens. The apertures are generally not prominent.

The zoöids are large (up to 1.5^{mm} long, or more). Their tissues are yellow, the stomach and intestine being orange. They have 12 or more stigmata in a row on each side and 16 tentacles of two sizes. When the zoöids are very large, there are often additional, still smaller tentacles between the larger ones. The testis is generally single, but sometimes it is divided into two. The vas deferens makes about a dozen spiral turns.

This is the commonest form at Bermuda.

Var. *pageti*, nov.

PLATE LII. FIGURE 45.

A dwarf variety of the last. The colonies are small (under 20^{mm} wide) and usually considerably under 2^{mm} thick. They have generally a distinct yellow tint, and the tissues of the zoöids are more strongly orange-tinted than in the last form, sometimes almost red, in which case the whole colony may have a salmon shade.

The zoöids are smaller and proportionately shorter than in var. *bermudense*. The spicules (fig. 45) are, however, similar. They have so many rays that unless highly magnified they appear almost spherical. Surface of colony rather smooth, apertures not conspicuous.

Often found associated with the last described form.

Var. *hamiltoni*, nov.

PLATE LII. FIGURES 43, 44 and 47. PLATE LXI. FIGURE 127b.

PLATE LXII. FIGURE 135.

In this the spicules are larger than in var. *bermudense* and they have coarser and less numerous but often rather longer points, and are more evenly distributed through the test, coming close to the upper surface. From this it follows that the colony is stiffer, harder and rougher than in the two last described forms. The zoöids are rather small (usually not much over 1^{mm} or 1.2^{mm} long) and placed near together. Their apertures are rather prominent on the surface. The colonies grow somewhat larger, but not very much thicker (generally about 2^{mm}) than those of var. *pageti*, into which it grades, and with which it is found associated. The colonies are very frequently decidedly yellow in color. It is a very common variety.

Var. *harringtonense*, nov.

PLATE LII. FIGURES 49 and 51.

This forms rather extensive (often 30 or 40^{mm} wide) colonies of moderate thickness (2^{mm} or over), white in color and resembling var. *bermudense*, but having much larger (up to 0.05^{mm}), longer pointed spicules. (Fig. 49.) They are abundantly placed throughout the test and make the colony hard and rough to the touch.

The zoöids are decidedly slenderer than in var. *bermudense*. They apparently have about 10 stigmata in a row on each side, short lobes to the branchial orifice, and but one testis. There are 16 tentacles or nearly that number. The vas deferens makes 8 or more turns (fig. 51).

Not common.

Var. *acutilobatum*, nov.

PLATE LII. FIGURES 46 and 52.

Resembles the last externally, but the colonies are rather thinner, and I have not observed such large ones. The spicules are small (0.025^{mm} in diameter), of remarkably uniform size and regularity of form, with very few points, which are conical with bulging sides (fig. 46). The zoöids are small and short (fig. 52), about 1^{mm} long in preservation, and are remarkable for the length and sharpness of the lobes of the branchial orifice. The testis is divided into two separate glands, each of which may be two-lobed. The vas deferens makes seven or eight turns.

Not common, but obtained both in 1898 and 1901.

Var. *somersi*, nov.

PLATE LII. FIGURE 48.

PLATE LXII. FIGURE 136.

Forms very small (10 to 20^{mm} wide), flat colonies of a pure white color. They are very thin (often under 1^{mm}) and not very opaque. The zoöids are as small as those of var. *acutilobatum*. They are placed rather far apart. The spicules are large (fig. 48), with regular conical points of some length, and are evenly but often not very closely distributed in the colony. The positions of the zoöids are very conspicuous from the surface, though the apertures are not especially so. There is but one common cloacal aperture to the colony. The branchial apertures of the zoöids have pointed lobes but much shorter ones than those of the last described form.

Quite generally distributed, though not very abundant.

Genus *Polysyncraton* Nott, 1891.

Separated from *Leptoclinum* (which it resembles in having four rows of stigmata) by having a number (sometimes as many as 10) of distinct pyriform testes, arranged in a circle, forming together a conical group, about which the vas deferens makes a few spiral turns: and by possessing an atrial languet.

The type of the genus is from New Zealand (13).

Polysyncraton amethysteum, n. sp.

PLATE LIV. FIGURES 62 and 64 to 67 inclusive. PLATE LVIII. FIGURE 102.

Colony more or less transparent except for a thin layer of spicules on the upper surface. The test is of an amethyst purple or rose purple tint, due to pigment contained in the test cells, while the tissues of the zoöids are bright red. These colors fade out in preservation, the test becoming yellowish and the zoöids yellow or orange. The colonies seldom exceed 30^{mm} in width and 3 or 3.5^{mm} in thickness.

The layer of white spicules on the upper surface of the colony shows in strong contrast to the colors of the test. It may readily be stripped off. The spicules are entirely confined to it. Large areas about the common cloacal openings are entirely bare of spicules, also small oval areas about the branchial orifices, but in these latter may be seen small V-shaped groups of spicules, six in number in each, corresponding to the six lobes of the branchial siphons. This arrangement of the spicules about the branchial openings occurs

sometimes in other genera of this family (*Leptoclinum*, *Didemnum*), but is especially conspicuous here. (Fig. 65.)

The spicules are always small with short and often more or less blunt and broken points. In some colonies they are all very minute, in other specimens they vary more in size (compare fig. 64 with fig. 67 both down to the same scale). The test contains vast numbers of bladder-cells.

The zoöids also vary much in size in different colonies, reaching 1.5^{mm} or more in length in many cases. There are six short lobes to the branchial siphon, and a rather long, somewhat forked languet over the atrial orifice. There are four rows of stigmata with a moderate number in each, and probably eight tentacles.

The male reproductive organs consist of about five (the number varies) separate pyriform testes placed radially with the small ends in the center, where the short ducts arising from them unite to form the vas deferens which coils about the group in the usual manner, making about five turns. The ovary lies between two of the testes on the side toward the stomach, more or less covered by or included in the coils of the vas deferens, except when the eggs become so large that it must extend beyond these limits.

This beautiful species is moderately common, both along the shore under stones, and in deeper water on corals, sponges, etc. It was obtained in Castle Harbor; Harrington Sound; and at Hungry Bay; and was collected both in 1898 and 1901. The specimens contain large reproductive organs and larvæ, and the species would probably be an unusually favorable object for embryological or histological investigation.

Genus **Diplosoma** MacDonald, 1858.

Colony incrusting, generally rather thin. The test is penetrated by more or less extensive cavities continuous with, and regarded as extensions of, the common cloacal cavities, which greatly reduce the amount of test substance, leaving in extreme cases little of it except the thin layer bounding the colony and a thin layer about each zoöid, the latter being retained in position by strands or columns of test substance continuous with the layer bounding the colony. All the rest of the interior of the colony becomes one large cavity. The extent to which this modification proceeds varies in different species and to a considerable degree in different individuals.

The test substance is gelatinous, becoming membranous on the surface, and from its nature, as well as from the extensive cavities

above mentioned, the colony is very soft and delicate. No spicules are present. The test is often very transparent.

The zoöids have six lobed or nearly simple branchial apertures, and simple atrial openings.

The branchial sac has four rows of rather large stigmata. The transverse vessels are muscular, and as in *Leptoclinum* there is a muscle band along each side of the dorsal lamina. The bands unite at the posterior end of the thorax, and are prolonged into a muscular and vascular process extending posteriorly and ventrally into the common test. It ends bluntly and is much weaker and less conspicuous than in *Leptoclinum*. I have found it in all the species of this genus described in this paper.

The intestinal loop is twisted and generally bent so that its axis lies about at right angles to that of the thorax. This brings the reproductive organs, which lie on the left side of the abdomen, under the intestinal loop. The stomach is oval and smooth-walled, on the outside at least.

There are two testes placed close together, forming as in *Leptoclinum* a conical mass, but the vas deferens does not coil about them.

With the related *Diplosomoides* Herdman, which has small stellate calcareous spicules, this genus is often made a separate family, the Diplosomidæ.

Diplosoma macdonaldi Herdman.

Diplosoma macdonaldi Herdman, Report Voy. Challenger, pt. xxxviii, p. 315.

PLATE LIII. FIGURE 60.

PLATE LX. FIGURE 124.

Colony large (50^{mm} across) and rather thin, not exceeding 2 or 2.25^{mm} in thickness. Test nearly colorless and very transparent, membranous on the surface. The cavities characteristic of the genus are well developed, yet there is considerable test substance about the zoöids which adheres very firmly to their mantles and contains here and there a few bladder cells. In addition to the small test cells, there are large oval or slightly irregular cells which stain deeply with plasma stains.

The zoöids are also nearly colorless except that the stomach and more or less of the intestinal loop is yellow or orange. This fades out in preserved specimens. The zoöids are large for this family, sometimes reaching 1.6^{mm} in length when straightened out and expanded. The mantle muscles are but slightly developed and are mostly transverse.

There are four rows of stigmata, with about a dozen in a row on each side. The stigmata are large with very narrow interstigmatic vessels. The transverse vessels are fairly muscular and contract strongly in preserved specimens, as the rest of the branchial sac is very delicate.

The endostyle is rather narrow. The dorsal languets are long enough to extend more than half way across the branchial sac. They are tentacular in form. The tentacles appear to be about twelve in number, and are of two sizes placed alternately.

This species was described by Herdman from a specimen found in shallow water at Bahia, Brazil.

The large colony here described, which I identify with the Brazilian form, was obtained in April, 1901, in Harrington Sound, on a piece of coral. Another smaller colony was obtained off Bailey's Bay a few days later. It was attached to a sponge, and differs in having somewhat smaller zoöids, but there seems to be little doubt that both are of the same species. Some of the zoöids contain well developed testes and small eggs, but none of those examined contained large eggs. Nearly all the zoöids in each specimen have buds.

Diplosoma lacteum, n. sp.

PLATE LIII. FIGURE 59.

This species forms small, somewhat flattened colonies measuring 10 to 15^{mm} across and 3 to 4^{mm} in thickness when alive. The cavities in the test are enormously developed and only a very thin layer of test surrounds each zoöid, while the layer bounding the colony is also very thin, so that preserved specimens are generally collapsed, and present a very different appearance from living ones. This is further increased by the fact that in life the test is opaque and of a milky white color which disappears in preservation, leaving the test colorless and transparent.

There is a little blackish pigment on the zoöids, contained in the mantle of the abdomen. The cells constituting the epithelium covering that part of the body are large and flattened, and contain the dark pigment chiefly near the edges, the center being clear and occupied by the nucleus, so that each cell appears as a small dark colored polygon with a clear center.

The zoöids measure at least one-third less than those of the last described species, but do not differ in structure as far as I have observed, except that there appear to be fewer stigmata in a row.

The writer collected a number of small colonies of this form under stones near low-water mark at Hungry Bay, May 21st, 1901. One or two specimens were also found in similar situations at Waterloo, on Castle Harbor, about the same date. None of the specimens examined contained large eggs, though in some the testes were well developed.

Diplosoma atropunctatum, n. sp.

PLATE LIII. FIGURE 56. PLATE LVIII. FIGURE 103.
PLATE LXII. FIGURE 137.

This species is closely related to *D. lacteum*, and the writer describes it with some reluctance, as he has but a single specimen. This is a colony about 25^{mm} across, which was found growing on a coral (*Porites*) in Harrington Sound, April 30th, 1901, in water about twelve feet deep. The test, both in the living and preserved condition, is perfectly colorless and transparent, allowing the small zoöids, which are but little larger than those of *D. lacteum*, to be seen with the greatest distinctness. This is in strong contrast to the milky white opaque test of living specimens of the last mentioned species. The test cavities are also less developed, leaving more test substance than is usual in *D. lacteum*.

The whole abdomen of the zoöid is deeply colored with blackish or dark greenish pigment, contained in the mantle cells as described in the last species, and as the thorax is colorless, the abdomens of the zoöids are conspicuous as small black dots, and the colony might easily be mistaken for a mass of eggs of some mollusk.

I found no noticeable differences in the structure of the zoöids by which they could be distinguished from those of *D. lacteum*. Many contained both large eggs and large testes.

Genus **Diplosomoides** Herdman, 1886.

Differs from *Diplosoma* only in having stellate calcareous spicules in the test.

Diplosomoides fragile n. sp.

PLATE LIII. FIGURES 57 and 58. PLATE LXI. FIGURE 126.

In appearance, this species resembles a *Leptoclinum*, as it forms very thin, flat, expanded colonies often 60^{mm} or 80^{mm} across, of a very pure white color, which is produced by the abundance of minute spicules. These are generally not much over .02^{mm} in diame-

ter, and have very short, but often very slender and numerous points, which are usually more or less rounded or broken at the ends, though they may be needle-like. The points are so numerous and short that the spicule appears practically spherical when not much magnified. They greatly resemble those of some forms of the genus *Leptoclinum*. In life, the colony is of a purer white color than most of the species of *Leptoclinum* found at Bermuda, but preserved specimens turn slightly yellowish.

This species may at once be distinguished from the other members of the family with which it is found associated by the great delicacy of its structure. It breaks or tears at the slightest touch, and is difficult to remove whole from the object on which it grows. This is due to the extensive development of the cavities of the test as already described in *Diplosoma*. The test is reduced to an upper and lower layer forming the two surfaces of the colony, and a small mass surrounding each zoöid, and the fact that it is in all parts quite densely crowded with the spicules renders the thin layers of test substance very brittle.

The zoöids are large (1.5^{mm} long) and also of very delicate structure. Their apertures are always distinctly visible on the surface of the colony. Their tissues are yellow or orange in color.

The musculature, both of the mantle and of the branchial sac, is very weak. The muscle bands along the dorsal lamina are distinguishable, but the muscular process is rudimentary, if indeed it is developed at all, and the transverse vessels of the branchial sac are not perceptibly muscular. All the vessels of the branchial sac are very slender. There are about a dozen large stigmata in a row on each side. The tentacles are slender and of at least two sizes; I have not determined the number.

The stomach wall is exceedingly thin and often becomes folded, but this is probably not its natural condition.

The reproductive organs resemble those of *Diplosoma*.

This is a very common species, occurring under stones near low-water mark at various points about the islands. I found it particularly abundant at Waterloo, on Castle Harbor, also at Long Bird Island and Coney Island.

Genus *Echinoclinum*, n. gen.

Test gelatinous, becoming tough and membranous on the surface and about the zoöids. The latter are surrounded by a more or less complete calcareous capsule composed of the test spicules.

These spicules are tetrahedral in form, with each angle prolonged into a pointed ray or spine, and usually so placed about the zoöid that one point is directed radially outward. A few are also scattered about in other parts of the test.

Zoöids with rather large branchial sacs with four rows of stigmata. Branchial aperture six-lobed, atrial plain.

Echinoclinum verrilli, n. sp.

PLATE L. FIGURES 23, 24 and 25.

The largest colony of this species which was obtained measured about 12^{mm} across and about 3^{mm} in thickness. The zoöids are arranged in branching systems.

The test is colorless and very transparent in the preserved specimens. I have no notes upon its appearance in life. Though soft and flexible, it is continuous and solid, and no such extensive cavities occur as is usual in *Diplosoma*. On the surface and immediately around the zoöids, where, as already mentioned, most of the spicules are situated, the test is very tough and membranous. Elsewhere it is soft and gelatinous, and contains only a few scattered spicules, and here and there a few bladder cells.

I have not been able to distinguish any muscular processes extending out from the zoöids into the test, but it is almost impossible to remove the zoöids from the above mentioned tough membranous layer of test which surrounds them. It adheres to the mantle very closely at several points. One of these is about the atrial aperture. In addition there are two small areas, one on each side of the posterior part of the thorax, where the mantle and test are very firmly united, but I have made out no vascular processes extending out at these points. Sections of the thorax show that in these places there is a concavity in the contour of the body wall, and a corresponding projection of the common test into it, this being the part which adheres to the mantle.

The spicules vary much in size, the largest measuring about $.15^{\text{mm}}$ across from point to point. On each side of the thorax of the zoöids, these are small groups containing smaller spicules than those found elsewhere. Apparently these are at the points above mentioned where the mantle and test adhere together. In addition to the spicules, the test contains some large, round, yellowish green cells, which are probably symbiotic algæ, as well as the usual small test cells.

The zoöids are small (less than 1^{mm} in length in the contracted

state), and pale yellowish in color. The mantle is not noticeably muscular, but there are strong muscles on the transverse vessels of the branchial sac and along each side of the dorsal lamina.

There are four rows of a dozen or more rather long stigmata and apparently about a dozen tentacles. Between the thorax and abdomen the body is constricted into a narrow but rather short peduncle. The mantle is somewhat produced just anterior to the atrial orifice, but hardly sufficiently to be termed a languet. The branchial siphon is short and has six small lobes.

The intestine forms a rather small twisted loop, and the stomach is rounded and smooth-walled externally, though slightly ridged on the inner surface in a longitudinal direction.

Though I have examined a great number of the zoöids, I have not found any with sexual organs developed, but many of them have small buds in the region of the peduncle.

Three small colonies were found in 1898, one of which was growing on a specimen of *Clavelina oblonga*; the other two on a branching alga. None were collected in 1901. I do not know the exact locality where the specimens were obtained.

Family **BOTRYLLIDÆ** Verrill, 1871.

Colony thin and expanded or thick and fleshy. Zoöids always arranged in systems. Test gelatinous, traversed by branching vessels with enlarged terminal bulbs, which are especially numerous near the margins of the colony.

Zoöids short-bodied, not divided into thorax and abdomen.

Branchial sac large, with numerous stigmata and with several internal longitudinal bars on each side, but no folds. Dorsal lamina a plain membrane. Tentacles usually few.

Loop of alimentary canal placed alongside the posterior portion of the branchial sac. Stomach-wall folded longitudinally. A large gastric cæcum is present.

Reproductive organs (both ovaries and testes) developed on both sides of the body. Budding from wall of peribranchial cavity.

Symplegma Herdman presents exceptions to this diagnosis.

Genus **Botrylloides** Milne-Edwards, 1842.

Distinguished from *Botryllus* by having the zoöids arranged in extended branching systems instead of small round or oval ones, and from *Sarcobotrylloides* von Drasche by forming thin instead of thick fleshy colonies.

The form of the systems is not a very satisfactory character on which to base a group of full generic rank, and various writers have attempted to attribute to *Botrylloides* additional distinguishing characters based on the cylindrical form and upright position of the zoöids in the colony, as well as on the position of the atrial siphon, which in this genus is said to be placed near the anterior end, while in *Botryllus* the zoöids are of more ovate form, lie horizontally in the colony and have their apertures more widely separated.

These characters are of very little significance. The form and position of the zoöids is chiefly dependent on the closeness with which they are crowded together in the colony, while the position, form, and length of the atrial siphon depend entirely on the relation of the zoöids to the common cloaca, or the branch of the same into which the zoöid discharges, and to which, of course, the atrial siphon must reach. Great variations in these characters may occur within the limits of a single colony, and they are not even of specific value. The genus must be separated from *Botryllus*, if separated at all, on the strength of its complex branching systems.

As with the Botryllidae of other parts of the world, the Bermuda forms are very variable, both in color and shape, and in the arrangement of the zoöids in the colony, and it is difficult to determine how many distinct species are really represented. The differences between the extremes of variation are ample for regarding them as distinct species. Yet so many colonies with characters intermediate between those of the types described below are to be met with in a large series of specimens, that the writer does not feel justified in giving the new forms which are here described full specific rank, and in this paper all the Bermuda forms, distinct from each other as the typical examples are, will be treated as subspecies of *B. nigrum* Herdman.

***Botrylloides nigrum* Herdman.**

Botrylloides nigrum Herdman, Report Voy. Challenger, pt. xxxviii, p. 50.

Botrylloides nigrum Herdman, Sluiter, Tunicaten von Süd-Afrika, Zoöl., Jahrbücher, vol. 11, 1897.

PLATE LIII. FIGURE 54.

PLATE LXI. FIGURE 125.

To this species, described by Herdman from specimens taken "near the island of Bermuda," most of the examples obtained can be referred without much question. It is a common species and was found both in 1898 and 1901, and also by Prof. Goode in 1876.

It forms flat, incrusting colonies, 2 or 2.5^{mm} in thickness, and sometimes 70^{mm} across. There is great variation in respect to the closeness with which the zooids are arranged in the colony in different specimens. Where they are placed close together the zooids are nearly cylindrical and have a nearly upright position; where they are less crowded, they lie more obliquely, with the anterior end turned up, so that the body is curved. There is also great variation in the number and conspicuousness of the test-vessels and their bulbs, and in some colonies the young zooids, or buds, appear between the rows of adults arranged with nearly as great regularity as the adults themselves, but often quite differently colored.

In addition to these variations the color varieties are almost innumerable. Not much weight can be placed on such differences in the case of this family. They do not constitute true varieties, but are mere individual peculiarities. The work of Pizon (14) on certain species of *Botryllus* emphasizes this fact and shows that the colors of the same individual may change from time to time.

In the majority of specimens the zooids are colored some shade of purple, purplish brown, or purplish red; sometimes so dark as to be almost black; at other times very pale and light colored. When the zooids are deeply tinted the test is usually dark colored and pervaded with more or less of the same tint which predominates in the zooids, so that it loses a good deal of its transparency. In light colored specimens it is often nearly colorless, allowing every detail of the external anatomy of the zooids and the test vessels to be seen with great clearness.

The purple pigment which gives the zooids their color is in part diffused through the tissues, but is chiefly contained in cells which occur most abundantly in the mantle near the anterior ends of the zooids. They are also present in other parts of the zooids, especially along the transverse vessels of the branchial sac, and on the walls of the end bulbs of the test-vessels. The purple pigment is also contained in many of the blood corpuscles, and in the cells contained in the bulbs of the test-vessels. The extent of its distribution is very variable.

In some cases this purple pigment is replaced by a light bluish grey pigment, but in preserved specimens this changes to purple.

In addition to this ground color the zooids are usually, though not always, marked with a light colored pigment. It is usually a peculiar and very pure white, which is contained in opaque oval cells of the same size as those containing the ground color. They either

cover the anterior end of the zoöids about the branchial orifice (often obscuring the ground color) or form a ring about it, or in other cases a star-shaped area with about eight rays. Frequently they are scattered over the mantle in small groups, on the bulbs of the test-vessels, and often elsewhere. The white may be replaced by pale greenish, light yellow or (in one specimen) even bright orange. This light colored pigment disappears completely when the animal dies, and the zoöids become some shade of purple, purple-red, or blackish, and the test loses most of the color it possessed during life (even where it was quite dark colored) and becomes much more transparent.

Space will not permit of more particular description of the various colors assumed by different specimens, all of which I consider no more than individual variations of one and the same species. It is, in many of its forms, among the most beautiful and brilliantly colored of compound ascidians, and the name *nigrum* is by no means appropriate, though black colonies do occasionally occur. Herdman wrote his description from alcoholic specimens, which are often black or nearly so.

There are nearly always small groups of very large round cells with purple or purplish red pigment on the mantle along each side of the endostyle. What their nature or function is I am unable to say. Such cells occur also in the varieties *concolor* and *planum*, described below.

The zoöids in this species are rather small. In the contracted state in which they occur in preserved specimens they do not average over 1.5^{mm} in length.

The mantle is (for this genus) fairly muscular and the zoöids in the contracted state are apt to assume the curved cylindrical form which is well shown in fig. 54 and is rather characteristic of the species. The mantle muscles consist of delicate fibers and are chiefly developed in the dorsal region. The transverse vessels of the branchial sac also have muscle fibers.

There are about thirteen rows of stigmata and three internal longitudinal bars on each side. Between each of these there are about three stigmata, but on each side of the dorsal lamina and endostyle there are four or five. The tentacles are eight in number, larger and smaller alternating. The atrial siphon is very large and forms a capacious chamber with a large funnel-shaped opening, the anterior lip of which is prolonged into a languet. The position, form and length of the siphon varies according to the relation of the zoöid to

the common cloacal chamber into which it discharges. It is usually back a considerable distance from the anterior end.

The stomach has about eight or ten longitudinal folds and a large cœcum on the side toward the intestine. With this the duct from the glandular organ about the intestine communicates. The tubes of this organ have large dilated extremities.

The male reproductive organs consist of a large many-lobed testis on each side, near the posterior end of the branchial sac; just anterior to them the ovaries are located. In many colonies none of the zoöids appear to have reproductive organs. Fig. 54 was drawn from such a specimen.

This form is very widely distributed at Bermuda, occurring attached to the under side of stones near low water mark, and in deeper water on the lower parts of corals and gorgonians. One of the specimens obtained by Goode was growing on eel grass as is the common habit of *Botryllus gouldii* Verrill of the New England coast. Sluiter records this species from South Africa.

The internal structure of the zoöids in the two following forms does not appear to differ from that of the typical *B. nigrum*.

Var. *planum*, nov.

PLATE LIII. FIGURE 55.

PLATE LIX. FIGURE 110.

The type specimen was obtained by Professor Verrill in 1898. It covers a number of square centimeters of the surface of a piece of limestone. In the preserved specimen the zoöids appear of a dark purplish color. Some of the mantle cells are especially rich in pigment, giving the zoöids a speckled appearance under the microscope. The peculiarity of the specimen is the greatly flattened and expanded condition of the colony, the zoöids lying on their ventral surfaces, well separated from each other, though arranged in the characteristic elongated systems of a *Botrylloides*.

The zoöids themselves are much flattened and the anterior end is sharply turned up. The mantle is nearly devoid of muscle fibers; it is much larger than the branchial sac, and the atrial siphon opens far back toward the posterior end.

Another specimen, incrusting a piece of coral, was obtained by Prof. Verrill, in 1901, in Harrington Sound. The zoöids are purple in color, but lack the deeply pigmented cells in the mantle. In both colonies the test-substance is transparent and nearly colorless, forming a very thin expanded layer over the object on which the colony grows. I have no notes on their colors during life.

Var. *concolor*, nov.

PLATE LIII. FIGURE 53.

The colony in this variety resembles that of the typical *B. nigrum* in form, though I have not seen specimens measuring more than 30 or 40^{mm} across. The zoöids are slightly larger, and the mantle-musculature appears to be generally weaker, so that in preserved specimens the zoöids are not generally found contracted into the compact cylindrical shape which, as already remarked, is rather characteristic of *B. nigrum*.

In life the color is a brilliant orange; the zoöids, and to some extent the test as well, having this color. It mimics quite closely the color of a species of sponge very abundant in the same situations. In specimens preserved in formalin the orange changes to a brown, red-brown, or even purplish.

Examples were collected in Harrington Sound, Castle Harbor, and at Somerset Id. It appears to be commoner on the reefs, attached to algæ, corals and gorgonians, than it is near low-water mark.

Var. *sarcinum*, nov.

Differs from the typical *B. nigrum* in forming a thick, fleshy colony of gelatinous consistency, with thick rounded edges. The type specimen measures about 50^{mm} across and is from 4 to 8^{mm} or more in thickness. The zoöids (purple in color in the preserved specimen) exactly resemble those of a typical *B. nigrum*. The gelatinous test is yellowish with a purplish tinge. It was obtained by Prof. Verrill in 1898.

There are other specimens in the collection which show characters more or less intermediate between this form and the true *nigrum*.

This variety forms a sufficiently thick and massive colony to be placed in the genus *Sarcobotrylloides* von Drasche, which is distinguished from *Botrylloides* only by the thickness of the colony. The writer is inclined to question the necessity of recognizing *Sarcobotrylloides*, even as a subgenus.

Genus *Symplegma* Herdman, 1886.

Symplegma viride Herdman.

Symplegma viride Herdman, Report Voy. Challenger, pt. xxxviii, p. 144, pl. xviii, figs. 7-14.

PLATE L. FIGURE 22.

Herdman described under this name a specimen, taken by the Challenger expedition "in shallow water near Bermuda," forming for it a new genus and placing it, though with some doubt, in the

Distomidæ. Lahille considered that it should be placed in the Botryllidæ, and Herdman in his later work has followed him in this. Only a single colony was obtained, and that, as Herdman says, was in poor condition. As far as the writer is aware, the species has not been found since, though through an oversight it was included in Prof. Verrill's (17) statement of the species found in 1898.

The following details are from Herdman's description :

The colony consists of heads connected by branching peduncles. The heads are narrow at the lower end and taper gradually into the peduncles. "The color of the head is a dull green with spots of reddish brown scattered here and there. The peduncle is of a dull greyish yellow color." (These no doubt were the colors of the preserved specimen.) Length of head of average size 12^{mm}, greatest thickness 7^{mm}, length of peduncle about 15^{mm}, thickness 3^{mm}.

The test is tough and firm. Muscle bands of the mantle not large, but numerous and running in all directions. The sphincters of the siphons are especially strong.

The branchial sac is large, with numerous stigmata, and provided with internal longitudinal bars. The dorsal lamina is a plain membrane and there are eight tentacles, all of one size.

The body of the zoöid is not divided into thorax and abdomen. The alimentary and reproductive organs form a mass projecting a short distance beyond the branchial sac. The stomach is folded longitudinally and provided with a cœcum.

There are branching vessels in the test, with enlarged terminal bulbs containing corpuscles.

Family **POLYSTYELIDÆ** Herdman, 1886. (**Polyzoidæ** Michaelsen, 1900.)

Colony variable in form, but always without systems, the atrial as well as the branchial aperture of each zoöid opening independently on its surface. Test penetrated by branching vessels with enlarged terminal bulbs.

Zoöids with both apertures four-lobed, if lobes are developed. Branchial sac with many rows of stigmata, with internal longitudinal bars, and often with folds. Dorsal lamina a plain membrane.

Alimentary loop usually lying alongside the branchial sac. Stomach-wall longitudinally folded.

Reproductive organs in the form of polycarps containing either testes or ovaries, or both, attached to the inner wall of the mantle in the peribranchial cavity. They are developed on both sides of the body.

Method of budding pallial (from wall of peribranchial cavity).

The most important work dealing with the classification of the members of this family is that of Michaelsen (12), previous classifications being based upon the form of the colony or other features of little significance.

Michaelsen makes the structure of the reproductive organs the chief character in distinguishing the genera. There is no doubt that this is a great advance toward a natural system, and although his innovations in the nomenclature may not be accepted in every instance, he is amply justified in rejecting many of the older and imperfectly characterized genera.

I have not, however, been able to include either of the two Bermuda forms, here described, in any of Michaelsen's genera. Even if only the structure of the reproductive organs be considered, his definitions would have to be modified (though in one case only slightly) in order to receive them, and I believe that other differences in the anatomy are of sufficient weight to justify the formation of new genera.

Michaelsenia, n. gen.

Colony incrusting. Test thick and leathery. Both apertures four-lobed.

Branchial sac with folds and many internal longitudinal bars.

Reproductive organs consist of a number of hermaphrodite polycarps of rounded or oval form, arranged in two rows (one each side of the endostyle) on the ventral surface of the body, from which they project into the test as papillæ or tubercles, invested by an evagination of the mantle, to the inner surface of which they are attached.

The form for which I have established this genus differs from the genus *Styela* of the Simple Ascidians in only two essential characters: first, in producing buds and forming colonies; second, in the above described arrangement of the sexual organs. In the character and appearance of the test, apertures, tentacles, and branchial sac, as well as in many minor particulars, the resemblance to *Styela* is very striking.

It is most closely related to Michaelsen's genus *Polyzoa* Lesson as far as the structure of the reproductive organs is concerned, though there the testis consists of but one vesicle in each polycarp. In that genus, moreover, the branchial sac is without folds and has but eight internal longitudinal bars on each side, and the form of the colony is very different.

Michaelsenia tinctoria, n. sp.

PLATE LIV. FIGURES 61 and 63.

PLATE LIX. FIGURE 109.

The examples found contain only a few zooids, from two or three to a dozen, and do not often measure more than 15^{mm} across or 3.5^{mm} in thickness at any point. The surface is finely wrinkled and uneven, often raised over the positions of the zooids, and the edges of the colony are thin and produced some distance beyond the zooids. It is practically free from all incrusting matter. The test-substance is tough and leathery, and opaque, except that about the edges of the colony, or in other places where it is thin and slightly pigmented, it is more or less translucent. The zooids and the test vessels (which have elongated club-shaped bulbs) can usually not be distinguished through it, and in many specimens the number and location of the former can only be seen by the slightly projecting apertures, which do not show their square or four-lobed shape when they are contracted, unless the zooid is removed from the test.

The color is a rather dull carmine-red, deeper about the apertures and paler near the edges and in the lower parts of the colony. Where the pigment is scarce, the test becomes yellowish. When sectioned and stained the test is seen to have a fine fibrillar structure.

The largest zooids measure from 5 to 6^{mm} in length and 2 to 2.4^{mm} across. They lie on the ventral surface, with the anterior end turned more or less abruptly upward, bringing the branchial orifice a little way back from the end, and are much flattened dorso-ventrally. The atrial orifice, which like the branchial is situated at the summit of a low conical projection, is placed at a varying distance from the posterior end.

The mantle, especially the dorsal part, is colored a bright carmine by pigment grains contained in its cells. These grains are situated near the periphery of the cells, the central part remaining clear. The mantle-muscles are weak and not gathered into bands.

There are a great many slender tentacles of two or three sizes, none of them very long.

The branchial sac has three or four distinct folds on each side. On each fold there are about three internal longitudinal bars, and usually one on each intervening space. The internal longitudinal bars are thus situated at unequal distances apart, there being some six or eight stigmata between them in some places and only about two on the folds. The large transverse vessels number about fifteen, but between each pair there is usually a more slender intermediate vessel. The stigmata (which are narrow) often run past

this intermediate vessel from one large vessel to the next. In other places the stigmata are interrupted by the intermediate vessel.

The stomach is long and narrow, deep yellow or brown in color, with many longitudinal folds and a small cœcum on the side toward the intestine. There are a considerable number of short atrial tentacles.

There are a number of polycarps arranged along each side of the ventral part of the body. They are hermaphrodite, containing two large pyriform or oval testes and a number of ova. Often, as sections of the colonies clearly show, they lie in small papillæ or knob-like evaginations of the body-wall which are thus more or less nearly surrounded by the test, and may communicate with the body only by a somewhat constricted neck. It is probably on account of these, as well as because of the large and strong vascular processes arising from the posterior ventral part of the body, that it is very difficult to remove the zooids from the test entire.

Specimens of this species preserved in formalin retain their natural color for a considerable time. In its character and appearance a colony closely resembles a flattened example of some of the simple ascidians of the family Cynthiidae, with which it is found associated, though the numerous apertures serve to distinguish it. The colony looks more like an aggregation of small simple ascidians than a compound ascidian.

This species is found on the under side of stones near low water mark, nowhere in great abundance, but widely distributed, and it was collected in 1901 at nearly all the points about the islands where much collecting was done.

Diandrocarpa, n. gen.

Colony incrusting. Apertures elliptical, without lobes. Tentacles few.

Branchial sac simple; no folds and few internal longitudinal bars. No small intermediate transverse vessels.

Loop of alimentary canal large, placed beside the branchial sac.

Reproductive organs consist of a single mass on each side of the body, each with two large pyriform or lobed testes and a group of eggs.

I form this genus for the species described below, which differs too much from the type of *Gynandrocarpa* Michaelsen to be placed in the same genus with it. (The type of Michaelsen's genus is

Goodsiria placenta Herdman, which forms pedunculated colonies and has a folded branchial sac with numerous longitudinal bars.)

Synstyela monocarpa Sluiter, from South Africa, which is included by Michaelsen in *Gynandrocarpa*, is however closely related to the form here described, and is better placed in this new genus than in *Gynandrocarpa*, and I have so defined the genus that it may be included. Possibly one or two other species might also find their place here. *Synstyela* Giard is rightly rejected by Michaelsen as too poorly defined to be certainly recognized.

***Diandrocarpa botryllopsis*, n. sp.**

PLATE LIV. FIGURE 68. PLATE LIX. FIGURES 120 and 121.

PLATE LX. FIGURE 123.

The colonies are very thin, seldom averaging over 2^{mm} thick, though the surface is slightly raised over the position of each zoöid. In outline they are very irregular, but sometimes measure 60^{mm} or more in the longest direction. Frequently they break up into a number of small colonies, which may remain slightly connected.

The test is very soft and gelatinous with a slightly tougher outer layer. It is transparent and almost colorless after death, but in the living and expanded animal it has more or less of the dark color of the zoöids. The reason for this is not clear, but it may be due in part to greater distension of the test vessels with colored corpuscles in the living animal. These vessels are quite numerous, especially in the marginal parts of the colony, and have club-shaped terminal bulbs, but the latter are not proportionately very large.

The zoöids reach about 2.5^{mm} in length and 1.3^{mm} in width, or slightly larger when fully expanded. They lie on their ventral surfaces, and have the branchial aperture close to the anterior end and the atrial near the middle of the body. The apertures project but little and are elliptical, with the long diameter parallel to the long axis of the body, and without lobes, but sometimes with minutely denticulate edges.

Their color (due chiefly to corpuscles contained in their vessels and in the mantle) is blackish, or some shade of dark purplish brown or brown, sometimes even dark olive. During life the branchial aperture is surrounded by an area of white pigment, or sometimes greenish white, pale salmon, or pale yellow. This has an irregularly stellate outline, and there is also considerable of the light pigment over the region of the ganglion and in small dots at various points on the mantle and on the bulbs of the test-vessels. This pigment

mostly disappears when the animal dies, and the dark pigment of the test and vessels usually becomes lighter and of a more purple tint. The whole coloration is strongly suggestive of the family Botryllidæ.

The zoöids taper toward the anterior end, and have the posterior end broad and rounded. They are more or less flattened in a dorso-ventral direction, or somewhat obliquely. The musculature of the mantle is chiefly transverse, but weak and inconspicuous. The tentacles are few in number and are probably of two sizes, placed alternately.

The branchial sac extends practically the whole length of the body and conforms to its shape. The dorsal lamina is a plain membrane. There are four, possibly five, internal longitudinal bars on each side, and four or five stigmata in the meshes of the network thus formed. The transverse vessels appear to be of one size only, but the branchial sac is somewhat irregular and the transverse vessels of the two sides do not meet the dorsal lamina exactly opposite each other. There are about 13 or 14 rows of stigmata.

The stomach and intestine lie on the left side of the branchial sac. The short, curved œsophagus extends ventrally and to the left, and opens into the stomach, which is grooved or folded longitudinally with about ten folds, and lies with its axis directed obliquely forward and somewhat ventrally. The cardiac end is the smaller. From the stomach the intestine, which is in this region of large diameter, proceeds forward and dorsally, then posteriorly and finally bends abruptly forward to form the rectum, which is of smaller diameter. The glandular tubes which surround the intestine have large dilated ends. I have not been able to determine that any atrial tentacles are present. The reproductive glands are generally further forward on the left side than on the right. On each side there are two large pyriform testes placed one behind the other, with their small ends together, and the ovary, which was small in all the specimens examined, was situated between or close against the testes.

The test vessels arise from the posterior part of the ventral side of the zoöid.

This is a moderately common species, and was collected in several places, especially, however, at Coney Island, and Waterloo on Castle Harbor. It was obtained both in 1898 and 1901, as well as by Prof. Goode in 1876-77, and generally grows on the under side of stones or other solid objects near or below low-water mark.

ASCIDIÆ SIMPLICES.

Fixed (rarely unattached and never free swimming) ascidians which do not reproduce by budding or form colonies.

The branchial sac is enormously developed, occupying the greater portion of the body and is provided with a very large number of stigmata.

The viscera lie alongside the branchial sac, though they may project behind it to a very slight extent.

This group is usually considered a sub-order.

Family **HALOCYNTHIIDÆ.** (*Cynthiidæ* Lac. Duth., 1877.)

Body usually attached, sometimes stalked.

Test membranous, coriaceous, or sometimes cartilaginous, sometimes incrustated with sand or other substances. Branchial and atrial apertures usually four-lobed.

Branchial sac longitudinally folded, with internal longitudinal bars, which do not bear papillæ.

Tentacles simple or compound.

Intestine on left side.

Reproductive organs attached to the inner surface of the mantle, on one or both sides of the body.

The name of the principal genus of this family was changed by Verrill to *Halocynthia*, as the name *Cynthia* was preoccupied, having been used for a genus of insects.* This change has not been generally adopted, but appears to be required. The family name requires a corresponding change.

***Polycarpa* Heller, 1877.**

Body sessile or more or less distinctly pedunculated.

Branchial sac with about four folds on each side. Tentacles simple. Dorsal lamina a plain membrane.

Reproductive organs consist of numerous small hermaphrodite gonads distributed on the inner surface of the mantle, on both sides of the body.

* Bulletin No. 15, U. S. Nat. Museum, p. 147, 1879.

***Polycarpa obtecta* Traustedt.**

Polycarpa obtecta Traustedt, Vestindiske Ascidiæ Simplicies, Aftryk af Vidensk. Meddel. fra den naturh. Foren. i Kjobenhavn, p. 51, pl. v, figs. 7-8, plate vi, fig. 15, 1882.

Polycarpa obtecta Sluiter, Tuniciers receullis en 1896 par la "Chazalie," Mém. Soc. Zoöl. France, vol. xi, p. 11.

Polycarpa multiphiala Verrill, Additions to the Tunicata and Molluscoidea of the Bermudas, these Trans., vol. x, part 2, page 591, 1900; vol. xi, pl. ix, fig. 7, 1901.

PLATE LVII. FIGURES 88, 89 and 92 to 94 inclusive. PLATE LXIII. FIGURES 140 and 144. PLATE LXIV. FIGURES 151 and 153.

Though the type of *P. multiphiala* Verrill differs in some points from Traustedt's description and figures of the West Indian form, other specimens from Bermuda agree with the latter more closely, and I do not think there is sufficient reason for regarding the two species as distinct.

The body usually measures somewhat more in length (that is antero-posteriorly) than in breadth (dorso-ventrally) and is, when not distended with water, decidedly compressed in a lateral direction. The test is tough, yet soft and flexible, rather thin toward the posterior end of the body, but thickened and much toughened near the anterior end, so that the siphons, though in reality fairly well developed (as may be seen when the animal is removed from the test), usually appear very short. The surface is sometimes partly covered with sand and shell fragments, in other cases bare. The inner surface is smooth and nacreous.

The color of the test is a dirty yellowish or brownish gray, often darkening to red, brown, or purplish brown about the apertures.

The animal is usually attached by a very small area near the posterior end, which may be thickened or even produced into a very rudimentary peduncle. Sometimes several individuals are attached together in a loosely connected group.

The largest specimens found do not much exceed 45^{mm} in greatest length. They are somewhat less in breadth, and not over 12 to 15^{mm} in thickness when not distended with water.

The mantle is smooth and rather thin, of a uniform dark brown color. The rather narrow muscle-bands run transversely, longitudinally and obliquely, forming a rather open and regular network. The apertures are distinctly four-lobed. The branchial siphon is the longest.

The tentacles are long and more or less brown-pigmented. Verill gives 40 as the number in the type specimen of *P. multiphiata*, but this number is sometimes exceeded. They vary somewhat in size, but no very regular arrangement, except an alternation of larger and small ones, is to be distinguished. Traustedt gives 36-40 as the number of tentacles.

The dorsal tubercle is large; the opening is horseshoe-shaped with incurved, but not spirally rolled, horns. (This was the condition in several specimens examined and agrees with Traustedt's description).

Traustedt states that there are 4 folds on the left and 5 on the right side. Sluiter mentions one specimen with 4 on each side. This I have found to be the case in most of the Bermuda specimens examined, though in one case a rudimentary fifth fold was present on the right side, next to the dorsal lamina. The folds are generally wide. The one nearest the dorsal lamina is the smallest. The internal longitudinal bars are very wide and flattened. They are quite numerous, about four or five occurring between the folds, and sometimes as many as 10 or 11 on one side of a fold. They are separated by 10 or 12 stigmata in the spaces between the folds (14 near the endostyle). This number diminishes to 3 or 4 or less near the summit of the folds, where the bars are so close together that when flattened down against the branchial sac they overlap each other for most of their width, covering the intervening stigmata entirely. The transverse vessels are of various sizes, but are not arranged with great regularity. Small transverse vessels crossing the stigmata without interrupting them are generally wanting.

The alimentary loop is of the same color as the mantle and branchial sac. It forms in some cases a moderately large, open loop; in others a much narrower one (see figs. 92, 93 and 94). The stomach is small. In all cases the alimentary loop is confined to the posterior half of the body.

The gonads are distributed to the number of 20 or more on each side of the body. They are flask-shaped bodies, and are so placed that their orifices are directed toward the atrial siphon. The central part of each is occupied by the ovary, and the oviduct opens at the extreme end of the gonad. The sperm-duct opens on a separate papilla or projection a little distance from the end, and is formed by the union of two branches, one of which runs along each side of the ovary and receives the ducts from the numerous small pyriform testes. (Figs. 88 and 89.) In these figures the ovaries are not fully ripe, and the gonads have an elongated phial-like form. This is one

of the characters upon which Verrill based the species *multiphiala*. When the ovaries are ripe and are distended with large eggs, the gonads become thick and swollen, and resemble in shape those shown in Traustedt's figure, though I have not found them developed to such an extent in any of the Bermuda specimens as was evidently the case in the individual figured by the latter author.

This species was collected both in 1898 and 1901. I obtained a few individuals at Coney Island and Long Bird Island, but it appears to be more common on the reefs than along the shore. A number of large specimens were found washed up on the beach, but still alive, at a place known as the "Scaur," on Somerset Island, May 5th, 1901.

Styela MacLeay, 1824.

Body attached, sessile, rarely pedunculated.

Test usually coriaceous.

Branchial sac with four folds on each side, or less. Dorsal lamina a plain membrane. Tentacles simple.

Reproductive organs on both sides of the body, attached to the inner surface of the mantle. Ovaries consist of a small number of elongated glandular tubes. Testes numerous, variously placed in relation to the ovaries.

Styela partita (Stimpson), var. *bermudensis*, nov.

S. partita: PLATE LV. FIGURE 69. PLATE LVI. FIGURES 76 to 78 inclusive.

PLATE LXIV. FIGURES 147 and 149. *S. partita* var. *bermudensis*: PLATE LV. FIGURES 70 to 75 inclusive. PLATE LXIII. FIGURES 142 and 143.

In Prof. Verrill's list (17) two species of *Styela* are mentioned as having been found at Bermuda; *S. partita* (Stimpson), a species originally described from Boston Harbor, and occurring on the Atlantic Coast of the United States from Massachusetts southward, and the Mediterranean species, *S. canopoides* Heller (4), which has also been recorded from the West Indies by Traustedt (16).

After an examination of about 25 specimens of this genus collected at various points about the Bermuda Islands in 1898 and 1901, including those on which Prof. Verrill based his list, I have come to a somewhat different conclusion. The Bermuda specimens vary a great deal in nearly every character, but I cannot satisfy myself from the material available that more than one species is really represented.

None of the specimens correspond exactly to specimens of *S. partita* from Massachusetts (Wood's Hole); though some bear a very strong external resemblance to them, even to the "alternate striping of red and white in the apertures," mentioned by Verrill, which is characteristic of *S. partita*; but as the differences are hardly tangible enough to base a species on, it seems best to consider the Bermuda form as a subspecies of *S. partita*. The specimen in Prof. Verrill's collection, marked *S. canopoides*, does not differ specifically from the others, though it certainly does correspond well with Heller's (4) and Traustedt's (16) description and figures of that species.

This raises the question as to the status of *S. partita* (Stimpson) as a species, and of its relations to *S. canopoides* and other European forms. Metcalf (11) has expressed the opinion that the New England form is only a variety of *Styela aggregata* of Northern Europe. He has not, however, given any detailed statement of his reasons for this belief. Unquestionably the two species are closely allied, but if the New England form is only a variety of a European species, it would seem more reasonable to regard it as a variety of *S. canopoides*, rather than of *S. aggregata*, especially as the latter is a northern species, while *S. partita* is distinctly southern in its distribution. This is, however, a point which I do not feel in a position to decide without a considerable series of European specimens for comparison, and in the present paper I shall confine myself to the consideration of the relations between the Bermuda and New England forms.

Though *Cynthia (Styela) partita* was described half a century or more ago, no account or figures of its internal anatomy have been published as far as I am aware.* The following details are from specimens taken at Wood's Hole, Mass., in July, 1901. They were growing attached to the piles of a wharf, in large masses (sometimes 8^{cm} across), which contained as many as a dozen individuals closely crowded together. The attachment was by the posterior end of the body. Where individuals grow singly, they are often attached by the whole ventral surface, or by a large part of it. In such specimens the branchial siphon may be a little back from the anterior end of the body.

The body tapers rather rapidly at the anterior end, and the atrial siphon is placed well forward and also directed more or less ante-

* Except Professor Verrill's figures of the gonads in this volume (pl. ix, figs. 8, a, b, c), 1901.

riorly. The test is tough and coriaceous, of a dirty yellowish color, becoming a purplish brown or red toward the anterior end of the body. It is not very thick at any point. On the outer surface it is finely wrinkled; within it is smooth and glistening.

The largest of these specimens does not exceed 30^{mm} in length, and most of the individuals are considerably smaller.

When removed from the test the body is ovate, with both the siphons near one end. The mantle is of a yellowish color, and rather thick and opaque, with numerous longitudinal muscle-bands, but few conspicuous bands running in other directions. The internal organs cannot be seen very readily through the mantle.

The tentacles vary in number in different specimens. As a rule the larger the specimen the more tentacles. The individual shown in figure 78 had hardly over 30, those shown in figures 76 and 77 had from 40 to 50. The tentacles are of several sizes. Sometimes they are arranged with some regularity; one tentacle of a given size being placed midway between two of the next larger size and so on; but this arrangement is not very strictly adhered to. Often those of the smallest size will be wanting in many of the places where, according to the above scheme, they should occur, or they may be represented by a mere tubercle, so that it is hard to say whether it should be counted as a tentacle or not. No doubt as the individual increases in size these grow out into tentacles.

The dorsal tubercle is variable in size and form, and its orifice had a different shape in each specimen examined, though always some modification of the U-form. The ends were not spirally coiled in any case. Evidently the form of the dorsal tubercle will not do as a specific character in this genus, if indeed it is of much value in any other genus of this family, which I am inclined to doubt.

The branchial sac has four distinct folds. These vary in size relatively to the interspaces in different individuals. Figure 69 shows a section extending clear across one side of the sac near the middle of the body. (Toward the ends of the body, the sac is more contracted and the number of stigmata between the bars becomes smaller.) It is taken from the individual shown in fig. 77, a fully adult and fairly large specimen. In this it will be seen that there are about 10 stigmata in the largest meshes in the interspaces between the folds (14 each side of the endostyle and 8 each side of the dorsal lamina). In the dorsal part of the sac, the bars are more crowded; and the maximum number of stigmata in a mesh is about eight. The first fold begins at the third bar from the endostyle and there are four

bars between the last fold and the dorsal lamina. There are from seven to ten bars between the base and summit of a fold, varying according to its breadth.

The transverse vessels are of four or five sizes : the smallest cross the stigmata at their middle point without interrupting them. In general they are arranged according to the same scheme as the tentacles, a vessel of a given size being located midway between two of the next larger size, but many irregularities occur. The transverse vessels become thicker as the dorsal lamina is approached.

The above may be taken as the average condition of the branchial sac in a fully adult specimen. Considerable individual variation occurs in the distribution and number of internal longitudinal bars on the folds and interspaces, and in the number of stigmata in the meshes formed by them. In many examples it averages one or two less than in the specimen shown in fig. 69. Figs. 147 and 149 show a part of the sac of such a specimen.

Such variations are merely individual peculiarities. In addition, there are also differences due to the age of the animal. The branchial sac in the individual shown in fig. 78 did not differ materially in structure from those of larger specimens, but when still smaller and evidently immature specimens are examined, the structure of the sac is found to be more or less simplified. One or more of the folds may be wanting or present only in a rudimentary condition, and the number of internal longitudinal bars, as well as of the stigmata, becomes reduced.

The intestinal loop is small and the intestine doubles back so that it comes in contact with the stomach near the middle of that organ, or a little posterior to the middle. The rectum is long and its opening has about a dozen rounded lobes, or more strictly, plications of the edge. The stomach is of a brownish orange color, and has from 18 to nearly 30 longitudinal folds in its wall, the number varying according to the age and size of the individual.

The ovaries consist of stout glandular tubes, usually two on each side (one of which may be forked). They pursue a more or less crooked course from near the endostyle (on the left side from near the intestine) and end near the atrial siphon. The sperm ducts accompany them and the openings are close beside those of the oviducts. In some specimens both orifices may be seen to have a lobed or plicated margin similar to that of the rectum, but the lobes are smaller. The testes are elongated, more or less branched organs of small size with enlarged ends. They are arranged along each side of the ova-

ries in varying numbers, and communicate with the sperm duct which follows the ovary by slender connecting ducts. Usually the larger the individual the more numerous and more extensively branched are the testes, though this is not always the case.

After this description of the New England form it will be sufficient to mention the particulars in which the Bermuda variety differs from it.

In the first place, it is of considerably smaller size, the largest specimen obtained measuring 22^{mm} by 10^{mm}. Most of them were hardly more than half this size. It is not unlikely, however, that if the collections had been made later in the season, larger specimens might have been found.

In external form it appears to vary more than the typical *partita*. It is attached either by a small area near the posterior end or by a part or the whole of the ventral surface, and in the latter case the siphons are both situated on the dorsal surface. The character of the surface of the test is very variable; it is generally roughest near the apertures, which are usually more or less prominent, but whether the ridges and wrinkles of the surface are large or small, regularly or irregularly disposed, low and rounded or prominent and sharp-edged, appears to be a character of no specific value.

The color is generally a more or less reddish or brownish yellow, or grayish yellow, becoming brown or red on the upper surface, especially about the siphons. The colors are brighter and the test proportionately thicker and of a more cartilaginous character than in the New England specimens. The striping of the apertures, which many specimens show in common with the typical *partita*, has been mentioned above.

As figs. 71 to 75 indicate, the form of the body and length and position of the siphons are very variable. The mantle is thinner, less muscular, and more transparent, though of a deeper yellow color in most cases, and the tentacles are rather more numerous, but the branchial sac does not appear to differ essentially from that of New England specimens of similar size.

The more usual form of the orifice of the dorsal tubercle is a U or horseshoe-shape, with one horn curved inward and posteriorly, alongside the other, but not spirally coiled. Considerably more complex forms occur, as is also the case in the true *partita*.

The reproductive organs are similar, but the testes are fewer and often are not branched at all, but merely simple elongated bodies.

This form was found in many localities about the islands and on

the reefs, attached to stones and corals. It is nowhere very abundant, nor did I ever find many individuals growing together or near together. Among the places where it was obtained were Coney and Long Bird Islands, Somerset Island, Harrington Sound, and Waterloo, Castle Harbor. One specimen was obtained at Hungry Bay.

Genus *Halocynthia* Verrill, 1879. (*Cynthia* Savigny, 1816.)

Body sessile or very nearly so, sometimes incrustated with sand. Both apertures 4-lobed.

Test coriaceous, rarely cartilaginous, no spicules.

Branchial sac with 6 or more longitudinal folds on each side. Tentacles compound. Dorsal lamina a continuous but sometimes toothed membrane, or it may be provided with a series of languets.

Intestine on left side forming a rather wide loop.

Reproductive organs developed on both sides.

Halocynthia rubrilabia Verrill.

Halocynthia rubrilabia Verrill, Additions to the Tunicata and Molluscoidea of the Bermudas, Trans. Conn. Acad. Sci., vol. x, p. 589, fig. 7, 1900.

PLATE LVI. FIGURE 83. PLATE LVII. FIGURES 86 and 90. PLATE LXII. FIGURE 133. PLATE LXIV. FIGURES 150 and 152.

Body swollen, oblong or ovate, usually longer than high, attached by the entire ventral surface or by a larger or smaller area near the posterior end which may be produced into a rudimentary peduncle. Siphons of variable length, widely separated, the branchial generally longer than the atrial.

Size 35 to 50^{mm} long, 25 to 30^{mm} high, 20 to 25^{mm} wide.

Test thick and firm (in many specimens remarkably so), deeply and irregularly wrinkled, in large specimens often so covered with extraneous matter that its reddish color shows only faintly. Apertures similar, 4-lobed, the test about them roughly nodulose or warty.

Mantle very muscular, especially on the right side; the muscle bands, of which the longitudinal are the most conspicuous, form a rather irregular, close, opaque network. Many oblique as well as transverse bands occur also. The mantle is yellow with a reddish tinge, usually becoming bright red on the siphons.

Tentacles all simply pinnate, about 20 in number and of various sizes; the larger ones number about a dozen and are thick, tapering to a point and provided with a row of simple pinnæ along each side. Dorsal tubercle U-shaped, with more or less spirally coiled horns, which may be both incurved or both curved to the right or left.

The branchial sac has 6 wide folds on each side separated by narrow interspaces on which there are but four or five internal longitudinal bars. There are, however, about 7 or 8 bars on the spaces each side of the endostyle and dorsal lamina. The bars are wide and flattened and placed near together, being separated by only four or five stigmata in the spaces between the folds and by a less number on the folds. Between the base and summit of the folds there are sometimes as many as 14 or 15 bars. The stigmata are short and rather wide.

The transverse vessels are mostly of about the same size with an occasional much larger one. In addition there are the usual fine vessels which cross the middle of the stigmata. There is often much red pigment on the vessels of the sac. The dorsal lamina is provided with a series of slender tentacle-like languets.

Prof. Verrill states that the anus has about 12 lobes. This is not of value as a specific character. One specimen had but 4 barely perceptible lobes. The intestine forms a broad loop. The stomach is but little enlarged and is partly covered by the large greenish hepatic gland which lies dorsal to it.

The reproductive glands are irregularly lobulated or foliated bodies arranged along each side of the genital ducts. When much enlarged they are so crowded that their serial arrangement is not very apparent. On the left side one series of the glands lies within the intestinal loop. Another set lies along the dorsal side of the intestine, the duct following close along the intestine and the glands lying only along one side of it, while in the case of those which lie within the loop, as well as the single set which is present on the right side of the body, they lie on each side of the duct.

This appears to be the commonest member of the family at Bermuda, at least in shallow water, where it is found adhering to stones, shells, corals, etc.

Halocynthia riiseana (Traustedt) var. ***munita***, nov.

PLATE LVI. FIGURE 84. PLATE LVII. FIGURES 85 and 87.

PLATE LXIII. FIGURE 141.

In addition to *H. rubrilabia* there is another species of the genus found at Bermuda, but it is much less common. It was only poorly represented by one or two small specimens in Prof. Verrill's collection and he considered it identical with Traustedt's West Indian species, *Cynthia Riiseana*. In 1901, I obtained three good sized specimens, of which the largest measures 28^{mm} by 25^{mm}. The others

were not much smaller. They were growing attached to stones along the shores of Coney Island and Long Bird Island.

From these, though the material is too scanty to give a satisfactory idea of the individual variations which specimens of this species are likely to exhibit, I believe that the Bermuda form is sufficiently different from the West Indian one, to justify its description, provisionally at least, as a new variety.

The body is ovate, slightly longer than deep, and decidedly compressed laterally. The test is not thick; it is soft and flexible, light colored, and would be translucent were it not for the dense coating of sand and shell fragments which cover not only the surface, but are more or less buried in the test substance. The area of attachment is small. The siphons are wide apart in two specimens, in the other they are rather near together. They are rather short in all cases. The appearance of the animals is rather that of a *Molgula* than one of the family to which they really belong.

The mantle is thin and more or less transparent with weak musculature. In one specimen the tips of the siphons are pink. None of the other specimens show any red color on any part of the body.

In all these particulars the examples differ from Traustedt's description, in which the test is described as leatherly with a wrinkled surface, and the mantle musculature as very strong.

There are about a dozen large tentacles beside some smaller ones. They differ greatly from those of *H. rubrilabia*, the largest ones being bipinnate (fig. 84). The dorsal tubercle, in the specimen in which I examined it, had a U-shaped aperture with one horn incurved, but not sufficiently to form a spiral. The dorsal lamina is provided with numerous tentacular languets. They begin a little way back from the anterior end, the lamina being plain for a little distance.

As in the last described form, there are six branchial folds on each side. There are, however, fewer internal longitudinal bars (I counted only ten or eleven on one side of one of the longest folds) and they are separated by 7 or 8 or even 9 stigmata in the meshes on the interspaces between the folds, instead of 4 or 5 as in *H. rubrilabia*. The stigmata are also longer and narrower than in that species, but in other respects the branchial sac resembles that of *H. rubrilabia*.

The intestinal loop is rather narrower than in that species and the reproductive organs differ, the gonads being spherical though arranged in a similar manner along each side of the genital ducts, with which they communicate by short branch ducts. There is only one series of reproductive organs on each side. On the left side it lies within the intestinal loop.

Microcosmus Heller, 1877.

Distinguished from *Halocynthia* by the plain, untoothed dorsal lamina, and by the narrow intestinal loop.

Microcosmus miniatus Verrill.

Microcosmus miniatus Verrill, Additions to the Tunicata and Molluscoidea of the Bermudas, Trans. Conn. Acad. Sci., vol. x, p. 590, 1900.

PLATE LVI. FIGURE 79. PLATE LVII. FIGURES 91 and 95. PLATE LXII. FIGURES 129 and 130. PLATE LXIV. FIGURE 148.

Test more or less completely red or dull orange-red externally, rather thick and tough, somewhat cartilaginous. In adult specimens it is much wrinkled and raised (especially on the dorsal surface and about the apertures) into prominent ridges with sharp rough edges. Young specimens are much smoother.

The shape is ovate, more or less elongated; the apertures are widely separated. The attachment is by an area of considerable extent on the ventral side, generally near the posterior end. In external appearance this species closely resembles *Halocynthia rubrilabia*, described above, but is usually colored more intensely and extensively red than that species, and the body is often somewhat more elongated. Internally the test is smooth and pearly and less deeply colored than on the outside.

Size of the largest specimen, 50 by 35 by 25^{mm}.

Removed from the test, the animal is ovate with very widely separated and divergent siphons of very variable size and length in different specimens, both four-lobed. The mantle, especially near the apertures, is more or less tinged with red. Its muscles, stronger on the dorsal part of the body, are gathered into very distinct and moderately thick bands, which for the most part cross each other nearly at right angles and form a rather open network, so that the internal organs are more or less distinctly visible through the mantle.

The tentacles are bipinnately branched. There are about 8 or 10 larger ones alternating with others of smaller size and between them are a variable number of still smaller ones. Even the smallest are somewhat branched. The aperture of the dorsal tubercle had spirally incurved horns in the specimens examined.

The number and arrangement of the folds of the branchial sac proved to be quite constant in a number of individuals of various sizes from about 15^{mm} in length up to individuals of full size. There are nine folds on each side of the sac, but the last one (that nearest the

endostyle) usually reaches only one-quarter or one-third of the distance back from the anterior end, and is often so rudimentary that it is easily overlooked. It is apt to be smaller on the left than on the right side of the body. The eighth fold is generally fairly large and of full length.

As a rule there are four or five internal longitudinal bars in the spaces between the folds and these are separated by from 5 to 8 stigmata. Along one side of a fold, from the base to the summit, there may be a dozen bars (if the fold is a large one), and the number of stigmata between them diminishes from about four near the base to three or two at the summit. The transverse vessels are numerous and rather stout, and the stigmata consequently are not very greatly elongated. There are various sizes of the transverse vessels but apparently no regular scheme in their arrangement. The smallest ones usually cross the stigmata without interrupting them. The larger ones have more or less conspicuous membranes attached to them.

The intestinal loop is very long and narrow, and the two portions lie in contact with each other for the greater part of the distance. The two dark colored hepatic glands lie close against and partially covering the stomach.

The reproductive organs consist of about four double clusters of follicles lying along and extending each side of a slender curved duct, which runs toward the atrial aperture. On the left side one group of follicles lies within the bend of the intestinal loop, the others outside of and dorsal to it and anterior to the rectum.

Fairly common on the reefs and attached to the under side of stones along the shores. Collected both in 1898 and 1901.

This species is closely allied to the West Indian species *M. variegatus* Heller, which is also described and figured in Traustedt's (16) work on the West Indian Simple Ascidiens. That species has from 8 to 10 branchial folds, of which three are short and only reach a part of the distance toward the posterior end of the sac. According to Traustedt's figure, it also has very large siphons, but this is a character which varies not only in different individuals, but is largely determined by the state of contraction of the specimen, and would hardly serve to separate the species; while the differences in color are easily explained by the fact that Heller and Traustedt undoubtedly wrote their descriptions from faded alcoholic specimens. The condition of the branchial folds seems, therefore, to be the chief distinguishing character. I have found this to be practically constant in a number of specimens of the present species.

Family **ASCIDIIDÆ** Herdman, 1880.

Body usually sessile, rarely pedunculated. Branchial aperture generally 8-lobed; atrial generally 6-lobed. Test gelatinous or cartilaginous, rarely chitinous or horny.

Branchial sac without folds. Internal longitudinal bars present and usually papillated. Stigmata straight or curved. Tentacles simple.

Alimentary canal on one side of the branchial sac, sometimes extending posteriorly beyond it to a slight extent.

Reproductive organs placed close against or within the intestinal loop.

Genus **Ascidia** Linn., 1767.

Body attached, sessile, rarely pedunculated; surface bare or incrustated with sand. Branchial and atrial apertures placed far apart, usually 8-lobed and 6-lobed respectively.

Test cartilaginous, membranous, or gelatinous, soft or hard, usually crowded with bladder-cells.

Branchial sac sometimes minutely plicated. Stigmata straight. Internal longitudinal bars generally papillated.

Dorsal lamina a continuous membrane, which may be provided with transverse ribs or with teeth. It is continued behind the œsophageal aperture.

Alimentary canal and reproductive organs on the left side of the body.

Ascidia atra Lesueur.

Ascidia atra Lesueur, Descriptions of several new species of *Ascidia*, Journ. Acad. Nat. Sci. of Philadelphia, vol. iii, pt. 1, p. 2, pl. i, fig. 2, 1823.

Ascidia nigra Sav.; Herdman, Prelim. Rep. Challenger, Proc. Royal Soc. Edinb., vol. ix, pp. 460 and 466, 1880.

Phallusia atra Lesueur; Traustedt, Vestindiske Ascidiæ Simplicæ, Aftryk af Vidensk. Meddel. fra den naturh. Foren. i Kjøbenhavn, p. 22, pl. iv, fig. 6, and pl. v, fig. 17, 1881.

Ascidia nigra Sav.; Herdman, Rep. Voy. Challenger (Zoöl.), vol. vi, part xvii, p. 210, 1882.

Ascidia atra Lesueur; Sluiter, Tuniciers recueillis dans la Mer des Antilles, etc., Mém. Soc. Zoöl. de France, vol. 11, p. 7, 1898.

PLATE LXIII. FIGURES 138 and 139.

The body is only moderately elongated, with large, anteriorly directed siphons which often have more than the normal number of lobes to the apertures. It is usually attached by the posterior end,

but sometimes by the left side. Its most conspicuous character is the abundant blue-black pigment which colors the test and many of the internal organs as well. In very young specimens the test is nearly colorless and transparent, but the dark pigment begins to appear while the individual is still very small.

The largest specimen obtained at Bermuda measured about 70x30^{mm}. In the West Indies it attains a considerably larger size.

The branchial sac tapers posteriorly. The internal longitudinal bars are provided with curved papillæ somewhat similar to those of *A. curvata* Traustedt illustrated below, but rather longer and more curved. They have a narrow membrane attached to the concave side. According to Traustedt the papillæ are bifid at the extremity. This does not appear to be common in the Bermuda specimens. There are about five or six stigmata in a mesh, and the sac exhibits minute undulations or plications between the internal longitudinal bars. The transverse vessels alternate in size. In addition there are much thicker ones at intervals.

The tentacles are numerous and slender, of several sizes, arranged with some degree of regularity. The dorsal tubercle generally has a U-shaped opening.

This species is common on the reefs and at a little distance much resembles a kind of sponge which abounds there. As already mentioned, the individuals found were of small size compared to those occurring in the West Indies.

It is questionable whether this form is distinct from *Phallusia nigra* Savigny, a European and Red Sea species. As far as I am aware, the only distinction between the two is that the European form has small intermediate papillæ on the internal longitudinal bars, midway between the transverse vessels. Both Traustedt and Sluiter mention their absence in the West Indian form, and I have failed to find them, even in the largest of the Bermuda specimens which I examined.

Herdman (6), though aware of Traustedt's observation, identifies the Bermuda form with Savigny's species, and mentions intermediate papillæ as present in parts of the branchial sac. He does not, however, expressly state that he found them in American specimens, and later may have changed his opinion, as in his Revised Classification of the Tunicata (7) he lists *A. nigra* Savigny and *A. atra* Lesueur as distinct species. *Phallusia violacea* Gould, from Rio Janiero, Brazil, may be identical with this species.*

* U. S. Exploring Expedition, Molluska and Shells, p. 495, fig. 610.

***Ascidia curvata* Traustedt.**

Ascidia curvata Traustedt, Vestindiske Ascidiæ Simplicæ, Aftryk af Vidensk. Meddel. fra den naturh. Foren. i Kjobenhavn, p. 25, pl. iv, figs. 8, 9, and 10, and pl. v, fig. 19, 1881.

PLATE LVI. FIGURES 80, 81 and 82.

PLATE LXIII. FIGURES 145 and 146.

The body is much more elongated than in the last species and tapers gradually toward the anterior end. It is strongly flattened laterally. The atrial siphon is generally situated behind the middle of the body. Both siphons are usually long and often turned to the right, the animal being generally attached by the entire left surface. Great variations in the external form of the body are common. The largest specimen measures about 50^{mm} in length and half as much in a dorso-ventral direction.

The test is greyish or practically colorless and transparent, soft and gelatinous, moderately thick on the right side but very thin and easily torn on the left side. Its surface may be smooth and glossy, allowing much of the internal structure to be seen, or it may be wrinkled or in some cases so incrustated with sand and shell fragments that nothing can be seen through it. The apertures generally have about the number of lobes characteristic of the genus, but they are not readily counted in the contracted state of the orifices. There are markings of light orange brown about the apertures in the living animal.

The mantle is very delicate and transparent. On the right side there are numerous but very slender muscle-bands, mostly transverse or only slightly oblique. They taper off and end soon after passing the median line on the dorsal and ventral surface, leaving the left side practically free from muscle bands except the sphincter muscles of the siphons, which are composed of similar delicate bands placed close together. Very few longitudinal bands are present.

The tentacles are numerous and placed close together, slender and uniformly tapering, of several sizes. The dorsal tubercle is small, U-shaped.

The branchial sac extends for a long distance behind the œsophageal opening. Its internal longitudinal bars are separated by 4 or 5 stigmata; 8 or 10 stigmata intervene between the dorsal lamina and the first bar on each side of it. In some places the transverse vessels are nearly equal in size, in other parts (especially in the posterior portion of the sac) they show more or less tendency to alternate in size. Very large vessels, such as are shown in Traustedt's

figure, do not appear to be frequent. The papillæ are rather stout, of moderate length and somewhat curved. Their ends are obtuse. Those opposite the smaller transverse vessels are smaller. These small transverse vessels are occasionally interrupted and rudimentary though the corresponding papillæ may be present and well developed.

In most parts of the sac there is little or no sign of the undulation or plication common in this genus, the sac being almost flat, but individuals vary in this respect. On the whole the branchial sac is of a simple type. Horizontal membranes are developed only on each side of the dorsal lamina and to a very slight degree on the adjacent parts of the sac. Elsewhere they are inconspicuous or wanting. The dorsal lamina is often nearly plain-edged for most of its length. In other cases it is finely denticulated in the posterior portion of the body.

The stomach and intestine are proportionately small and form a very compact and short loop. The stomach has a few longitudinal folds and during life is of an orange color. This color may also extend to part of the intestinal loop.

The reproductive organs lie between the stomach and intestine and the branchial sac. The duct follows the rectum and ends near the anal opening.

This species was found at Coney Island, Long Bird Island, in Harrington Sound, at Somerset Island, and many other places, attached to stones, shells, etc. It is one of the commonest simple ascidians at Bermuda. Traustedt's specimen (he appears to have had but one) was from St. Thomas, W. I.

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EXPLANATION OF PLATES XLVIII-LXIV.

The figures showing entire zoöids were in all cases drawn with the aid of a camera lucida, as far as the outlines of the body and the principal organs are concerned; the smaller details were necessarily filled in without it. The magnification of the figures of zoöids is uniform; 32 diameters, except in the case of a few forms with zoöids too large to admit of this. It is hoped that these figures will give a better conception of the relative sizes of the zoöids than simple measurements, as the latter fail to give any idea of the state of contraction the animal is in. It has not been possible to get fully expanded specimens in the case of most species, but the degree of contraction, of the thorax at least, may be judged by the course of the endostyle, which is crooked or convoluted in the contracted state, but straight or nearly so when the animal is fully expanded. In all cases they have been represented as if transparent to show the internal structure.

The figures showing spicules are also (with the exception of those of *Cystodytes* and *Echinoclinum*) drawn to a uniform scale, a magnification of 450 diameters, and all were drawn with a camera lucida. In selecting spicules for illustration, neither the largest nor the smallest, nor the extremes of variation in form to be found in the colony, were chosen, but a group was selected that would give a fair idea of the forms and sizes most characteristic of the species or variety.

In regard to the photographs of the simple ascidians, it may not be out of place to say that all the Bermuda species vary endlessly in their external characters and shape, and the writer would caution against the belief that even very great differences in these characters, from the specimens illustrated, are necessarily indicative of difference in species. With the exception of a few (mentioned in the descriptions of the figures), which were taken from living specimens by Mr. A. Hyatt Verrill, all the photographs were made from specimens preserved in formalin.

I am indebted to Prof. A. E. Verrill for the use of the photographs from which plate lxiv and also figs. 138 and 139 were made.

PLATE XLVI.

Figure 1.—*Clavelina oblonga* Herdman. Zoöid containing embryos and larvae seen from the right side. $\times 12$. Page 334.

Figure 2.—*Distoma capsulatum* n. sp. Zoöid seen from the left side; showing the arrangement of the mantle muscles. $\times 32$. Page 341.

Figure 3.—*Rhodozona picta* (Verrill). Zoöid seen from the left side. $\times 8$. Page 335.

PLATE XLVII.

Figure 4.—*Ecteinascidia turbinata* Herdman. Young individual with no reproductive organs developed. Seen from the left side. $\times 16$. Page 338.

Figure 5.—*Rhodozona picta* (Verrill). Side view of thorax to show the arrangement of the muscle bands in the mantle. $\times 9$. Page 335.

Figure 6.—*Ecteinascidia turbinata* Herdman. Colony of adult individuals. Two-thirds the natural size. (After Herdman.) Page 338.

Figure 7.—*Clavelina oblonga* Herdman. Colony of four individuals, the two on the left being expanded, the others contracted as usual in preserved specimens. $\times 2$. Page 334.

Figure 8.—*Perophora viridis* Verrill. Individual seen from the left side, showing outline of test and part of the branching stolen. $\times 32$. Page 337.

PLATE XLVIII.

Figure 9.—*Distoma olivaceum*, n. sp. Zoöid seen from the left side. Showing the arrangement of the back pigment dots on the mantle (chiefly on the thorax). $\times 32$. Musculature of mantle not shown. Page 344.

Figure 10.—*Distoma clarum*, n. sp. Zoöid seen from the left side, containing large eggs and larvae. Showing muscle bands of mantle. $\times 32$. Page 345.

Figure 11.—*Distoma obscuratum*, n. sp. Zoöid (much contracted) seen from the left side. $\times 32$. Musculature of mantle not shown. Page 343.

Figure 12.—*Cystodytes violaceus*, n. sp. Zoöid (much contracted) seen from the left dorsal aspect, containing two large eggs. Rectum containing pellets of undigested matter. $\times 32$. Page 348.

Figure 13.—*Cystodytes violaceus*. Small spicules which are scattered in the test. $\times 40$. Page 348.

Figure 14.—*Cystodytes violaceus*. Large spicules forming the capsules about the zoöids, but occurring to some extent elsewhere in the test. $\times 40$. Page 348.

PLATE XLIX.

Figure 15.—*Distaplia bermudensis*, n. sp. Zoöid seen from the right side, showing the muscle bands of the mantle. $\times 32$. *i. tr* = intermediate transverse vessel of branchial sac. Page 349.

Figure 16.—*Distoma convexum*, n. sp. Zoöid seen from the left side, showing arrangement of brown pigment spots on the mantle. $\times 32$. Musculature of mantle not shown. Page 342.

Figure 17.—*Cystodytes draschii* Herdman. Zoöid seen from the left side. $\times 32$. Page 347.

Figures 18 and 19.—*Distaplia bermudensis*, n. sp. Colony of the flattened incrusting form showing the arrangement of the zoöids. Side and top view. $\times 2$. Page 349.

PLATE L.

Figure 20.—*Amaroucium bermudæ*, n. sp. Zoöid with short post-abdomen, seen from the right side. Dorsal languets not represented in the figure. Ovary not developed. *e. c.* = large ectoderm cells on the mantle. $\times 32$. Page 352.

Figure 21.—*Amaroucium exile*, n. sp. Zoöid seen from the left side containing a large embryo. Dorsal languets not represented. $\times 32$. Page 354.

Figure 22.—*Symplegma viride* Herdman. Colony, two-thirds the natural size. (After Herdman.) Page 378.

Figure 23.—*Echinoclinum verrilli*, n. sp. Entire colony incrusting a branching alga, showing distribution of zoöids and spicules. $\times 2$. Page 372.

Figure 24.—*Echinoclinum verrilli*. Zoöid seen from the left side. No reproductive organs developed. $\times 32$. Page 372.

Figure 25.—*Echinoclinum verrilli*. Spicules from the test. $\times 225$. Page 372.

PLATE LI.

Figure 26.—*Didemnum lucidum*, n. sp. Spicules. $\times 450$. Page 360.

Figure 27.—*Didemnum savignii* Herdman. Spicules. $\times 450$. Page 358.

Figure 28.—*Didemnum lucidum*, n. sp. Colony incrusting a branching alga, showing distribution of zoöids and spicules. $\times 2$. Page 360.

Figure 29.—*Didemnum porites*, n. sp. Spicules. $\times 450$. Page 360.

Figure 30.—*Didemnum atrocantum*, n. sp. Spicules. $\times 450$. Page 359.

Figure 31.—*Didemnum solidum*, n. sp. Spicule. $\times 450$. Page 358.

Figure 32.—*Didemnum orbiculatum*, n. sp. Spicules. $\times 450$. Page 361.

Figure 33.—*Didemnum porites*, n. sp. Zoöid seen from the left side. $\times 32$. Page 360.

- Figure 34.—*Didemnum atrocantum*, n. sp. Zoöid seen from the right side. × 32. Page 359.
- Figure 35.—*Didemnum savignii* Herdman. Zoöid seen from the left side. × 32. Page 358.
- Figure 36.—*Didemnum solidum*, n. sp. Zoöid seen from the right side. × 32. Page 358.
- Figure 37.—*Didemnum lucidum*, n. sp. Zoöid seen from the left side. No reproductive organs developed. × 32. Page 360.
- Figure 38.—*Didemnum orbiculatum*, n. sp. Zoöid seen from the left side. The female reproductive organs only are developed. × 32. Page 361.

PLATE LII.

- Figure 39.—*Leptoclinum speciosum*, var. nov. *bermudense*. Spicules. × 450. The smallest spicules were about the branchial orifices. (See also Figure 42.) Page 364.
- Figure 40.—*Leptoclinum albidum*, var. *luteolum* Verrill. From Vineyard Sound, Massachusetts. Spicules. × 450. (Introduced for comparison with the Bermuda forms.) Page 363.
- Figure 41.—*Leptoclinum albidum* Verrill. From the Bay of Fundy. Spicules. × 450. (Introduced for comparison.) Page 363.
- Figure 42. *Leptoclinum speciosum* var. nov. *bermudense*. Spicules (× 450) from a different colony from figure 39, showing forms with blunt and broken points. Page 364.
- Figures 43 and 44.—*Leptoclinum speciosum* var. nov. *hamiltoni*. Spicules from two different colonies. × 450. (See also figure 47.) Page 365.
- Figure 45.—*Leptoclinum speciosum*, var. nov. *pageti*. Spicules. × 450. (The small spicules in the right hand part of the figure were in small groups alongside the bodies of the zoöids, not scattered among the other spicules.) Page 364.
- Figure 46.—*Leptoclinum speciosum*, var. nov. *acutilobatum*, Spicules. × 450. Page 365.
- Figure 47.—*Leptoclinum speciosum*, var. nov. *hamiltoni*. Spicules (× 450) with thicker points than those shown in figures 43 and 44. Page 365.
- Figure 48.—*Leptoclinum speciosum*, var. nov. *somersi*. Spicules. × 450. Page 366.
- Figure 49.—*Leptoclinum speciosum*, var. nov. *harringtonense*. Spicules. × 450. Page 365.
- Figure 50.—*Leptoclinum speciosum*, var. nov. *bermudense*. Zoöid seen from left side. × 32. Page 364.
- Figure 51.—*Leptoclinum speciosum*, var. nov. *harringtonense*. Zoöid from the same colony as the spicules shown in figure 49. × 32. Page 365.
- Figure 52.—*Leptoclinum speciosum*, var. nov. *acutilobatum*. Zoöid from the same colony as the spicules shown in figure 46. × 32. Page 365.

PLATE LIII.

- Figure 53.—*Botrylloides nigrum*, var. nov. *concolor*. Zoöid seen from the right side. The male reproductive organs only are developed on the right side. On the left side a large egg is present just anterior to the testes. × 32. Page 378.

- Figure 54.—*Botrylloides nigrum* Herdman. Zoöid seen from the right side. No reproductive organs developed. Page 374.
- Figure 55.—*Botrylloides nigrum*, var. nov. *planum*. Zoöid seen from above (from the dorsal side). $\times 32$. Page 377.
- Figure 56.—*Diplosoma atropunctatum*, n. sp. Zoöid seen from the left side. $\times 32$. Page 370.
- Figure 57.—*Diplosomoides fragile*, n. sp. Zoöid seen from the left side, fully expanded. $\times 32$. Page 370.
- Figure 58.—*Diplosomoides fragile*. Spicules. $\times 450$. Page 370.
- Figure 59.—*Diplosoma lacteum*, n. sp. Zoöid seen from the left side. $\times 32$. Page 369.
- Figure 60.—*Diplosoma macdonaldi* Herdman. Zoöid seen from the left side. Rectum containing pellets of undigested material. $\times 32$. Page 368.

PLATE LIV.

- Figure 61.—*Michaelsenia tinctoria*, n. sp. Zoöid seen from the right side. The outline about it is that of the mantle, not the test. To simplify the figure the internal longitudinal bars of the branchial sac are not indicated. (See figure 63.) $\times 24$. *at. tn.*—atrial tentacle. Page 381.
- Figure 62.—*Polysyncraton amethysteum*, n. sp. Zoöid seen from the left side, showing the muscle bands in the mantle. $\times 32$. Page 366.
- Figure 63.—*Michaelsenia tinctoria*, n. sp. Part of the endostyle and two of the folds of the branchial sac. Showing internal longitudinal bars. $\times 48$. Page 381.
- Figure 64.—*Polysyncraton amethysteum*, n. sp. Spicules. $\times 450$. (See also figure 67.) Page 366.
- Figure 65.—*Polysyncraton amethysteum*. Upper surface of part of a colony including the branchial orifices of two zoöids. Showing the distribution of the spicules, which are confined to the upper surface of the colony. $\times 16$. Page 366.
- Figure 66.—*Polysyncraton amethysteum*. Zoöid seen from the anterior end, containing a large egg; showing displacement of the coils of the vas deferens due to the enormous development of the egg, which has reached its full size. $\times 32$. Page 366.
- Figure 67.—*Polysyncraton amethysteum*. Spicules from a colony in which they average of smaller and more uniform size than those shown in figure 64. $\times 450$. Page 366.
- Figure 68.—*Diandrocarpa botrylloids*, n. sp. Zoöid seen somewhat obliquely from the right side. (The reproductive organs of the left side are indicated in outline.) This individual is less compressed dorso-ventrally than is usually the case. $\times 32$. Page 383.

PLATE LV.

- Figure 69.—*Styela partita* (Stimpson), from Wood's Hole, Mass. Part of the branchial sac from near the middle of the body extending from the endostyle to the dorsal lamina. $\times 10$. (Introduced for comparison with the Bermuda form.) Taken from the specimen shown in figure 77. Page 389.

Figure 70.—*Styela partita*, var. nov. *bermudensis*. Part of the branchial sac from near the middle of the body extending from the endostyle to the dorsal lamina. $\times 10$. (Taken from the specimen shown in figure 72.) Page 388.

Figures 71 to 75 inclusive.—*Styela partita*, var. nov. *bermudensis*. Five individuals, showing the outlines of the body when removed from the test, the alimentary canal and the reproductive organs of the left and right sides. $\times 1\frac{1}{3}$. Page 388.

PLATE LVI.

Figures 76, 77 and 78.—*Styela partita* (Stimpson) from Wood's Hole, Mass. Three individuals, showing the outlines of the body when removed from the test, the alimentary canal and the reproductive organs of the left and right sides. $\times 1\frac{1}{3}$. Page 389.

Figure 79.—*Microcosmus miniatus* Verrill. Tentacle. \times about 36. Page 396.

Figure 80.—*Ascidia curvata* Traustedt. Small part of the branchial sac showing part of the dorsal lamina. From the posterior part of the body. $\times 40$. (*h. m.* = horizontal membrane of transverse vessel.) Page 400.

Figure 81.—*Ascidia curvata* Traustedt. Small individual seen from the right side showing the outline of the test and the muscle bands of the mantle; also the papillae of the branchial sac. The alimentary canal and reproductive organs, situated on the left side, are visible through the transparent tissues. $\times 4$. Page 400.

Figure 82.—*Ascidia curvata* Traustedt. Anterior end of the dorsal lamina and adjacent part of the branchial sac, dorsal tubercle and part of the tentacles. $\times 20$. (*h. m.* = horizontal membrane of transverse vessel.) Page 400.

Figure 83.—*Halocynthia rubrilabia* Verrill. Tentacle. \times about 36. Page 393.

Figure 84.—*Halocynthia riiseana* (Traustedt), var. nov. *munita*. Tentacle. \times about 36. Page 394.

PLATE LVII.

Figure 85.—*Halocynthia riiseana*, var. nov. *munita*. Small piece of the branchial sac from one of the spaces between two folds near the middle of the body. $\times 24$. Page 394.

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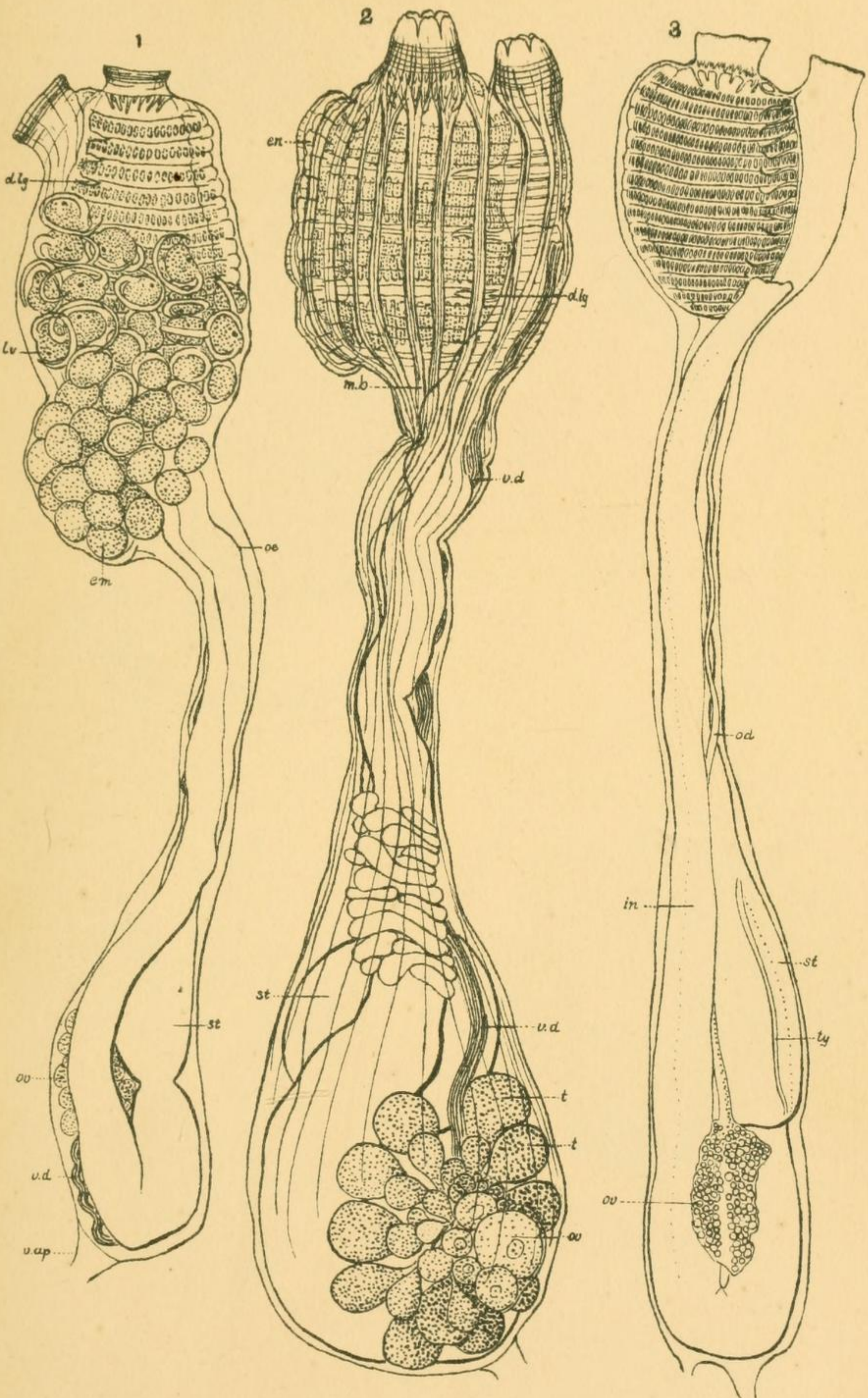
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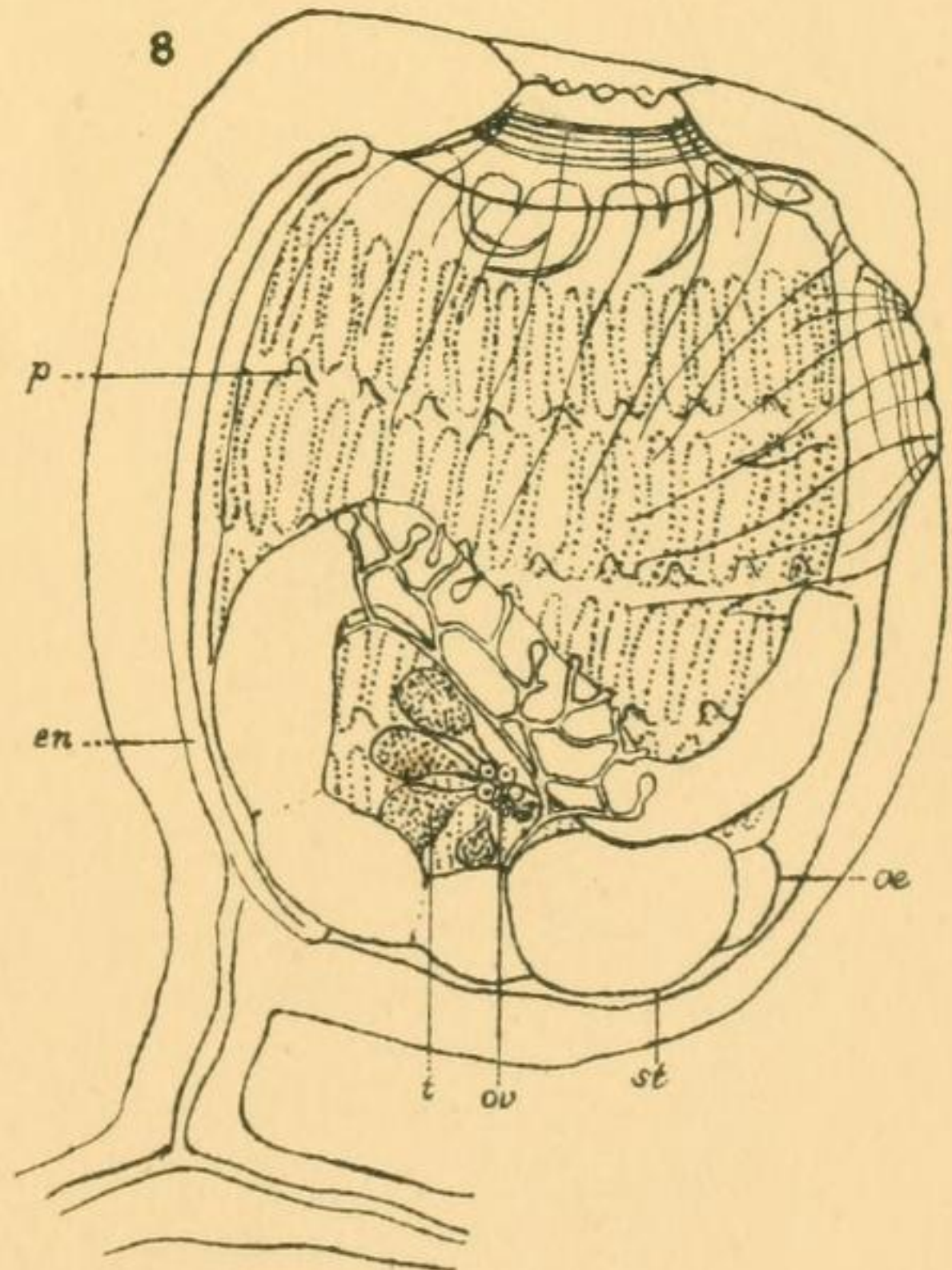
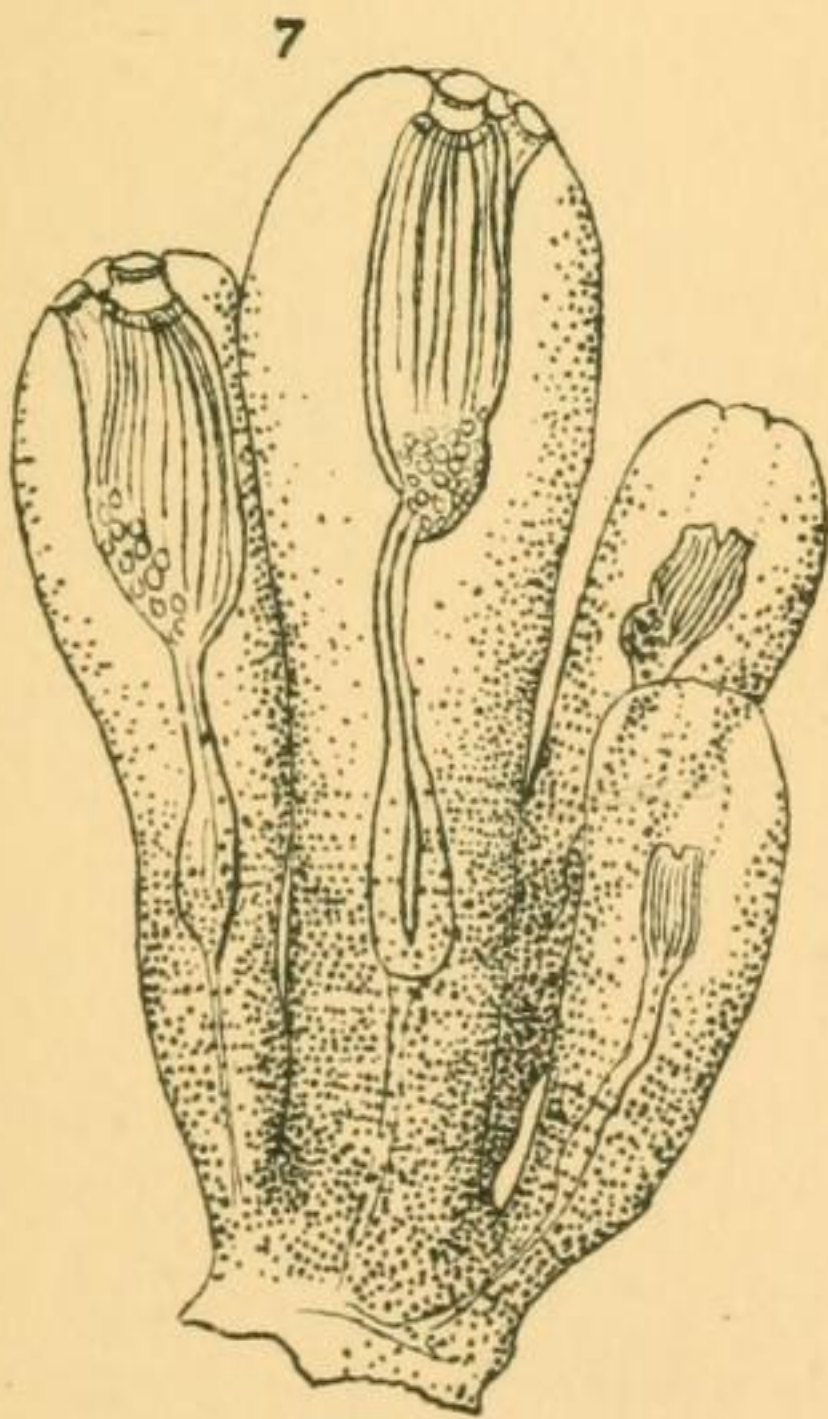
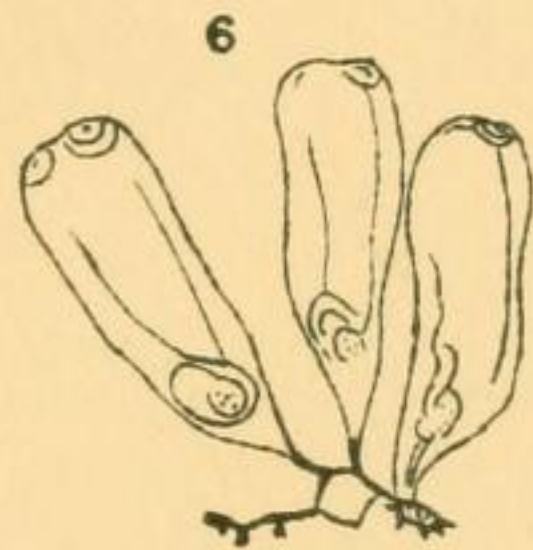
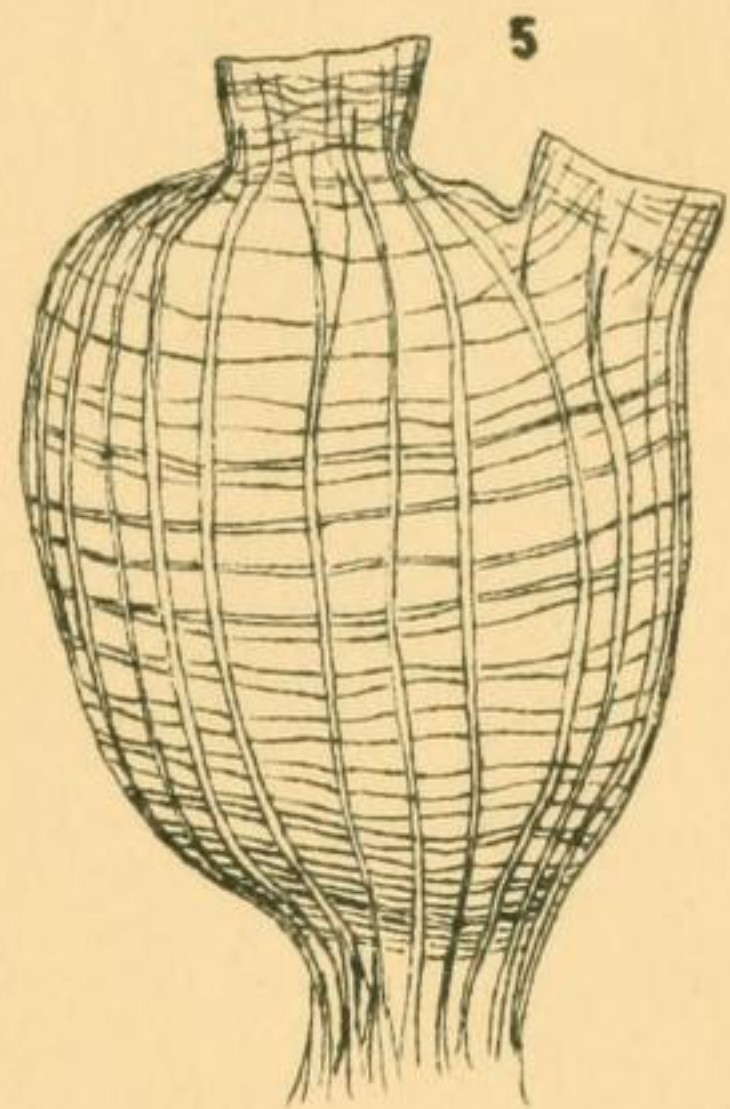
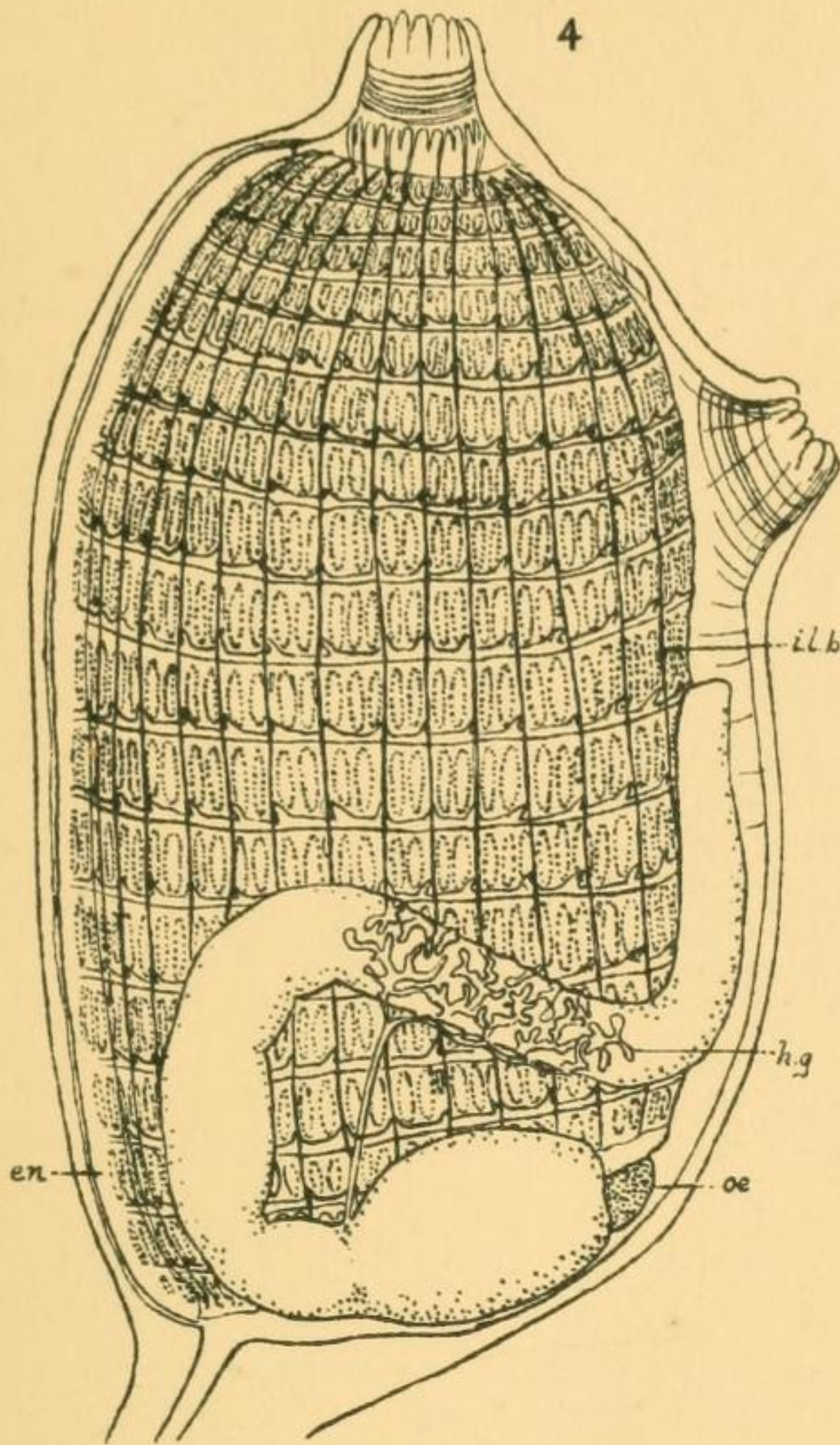
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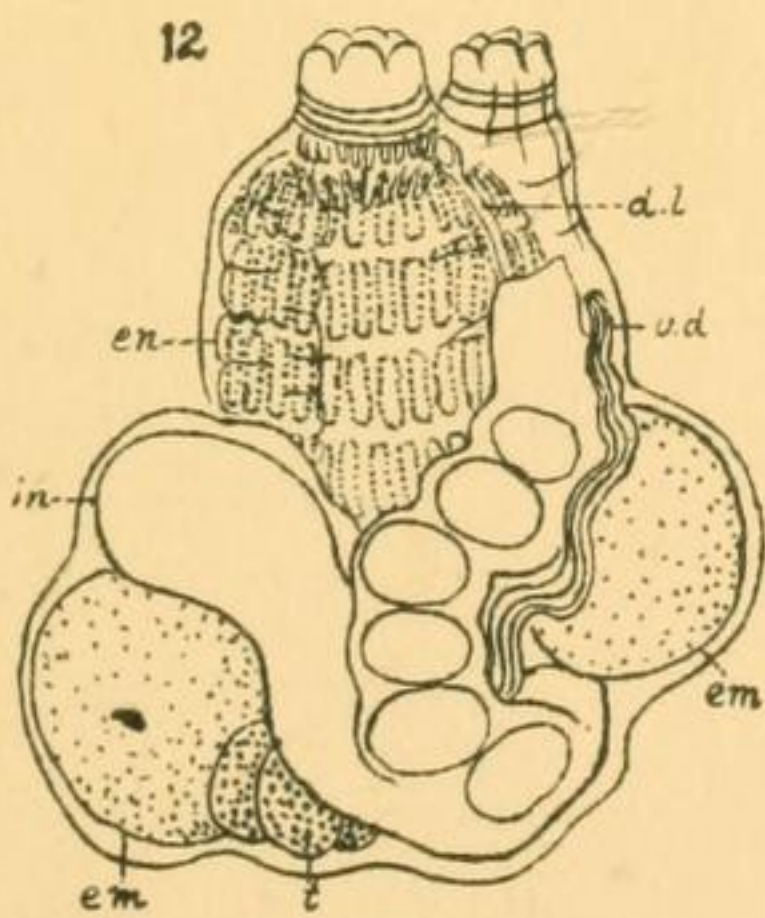
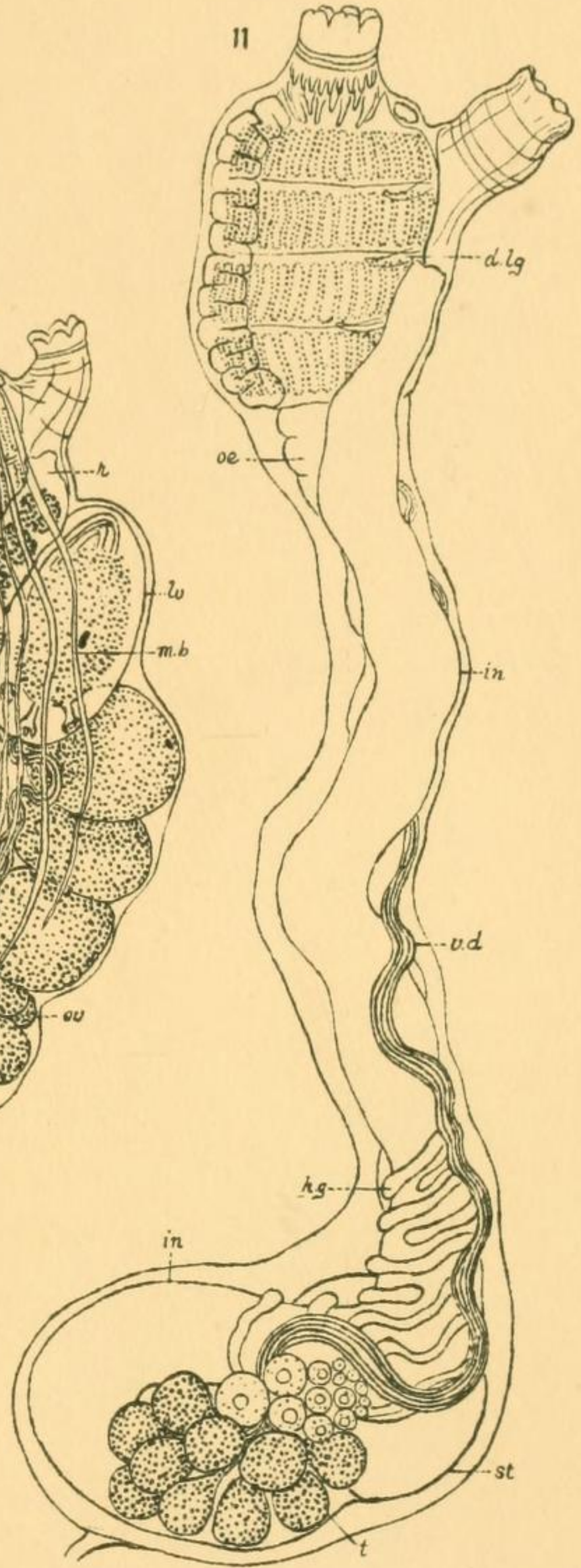
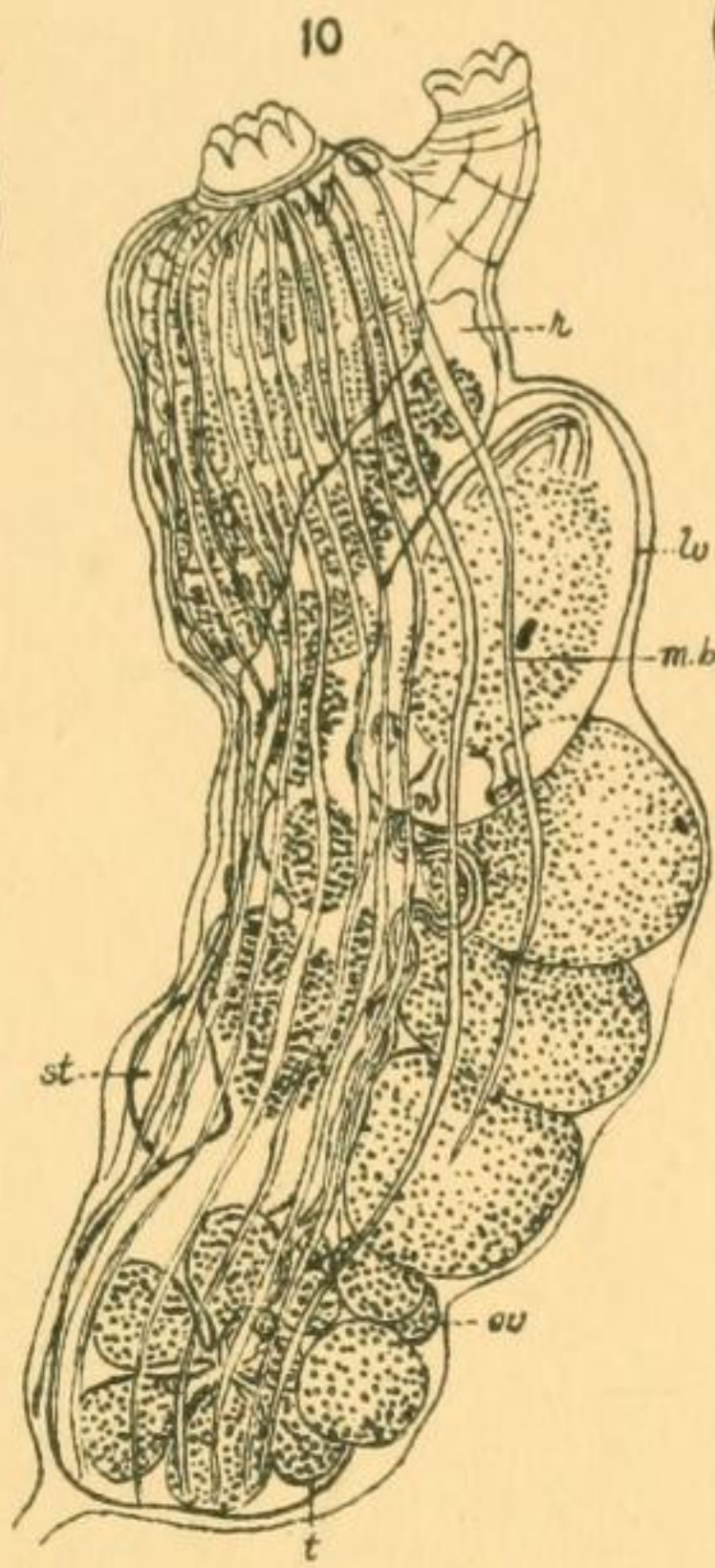
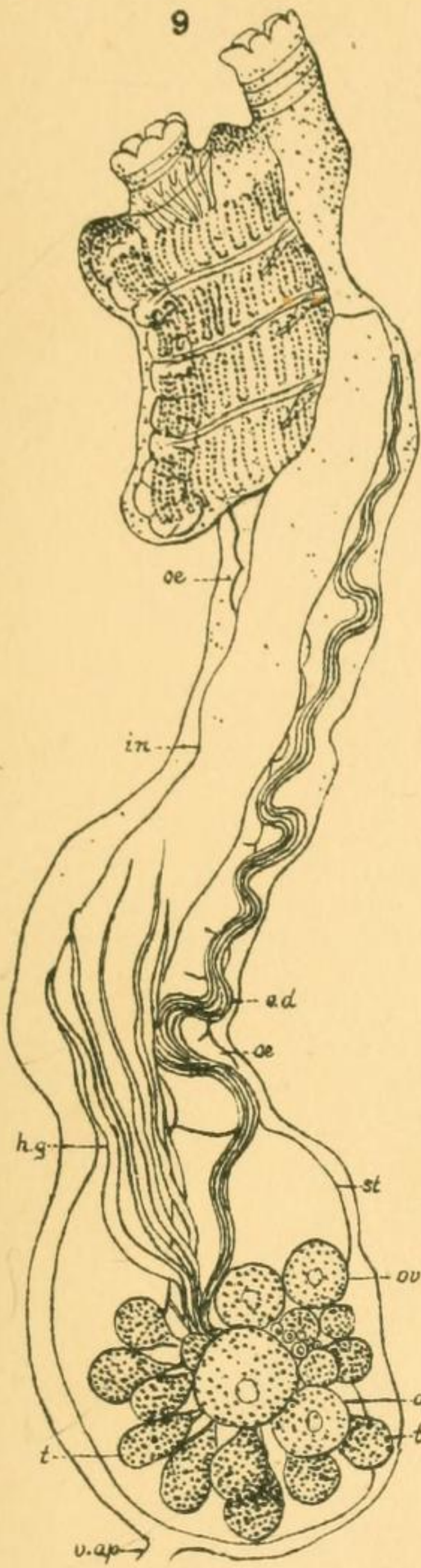
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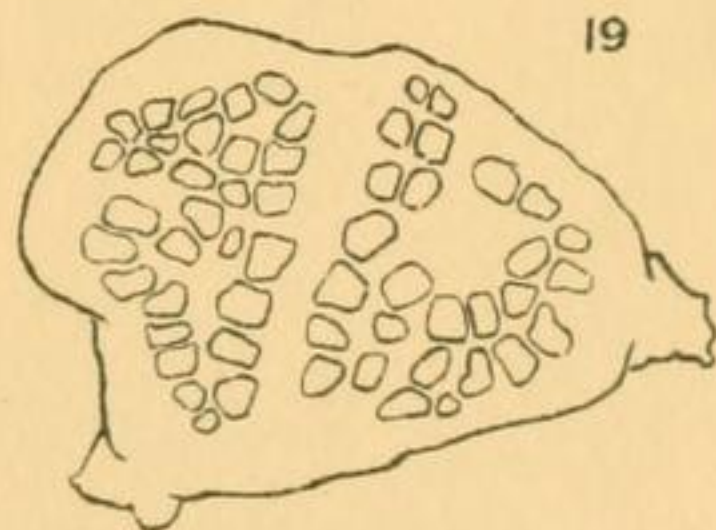
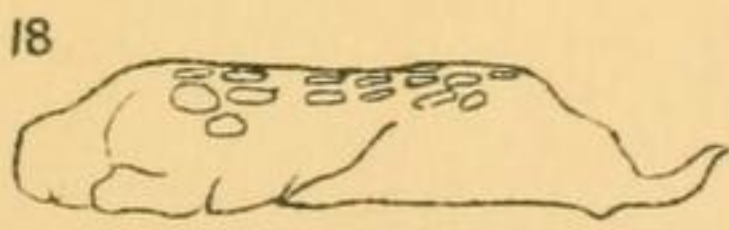
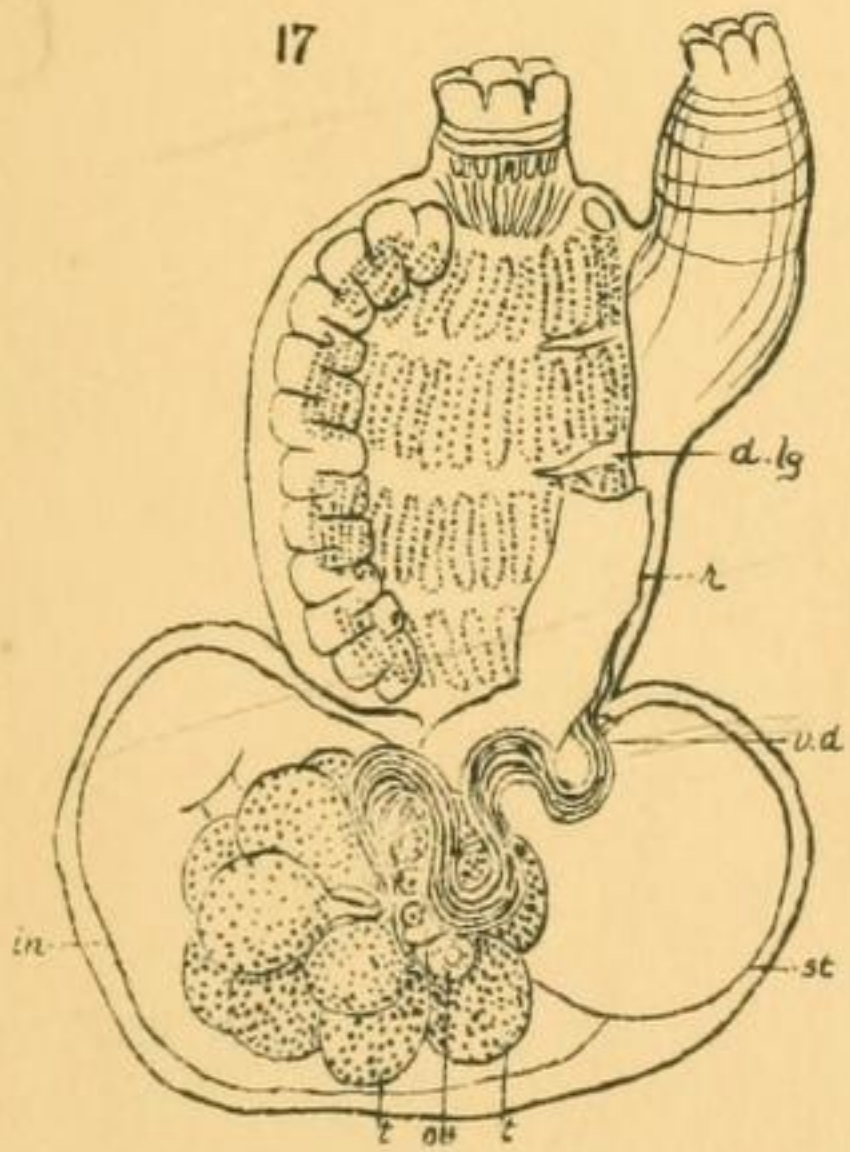
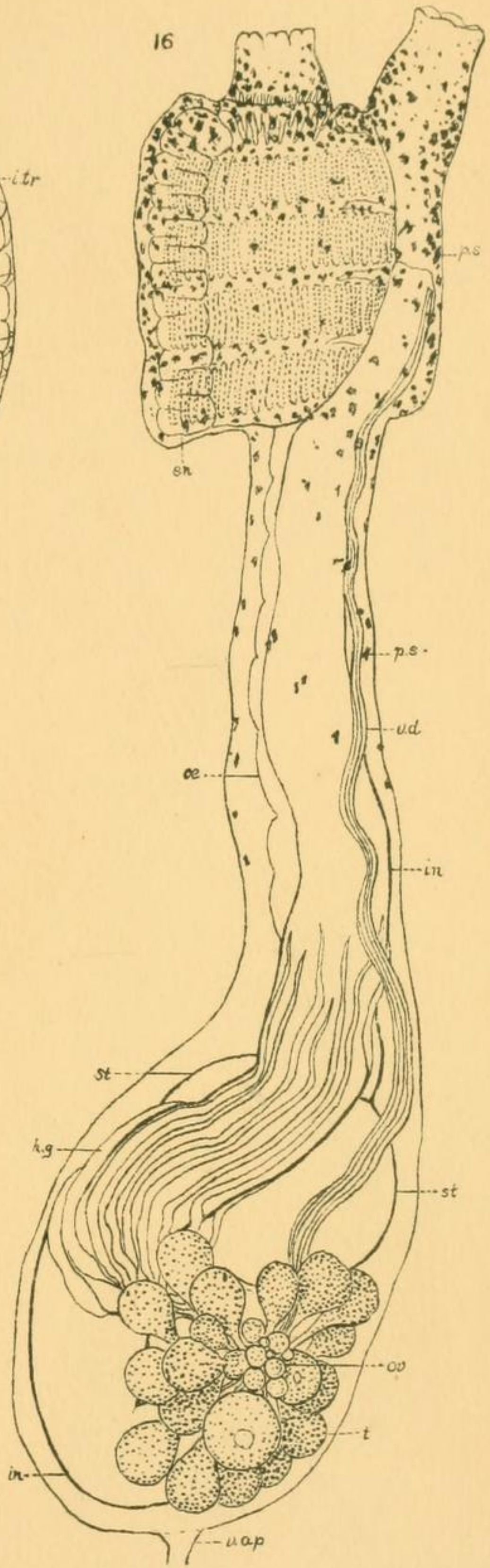
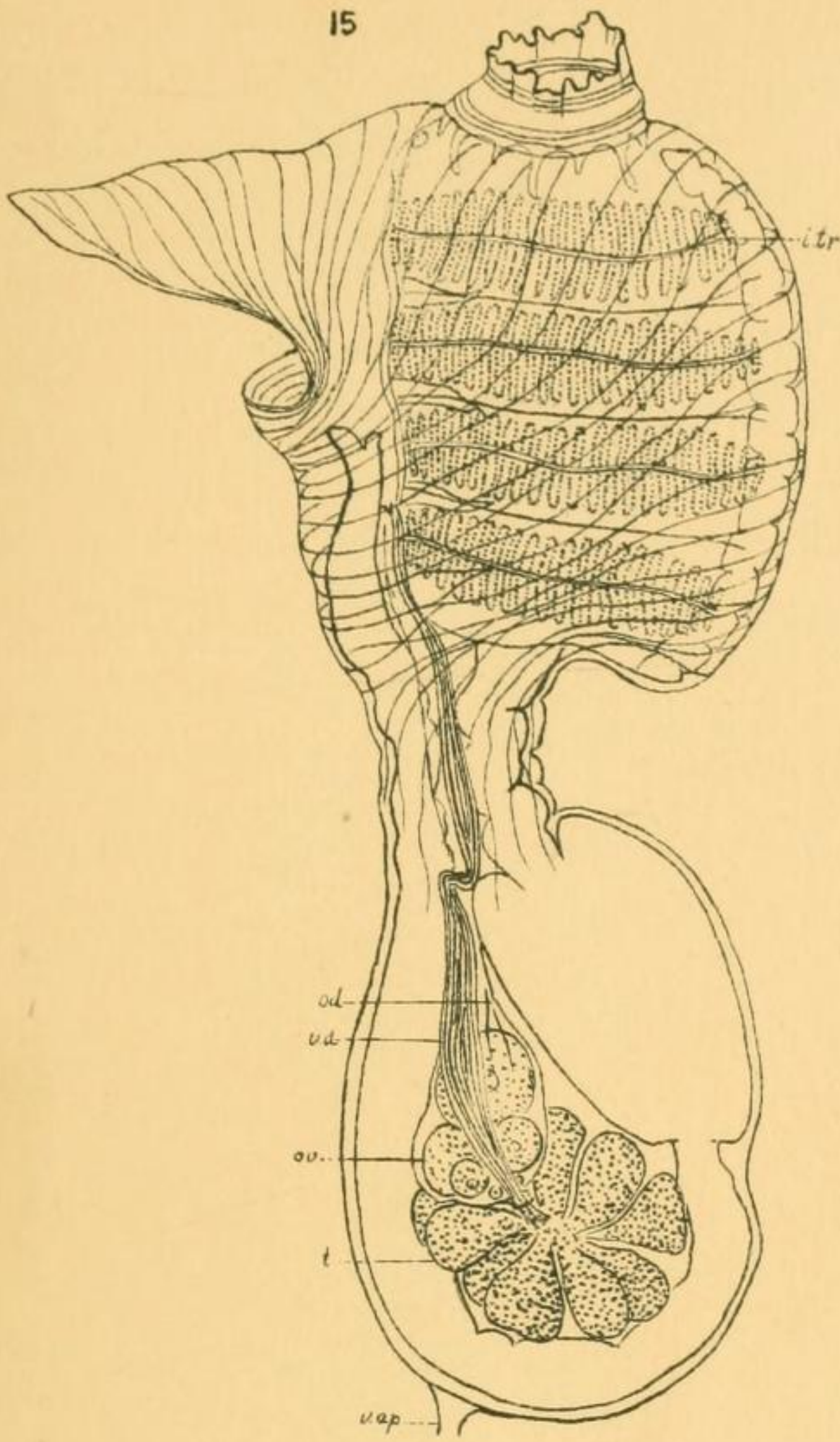
[For explanation of any other abbreviations, see description of figure.]

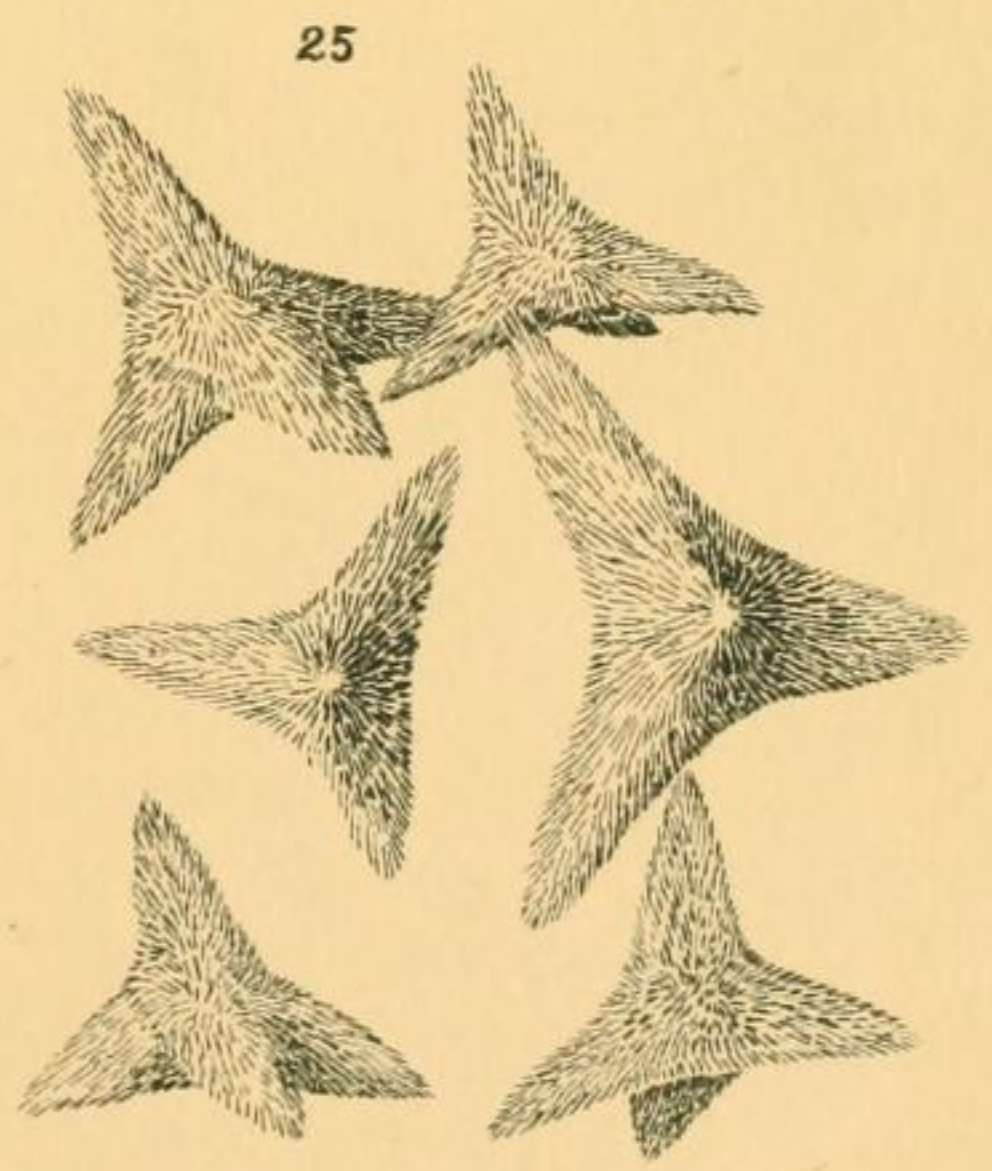
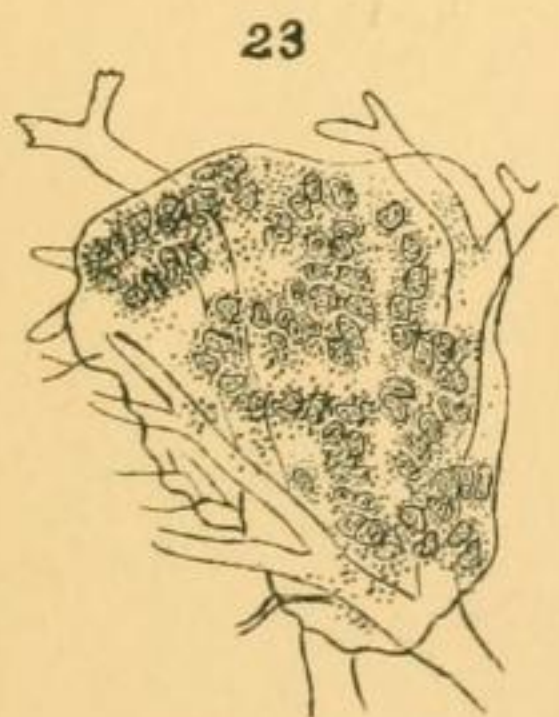
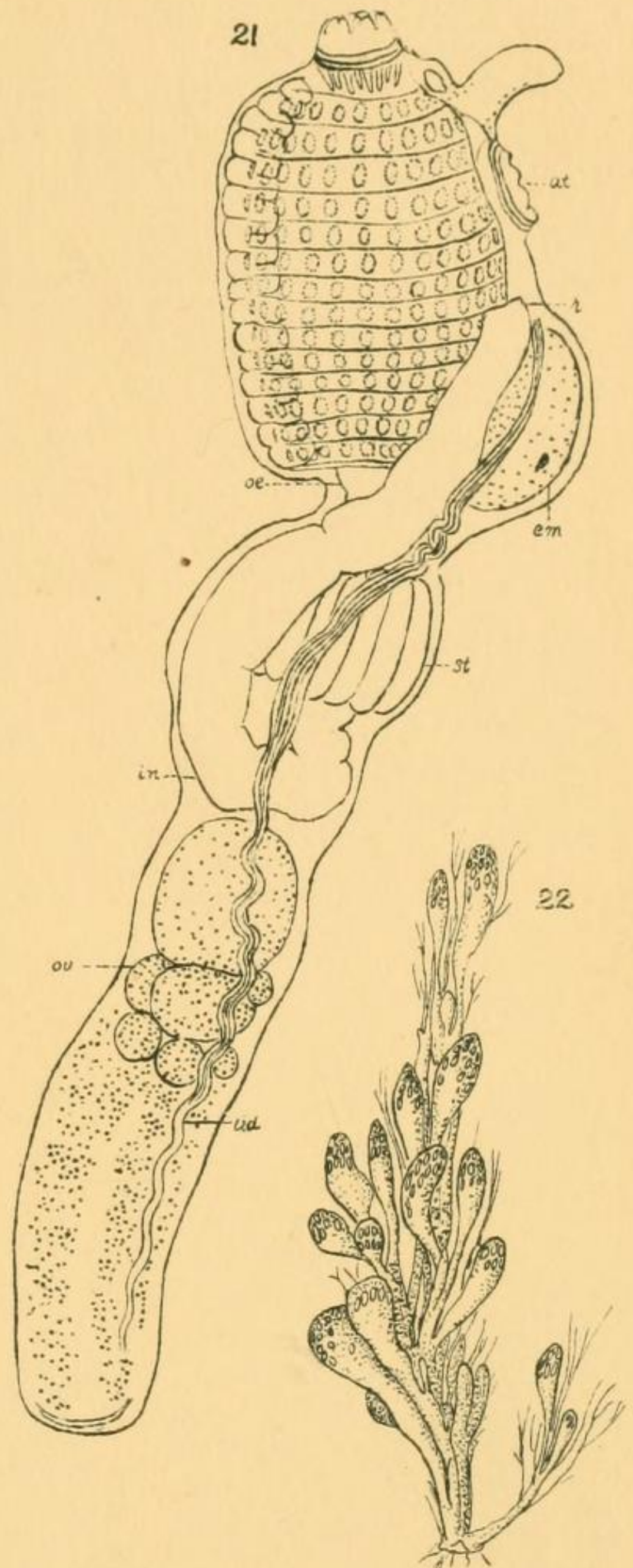
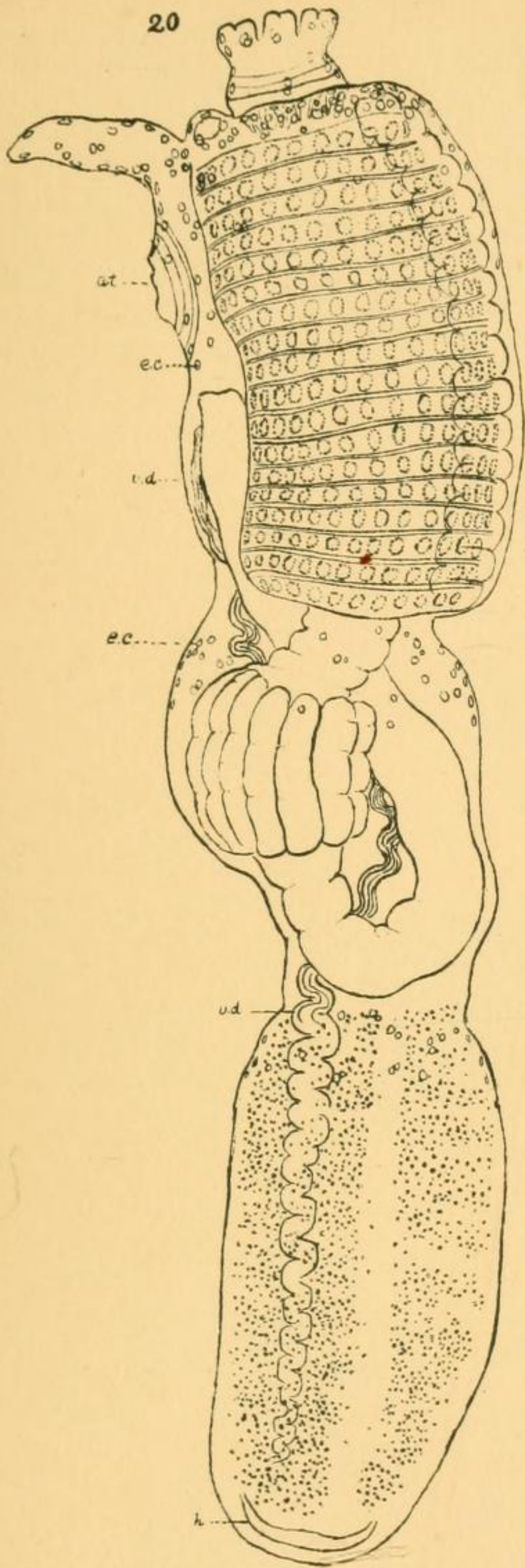
at.	atrial aperture.	od.	oviduct.
br.	branchial aperture.	oe.	œsophagus.
d. l.	dorsal lamina.	ov.	ovary.
d. lg.	dorsal languet.	p.	papilla.
d. t.	dorsal tubercle.	p. c.	pigment cell.
em.	embryo.	pep.	polycarp.
en.	endostyle.	p. s.	pigment spot.
fd.	fold.	r.	rectum.
g.	ganglion.	rep.	reproductive glands.
g. c.	gastric cœcum.	sg.	stigilla.
h.	heart.	st.	stomach.
h. g.	hepatic gland.	t.	testes.
in.	intestine.	tn.	tentacle.
i. l. b.	internal long. bar.	tr. v.	transverse vessel.
lg.	languet.	ty.	typhlosole.
lv.	larva.	v. ap.	vascular appendage.
m. a.	muscular appendage.	v. d.	vas deferens.
m. b.	muscle band.		

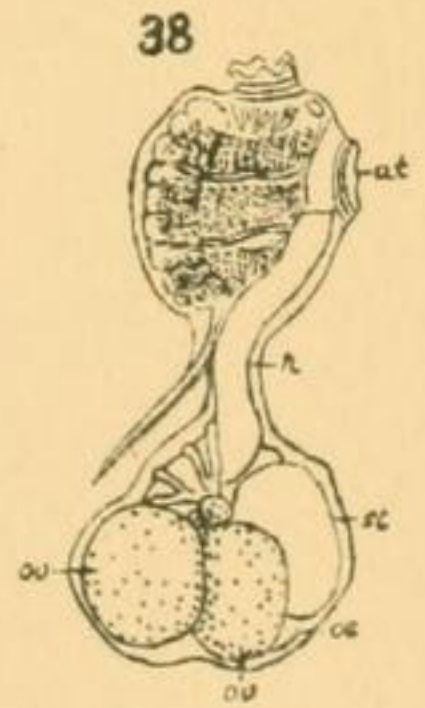
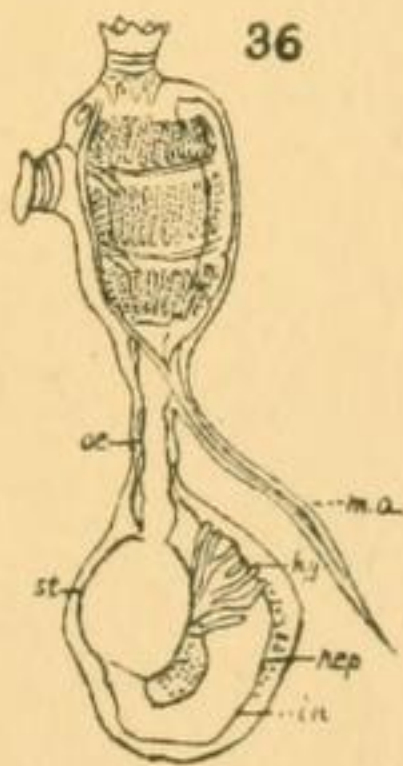
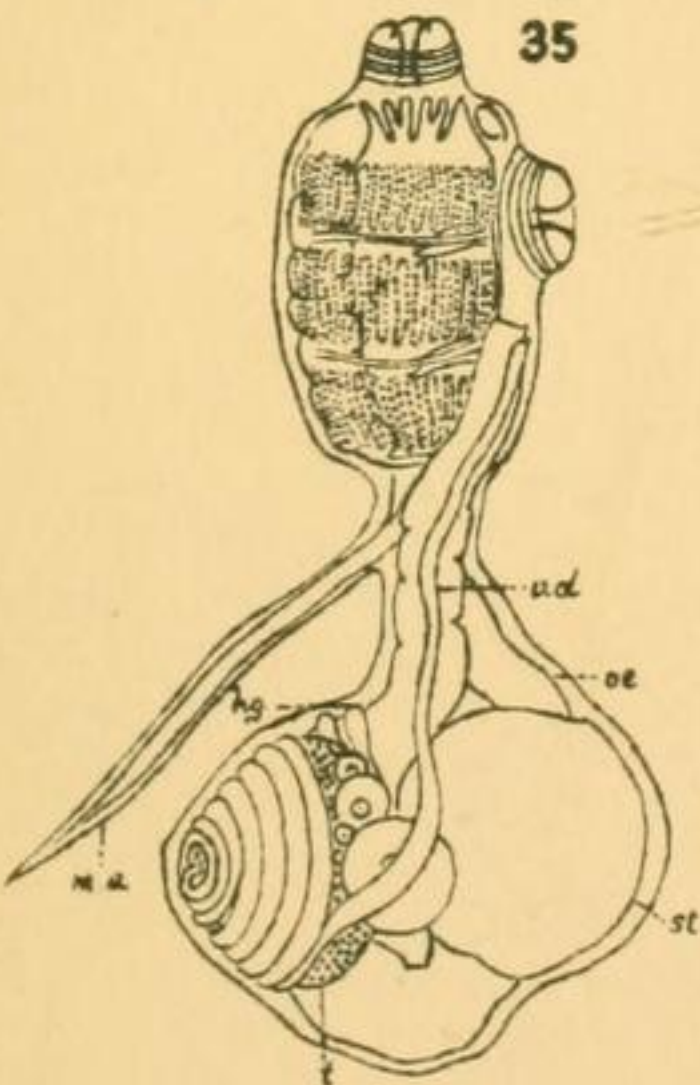
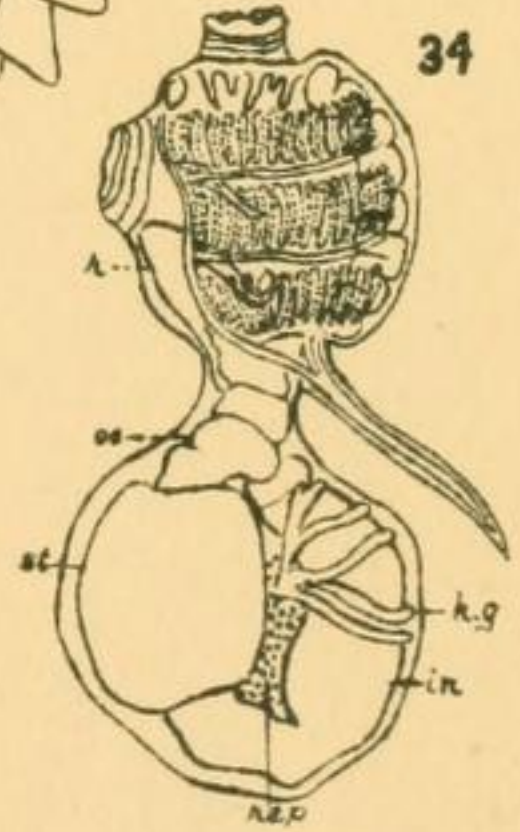
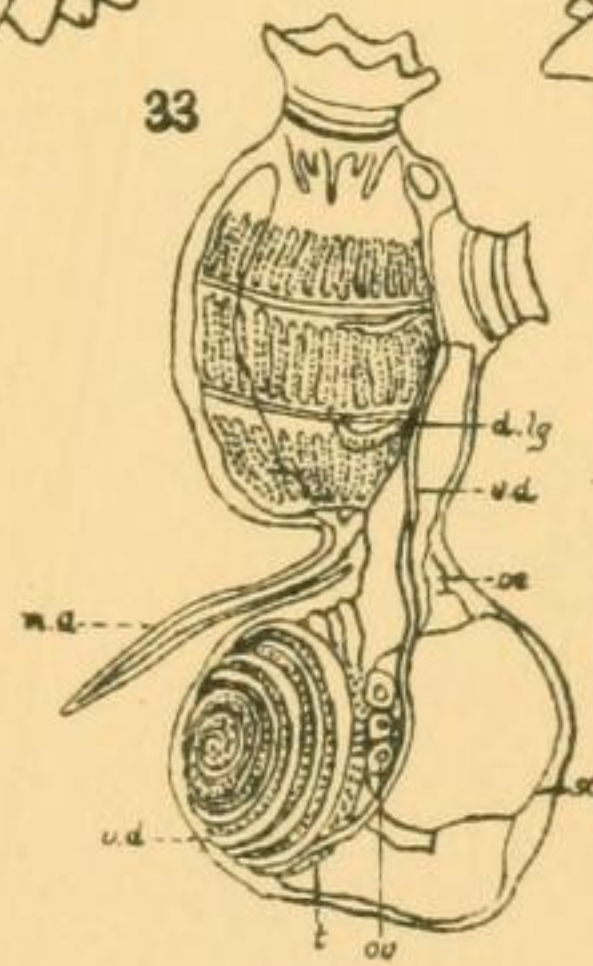
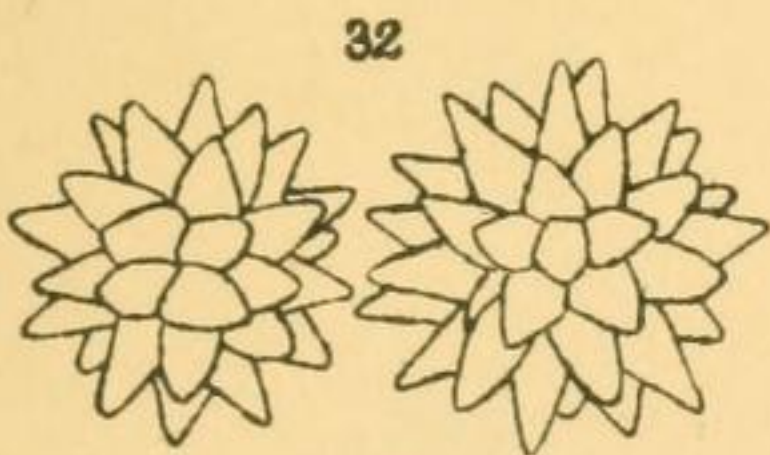
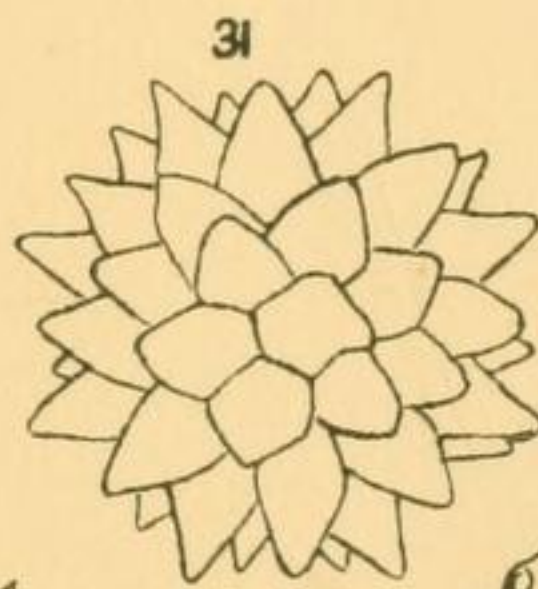
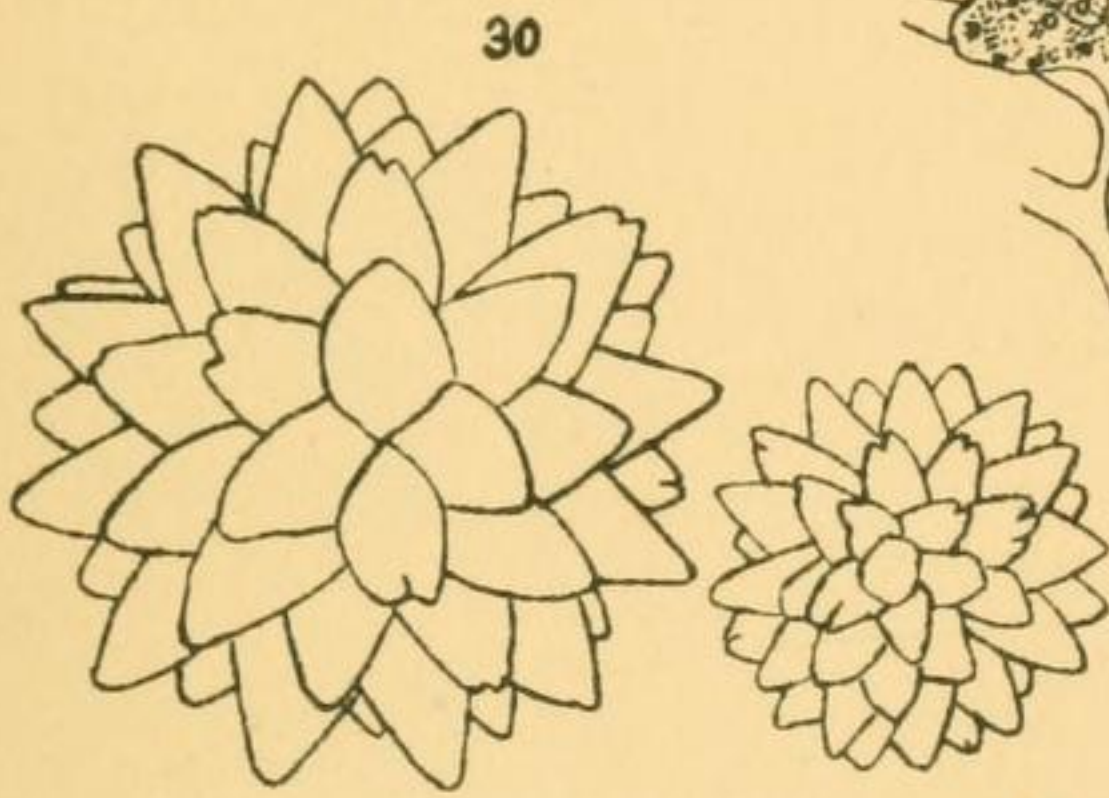
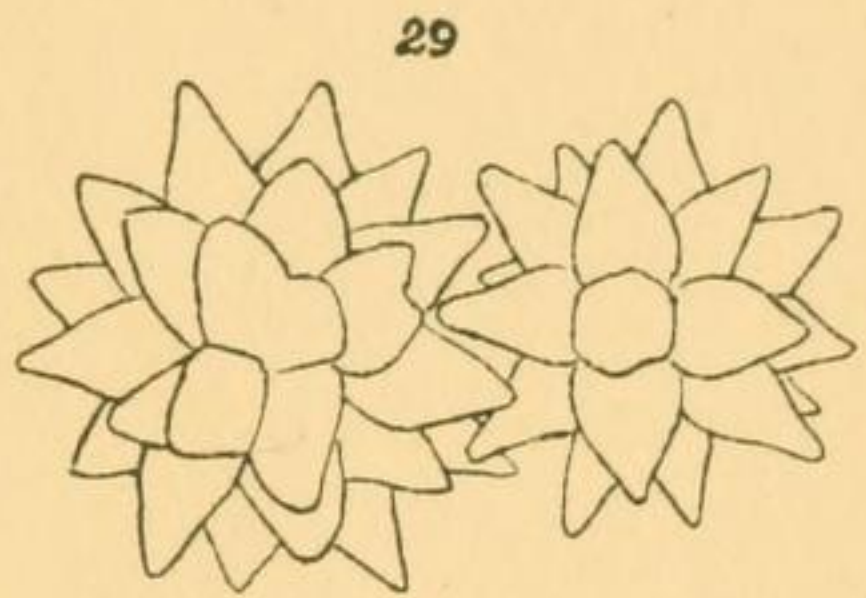
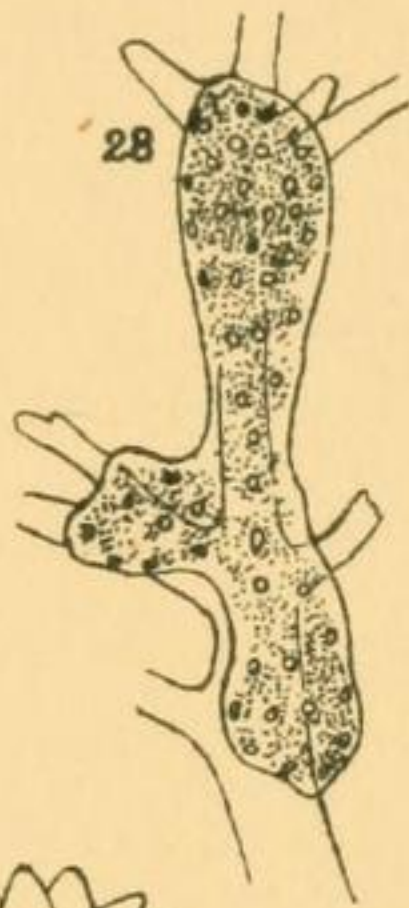
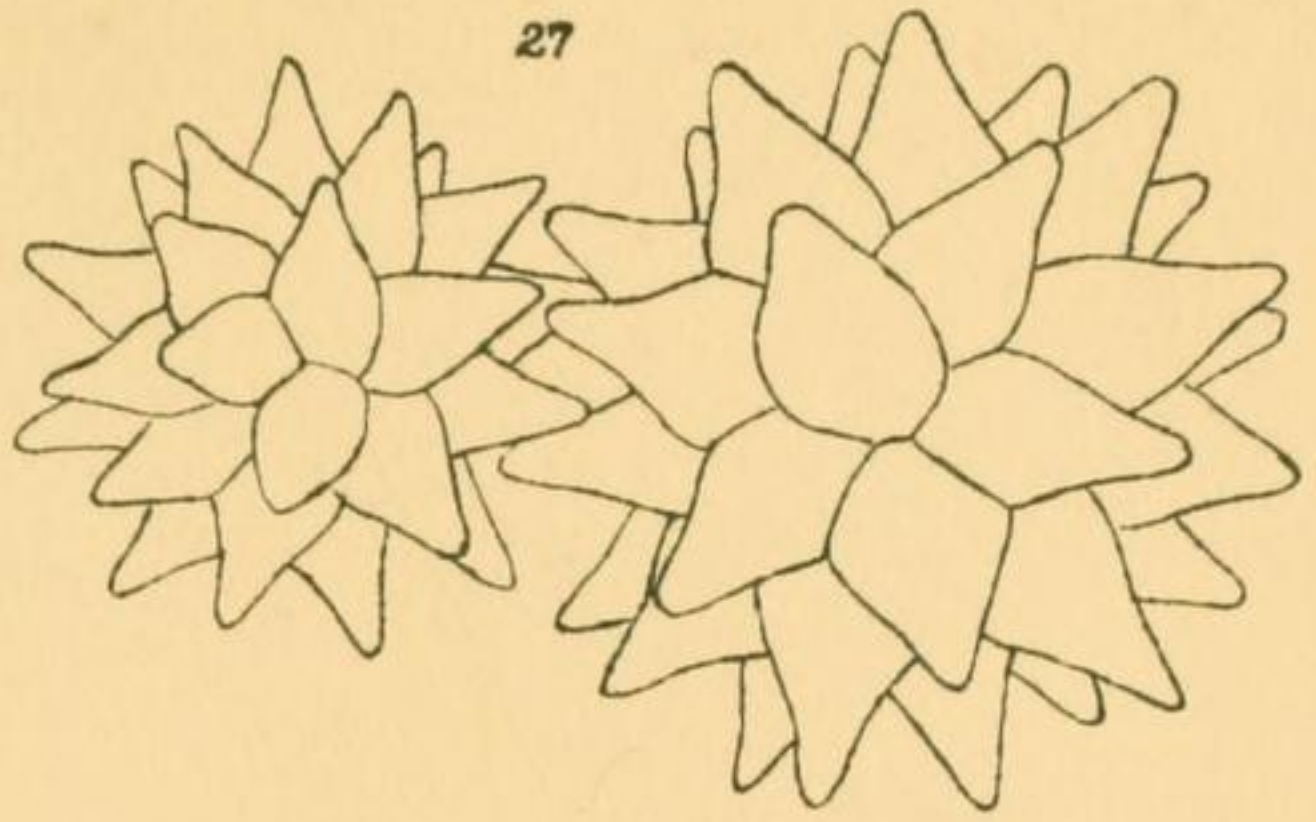
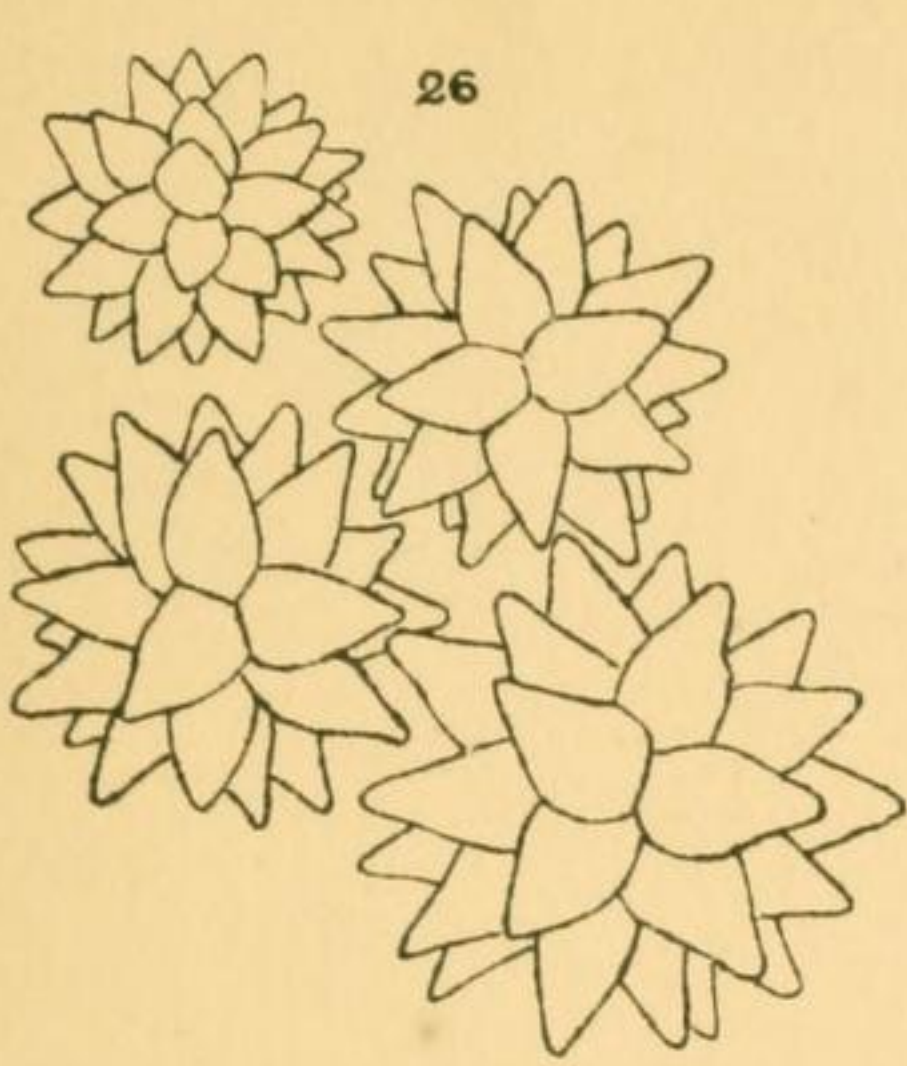


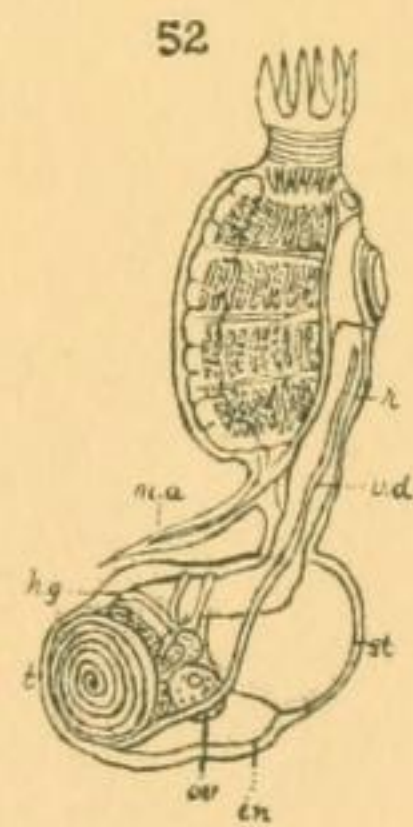
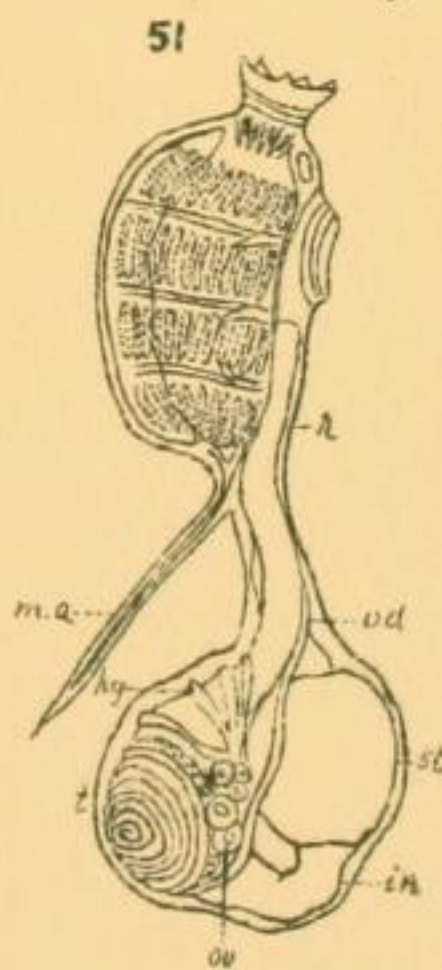
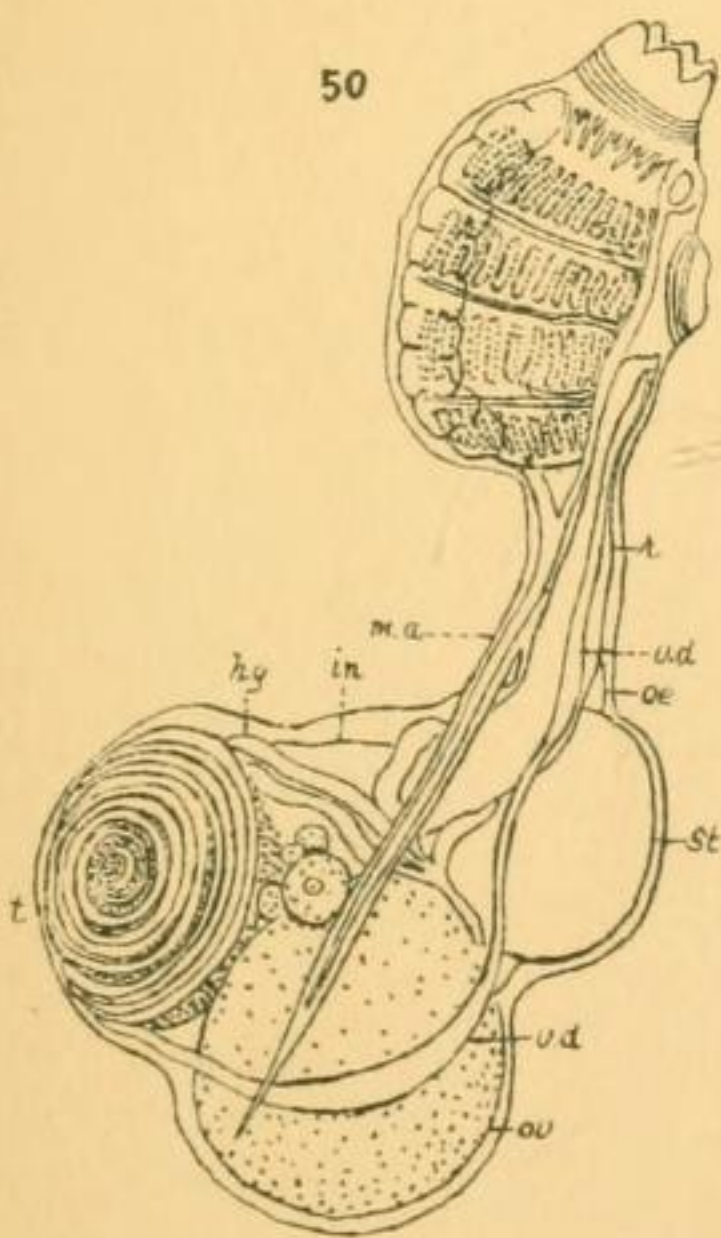
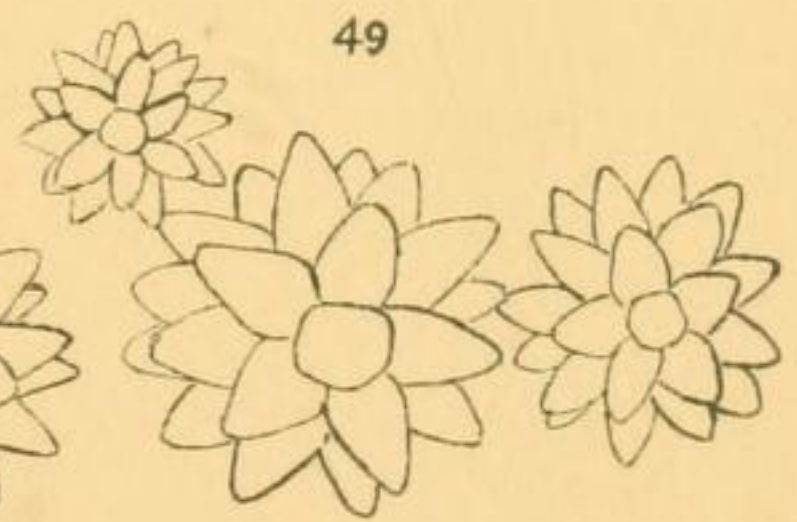
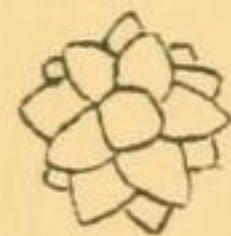
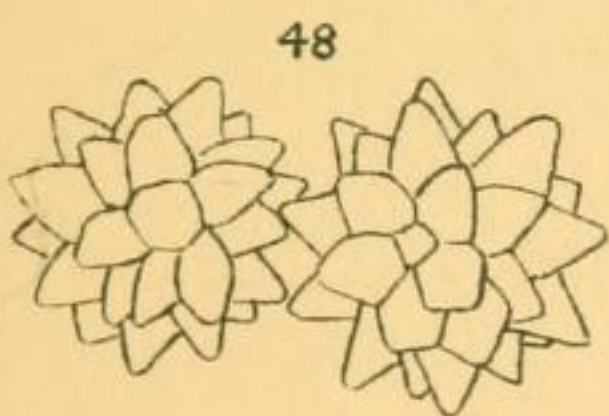
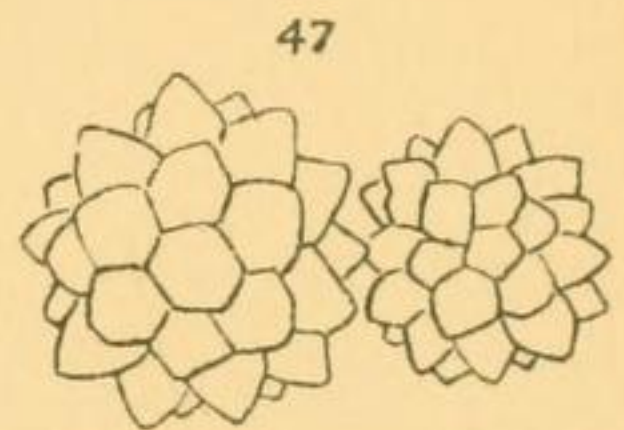
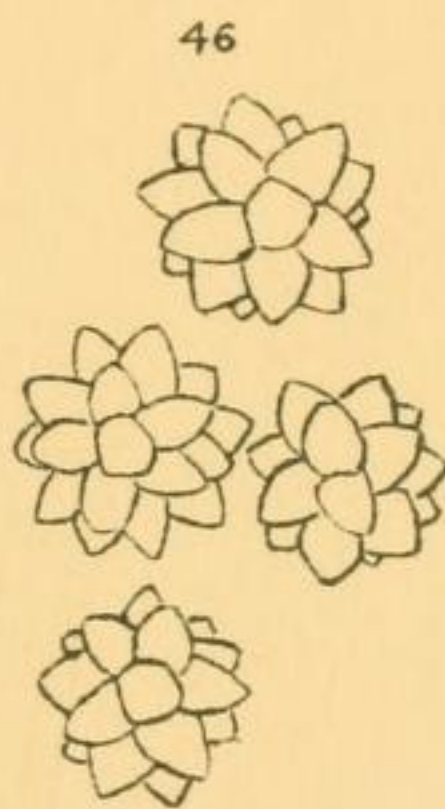
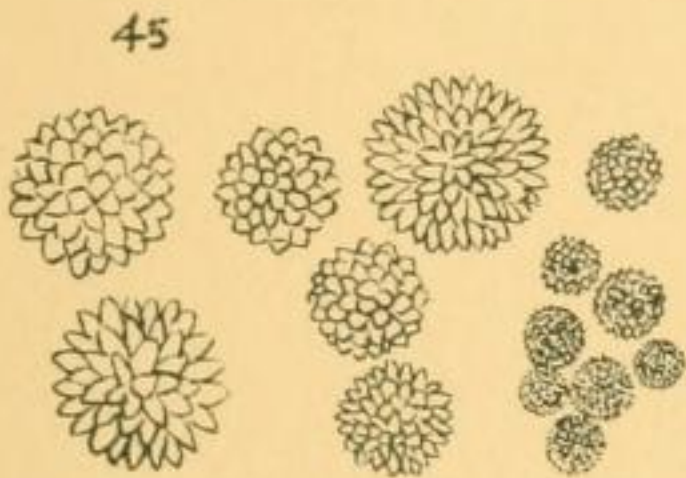
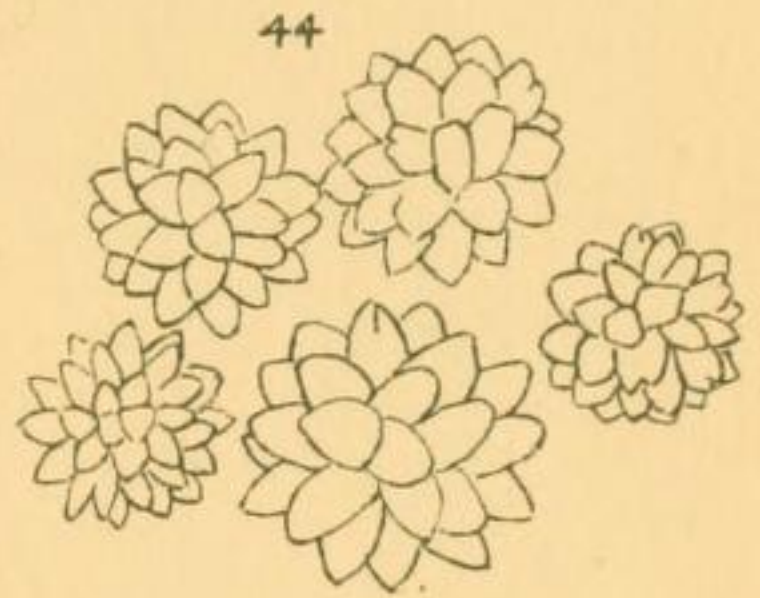
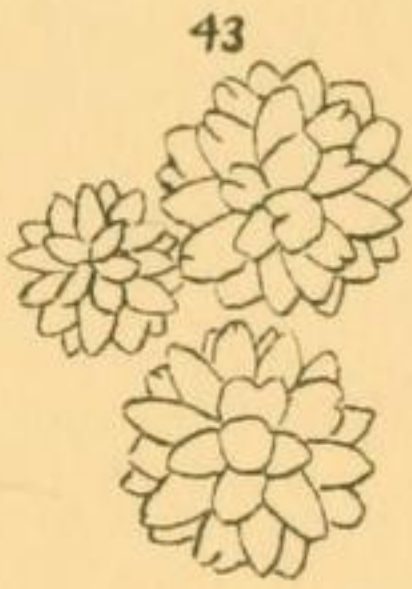
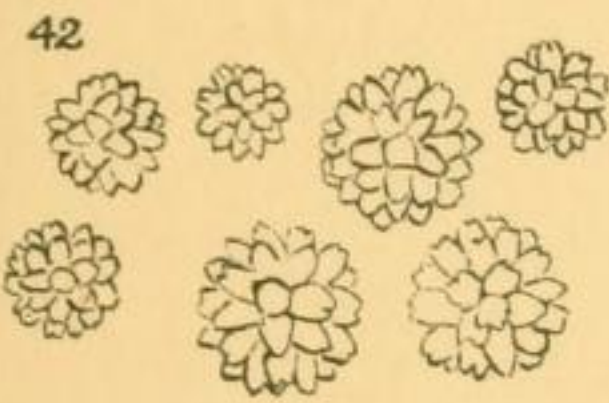
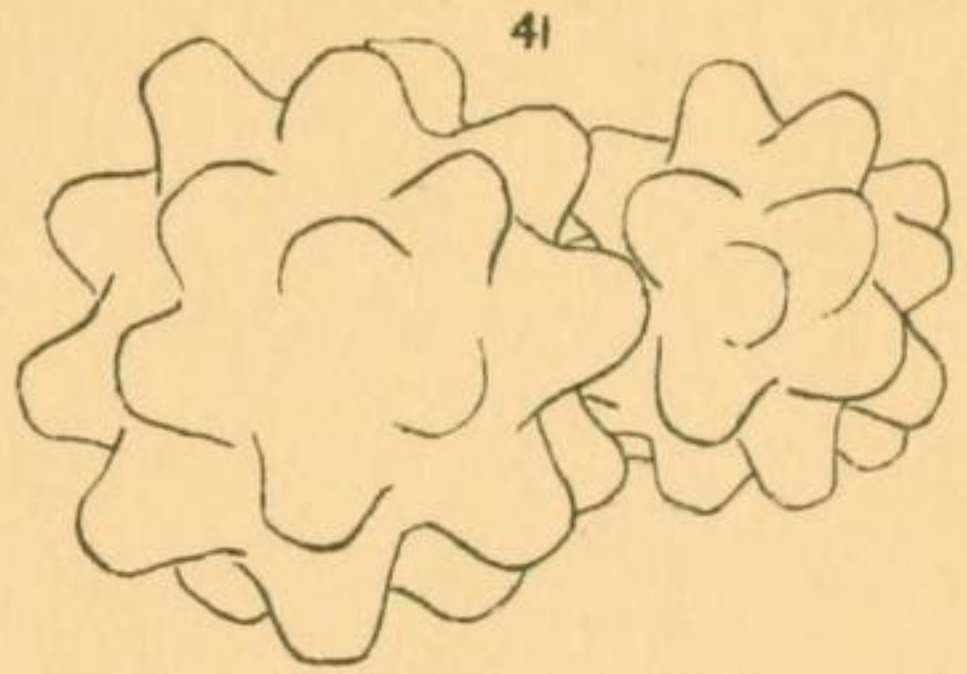
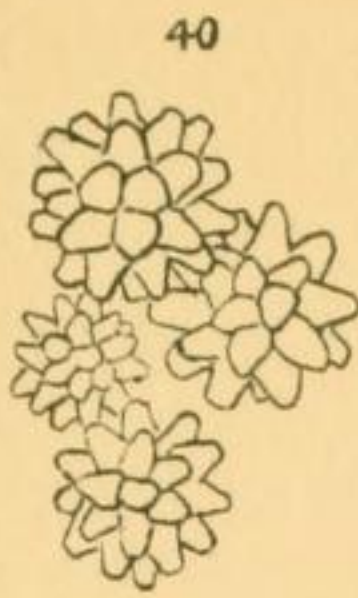
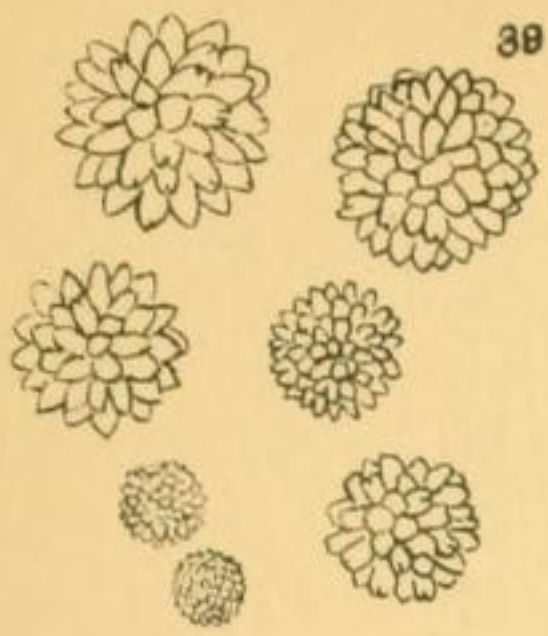


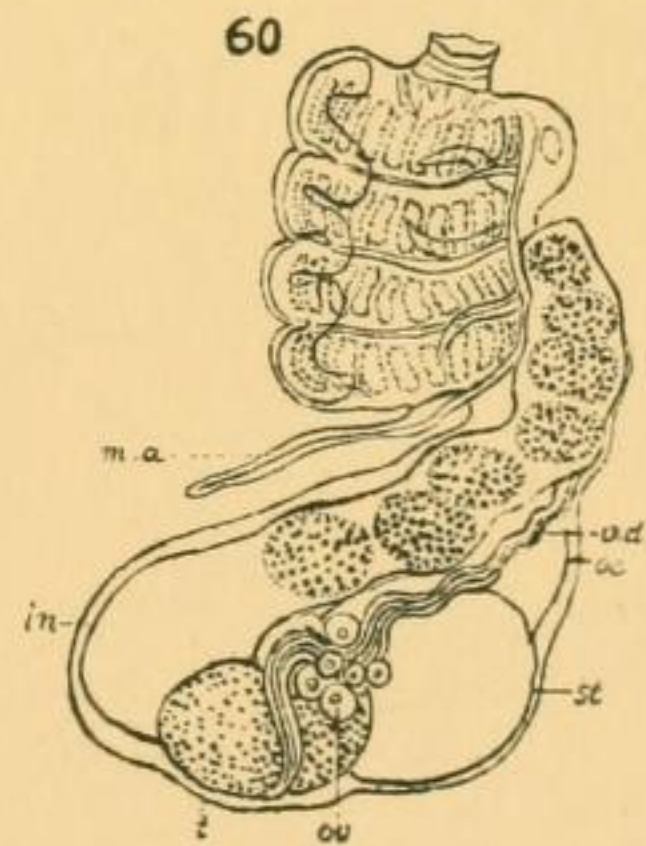
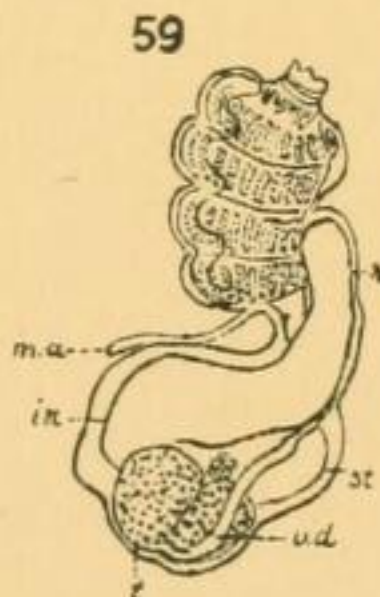
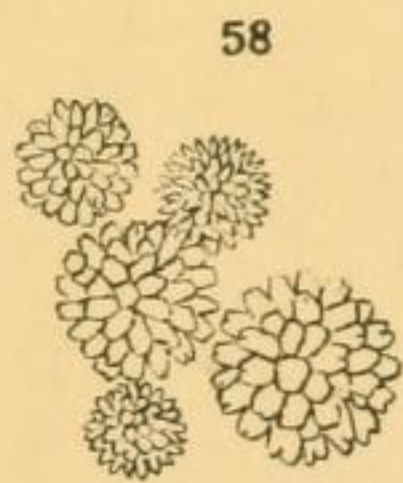
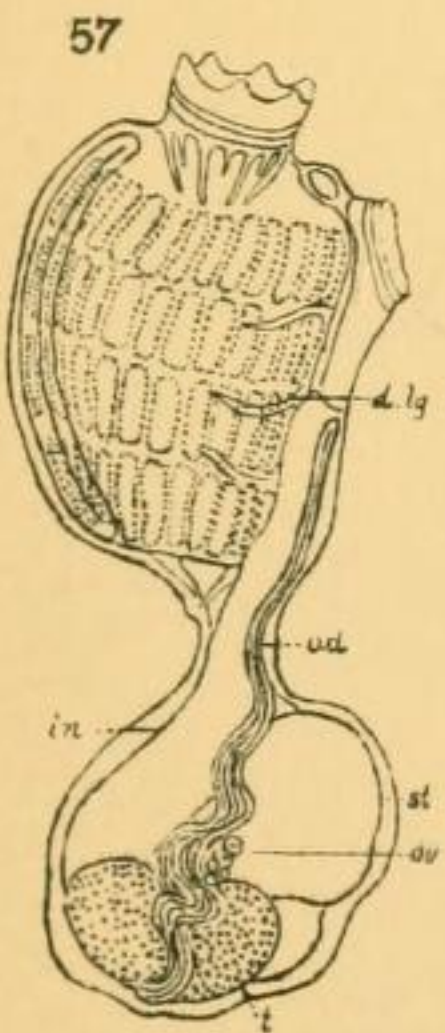
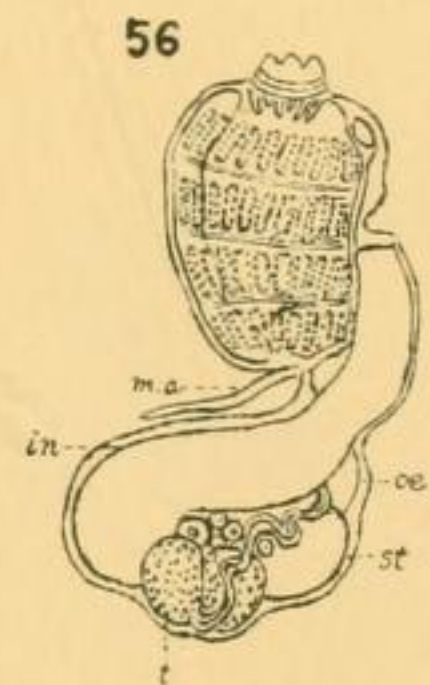
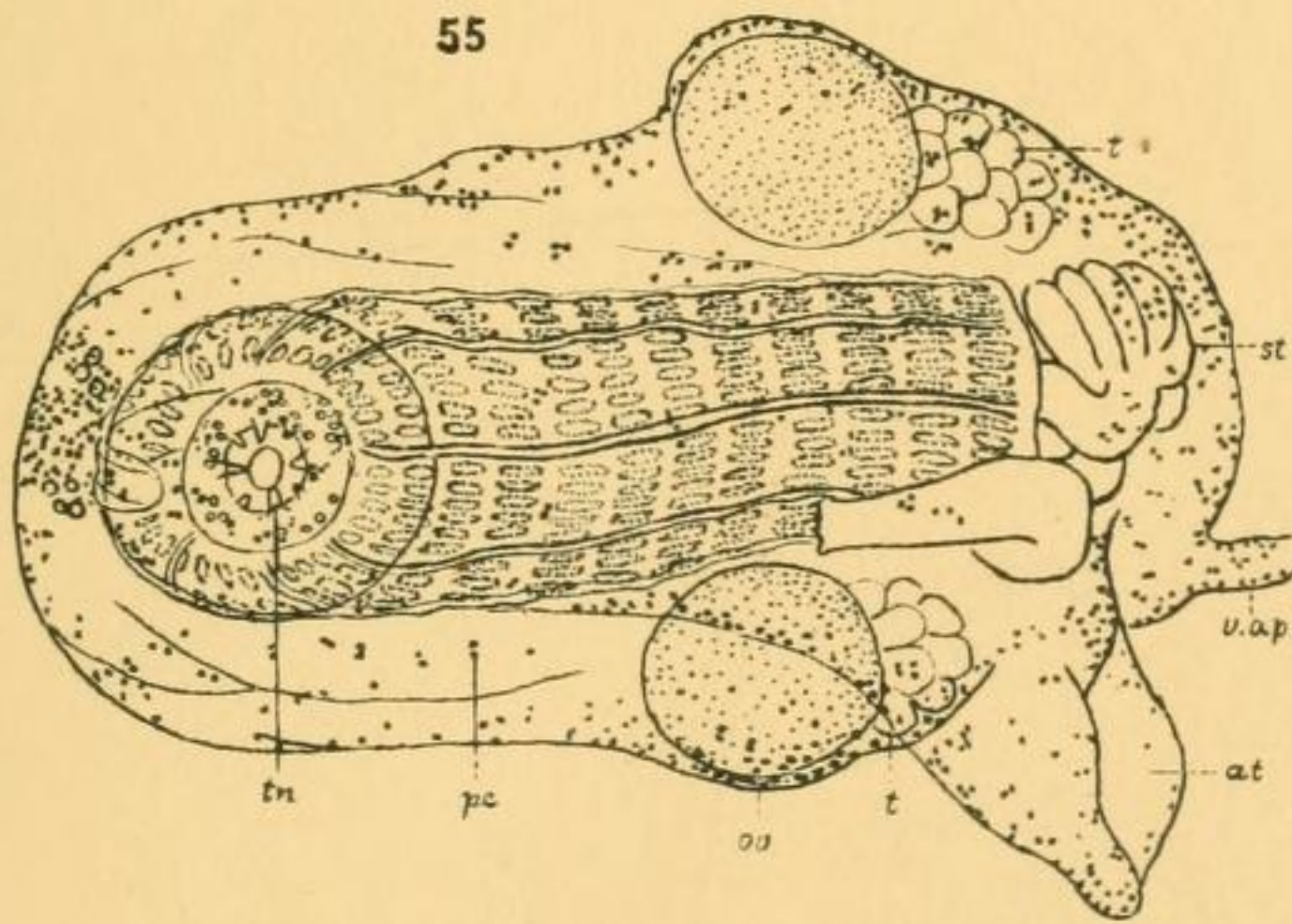
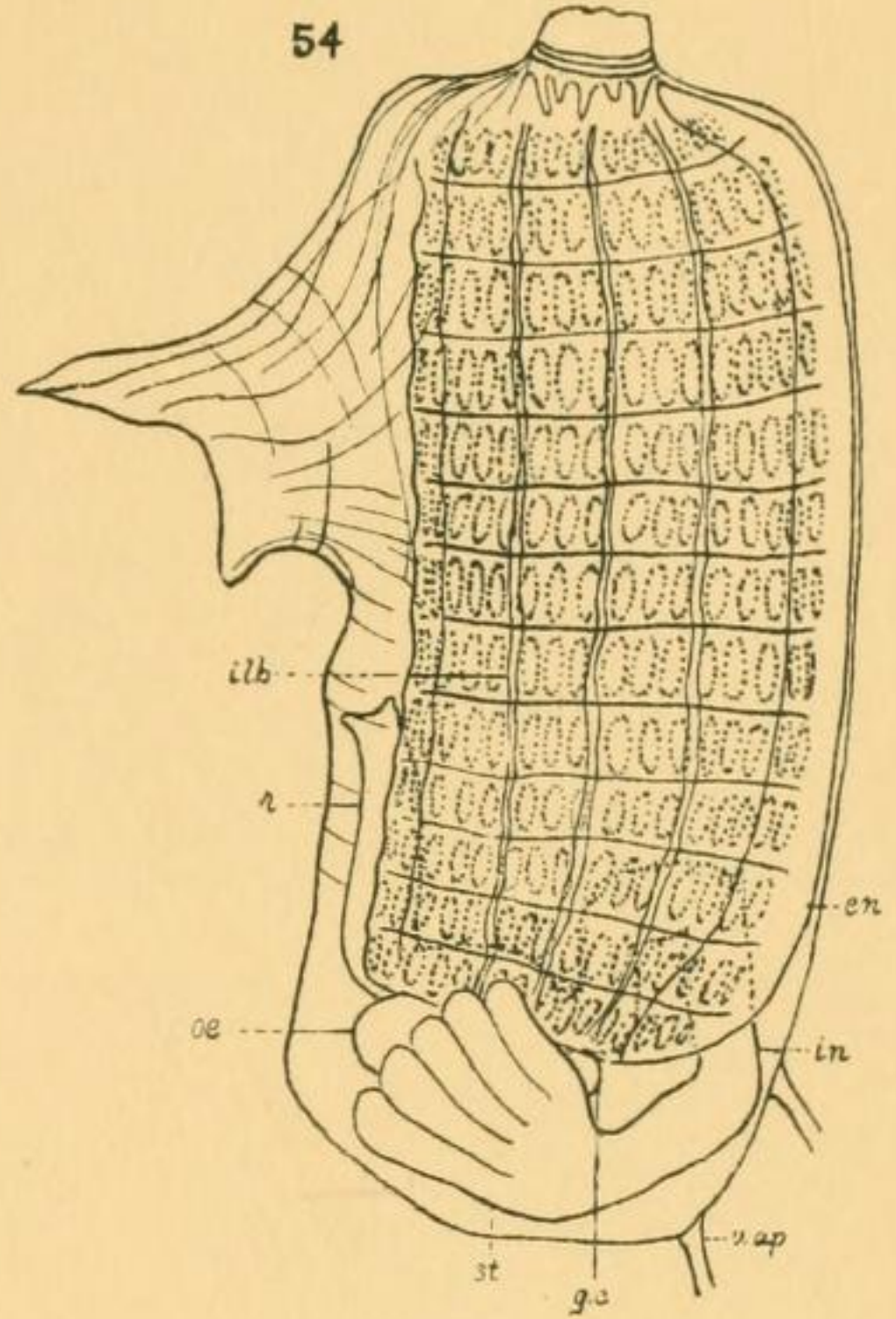
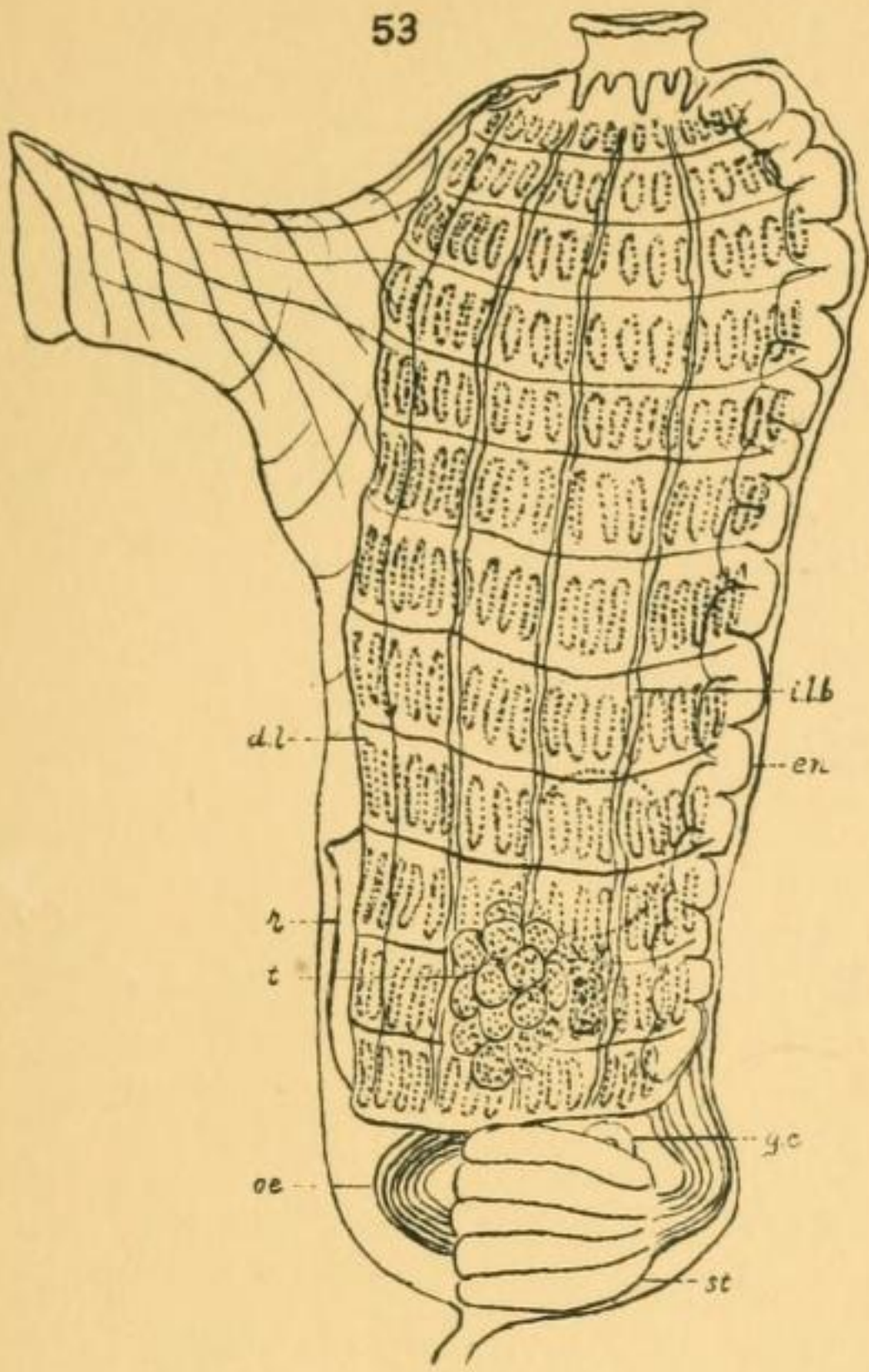


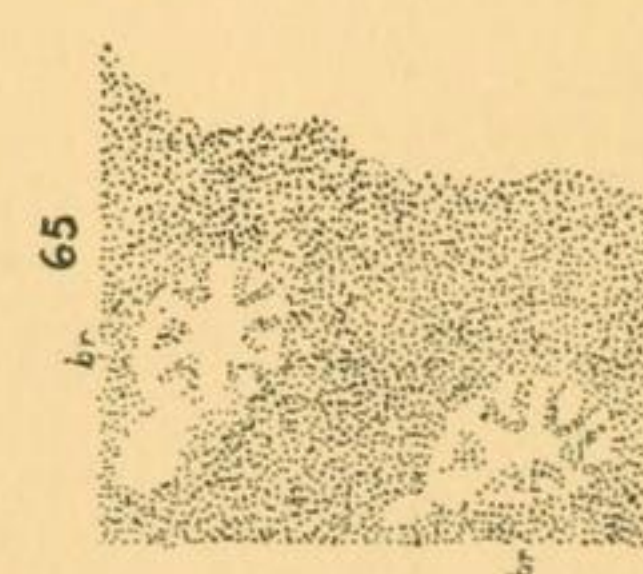
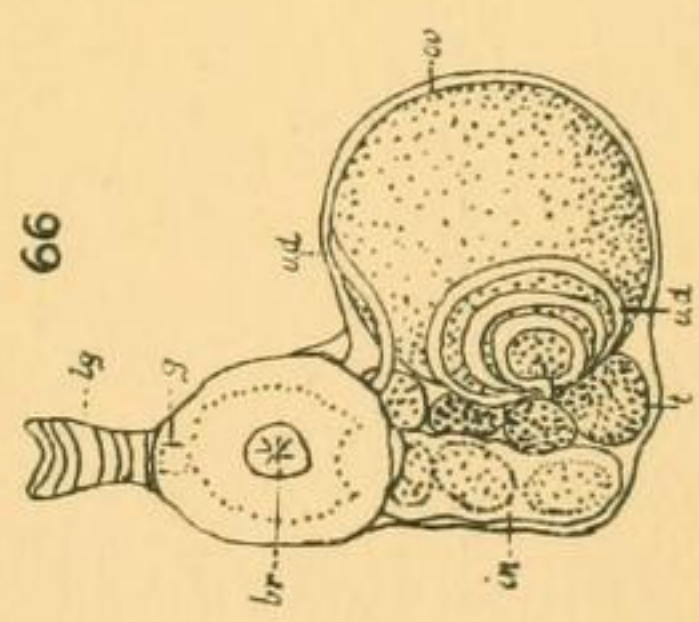
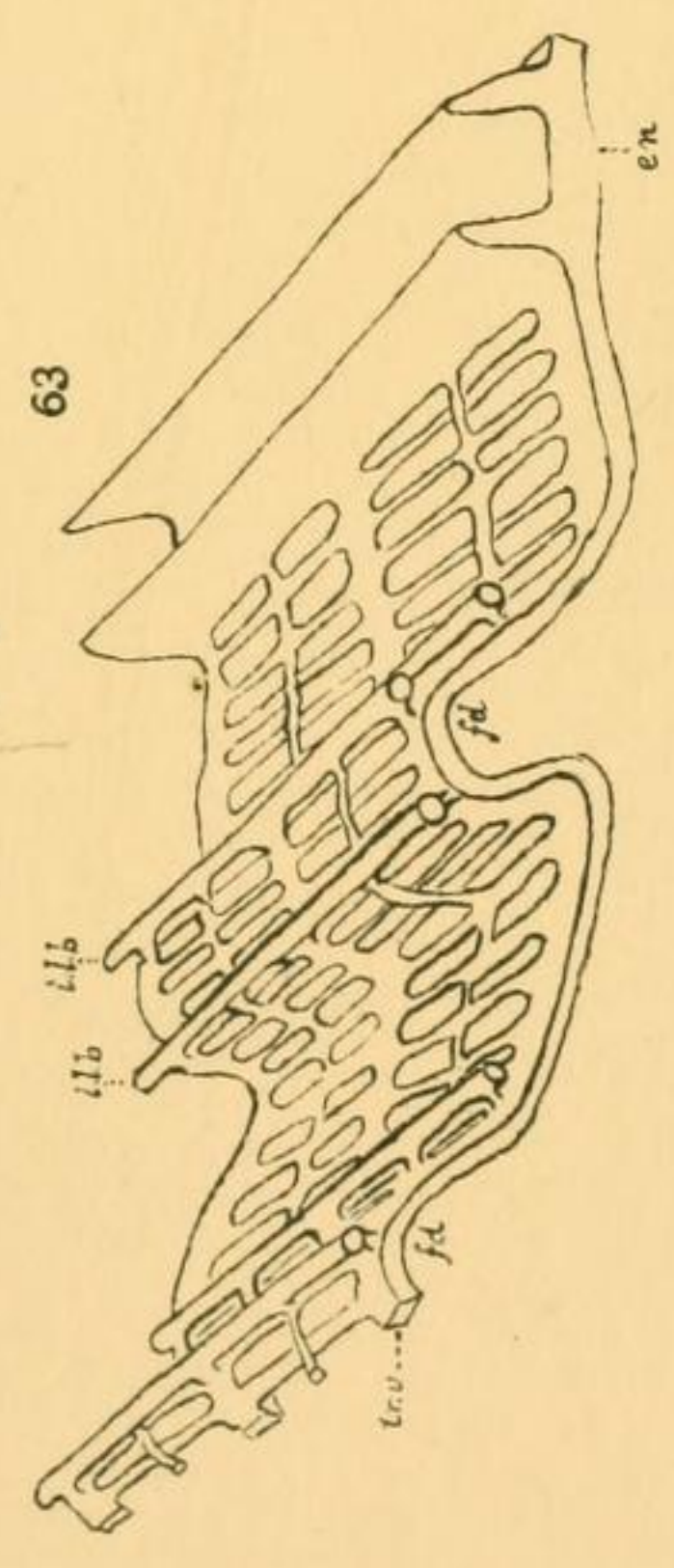
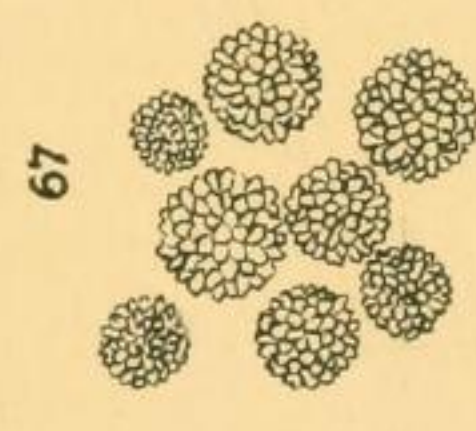
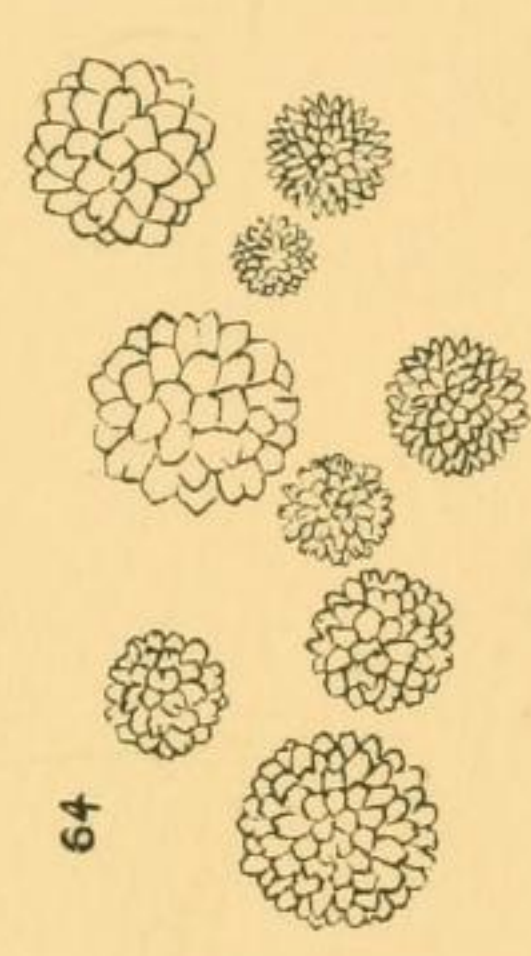
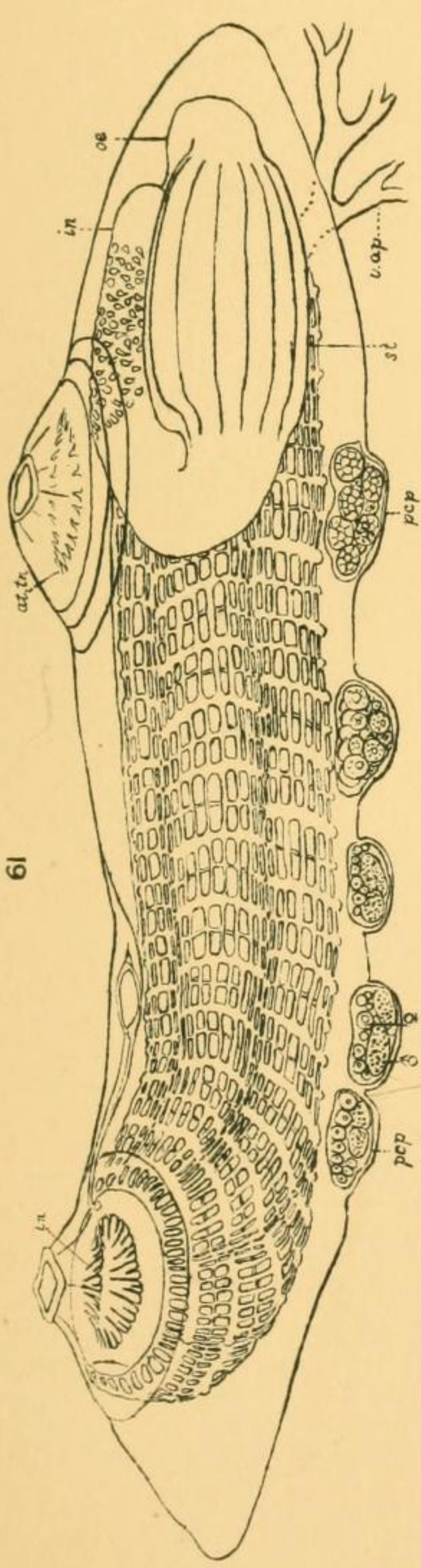
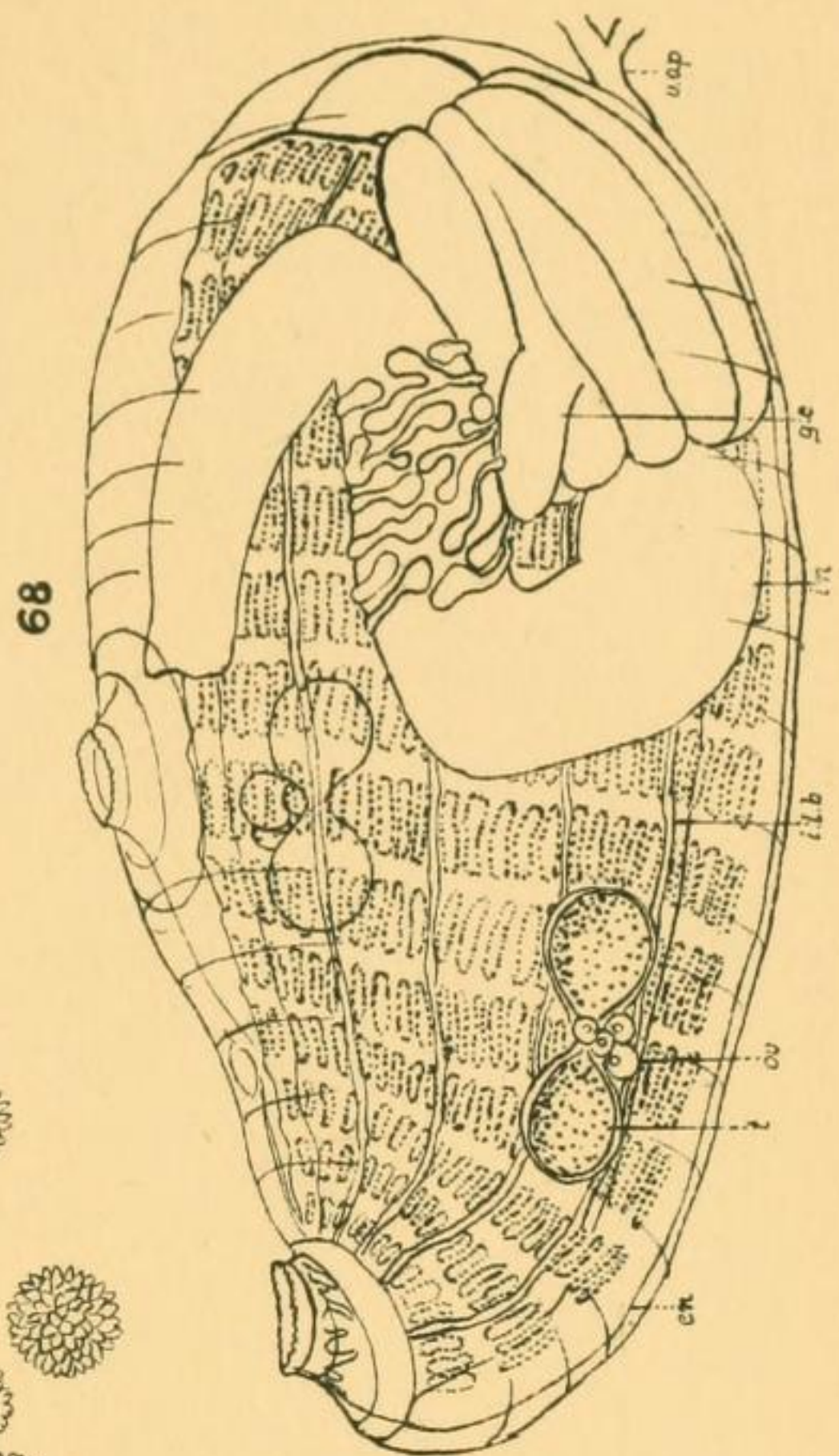
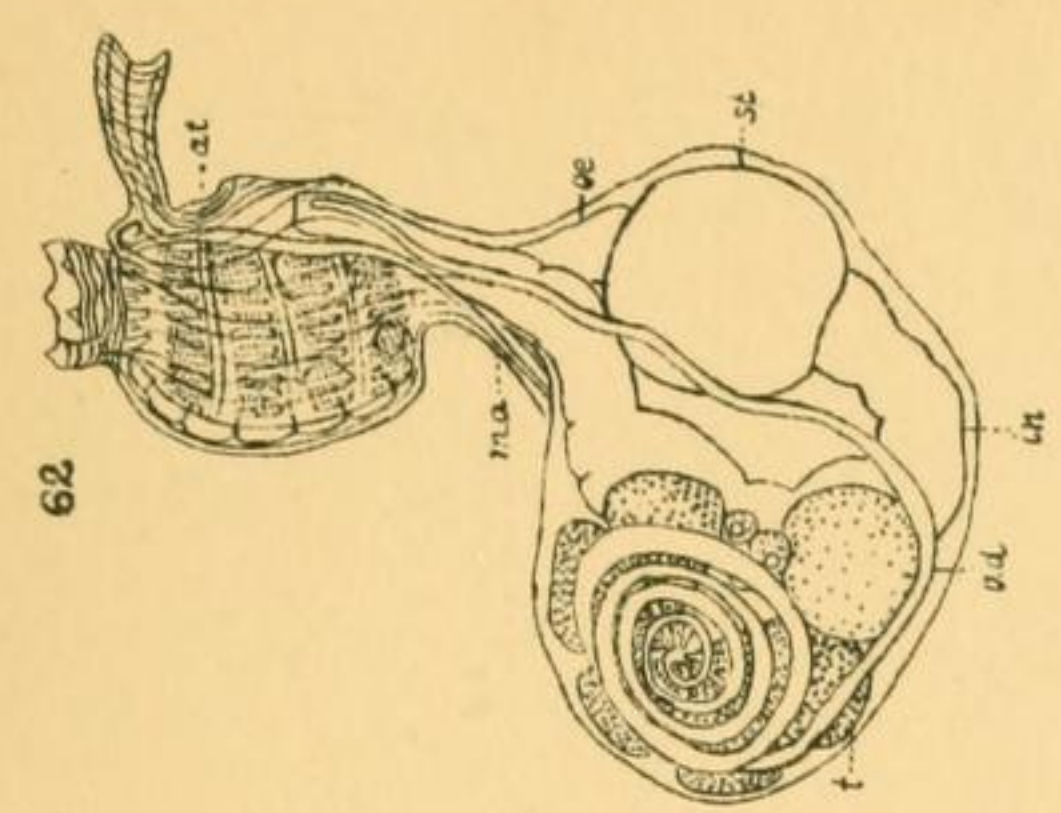


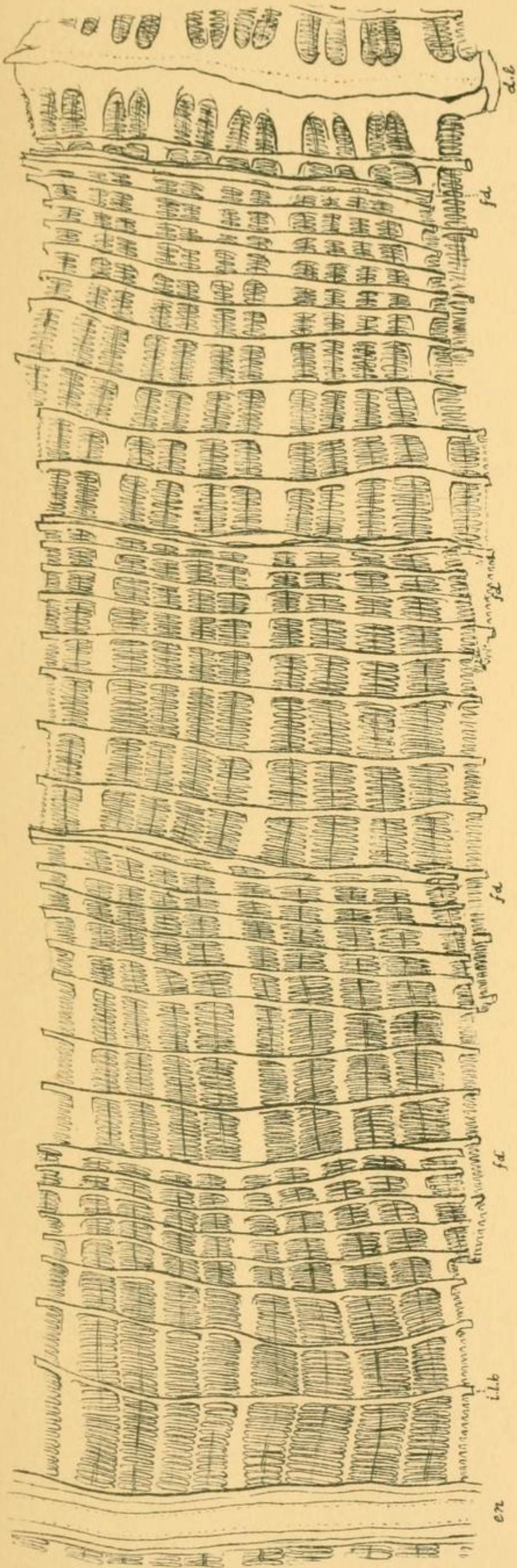




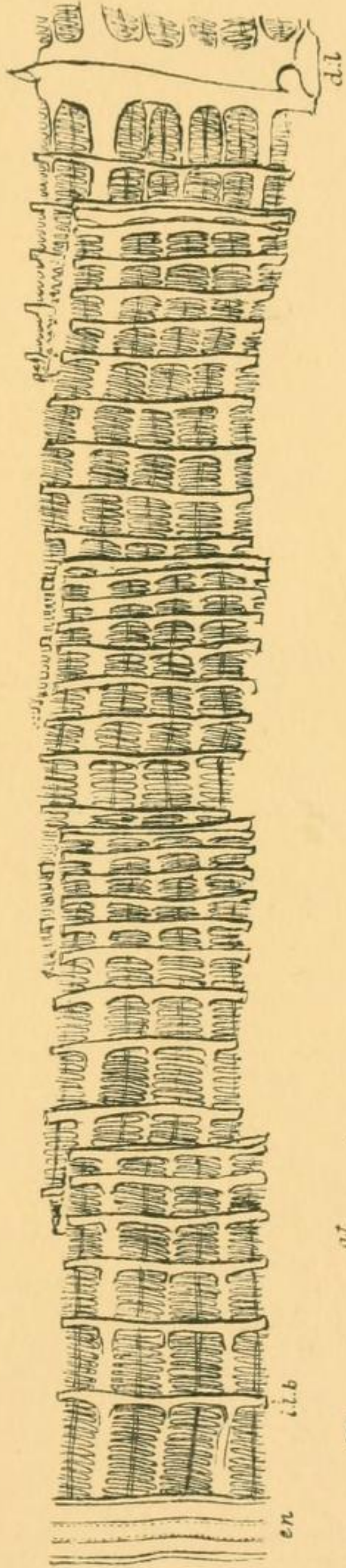




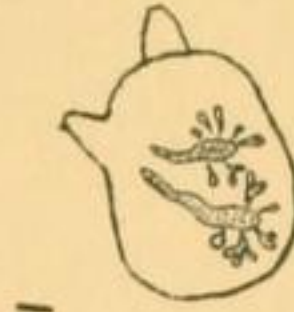




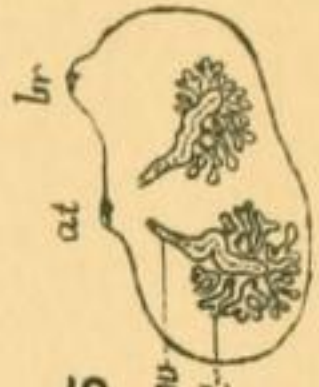
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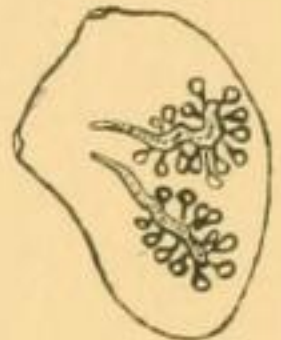
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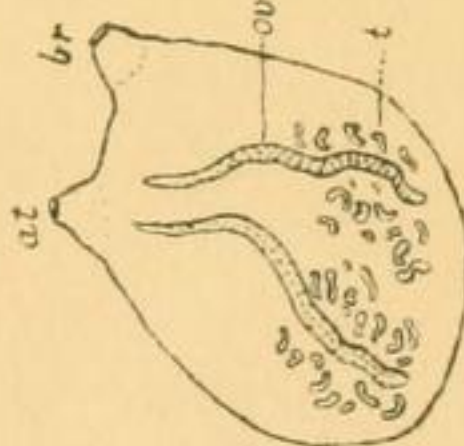
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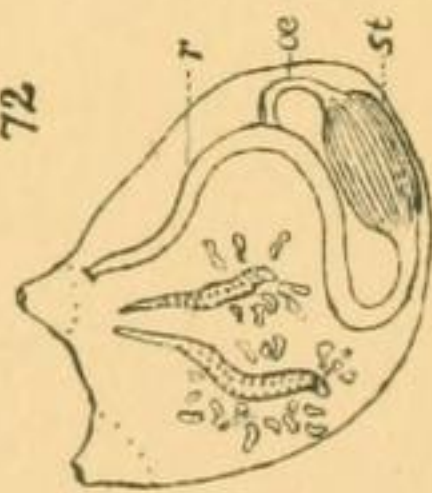
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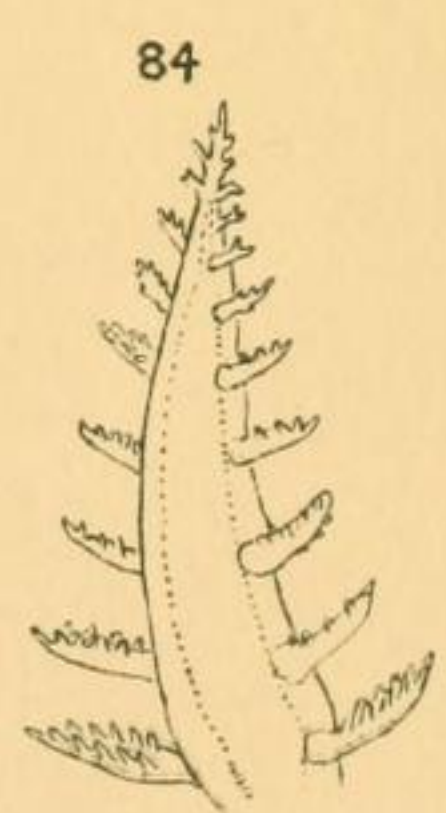
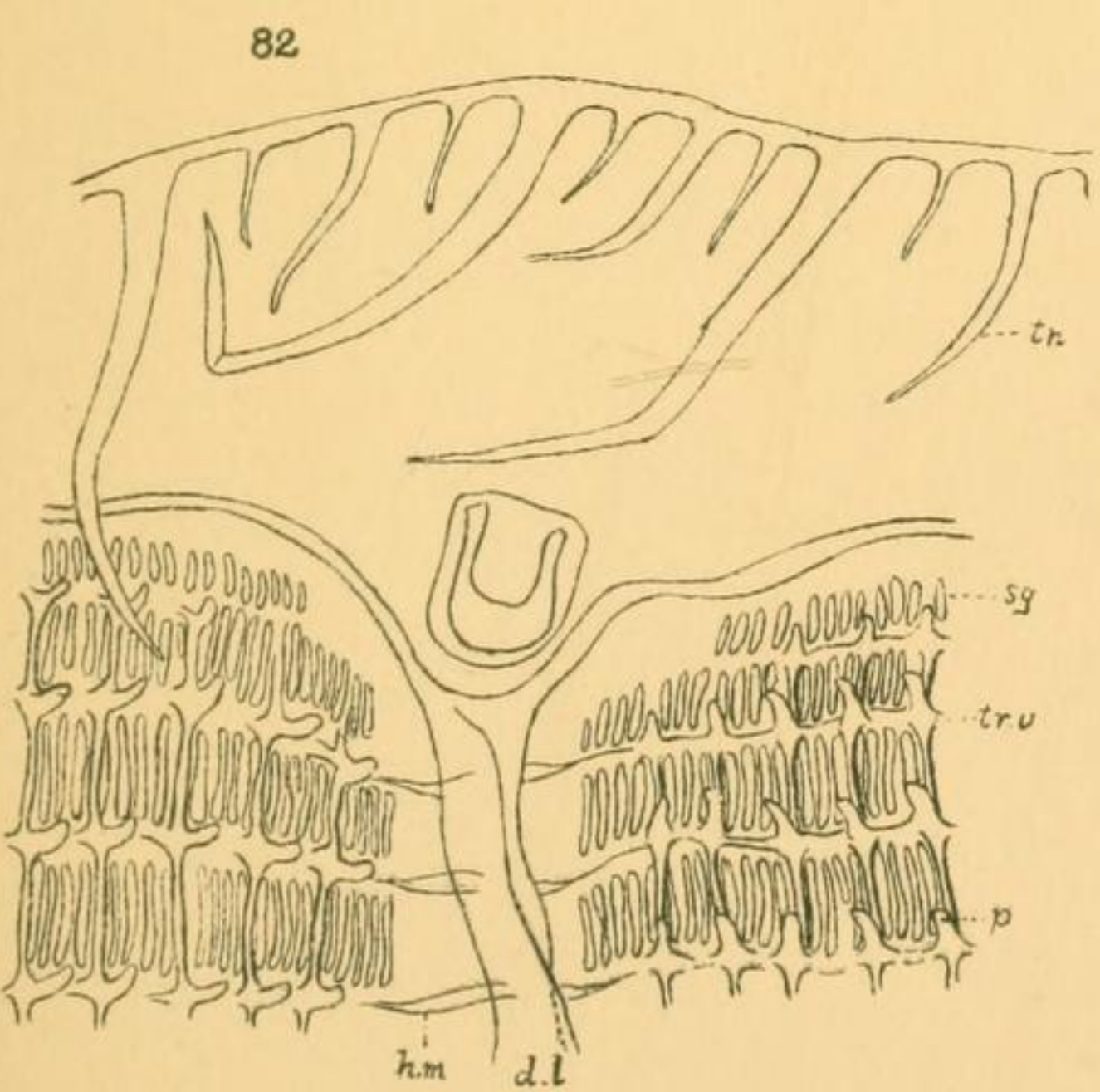
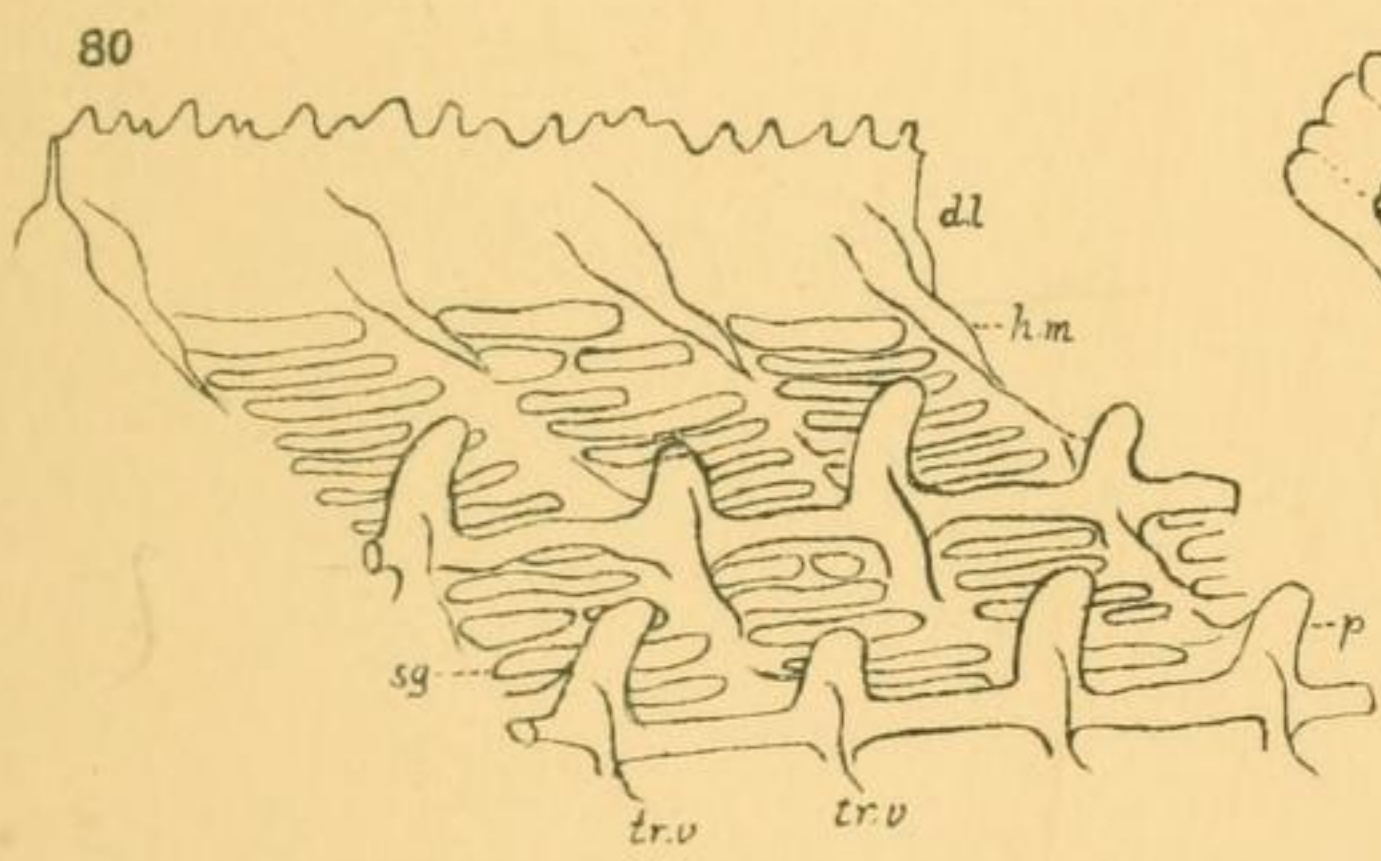
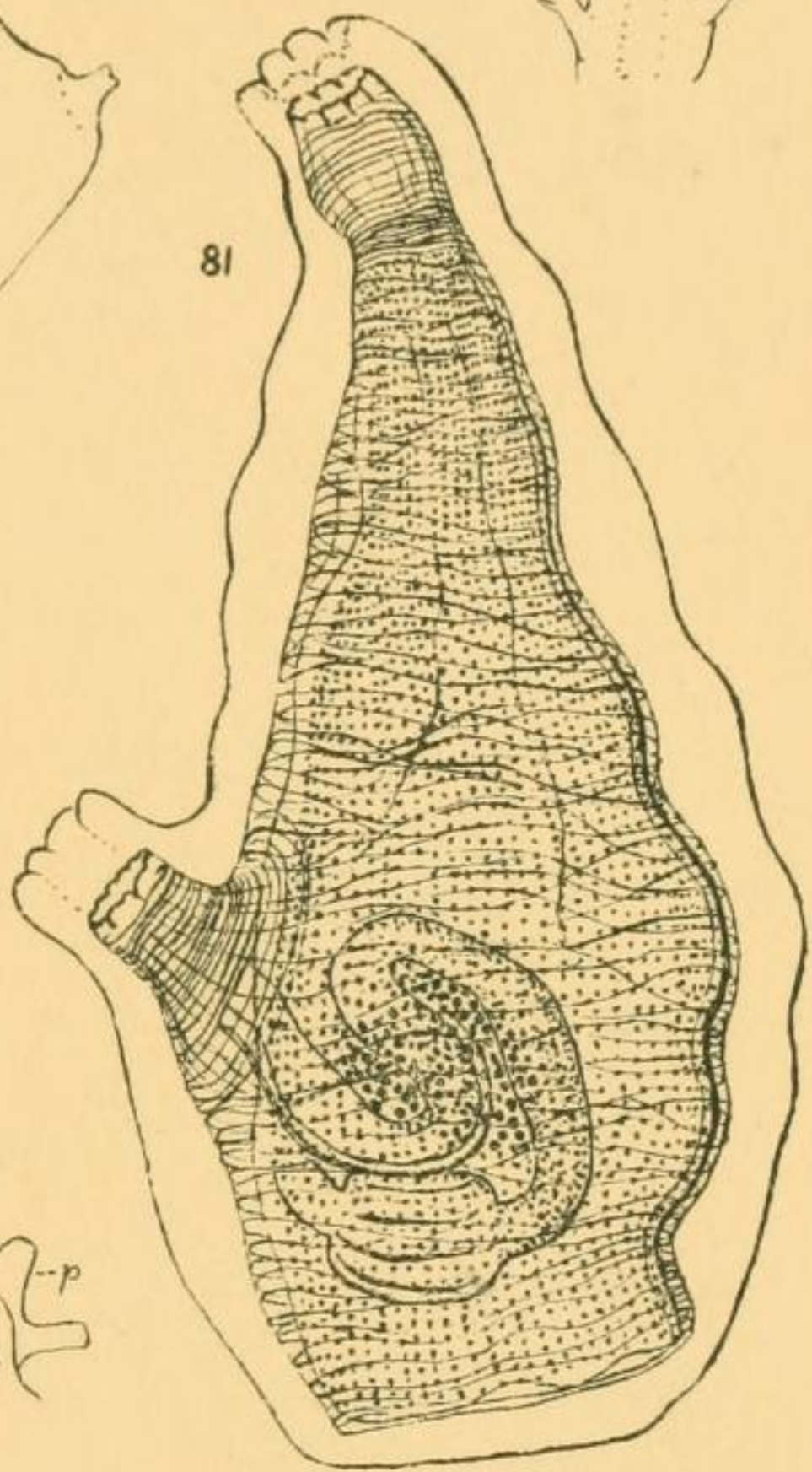
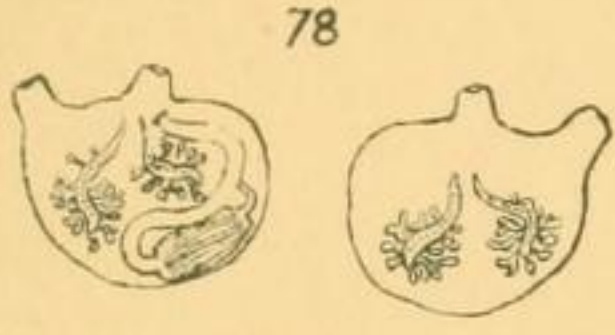
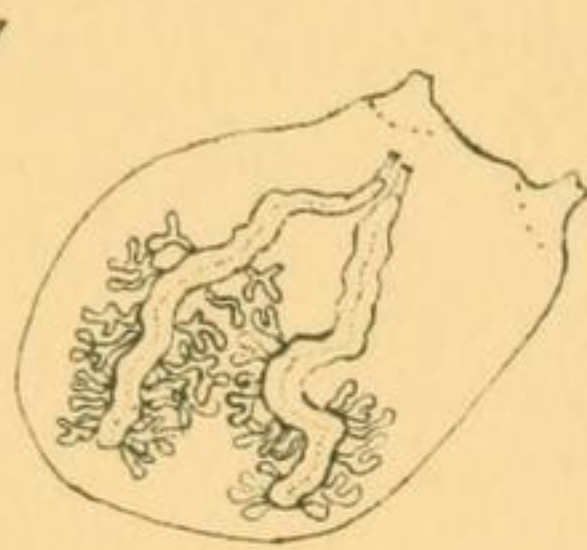
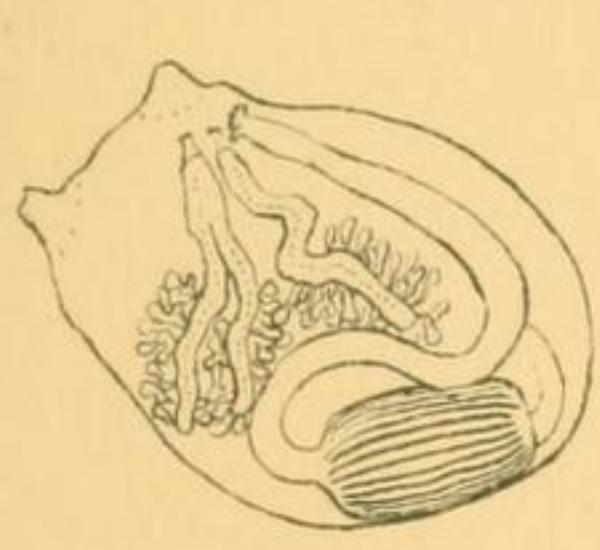
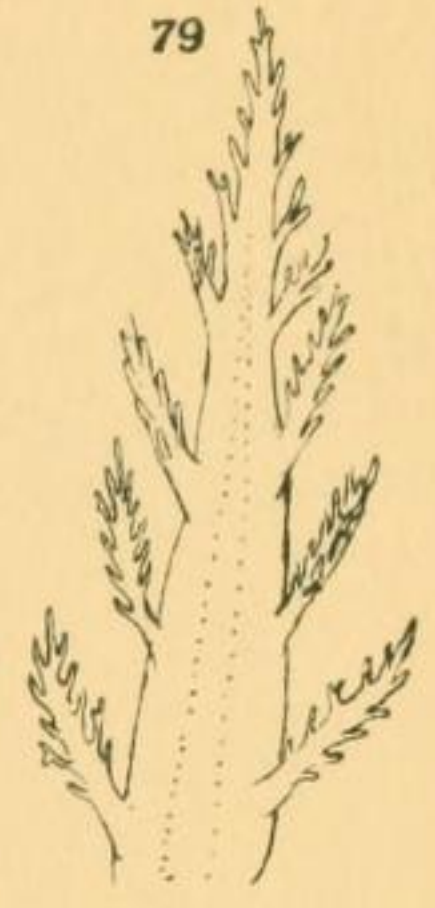
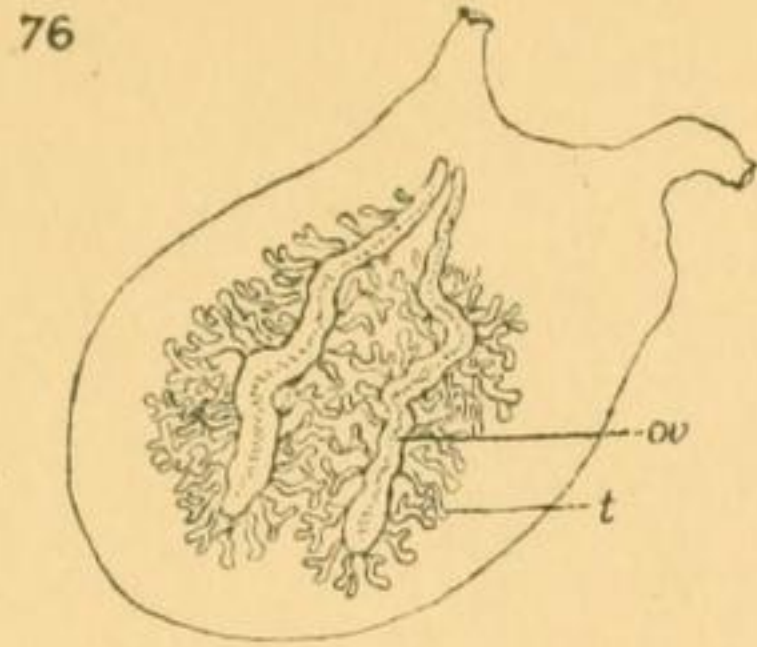
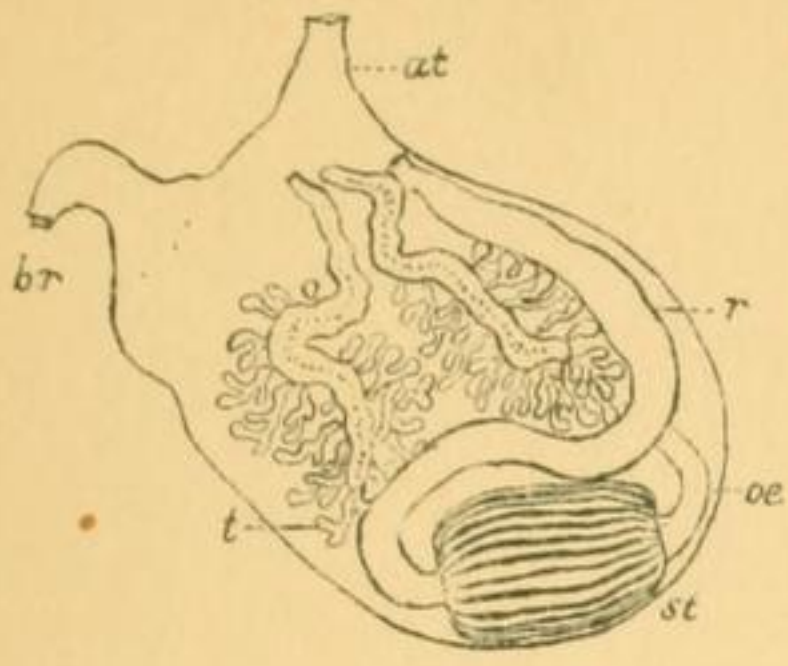


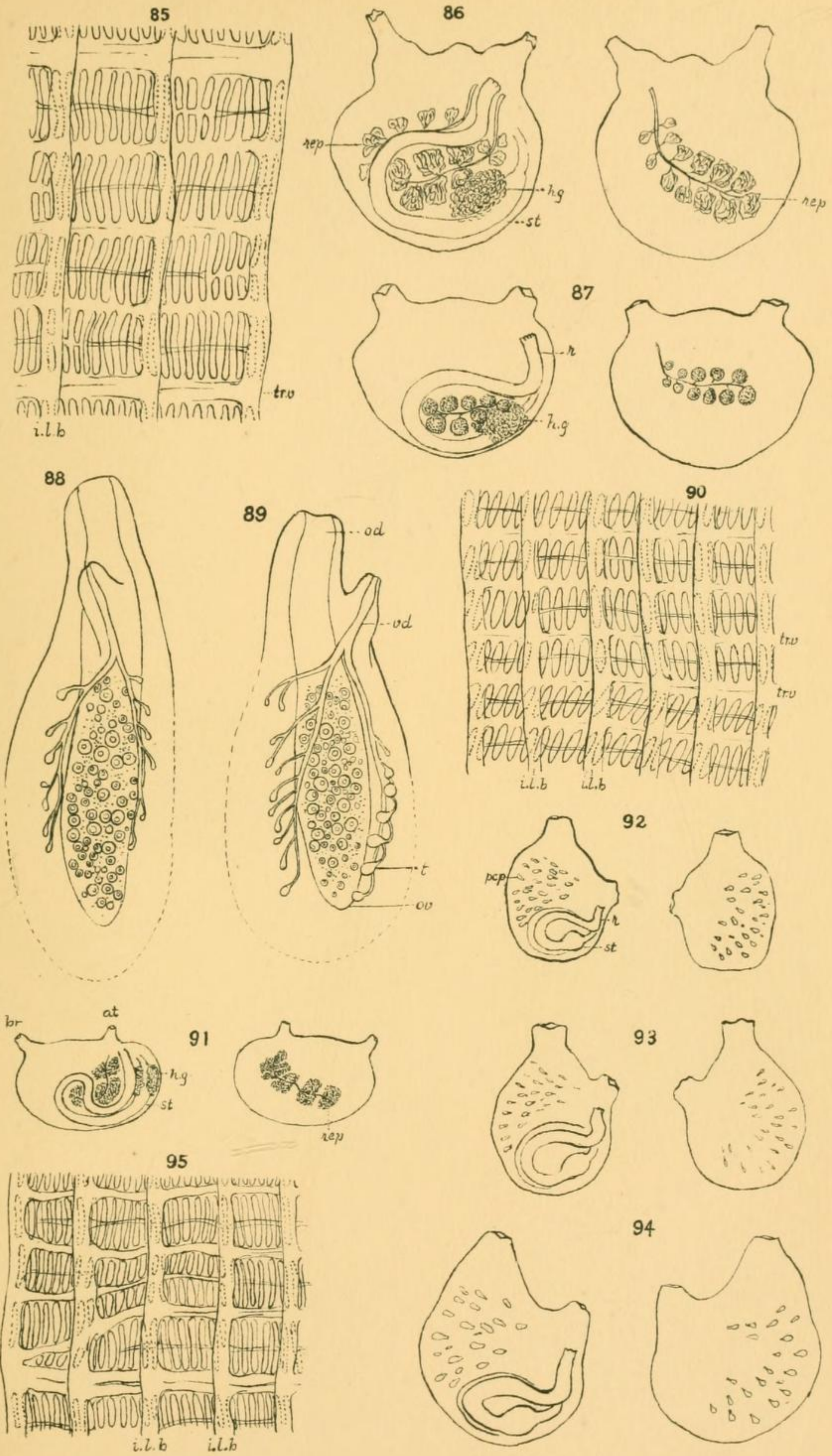
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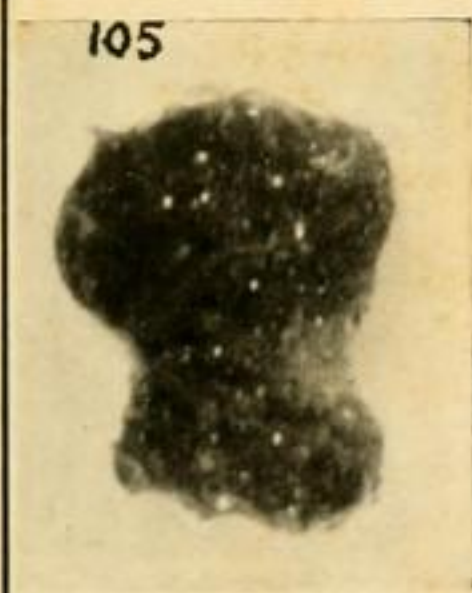
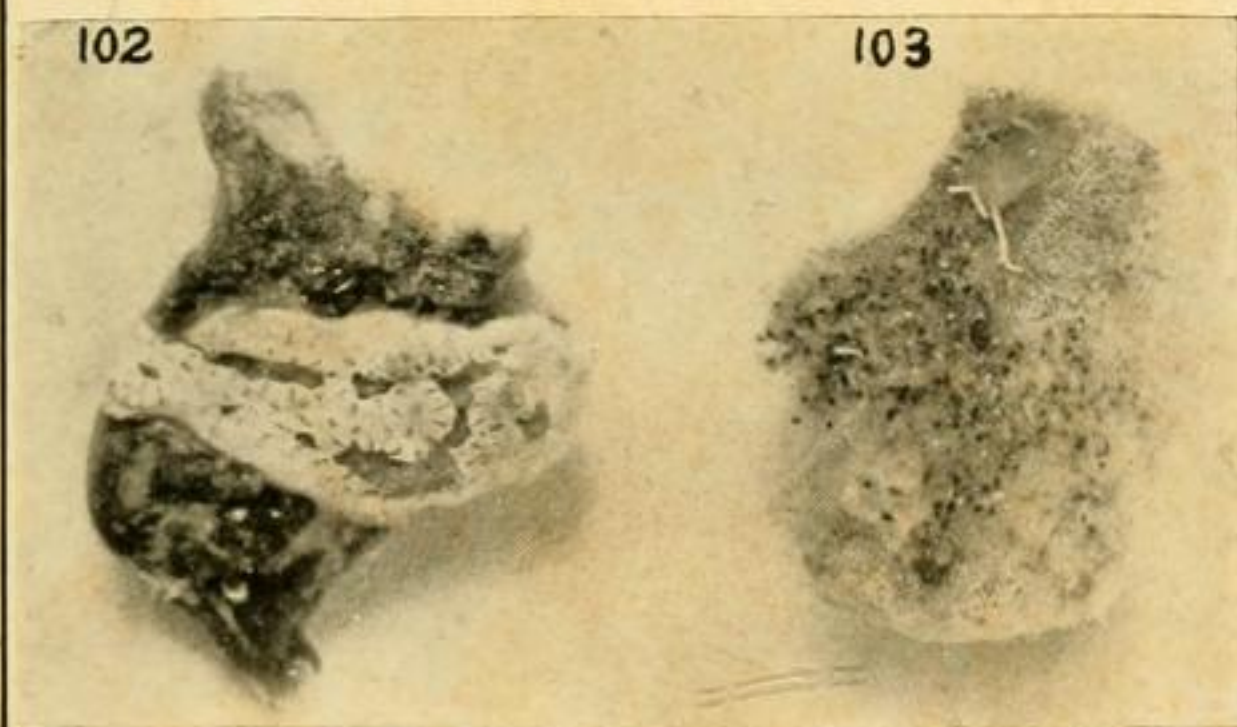
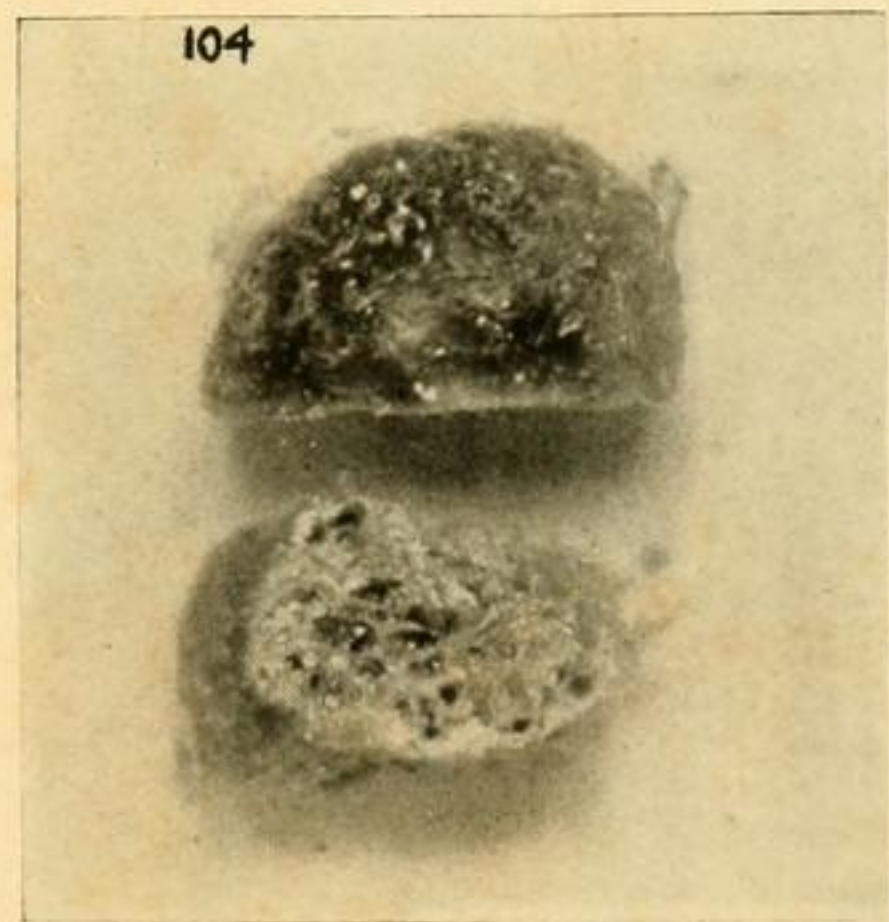
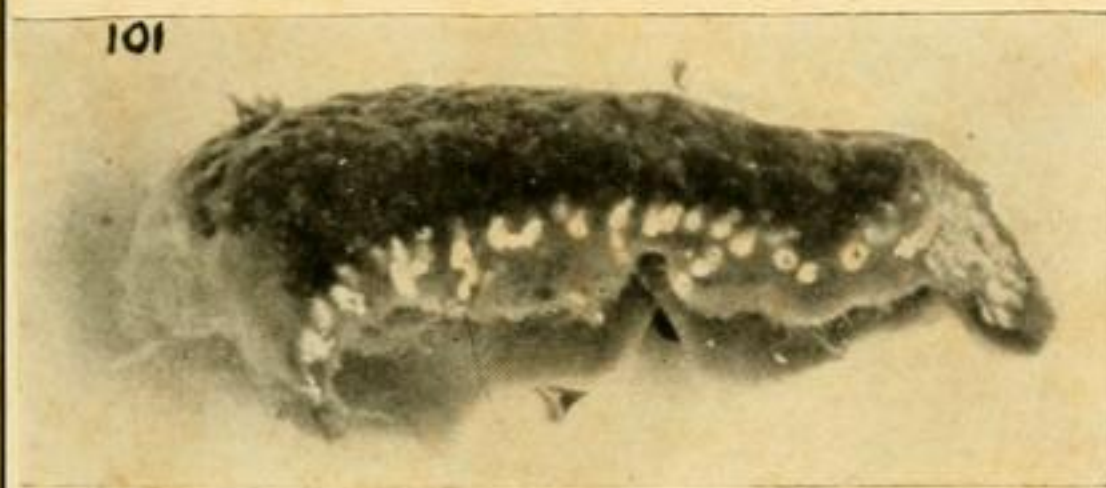
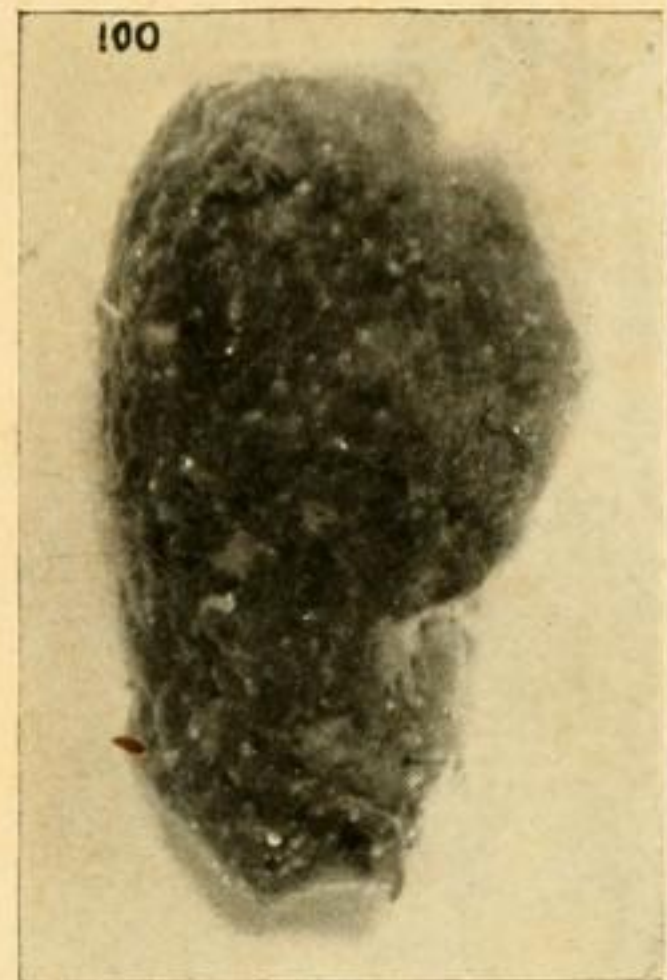
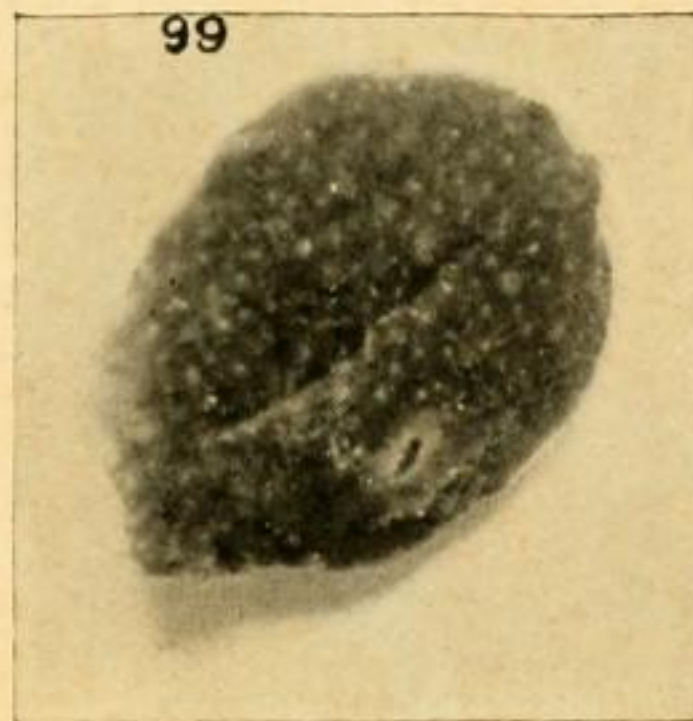
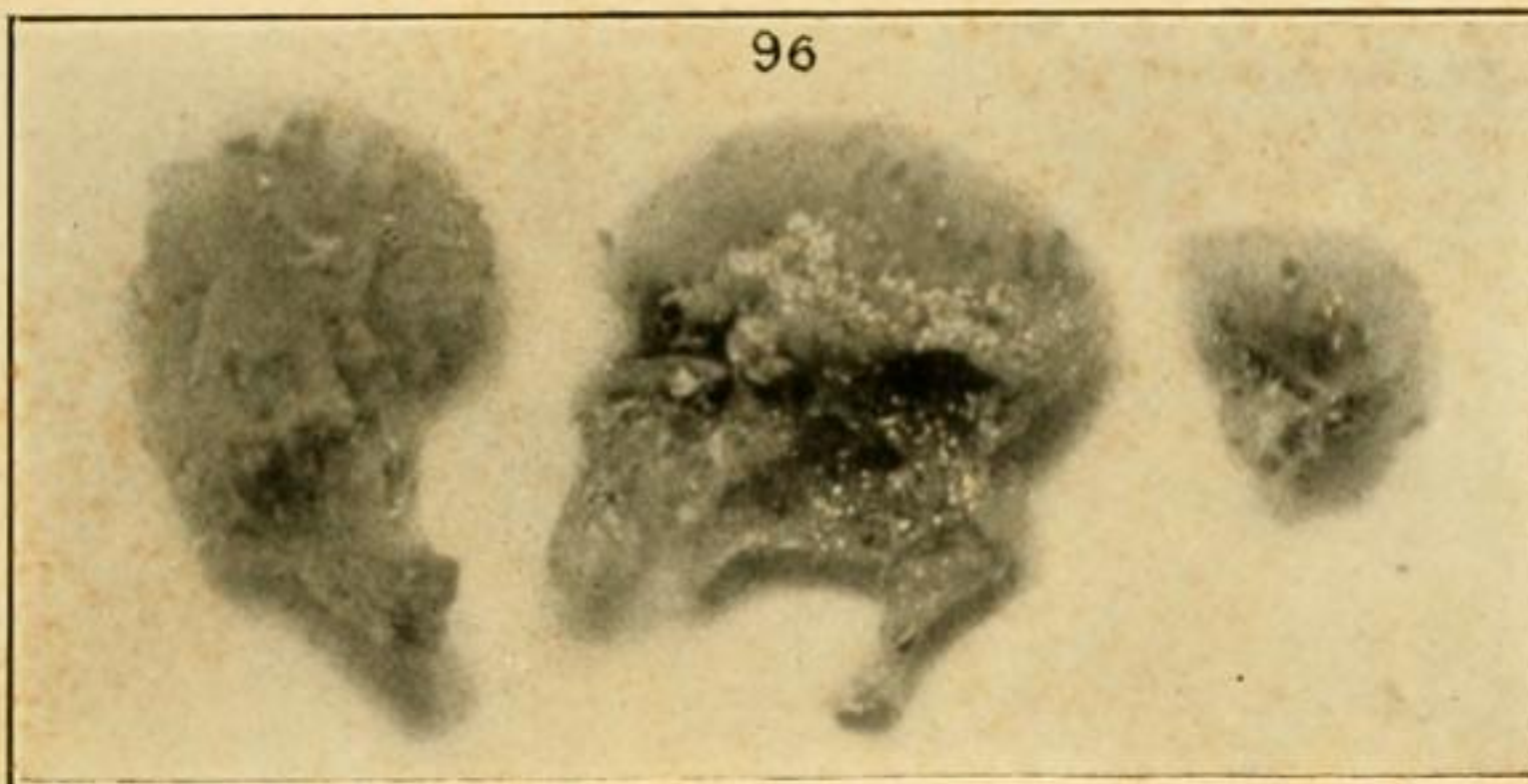


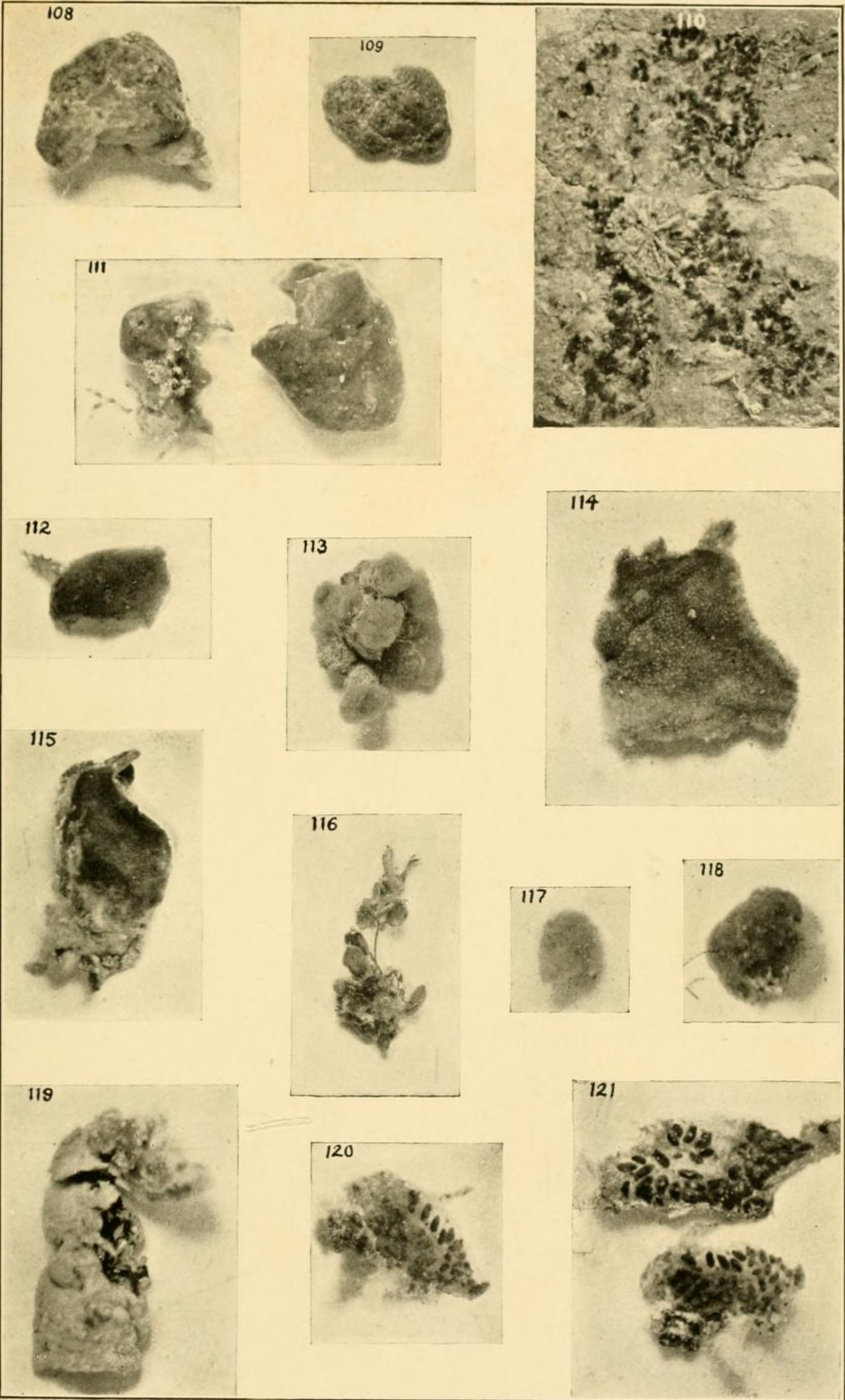
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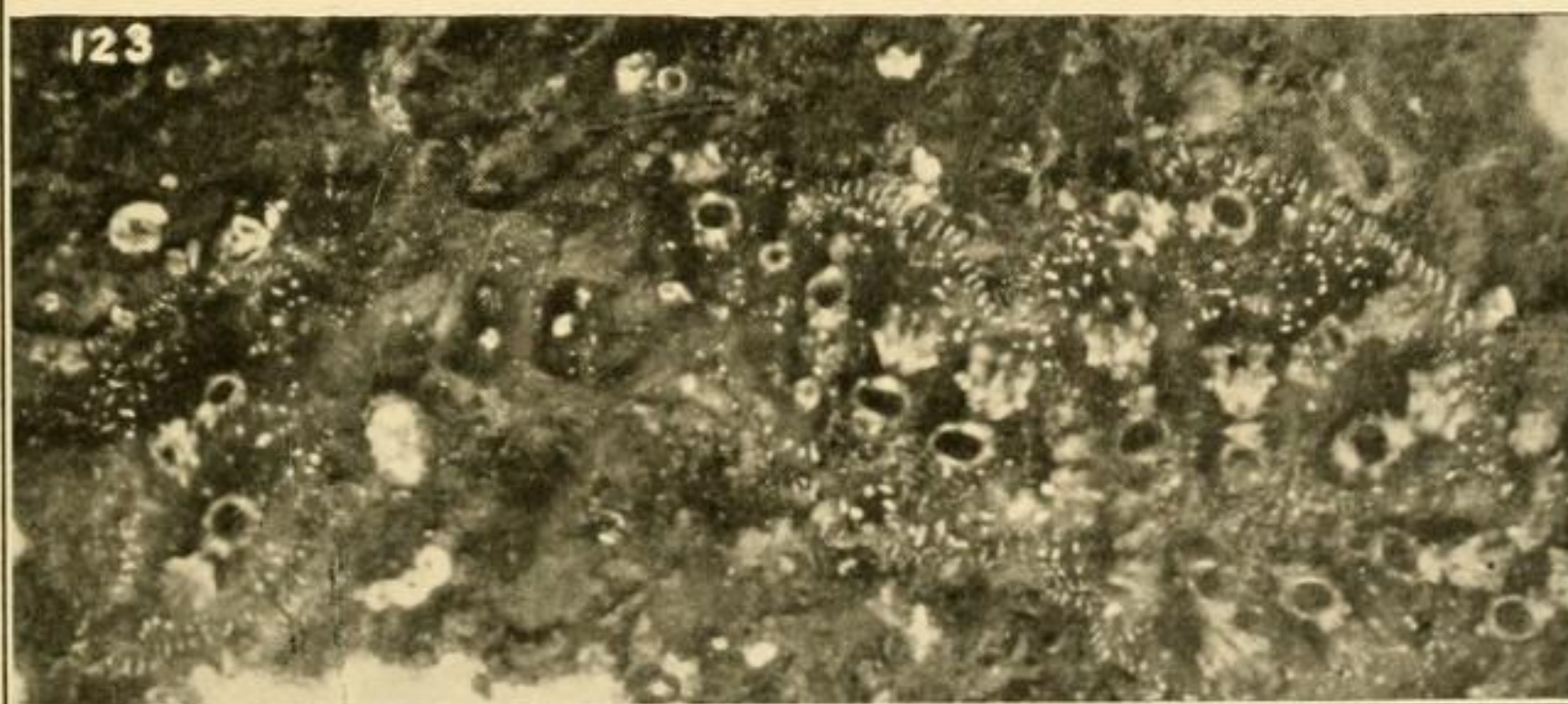
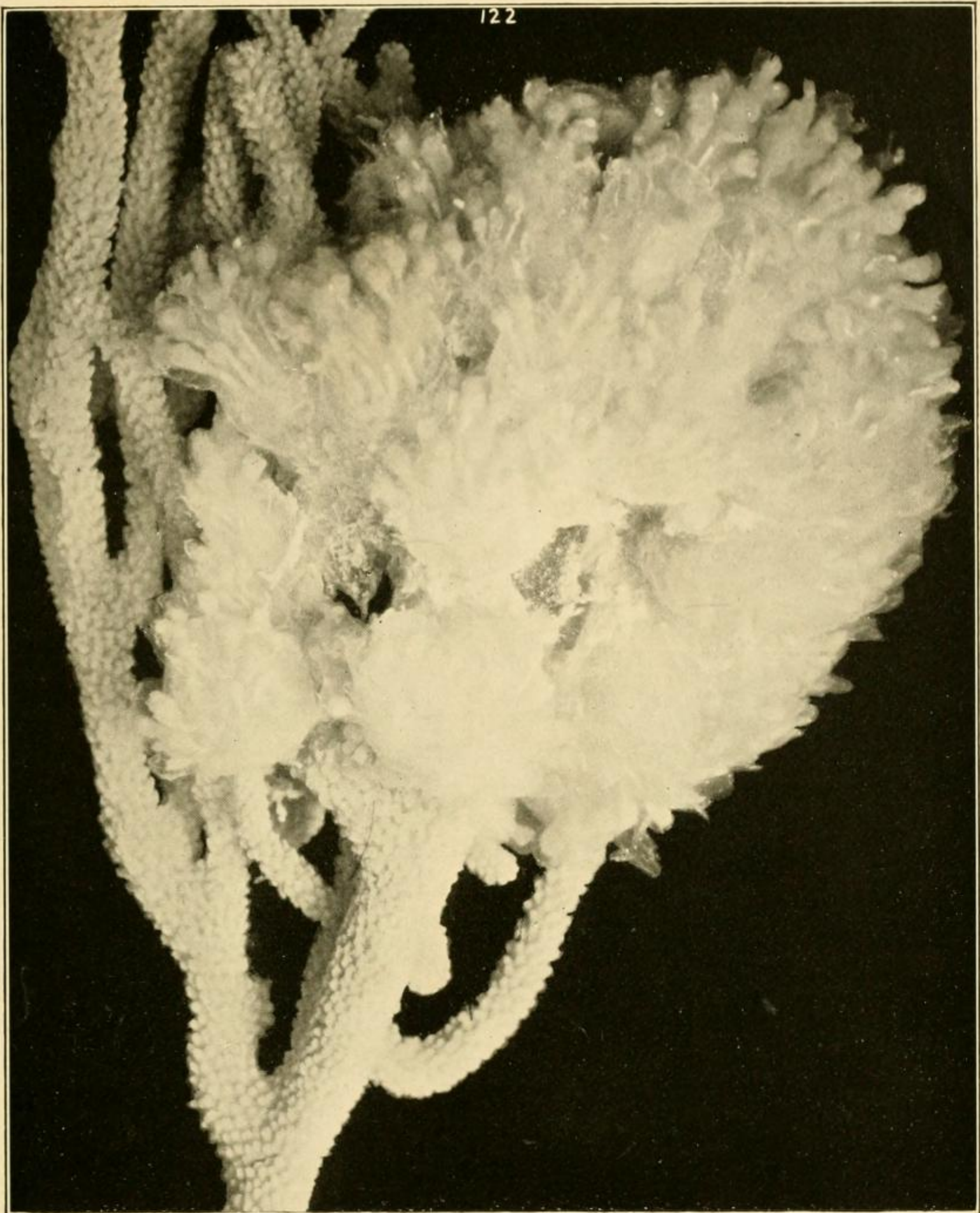




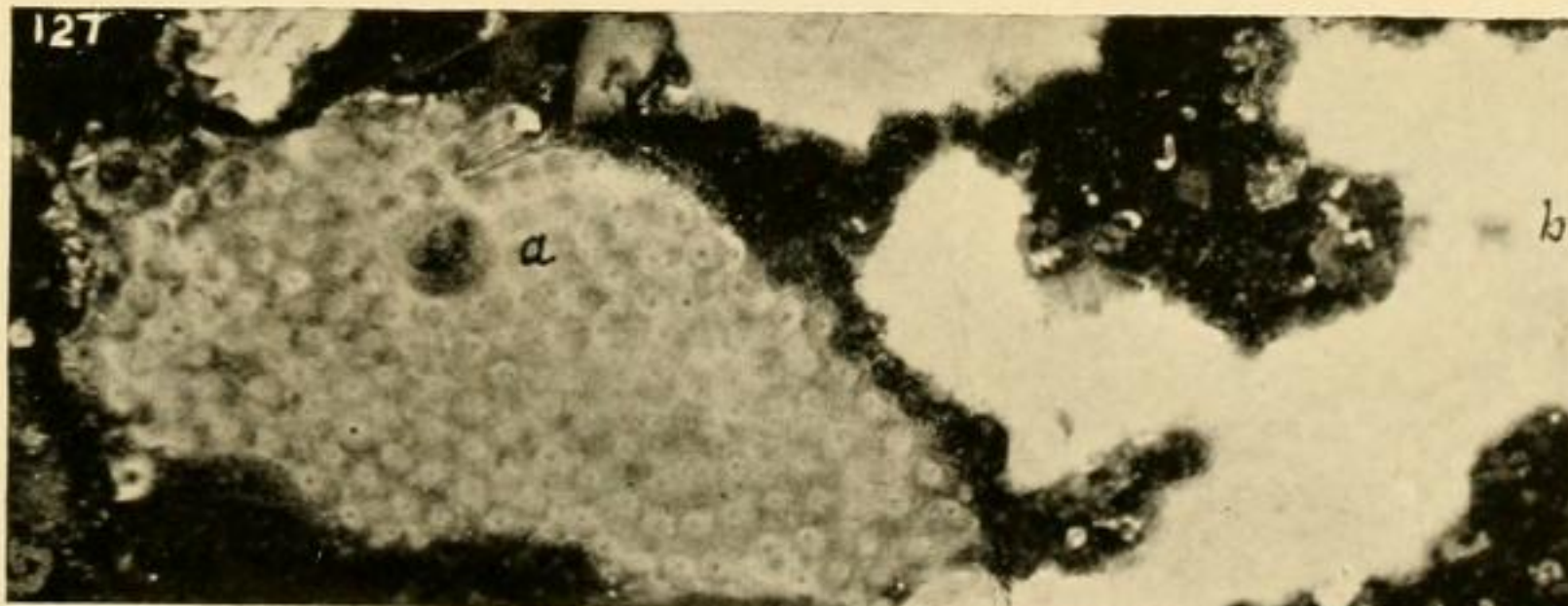
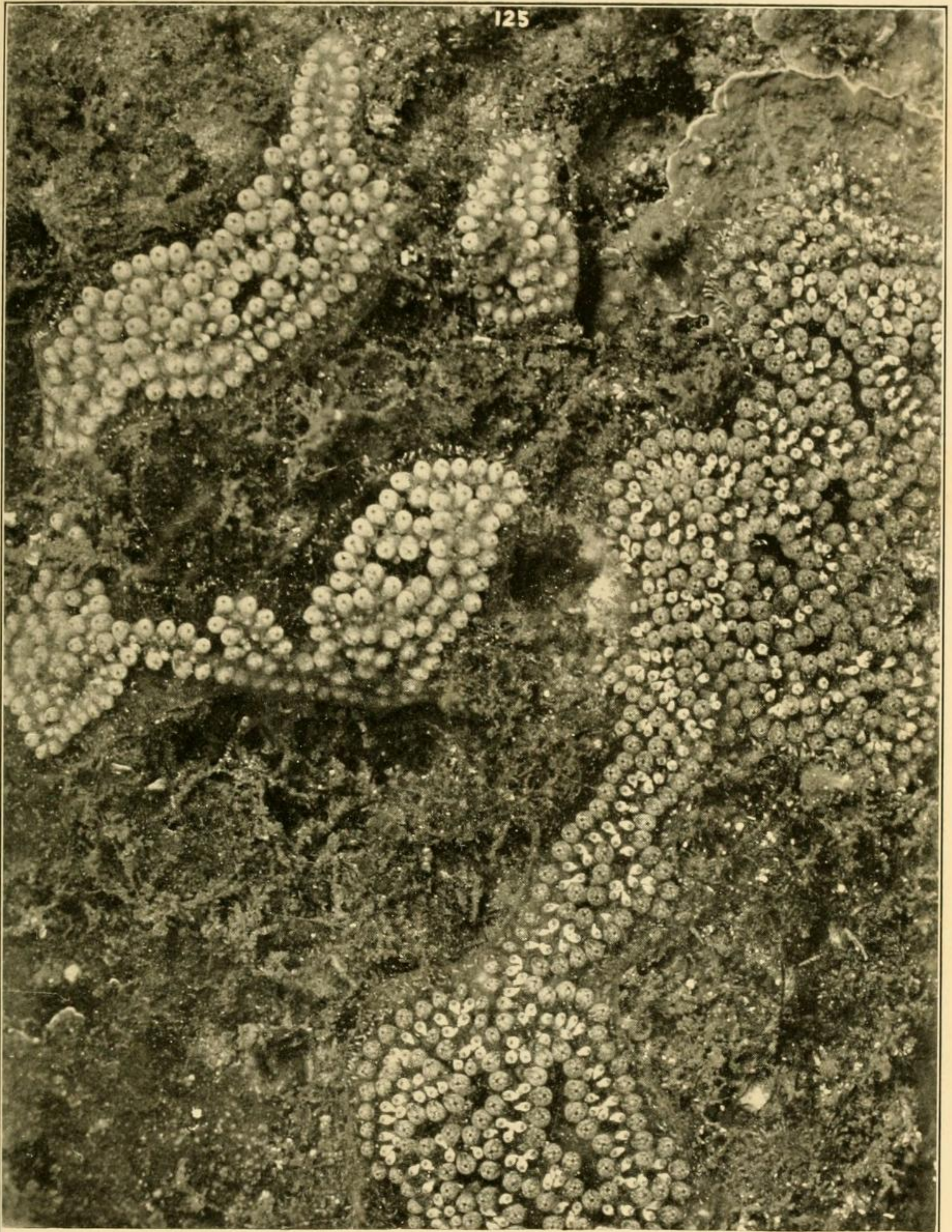




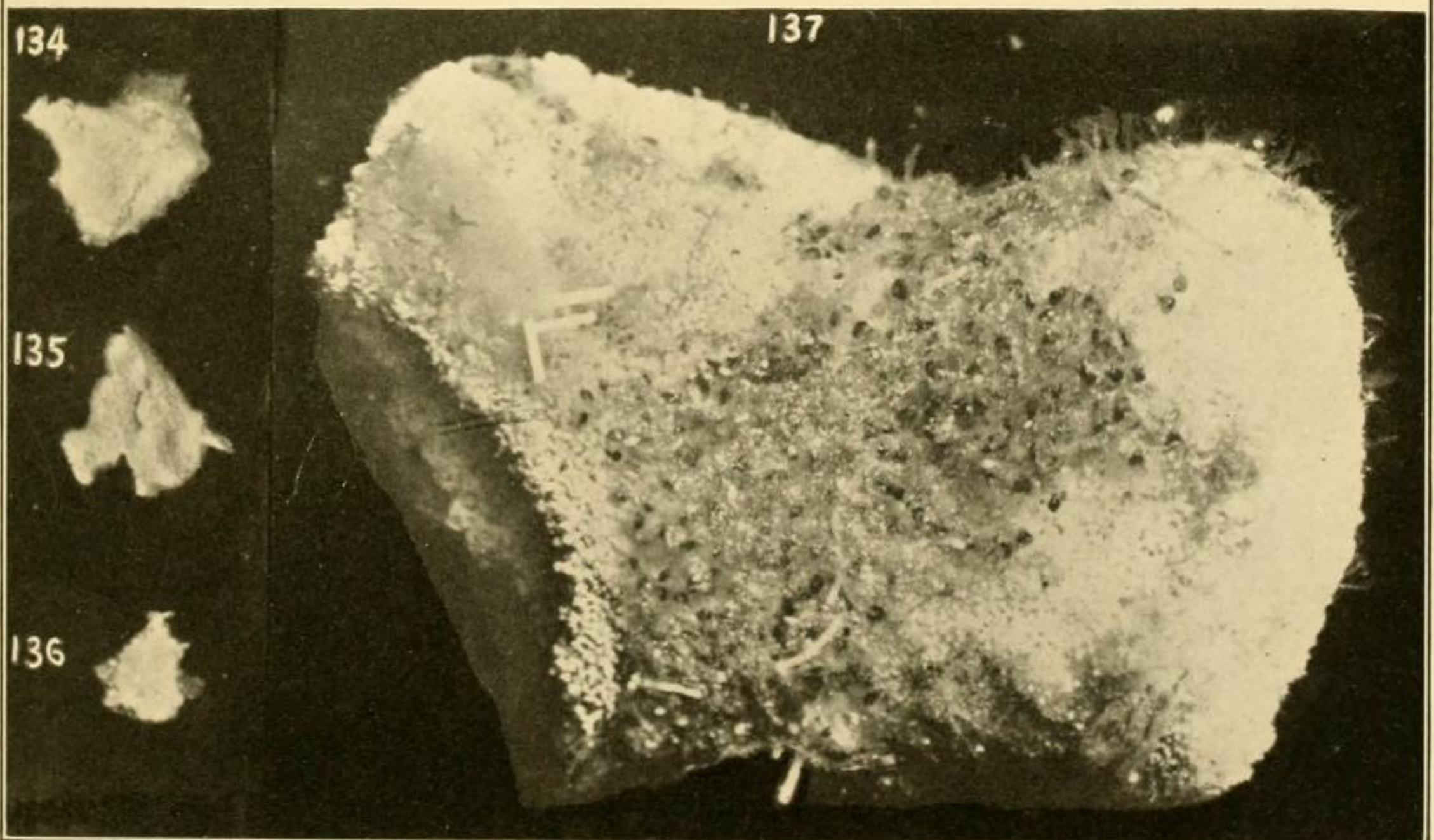
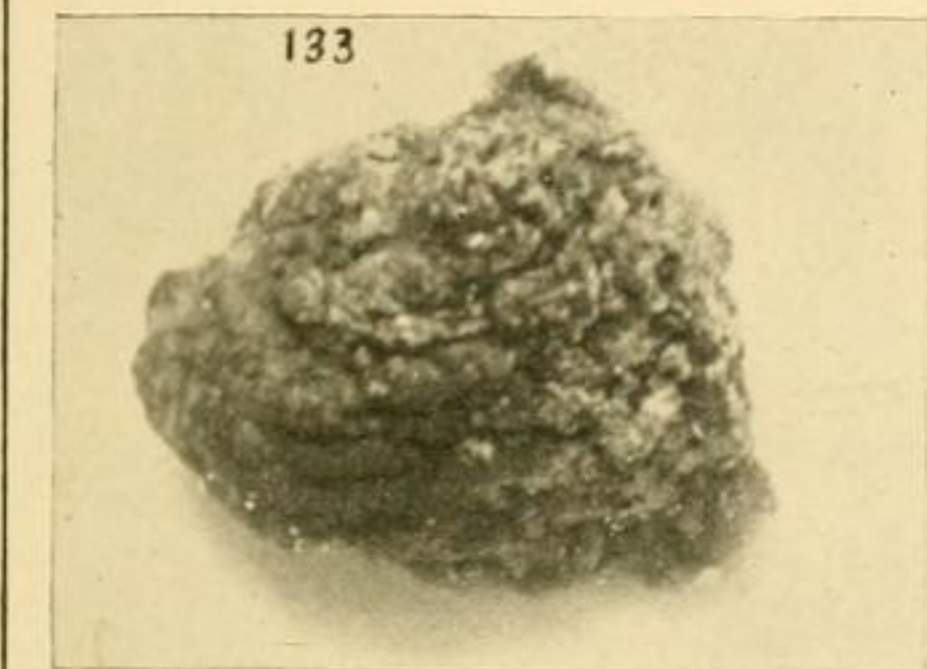
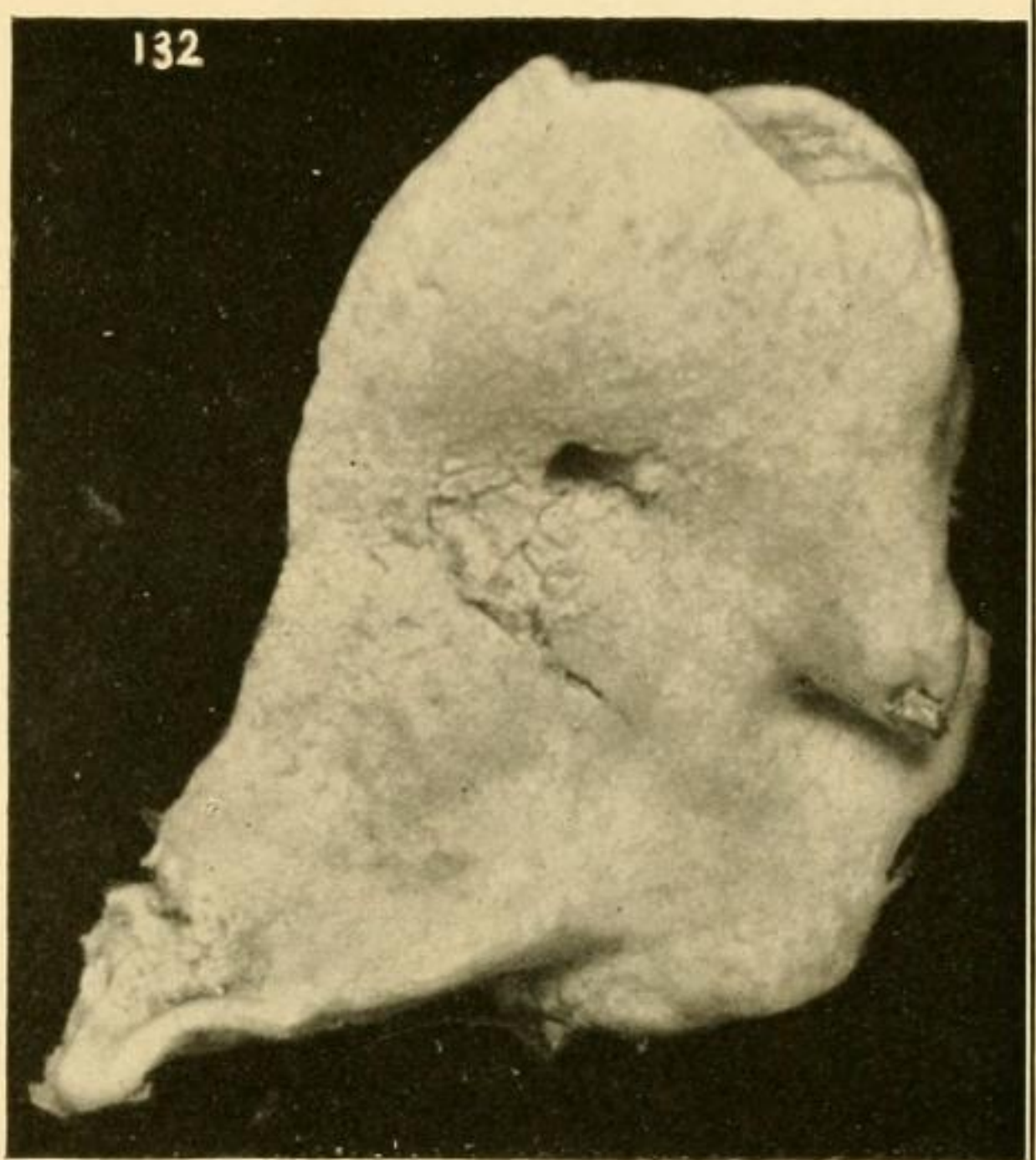
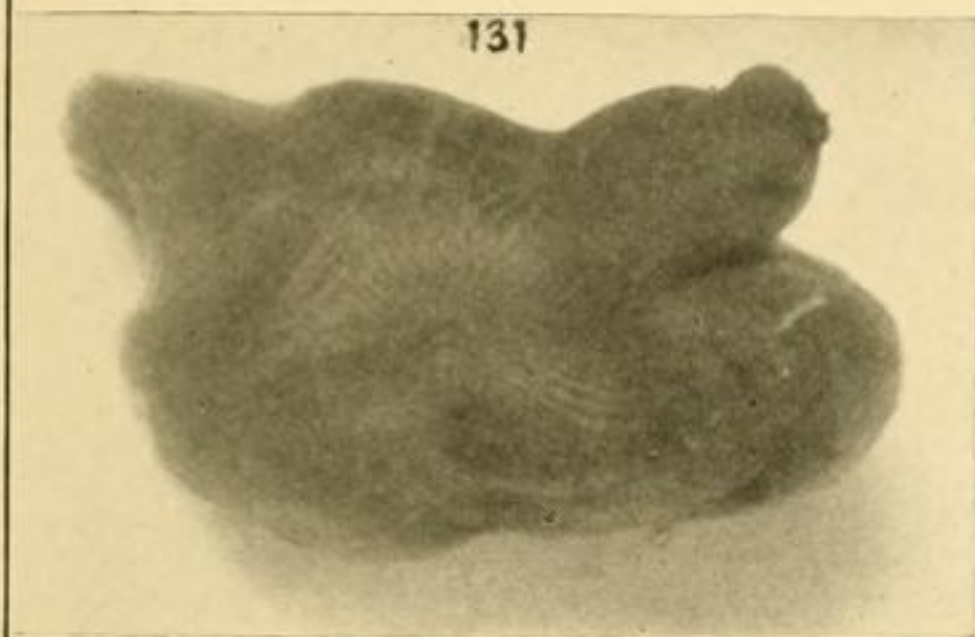
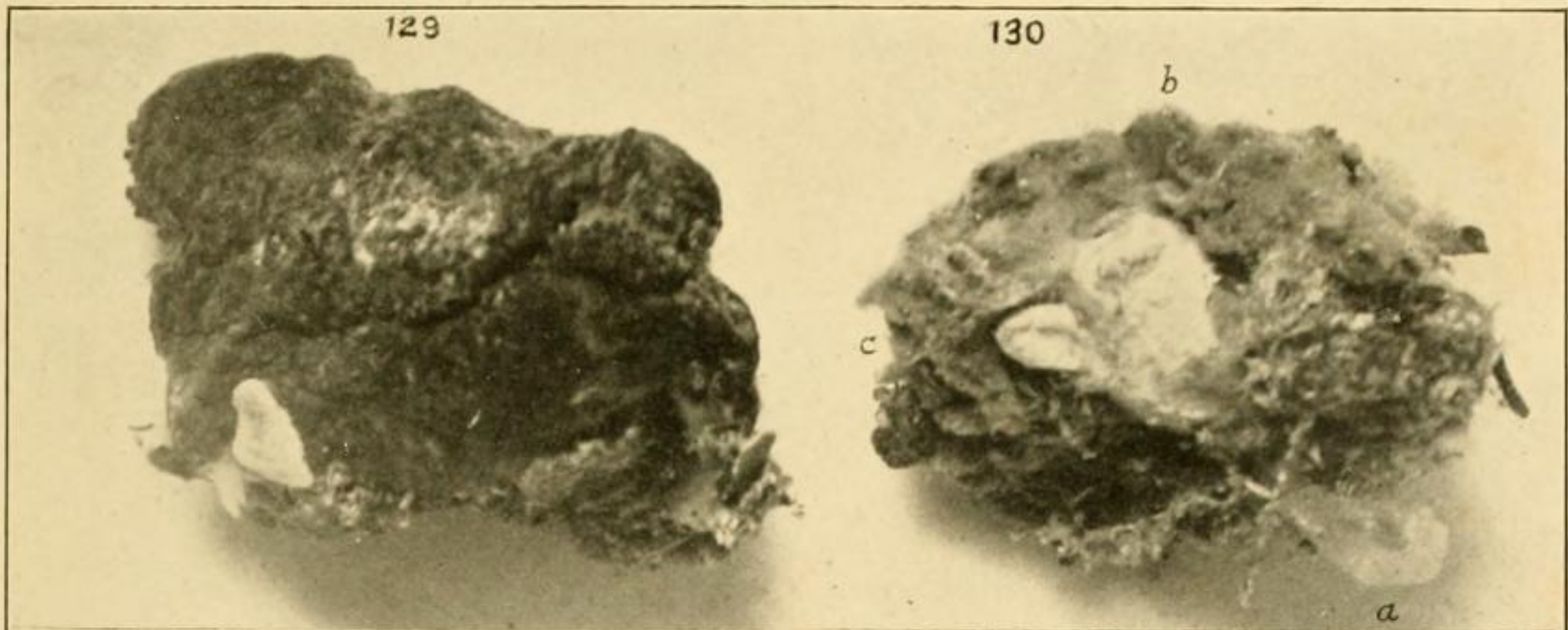




A. Hyatt Verrill, Photo.



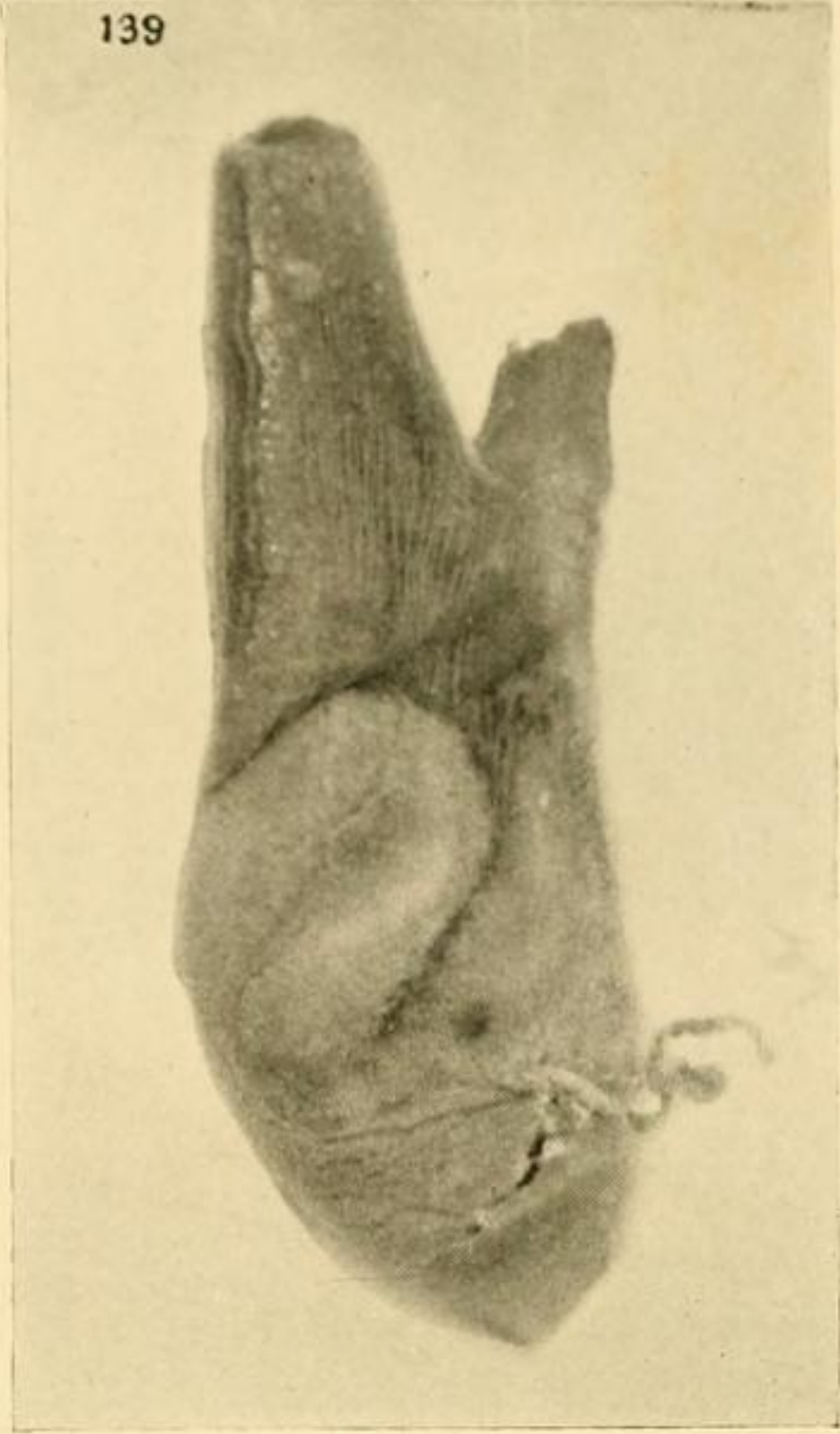
A. Hyatt Verrill, Photo.



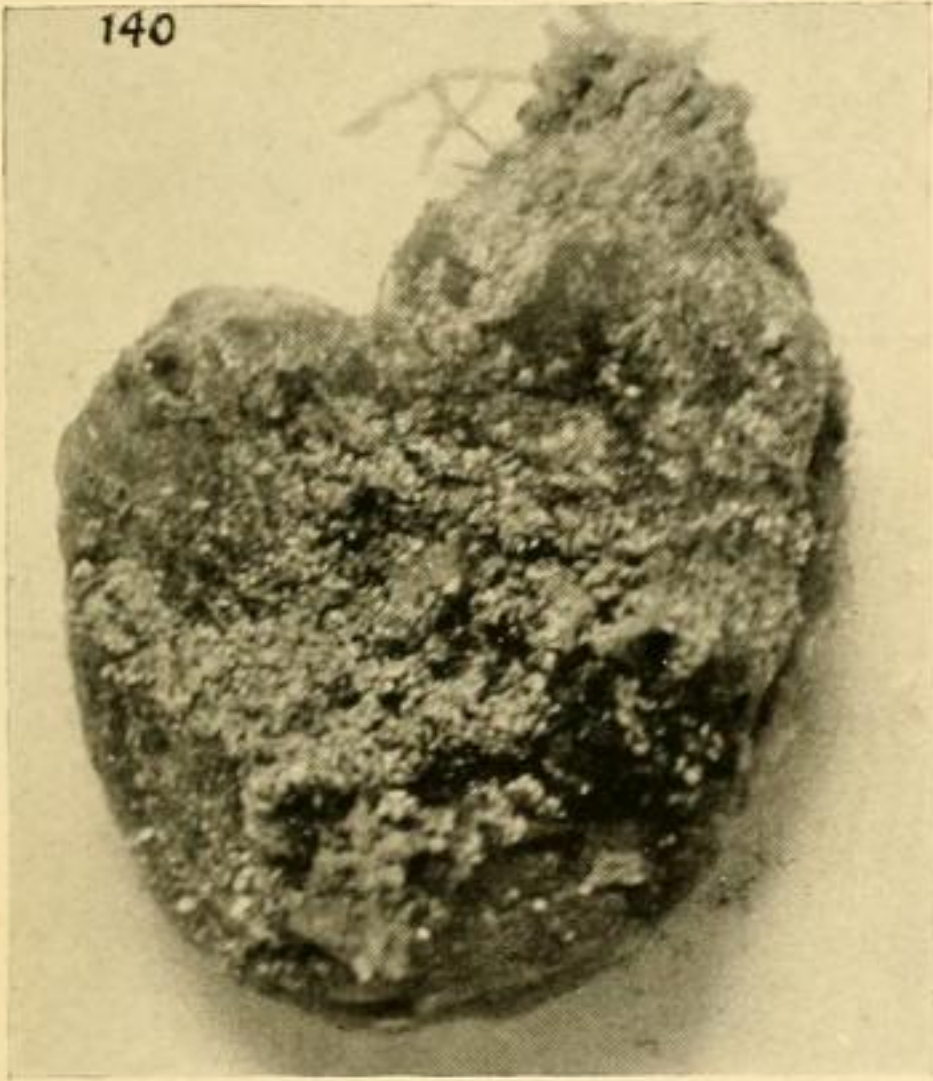
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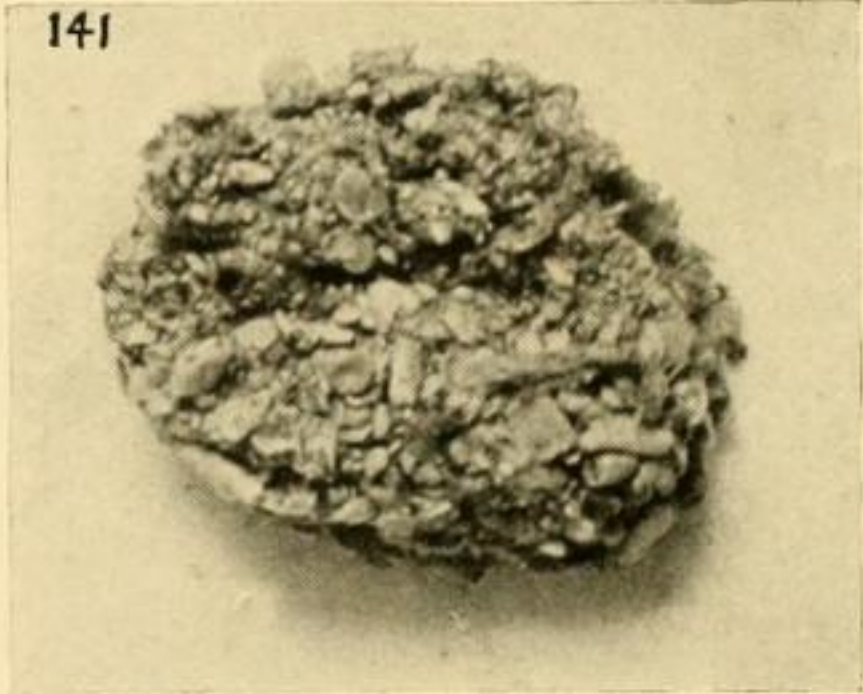
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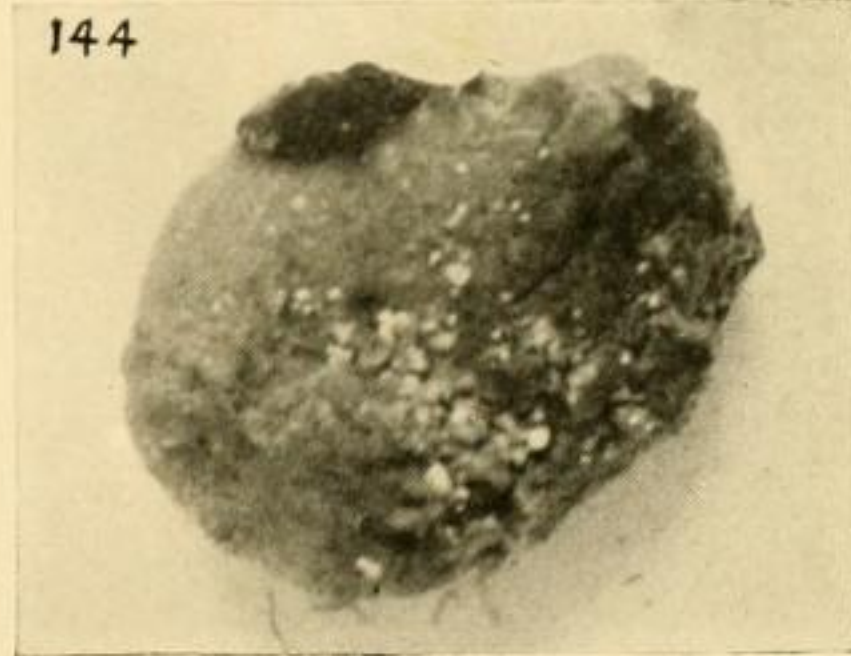
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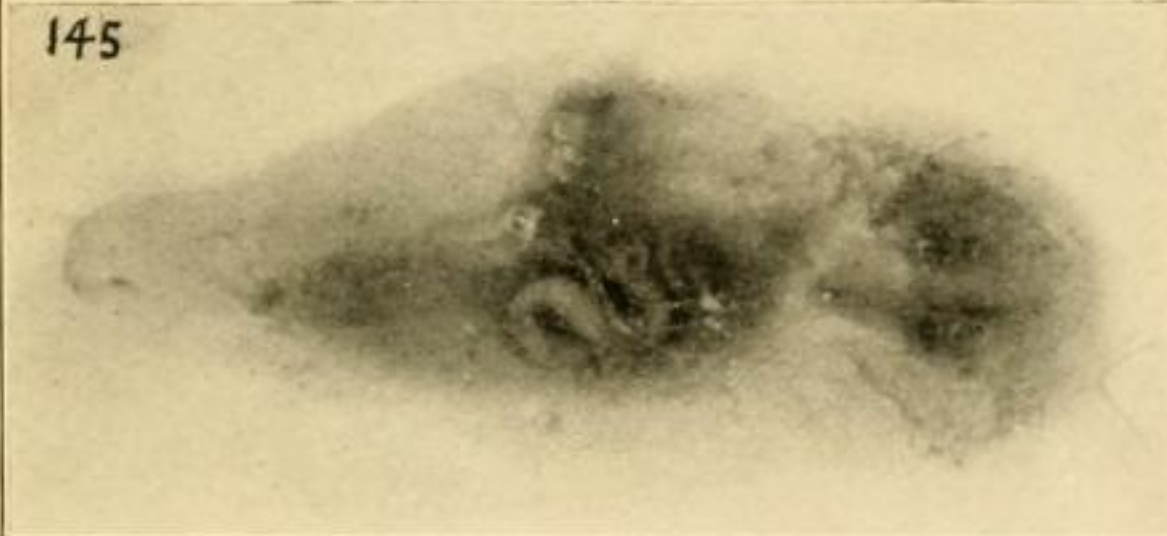


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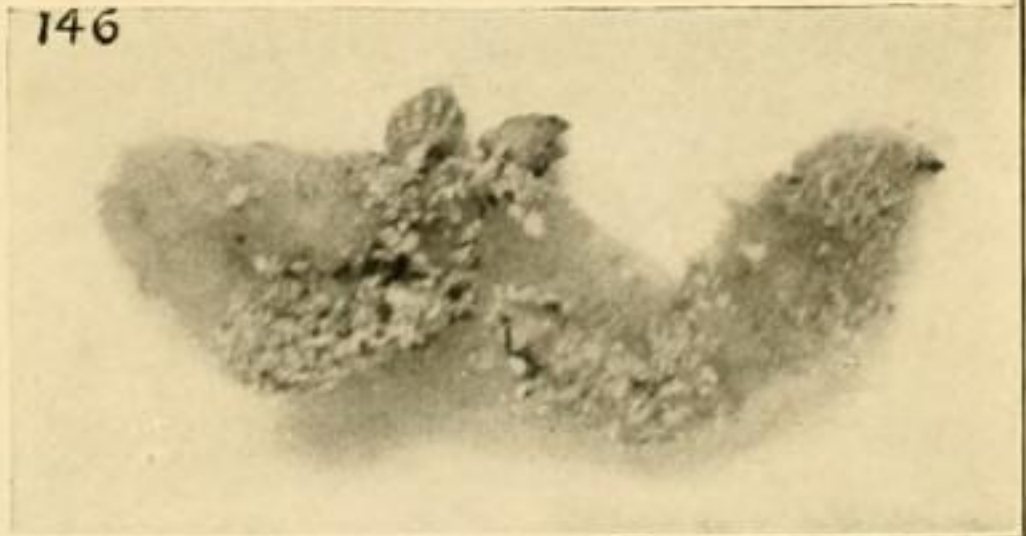


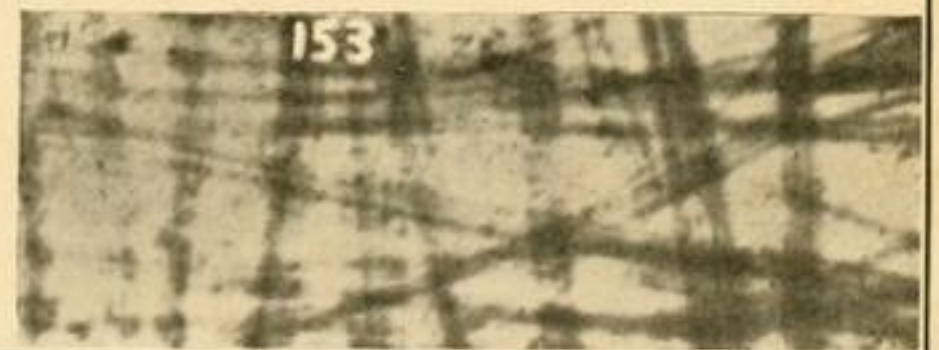
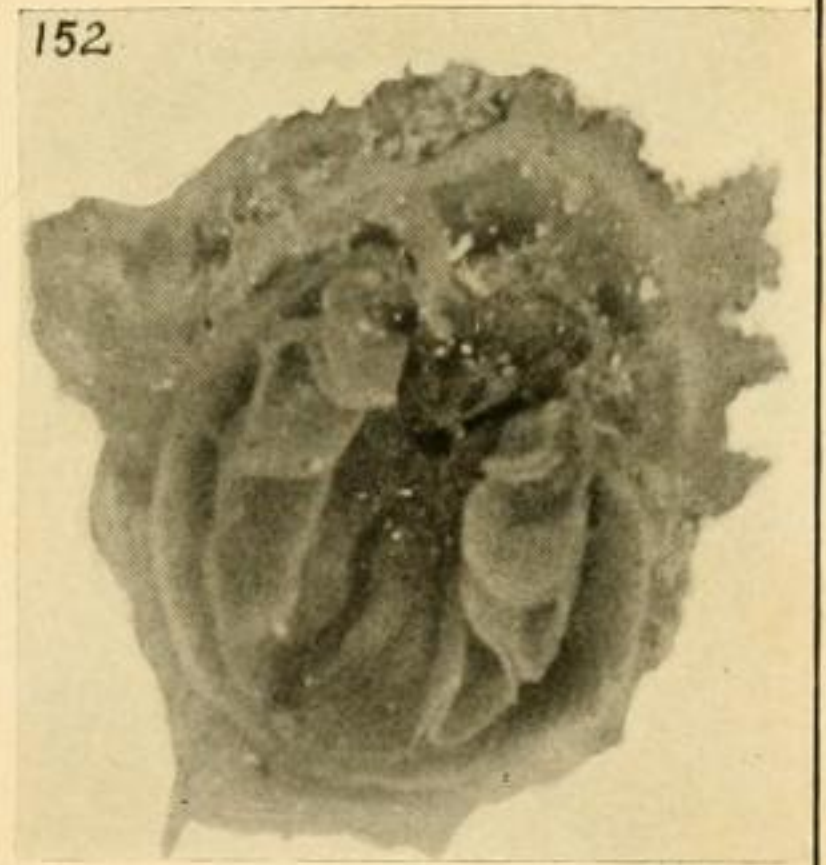
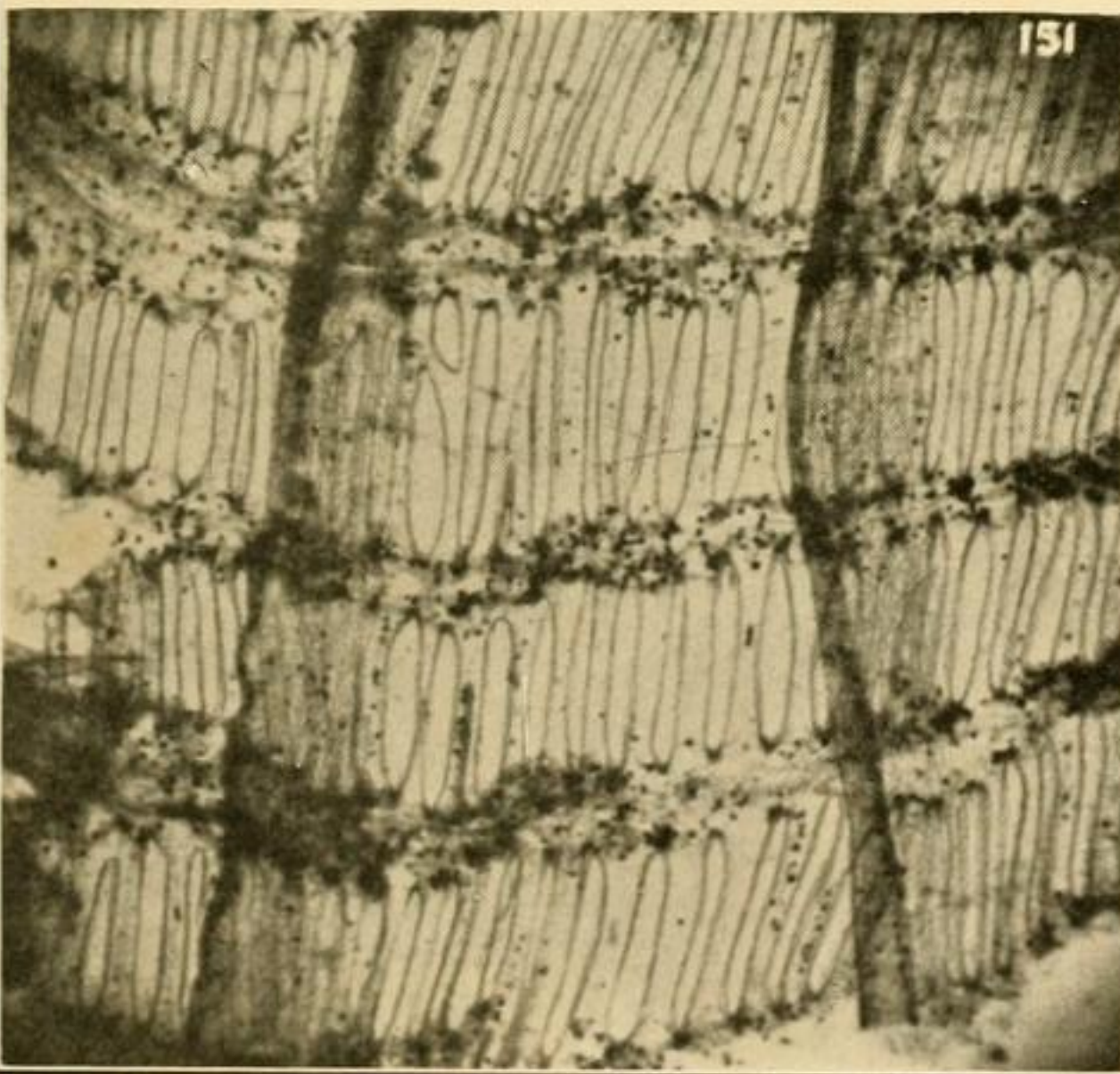
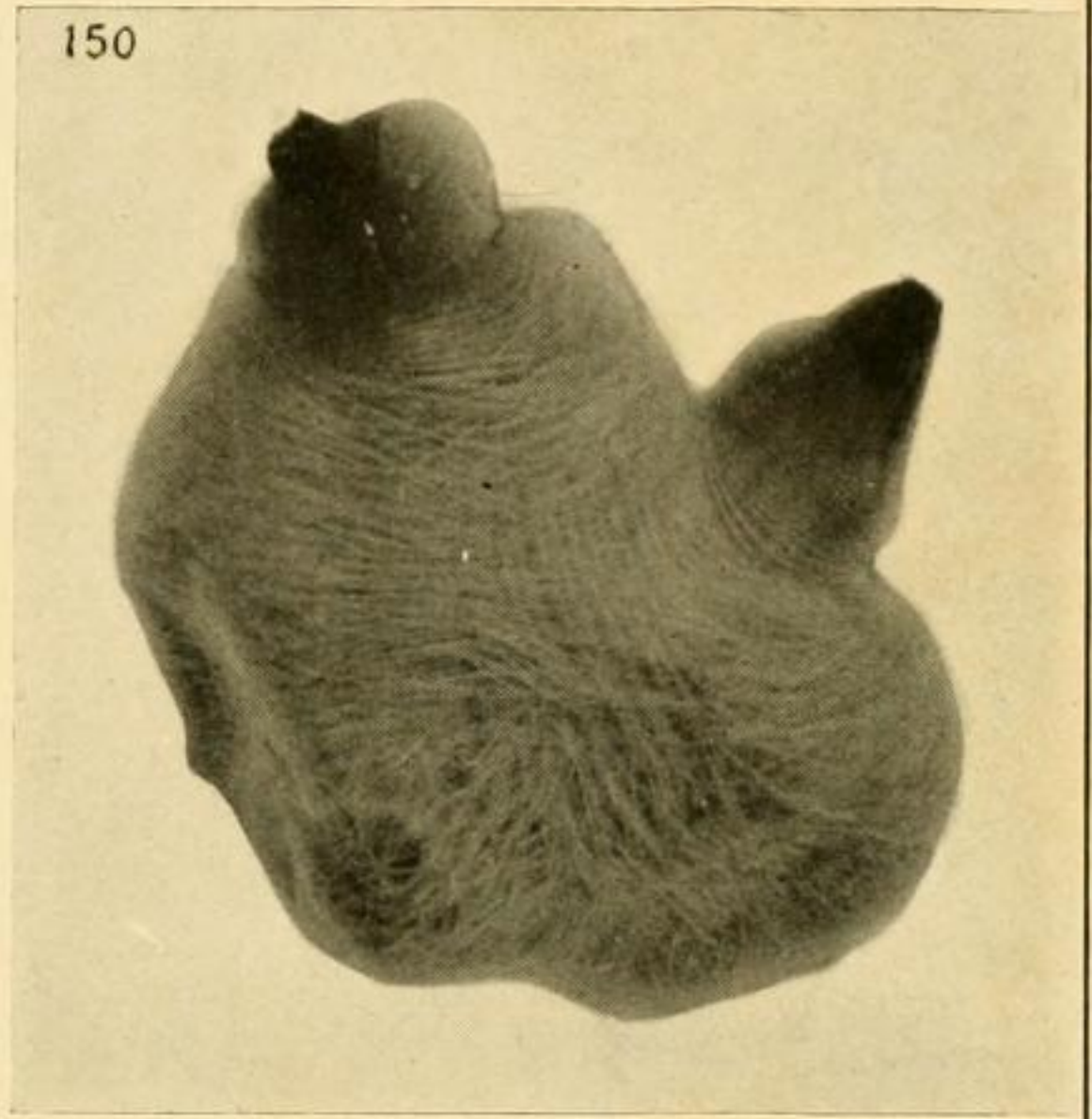
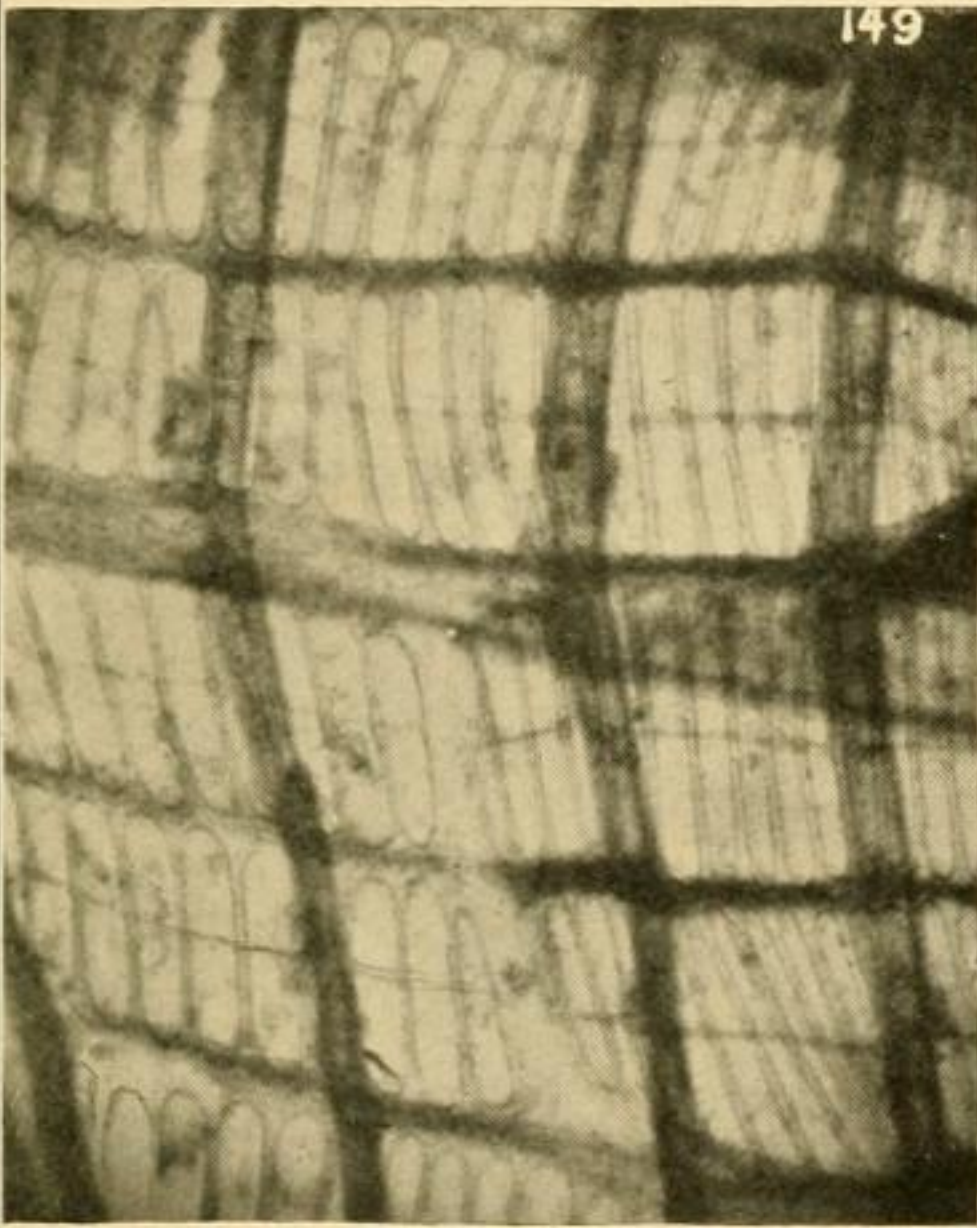
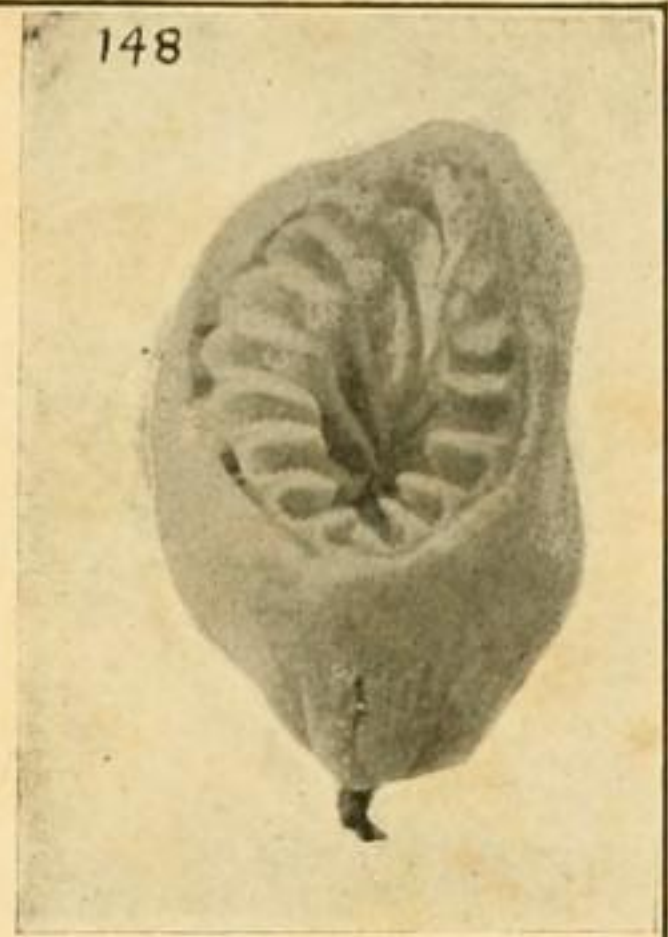
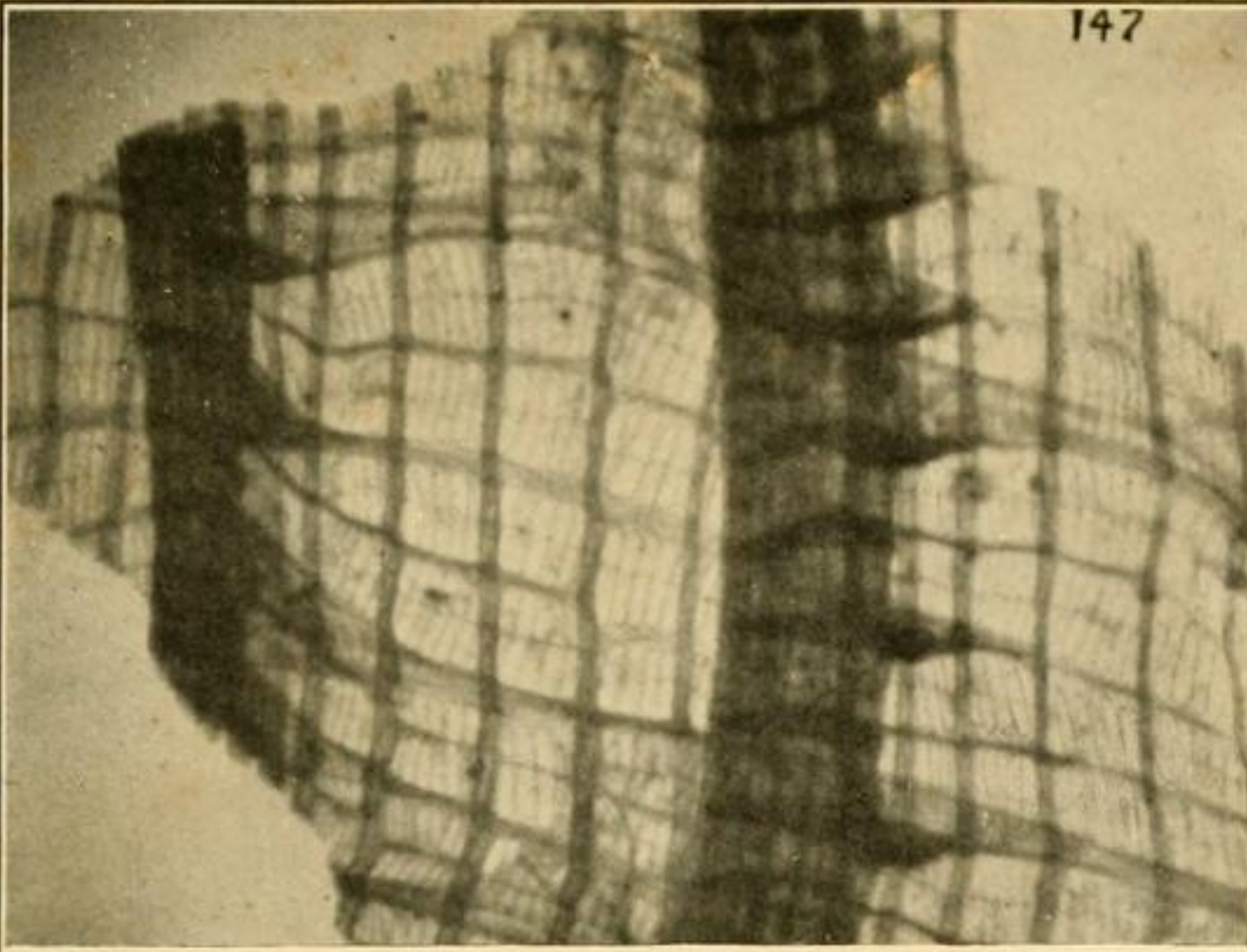
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A. Hyatt Verrill, Photo.